Hilti PROFIS Engineering 3.1.6

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Design:	45 kVA Transformers Anchorage	Date:	12/3/2024
Fastening point:			

3.1 Steel Strength

N_{sa} = ESR value — refer to ICC-ES ESR-4868
$\phi\ N_{sa} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.14	58,000

Calculations

N_{sa} [lb]
8,230

Results

N_{sa} [lb]	ϕ_{steel}	$\phi\ N_{sa}$ [lb]	N_{ua} [lb]
8,230	0.750	6,172	600

3.2 Bond Strength

$N_a = \left(\frac{A_{Na}}{A_{Na0}}\right) \psi_{ed,Na}\ \psi_{cp,Na}\ N_{ba}$ — ACI 318-19 Eq. (17.6.5.1a)

$\phi\ N_a \geq N_{ua}$ — ACI 318-19 Table 17.5.2

A_{Na} see ACI 318-19, Section 17.6.5.1, Fig. R 17.6.5.1(b)

$A_{Na0} = (2\ c_{Na})^2$ — ACI 318-19 Eq. (17.6.5.1.2a)

$c_{Na} = 10\ d_a \sqrt{\frac{\tau_{uncr}}{1100}}$ — ACI 318-19 Eq. (17.6.5.1.2b)

$\psi_{ed,Na} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{Na}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.5.4.1b)

$\psi_{cp,Na} = \mathrm{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{c_{Na}}{c_{ac}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.5.5.1b)

$N_{ba} = \lambda_a \cdot \tau_{k,c} \cdot \alpha_{N,seis} \cdot \pi \cdot d_a \cdot h_{ef}$ — ACI 318-19 Eq. (17.6.5.2.1)

Variables

$\tau_{k,c,uncr}$ [psi]	d_a [in.]	h_{ef} [in.]	$c_{a,min}$ [in.]	$\alpha_{overhead}$	$\tau_{k,c}$ [psi]
2,354	0.500	6.000	6.000	1.000	1,204

c_{ac} [in.]	λ_a	$\alpha_{N,seis}$
16.326	1.000	0.990

Calculations

c_{Na} [in.]	A_{Na} [in.^{2}]	A_{Na0} [in.^{2}]	$\psi_{ed,Na}$
7.282	176.41	212.11	0.947

$\psi_{cp,Na}$	N_{ba} [lb]
1.000	11,231

Results

N_a [lb]	ϕ_{bond}	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\ N_a$ [lb]	N_{ua} [lb]
8,848	0.650	0.750	1.000	4,313	600

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3.3 Concrete Breakout Failure

$N_{cb} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$ — ACI 318-19 Eq. (17.6.2.1a)

$\phi N_{cb} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9 h_{ef}^2$ — ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = MAX\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ — ACI 318-19 Eq. (17.6.2.2.1)

Variables

h_{ef} [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
6.000	6.000	1.000	16.326	17	1.000	4,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
225.00	324.00	0.900	1.000	16,760

Results

N_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕN_{cb} [lb]	N_{ua} [lb]
10,475	0.650	0.750	1.000	5,107	600

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4 Shear load

	Load V_{ua} [lb]	Capacity ϕ V_n [lb]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	300	1,541	20	OK
Steel failure (with lever arm)*	300	411	74	OK
Pryout Strength (Bond Strength controls)**	300	12,387	3	OK
Concrete edge failure in direction x+**	300	8,629	4	OK

* highest loaded anchor **anchor group (relevant anchors)
When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

4.1 Steel Strength

$V_{sa,eq}$ = ESR value refer to ICC-ES ESR-4868
ϕ $V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]	$\alpha_{V,seis}$
0.14	58,000	0.600

Calculations

$V_{sa,eq}$ [lb]
2,964

Results

$V_{sa,eq}$ [lb]	ϕ_{steel}	ϕ_{eb}	ϕ $V_{sa,eq}$ [lb]	V_{ua} [lb]
2,964	0.650	0.800	1,541	300

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4.2 Steel failure (with lever arm)

V_s^M	$= \frac{\alpha_M \cdot M_s}{L_b}$	bending equation for stand-off
M_s	$= M_s^0 \left(1 - \frac{N_{ua}}{\phi N_{sa}}\right)$	resultant flexural resistance of anchor
M_s^0	$= (1.2)\ (S)\ (f_{u,min})$	characteristic flexural resistance of anchor
$\left(1 - \frac{N_{ua}}{\phi N_{sa}}\right)$		reduction for tensile force acting simultaneously with a shear force on the anchor
S	$= \frac{\pi (d)^3}{32}$	elastic section modulus of anchor bolt at concrete surface
L_b	$= z + (n)(d_0)$	internal lever arm adjusted for spalling of the surface concrete
ϕV_s^M	$\geq V_{ua}$	ACI 318-19 Table 17.5.2

Variables

α_M	$f_{u,min}$ [psi]	N_{ua} [lb]	ϕN_{sa} [lb]	z [in.]	n	d_0 [in.]
2.00	58,000	600	6,172	1.250	0.500	0.500

Calculations

M_s^0 [in.lb]	$\left(1 - \frac{N_{ua}}{\phi N_{sa}}\right)$	M_s [in.lb]	L_b [in.]
525	0.903	474	1.500

Results

V_s^M [lb]	ϕ_{steel}	ϕV_s^M [lb]	V_{ua} [lb]
632	0.650	411	300

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4.3 Pryout Strength (Bond Strength controls)

$V_{cp} = k_{cp}\left[\left(\frac{A_{Na}}{A_{Na0}}\right) \psi_{ed,Na} \psi_{cp,Na} N_{ba}\right]$ ACI 318-19 Eq. (17.7.3.1a)

$\phi V_{cp} \geq V_{ua}$ ACI 318-19 Table 17.5.2

A_{Na} see ACI 318-19, Section 17.6.5.1, Fig. R 17.6.5.1(b)

$A_{Na0} = (2 c_{Na})^2$ ACI 318-19 Eq. (17.6.5.1.2a)

$c_{Na} = 10 d_a \sqrt{\frac{\tau_{uncr}}{1100}}$ ACI 318-19 Eq. (17.6.5.1.2b)

$\psi_{ed,Na} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{Na}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.5.4.1b)

$\psi_{cp,Na} = MAX\left(\frac{c_{a,min}}{c_{ac}}, \frac{c_{Na}}{c_{ac}}\right) \leq 1.0$ ACI 318-19 Eq. (17.6.5.5.1b)

$N_{ba} = \lambda_a \cdot \tau_{k,c} \cdot \alpha_{N,seis} \cdot \pi \cdot d_a \cdot h_{ef}$ ACI 318-19 Eq. (17.6.5.2.1)

Variables

k_{cp}	$\alpha_{overhead}$	$\tau_{k,c,uncr}$ [psi]	d_a [in.]	h_{ef} [in.]	$c_{a,min}$ [in.]	$\tau_{k,c}$ [psi]
2	1.000	2,354	0.500	6.000	6.000	1,204

c_{ac} [in.]	λ_a	$\alpha_{N,seis}$
16.326	1.000	0.990

Calculations

c_{Na} [in.]	A_{Na} [in.^{2}]	A_{Na0} [in.^{2}]	$\psi_{ed,Na}$
7.282	176.41	212.11	0.947

$\psi_{cp,Na}$	N_{ba} [lb]
1.000	11,231

Results

V_{cp} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cp} [lb]	V_{ua} [lb]
17,695	0.700	1.000	1.000	12,387	300

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4.4 Concrete edge failure in direction x+

$V_{cb} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ed,V} \psi_{c,V} \psi_{h,V} \psi_{parallel,V} V_b$ — ACI 318-19 Eq. (17.7.2.1a)

$\phi V_{cb} \geq V_{ua}$ — ACI 318-19 Table 17.5.2

A_{Vc} see ACI 318-19, Section 17.7.2.1, Fig. R 17.7.2.1(b)

$A_{Vc0} = 4.5 c_{a1}^2$ — ACI 318-19 Eq. (17.7.2.1.3)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.7.2.4.1b)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ — ACI 318-19 Eq. (17.7.2.6.1)

$V_b = \left(7\left(\frac{l_e}{d_a}\right)^{0.2}\sqrt{d_a}\right) \lambda_a \sqrt{f'_c}\, c_{a1}^{1.5}$ — ACI 318-19 Eq. (17.7.2.2.1a)

Variables

c_{a1} [in.]	c_{a2} [in.]	$\psi_{c,V}$	h_a [in.]	l_e [in.]
6.000	6.000	1.000	9.000	4.000

λ_a	d_a [in.]	f'_c [psi]	$\psi_{parallel,V}$
1.000	0.500	4,500	2.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
135.00	162.00	1.000	1.000	7,397

Results

V_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cb} [lb]	V_{ua} [lb]
12,328	0.700	1.000	1.000	8,629	300

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

5 Combined tension and shear loads, per ACI 318-19 section 17.8

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.139	0.731	5/3	64	OK

$\beta_{NV} = \beta_N^{\zeta} + \beta_V^{\zeta} <= 1$

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6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- ACI 318 does not specifically address anchor bending when a stand-off condition exists. PROFIS Engineering calculates a shear load corresponding to anchor bending when stand-off exists and includes the results as a shear Design Strength!
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to https://submittals.us.hilti.com/PROFISAnchorDesignGuide/
- "An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-19, Chapter 17, Section 17.10.5.3 (a) that requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, the connection design (tension) shall satisfy the provisions of Section 17.10.5.3 (b), Section 17.10.5.3 (c), or Section 17.10.5.3 (d). The connection design (shear) shall satisfy the provisions of Section 17.10.6.3 (a), Section 17.10.6.3 (b), or Section 17.10.6.3 (c)."
- Section 17.10.5.3 (b) / Section 17.10.6.3 (a) require the attachment the anchors are connecting to the structure be designed to undergo ductile yielding at a load level corresponding to anchor forces no greater than the controlling design strength. Section 17.10.5.3 (c) / Section 17.10.6.3 (b) waive the ductility requirements and require the anchors to be designed for the maximum tension / shear that can be transmitted to the anchors by a non-yielding attachment. Section 17.10.5.3 (d) / Section 17.10.6.3 (c) waive the ductility requirements and require the design strength of the anchors to equal or exceed the maximum tension / shear obtained from design load combinations that include E, with E increased by ω_0.
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!

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7 Installation data

Profile: no profile

Hole diameter in the fixture: d_f = 0.562 in.

Plate thickness (input): 0.500 in.

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and diameter: HIT-HY 200 V3 + HAS-V-36 (ASTM F1554 Gr.36) 1/2

Item number: not available (element) / 2334276 HIT-HY 200-R V3 (adhesive)

Maximum installation torque: 360 in.lb

Hole diameter in the base material: 0.562 in.

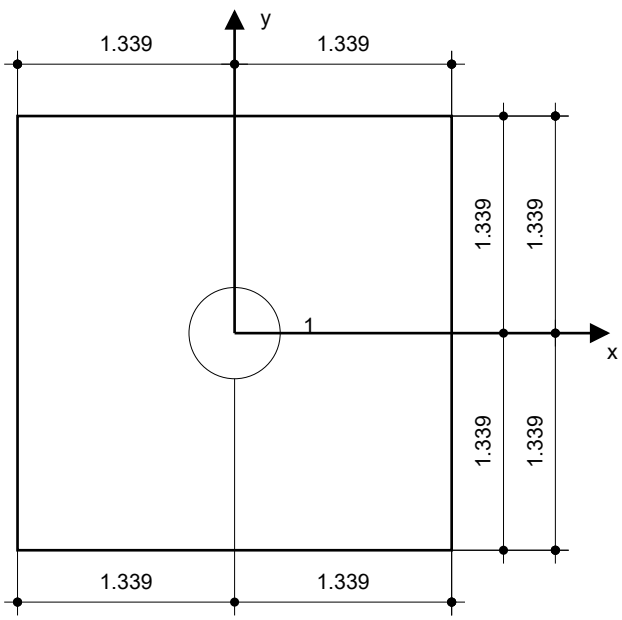
Hole depth in the base material: 6.000 in.

Minimum thickness of the base material: 7.250 in.

Hilti HAS threaded rod with HIT-HY 200 V3 ASTM F1554 Grade 36 injection mortar with 6 in embedment hef, 1/2, Carbon steel, Safe Set System, Hammer drilled installation per ESR-4868

7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Compressed air with required accessories to blow from the bottom of the hole • Proper diameter wire brush	• Dispenser including cassette and mixer • Torque wrench



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	0.000	0.000	-	6.000	6.000	-

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8 Remarks; Your Cooperation Duties

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TETRA TECH

SHEET NO.		**DATE**	3-Dec-24
CHECKED BY		**OFFICE**	Irvine
TELEPHONE	(949) 809 - 5000		
ENGINEER Tony Arzate	**JOB NUMBER**	200-42064-22005	

SUBJECT Ben Lomond Transfer Station
Oil & Anti Freeze Tank

Seismic Base Shear (Oil & Anti Freeze Tank)

Per ASCE 7-16, Chapter 13

Design Spectral Response Acceleration

Risk Category	II		
Soil Site Class	E		*(Table 20.3-1)*
S_s =	1.97	g	
S_1 =	0.783	g	
F_a =	0.900	g	(Table 11.4-1)
F_v =	0.800	g	*(Table 11.4-2)*
$S_{DS} = 2/3S_sF_a$ =	1.182	g	*(Eq. 11.4-3)*
$S_{D1} = 2/3S_1F_v$ =	0.418	g	*(Eq. 11.4-4)*

Design Coefficients

Response Modification Factor, R_p	1.5		*(Table 13.6-1)*
Amplification Factor, a_P	1.0		*(Table 13.6-1)*
Overstrength Factor, Ω_0	2.0		*(Table 13.6-1)*

Seismic Design Category (SDC)

SDC =	E		*(Table 11.6-1,2)*

Seismic Response Coefficient (F_P)

Importance Factor (I_E)	1.00		(Table 1.5-2)
$F_P = 0.4a_pS_{DS}/(R_p/I_E)(1+2z/h)$=	0.946	g	*(Eq. 13.3-1)*
Not Greater Than: $F_P = 1.6S_{DS}I_E$ =	1.891	g	*(Eq. 13.3-2)*
Not Less Than: $F_P = 0.3\ S_{DS}\ I_E$ =	0.355	g	*(Eq. 13.3-3)*

Seismic Forces

$V = F_P\ W$ =	0.946	W	*(Sec 13.3.1)*

TETRA TECH

Sheet No.:		**of**	**Date:** 3-Dec-24
Checked By:			**Office:** Irvine
Telephone:	(949) 809 - 5000		
Engineer:	Tony Arzate	**Job No.:**	200-42064-22005
Subject:	Ben Lomond Transfer Station		
	Oil Tank		

Global Stability of Oil Tank due to Seismic Loads

Properties

W, Weight	=	5.43	kip
V, Seismic Force	=	5.14	kip
Height	=	4.92	ft
Min. Width	=	3.83	ft
C.O.G.	=	3.28	ft (Assumed 2/3 height)
Equipment Area	=	22.36	ft^2
Load	=	0.24	ksf

Overturning Moment

(1.0EL) Mot = 5.14 kips x 1 x 3.28 ft = 16.8 kip - ft

Resisting Moment

(0.9-0.2Sds) Mr = (0.9 - 0.2 x 1.182) x 5 kips x 1.92 ft = 6.9 kip - ft

Net Moment

$M_{OT\ NET}$ = 16.8 kip-ft - 6.9 kip-ft = 9.9 kip-ft

Factor of Safety for Overturning

F.S. = 0.41 < 1.5 **NG!**

**** Equipment not stable enough to self-support; Mechanical anchorage required.***

Anchorage Loads & Requirements

No. of Bolts	=	4							
Ω_0	=	2							
$\Omega_0 * M_{OT\ NET}$	=	19.85	kip-ft						
T/C	=	19.85	kip-ft	/	3.83 ft	/	2.00 anchors	=	2.6 kip uplift/per anchor
$\Omega_0 * V$	=	10.3	kip						
V	=	10.3	kip	/	4 anchors	=	2.6 kip shear/per anchor		

T/C	=	2.590	kip uplift/per anchor
V	=	2.568	kip shear/per anchor

TETRA TECH

Sheet No.:		**of**	**Date:** 3-Dec-24
Checked By:			**Office:** Irvine
Telephone:	(949) 809 - 5000		
Engineer:	Tony Arzate	**Job No.:**	200-42064-22005
Subject:	Ben Lomond Transfer Station		
	Anti Freeze Tank		

Global Stability of Anti Freeze Tank due to Seismic Loads

Properties

W, Weight	=	1.13	kip
V, Seismic Force	=	1.07	kip
Height	=	4.00	ft
Min. Width	=	2.50	ft
C.O.G.	=	2.67	ft (Assumed 2/3 height)
Equipment Area	=	6.25	ft^2
Load	=	0.18	ksf

Overturning Moment

(1.0EL) Mot = 1.07 kips x 1 x 2.67 ft = 2.8 kip - ft

Resisting Moment

(0.9-0.2Sds) Mr = (0.9 - 0.2 x 1.182) x 1 kips x 1.25 ft = 0.9 kip - ft

Net Moment

$M_{OT\ NET}$ = 2.8 kip-ft - 0.9 kip-ft = 1.9 kip-ft

Factor of Safety for Overturning

F.S. = 0.33 < 1.5 **NG!**

**** Equipment not stable enough to self-support; Mechanical anchorage required.***

Anchorage Loads & Requirements

No. of Bolts	=	4							
Ω_0	=	2							
$\Omega_0 * M_{OT\ NET}$	=	3.82	kip-ft						
T/C	=	3.82	kip-ft	/	2.50 ft	/	2.00 anchors	=	0.8 kip uplift/per anchor
$\Omega_0 * V$	=	2.1	kip						
V	=	2.1	kip	/	4 anchors	=	0.5 kip shear/per anchor		

T/C	=	0.8	kip uplift/per anchor
V	=	0.533	kip shear/per anchor

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Design:	Oil Tank & AntiFreeze Tank Anchorage	Date:	12/3/2024
Fastening point:			

Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-HY 200 V3 + HAS-E-55 (ASTM F1554 Gr.55) 3/4**
Item number:	2198016 HAS-E-55 3/4"x6" (element) / 2334276 HIT-HY 200-R V3 (adhesive)
Specification text:	Hilti HAS threaded rod with HIT-HY 200 V3 ASTM F1554 Grade 55 injection mortar with 4 in embedment hef, 3/4, Carbon steel, Safe Set System, Hammer drilled installation per ESR-4868
Effective embedment depth:	$h_{ef,act}$ = 4.000 in. ($h_{ef,limit}$ = - in.)
Material:	ASTM F1554 Grade 55
Evaluation Service Report:	ESR-4868
Issued I Valid:	6/1/2023 | 11/1/2024
Proof:	Design Method ACI 318-19 / Chem
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate[R] :	l_x x l_y x t = 2.677 in. x 2.677 in. x 0.500 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, Custom, f_c' = 4,000 psi; h = 6.000 in., Temp. short/long: 32/32 °F
Installation:	**Hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.10.5.3 (d)) Shear load: yes (17.10.6.3 (c))

[R] - The anchor calculation is based on a rigid anchor plate assumption.

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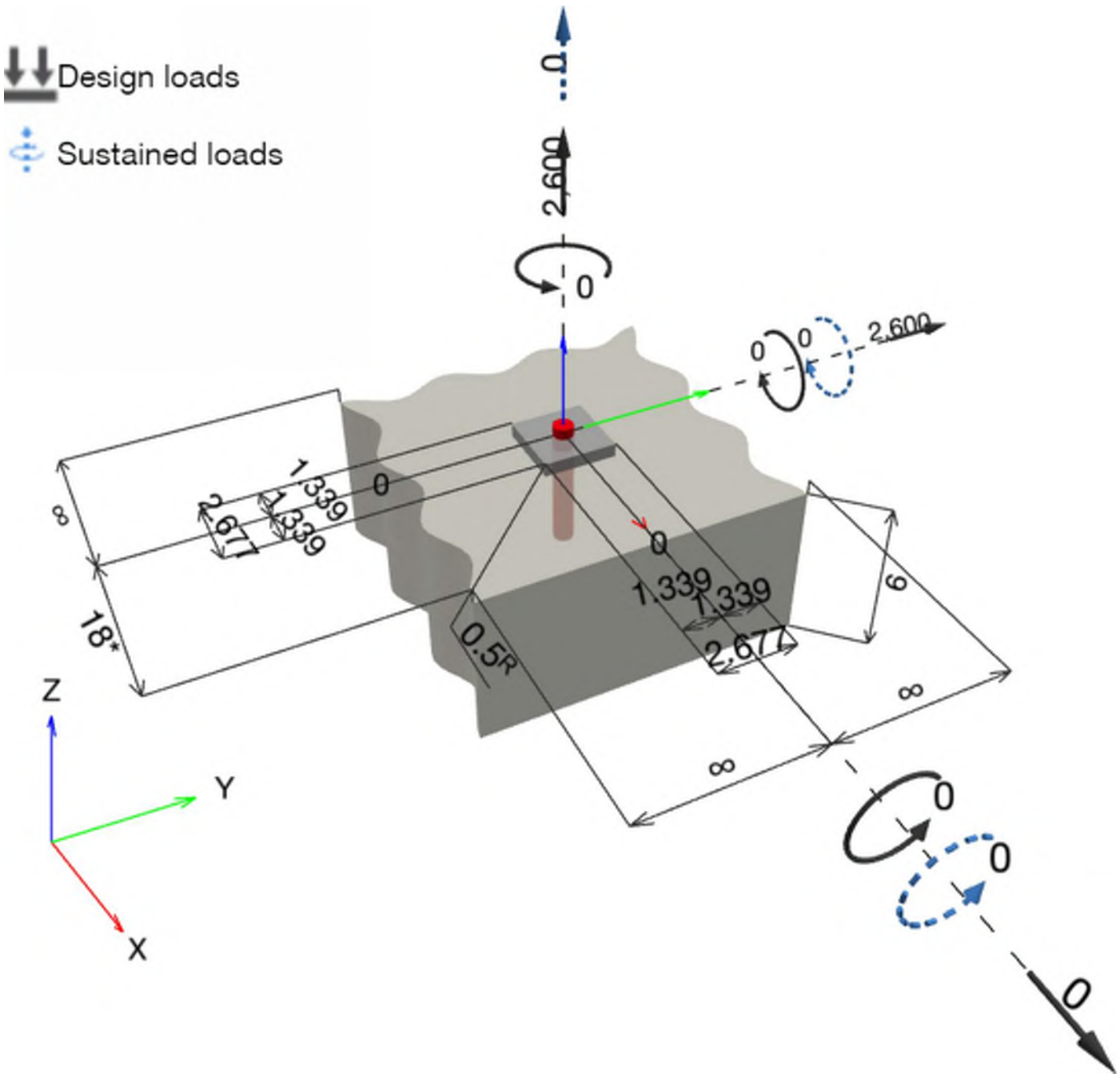
Geometry [in.] & Loading [lb, in.lb]



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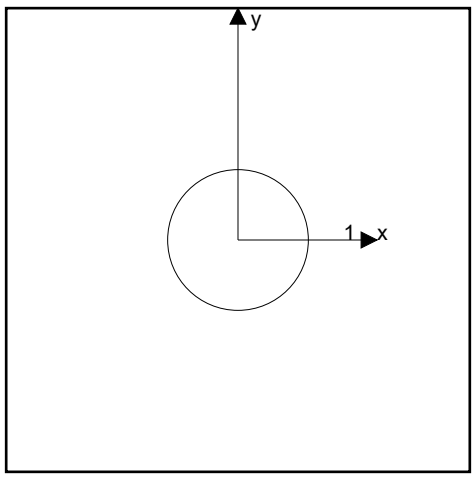
1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 2,600; V_x = 0; V_y = 2,600; M_x = 0; M_y = 0; M_z = 0;	yes	63

2 Load case/Resulting anchor forces



Anchor reactions [lb]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	2,600	2,600	0	2,600

Max. concrete compressive strain: - [‰]
Max. concrete compressive stress: - [psi]
Resulting tension force in (x/y)=(0.000/0.000): 2,600 [lb]
Resulting compression force in (x/y)=(-/-): 0 [lb]

Anchor forces are calculated based on the assumption of a rigid anchor plate.

3 Tension load

	Load N_{ua} [lb]	Capacity ϕ N_n [lb]	Utilization $\beta_N = N_{ua}/\phi$ N_n	Status
Steel Strength*	2,600	18,817	14	OK
Bond Strength**	2,600	6,068	43	OK
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	2,600	4,193	63	OK

* highest loaded anchor **anchor group (anchors in tension)

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3.1 Steel Strength

N_{sa} = ESR value — refer to ICC-ES ESR-4868
$\phi\ N_{sa} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.33	75,000

Calculations

N_{sa} [lb]
25,090

Results

N_{sa} [lb]	ϕ_{steel}	$\phi\ N_{sa}$ [lb]	N_{ua} [lb]
25,090	0.750	18,817	2,600

3.2 Bond Strength

$N_a = \left(\frac{A_{Na}}{A_{Na0}}\right) \psi_{ed,Na}\ \psi_{cp,Na}\ N_{ba}$ — ACI 318-19 Eq. (17.6.5.1a)

$\phi\ N_a \geq N_{ua}$ — ACI 318-19 Table 17.5.2

A_{Na} see ACI 318-19, Section 17.6.5.1, Fig. R 17.6.5.1(b)

$A_{Na0} = (2\ c_{Na})^2$ — ACI 318-19 Eq. (17.6.5.1.2a)

$c_{Na} = 10\ d_a \sqrt{\frac{\tau_{uncr}}{1100}}$ — ACI 318-19 Eq. (17.6.5.1.2b)

$\psi_{ed,Na} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{Na}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.5.4.1b)

$\psi_{cp,Na} = \mathrm{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{c_{Na}}{c_{ac}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.5.5.1b)

$N_{ba} = \lambda_a \cdot \tau_{k,c} \cdot \alpha_{N,seis} \cdot \pi \cdot d_a \cdot h_{ef}$ — ACI 318-19 Eq. (17.6.5.2.1)

Variables

$\tau_{k,c,uncr}$ [psi]	d_a [in.]	h_{ef} [in.]	$c_{a,min}$ [in.]	$\alpha_{overhead}$	$\tau_{k,c}$ [psi]
2,327	0.750	4.000	18.000	1.000	1,321

c_{ac} [in.]	λ_a	$\alpha_{N,seis}$
8.552	1.000	1.000

Calculations

c_{Na} [in.]	A_{Na} [in.^{2}]	A_{Na0} [in.^{2}]	$\psi_{ed,Na}$
10.859	471.66	471.66	1.000

$\psi_{cp,Na}$	N_{ba} [lb]
1.000	12,447

Results

N_a [lb]	ϕ_{bond}	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\ N_a$ [lb]	N_{ua} [lb]
12,447	0.650	0.750	1.000	6,068	2,600

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3.3 Concrete Breakout Failure

$N_{cb} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$ — ACI 318-19 Eq. (17.6.2.1a)

$\phi N_{cb} \geq N_{ua}$ — ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9 h_{ef}^2$ — ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = MAX\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ — ACI 318-19 Eq. (17.6.2.2.1)

Variables

h_{ef} [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
4.000	18.000	1.000	8.552	17	1.000	4,000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
144.00	144.00	1.000	1.000	8,601

Results

N_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕN_{cb} [lb]	N_{ua} [lb]
8,601	0.650	0.750	1.000	4,193	2,600

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4 Shear load

	Load V_{ua} [lb]	Capacity ϕ V_n [lb]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	2,600	9,786	27	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Concrete Breakout Strength controls)**	2,600	12,042	22	OK
Concrete edge failure in direction x+**	2,600	27,008	10	OK

* highest loaded anchor **anchor group (relevant anchors)
When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

4.1 Steel Strength

$V_{sa,eq}$ = ESR value refer to ICC-ES ESR-4868
ϕ $V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]	$\alpha_{V,seis}$
0.33	75,000	1.000

Calculations

$V_{sa,eq}$ [lb]
15,055

Results

$V_{sa,eq}$ [lb]	ϕ steel	ϕ $V_{sa,eq}$ [lb]	V_{ua} [lb]
15,055	0.650	9,786	2,600

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4.2 Pryout Strength (Concrete Breakout Strength controls)

$V_{cp} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \right]$ ACI 318-19 Eq. (17.7.3.1a)

$\phi V_{cp} \geq V_{ua}$ ACI 318-19 Table 17.5.2

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$A_{Nc0} = 9 h_{ef}^2$ ACI 318-19 Eq. (17.6.2.1.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.4.1b)

$\psi_{cp,N} = MAX \left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0$ ACI 318-19 Eq. (17.6.2.6.1b)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ ACI 318-19 Eq. (17.6.2.2.1)

Variables

k_{cp}	h_{ef} [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
2	4.000	18.000	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
8.552	17	1.000	4,000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
144.00	144.00	1.000	1.000	8,601

Results

V_{cp} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cp} [lb]	V_{ua} [lb]
17,203	0.700	1.000	1.000	12,042	2,600

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4.3 Concrete edge failure in direction x+

$V_{cb} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ed,V} \psi_{c,V} \psi_{h,V} \psi_{parallel,V} V_b$ — ACI 318-19 Eq. (17.7.2.1a)

$\phi V_{cb} \geq V_{ua}$ — ACI 318-19 Table 17.5.2

A_{Vc} see ACI 318-19, Section 17.7.2.1, Fig. R 17.7.2.1(b)

$A_{Vc0} = 4.5 c_{a1}^2$ — ACI 318-19 Eq. (17.7.2.1.3)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ — ACI 318-19 Eq. (17.7.2.4.1b)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ — ACI 318-19 Eq. (17.7.2.6.1)

$V_b = \left(7\left(\frac{l_e}{d_a}\right)^{0.2}\sqrt{d_a}\right) \lambda_a \sqrt{f'_c}\, c_{a1}^{1.5}$ — ACI 318-19 Eq. (17.7.2.2.1a)

Variables

c_{a1} [in.]	c_{a2} [in.]	$\psi_{c,V}$	h_a [in.]	l_e [in.]
18.000	-	1.000	6.000	4.000

λ_a	d_a [in.]	f'_c [psi]	$\psi_{parallel,V}$
1.000	0.750	4,000	2.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
324.00	1,458.00	1.000	2.121	40,923

Results

V_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cb} [lb]	V_{ua} [lb]
38,583	0.700	1.000	1.000	27,008	2,600

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

5 Combined tension and shear loads, per ACI 318-19 section 17.8

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.620	0.266	5/3	57	OK

$\beta_{NV} = \beta_N^{\zeta} + \beta_V^{\zeta} <= 1$

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6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to https://submittals.us.hilti.com/PROFISAnchorDesignGuide/
- "An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-19, Chapter 17, Section 17.10.5.3 (a) that requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, the connection design (tension) shall satisfy the provisions of Section 17.10.5.3 (b), Section 17.10.5.3 (c), or Section 17.10.5.3 (d). The connection design (shear) shall satisfy the provisions of Section 17.10.6.3 (a), Section 17.10.6.3 (b), or Section 17.10.6.3 (c)."
- Section 17.10.5.3 (b) / Section 17.10.6.3 (a) require the attachment the anchors are connecting to the structure be designed to undergo ductile yielding at a load level corresponding to anchor forces no greater than the controlling design strength. Section 17.10.5.3 (c) / Section 17.10.6.3 (b) waive the ductility requirements and require the anchors to be designed for the maximum tension / shear that can be transmitted to the anchors by a non-yielding attachment. Section 17.10.5.3 (d) / Section 17.10.6.3 (c) waive the ductility requirements and require the design strength of the anchors to equal or exceed the maximum tension / shear obtained from design load combinations that include E, with E increased by ω_0.
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!

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7 Installation data

Profile: no profile

Hole diameter in the fixture: d_f = 0.812 in.

Plate thickness (input): 0.500 in.

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and diameter: HIT-HY 200 V3 + HAS-E-55 (ASTM F1554 Gr.55) 3/4

Item number: 2198016 HAS-E-55 3/4"x6" (element) / 2334276 HIT-HY 200-R V3 (adhesive)

Maximum installation torque: 1,200 in.lb

Hole diameter in the base material: 0.875 in.

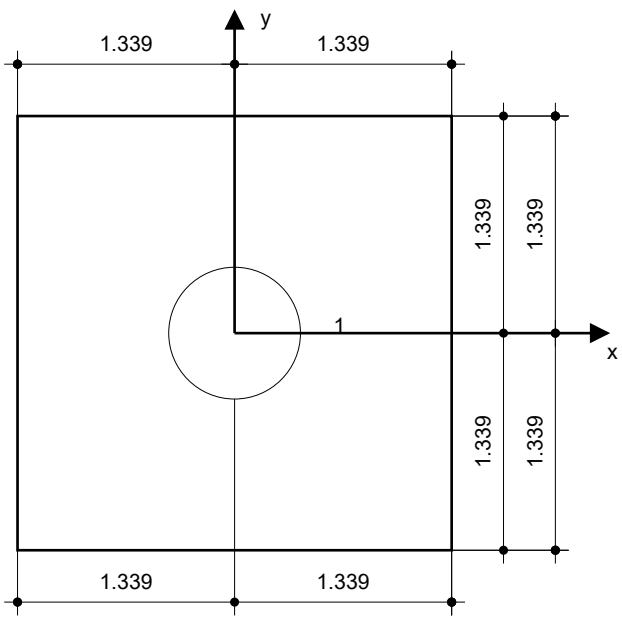
Hole depth in the base material: 4.000 in.

Minimum thickness of the base material: 5.750 in.

Hilti HAS threaded rod with HIT-HY 200 V3 ASTM F1554 Grade 55 injection mortar with 4 in embedment hef, 3/4, Carbon steel, Safe Set System, Hammer drilled installation per ESR-4868

7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Compressed air with required accessories to blow from the bottom of the hole • Proper diameter wire brush	• Dispenser including cassette and mixer • Torque wrench



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	0.000	0.000	-	18.000	-	-

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8 Remarks; Your Cooperation Duties

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Engineer: Tony Arzate
Subject: Ben Lomond Design Check

Oil & Anti Freeze Tank Equipment

$\phi N_n := 0.8 \cdot 18.817\ kip = 15.054\ kip$ From Hilti Profis

$N_{ua} := 2.59\ kip$ From Hilti Profis

$$\frac{N_{ua}}{\phi N_n} = 0.172$$

$\phi V_n := 0.8 \cdot 9.786\ kip = 7.829\ kip$ From Hilti Profis

$V_{ua} := 2.568\ kip$ From Hilti Profis

$$\frac{V_{ua}}{\phi V_n} = 0.328$$

$\beta_v := \max\left(\frac{V_{ua}}{\phi V_n}, .27\right) = 0.328$ From Hilti Profis

$\beta_n := \max\left(\frac{N_{ua}}{\phi N_n}, .63\right) = 0.63$ From Hilti Profis

$\beta_v + \beta_n = 0.958 <$ 1.2 per ACI 318 17.8.3

Division	Section Title

SPECIFICATIONS GROUP

General Requirements Subgroup

DIVISION 01 - GENERAL REQUIREMENTS

015723 TEMPORARY STORM WATER POLLUTION CONTROL

Facility Construction Subgroup

DIVISION 02 - EXISTING CONDITIONS

024119 SELECTIVE DEMOLITION

DIVISION 03 - CONCRETE

030130 MAINTENANCE OF CAST-IN-PLACE CONCRETE
031000 CONCRETE FORMING AND ACCESSORIES
032000 CONCRETE REINFORCING
033000 CAST-IN-PLACE CONCRETE

DIVISION 04 - MASONRY

042000 UNIT MASONRY

DIVISION 05 - METALS

051200 STRUCTURAL STEEL FRAMING
053100 STEEL DECKING
054000 COLD-FORMED METAL FRAMING
055000 METAL FABRICATIONS

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

064116 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

071113 BITUMINOUS DAMPPROOFING
071900 WATER REPELLENTS
072100 THERMAL INSULATION
072600 VAPOR RETARDERS
07411316 STANDING-SEAM METAL ROOF PANELS
07421313 FORMED METAL WALL PANELS
075419 POLYVINYL-CHLORIDE (PVC) ROOFING
076200 SHEET METAL FLASHING AND TRIM
077200 ROOF ACCESSORIES
079200 JOINT SEALANTS

DIVISION 08 - OPENINGS

081113	HOLLOW METAL DOORS AND FRAMES
083113	ACCESS DOORS AND FRAMES
084113	ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS
085113	ALUMINUM WINDOWS
087100	DOOR HARDWARE
088000	GLAZING

DIVISION 09 - FINISHES

092216	NON-STRUCTURAL METAL FRAMING
092900	GYPSUM BOARD
093013	CERAMIC TILING
095113	ACOUSTICAL PANEL CEILINGS
096513	RESILIENT BASE AND ACCESSORIES
096519	RESILIENT TILE FLOORING
099123	INTERIOR PAINTING
099600	HIGH-PERFORMANCE COATINGS

DIVISION 10 - SPECIALTIES

101423	PANEL SIGNAGE
102800	TOILET, BATH, AND LAUNDRY ACCESSORIES
104413	FIRE PROTECTION CABINETS
105113	METAL LOCKERS
107300	NON-LOAD BEARING SHADE CANOPIES

DIVISION 11 – EQUIPMENT

113013	RESIDENTIAL APPLIANCES

DIVISION 12 - FURNISHINGS

122113	HORIZONTAL LOUVER BLINDS
12366116	SOLID SURFACING COUNTERTOPS

DIVISION 13 - SPECIAL CONSTRUCTION

133410	NONSTRUCTURAL COMPONENTS AND CLADDING REQUIREMENTS
133419	METAL BUILDING SYSTEMS

Facility Services Subgroup

DIVISION 22 - PLUMBING

220523	GENERAL-DUTY VALVES FOR PLUMBING PIPING
220529	HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

220553	IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT
220700	PLUMBING INSULATION
221100	FACILITY WATER DISTRIBUTION
221300	FACILITY SANITARY SEWERAGE
221400	FACILITY STORM DRAINAGE
221414	STORM DRAINAGE PIPING
221423	STORM DRAINAGE PIPING SPECIALTIES
223300	ELECTRIC DOMESTIC WATER HEATERS
224000	PLUMBING FIXTURES

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

230513	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
230529	HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
230548	VIBRATION AND SEISMIC CONTROLS FOR HVAC
230553	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
230593	TESTING, ADJUSTING, AND BALANCING FOR HVAC
230700	HVAC INSULATION
232300	REFRIGERANT PIPING
233100	HVAC DUCTS AND CASINGS
233400	HVAC FANS
233700	AIR OUTLETS AND INLETS
238126	SPLIT-SYSTEM AIR-CONDITIONERS

DIVISION 26 - ELECTRICAL

260010	SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL
260519	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
260523	CONTROL-VOLTAGE ELECTRICAL POWER CABLES
260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
260533	RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS
26053313	CONDUITS FOR ELECTRICAL SYSTEMS
260543	UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS
260544	SLEEVES & SLEEVE SEALS FOR ELECTRICAL RACEWAYS & CABLING
260548	VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS
260573	POWER SYSTEM STUDIES
260923	LIGHTING CONTROL DEVICES
262213	LOW-VOLTAGE DISTRIBUTION TRANSFORMERS
262413	SWITCHBOARDS
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SECTION 015723 - TEMPORARY STORM WATER POLLUTION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Temporary stormwater pollution controls.

1.3 STORMWATER POLLUTION PREVENTION PLAN

A. The Stormwater Pollution Prevention Plan (SWPPP) is part of the Contract Documents and is bound into this Project Manual.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site.

1. Meet with Owner, Engineer, Construction manager, and earthwork subcontractor.
2. Review requirements of the SWPPP, including permitting process, worker training, and inspection and maintenance requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Stormwater Pollution Prevention Plan (SWPP): Within 15 days of date established for commencement of the Work, submit completed SWPPP.

B. EPA authorization under the EPA's "2017 Construction General Permit (CGP)."

C. Stormwater Pollution Prevention (SWPP) Training Log: For each individual performing Work under the SWPPP.

D. Inspection reports.

1.6 QUALITY ASSURANCE

A. Stormwater Pollution Prevention Plan (SWPPP) Coordinator: Experienced individual or firm with a record of successful water pollution control management coordination of projects with similar requirements.

1. SWPPP Coordinator shall complete and finalize the SWPPP form.
2. SWPPP Coordinator shall be responsible for inspections and maintaining of all requirements of the SWPPP.

B. Installers: Trained as indicated in the SWPPP.

PART 2 - PRODUCTS

2.1 TEMPORARY STORMWATER POLLUTION CONTROLS

A. Provide temporary stormwater pollution controls as required by the SWPPP.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with all best management practices, general requirements, performance requirements, reporting requirements, and all other requirements included in the SWPPP.

B. Locate stormwater pollution controls in accordance with the SWPPP.

C. Conduct construction as required to comply with the SWPPP and that minimize possible contamination or pollution or other undesirable effects.

1. Inspect, repair, and maintain SWPPP controls during construction.

a. Inspect all SWPPP controls not less than every seven days, and after each occurrence of a storm event, as outlined in the SWPPP.

D. Remove SWPPP controls at completion of construction and restore and stabilize areas disturbed during construction.

END OF SECTION 015723

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Demolition and removal of selected portions of exterior or interior of building or structure and site elements.
2. Removal and salvage of existing items for delivery to Owner and removal of existing items for reinstallation.

B. Related Requirements:

1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 015639 "Temporary Tree and Plant Protection" for temporary protection of existing trees and plants that are affected by selective demolition.
3. Section 017300 "Execution" for cutting and patching procedures.
4. Section 013516 "Alteration Project Procedures" for general protection and work procedures for alteration projects.
5. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of selective demolition.
6. Section 330500 "Common Work Results for Utilities" for removal of site utility systems piping, equipment, and components.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner as indicated.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage; prepare for reuse; and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be removed.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.4 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.
6. Review and finalize protection requirements.
7. Review procedures for noise and dust control.
8. Review storage, protection, and accounting for items to be removed for salvage or reinstallation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For refrigerant recovery technician.

B. Engineering Survey: Submit engineering survey of condition of building.

C. Survey of Existing Conditions: Submit survey.

D. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust and noise control. Indicate proposed locations and construction of barriers.

E. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Temporary interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed in accordance with EPA regulations. Include name and address of technician and date refrigerant was recovered.

G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Universal certified by an EPA-approved certification program.

1.9 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials:

1. Hazardous materials are present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.

    a. Hazardous material remediation is specified in Section <**Insert Section number**> "<**Insert Section title**>."
    b. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified in Section <**Insert Section number**> "<**Insert Section title**>."

E. Historic Areas: Demolition and hauling equipment and other materials to be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches or more.

F. On-site sale of removed items or materials is not permitted.

1.10 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Engage a professional engineer to perform Pan engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.

E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

F. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video. Comply with Section 013233 "Photographic Documentation."

1. Inventory and record the condition of items to be removed for salvage or reinstallation. Photograph or video conditions that might be misconstrued as damage caused by removal.
2. Photograph or video existing conditions of adjoining construction including finish surfaces, that might be misconstrued as damage caused by selective demolition operations or removal of items for salvage or reinstallation.

3.2 PREPARATION

A. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

B. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location, and reinstalled in their original locations after selective demolition operations are complete.

3.3 UTILITY SERVICES AND BUILDING SYSTEMS

A. Existing Services/Systems to Remain: Maintain utilities and building systems and equipment to remain and protect against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utilities and building systems serving areas to be selectively demolished.

1. Arrange to shut off utilities with utility companies.
2. If disconnection of utilities and building systems will affect adjacent occupied parts of the building, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to those parts of the building.
3. Demolish and remove existing building systems, equipment, and components indicated on Drawings to be removed.

a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

b. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
c. Equipment to Be Removed: Disconnect and cap services and remove equipment and components.

4. Abandon existing building systems, equipment, and components indicated on Drawings to be abandoned in place.

a. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
b. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

5. Remove and reinstall/salvage existing building systems, equipment, and components indicated on drawings to be removed and reinstalled or removed and salvaged:

a. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment and components; when appropriate, reinstall, reconnect, and make equipment operational.
b. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and components and deliver to Owner.

3.4 SALVAGE/REINSTALL

A. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

B. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

3.5 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain fire watch during and for at least 24 hours after flame-cutting operations.
6. Maintain adequate ventilation when using cutting torches.
7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed trafficways if required by authorities having jurisdiction.
2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete:

1. Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

D. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate..

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

3.8 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 030130 - MAINTENANCE OF CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bonding agents.
2. Patching mortar.
3. Preplaced concrete materials.
4. Joint filler.
5. Epoxy crack-injection materials.
6. Corrosion-inhibiting materials.
7. Polymer-overlay materials.
8. Polymer-sealer materials.
9. Composite reinforcement materials.

1.2 UNIT PRICES

A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."

1. Unit prices apply to authorized work covered by estimated quantities
2. Unit prices apply to authorized additions to and deletions from the Work as authorized by Change Orders.

B. General: Unit prices include the cost of preparing existing construction to receive the Work indicated and costs of field quality control required for units of Work completed.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to concrete work, including, but not limited to, the following:

a. Verify concrete-maintenance specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Concrete restoration specialist.
c. Materials, material application, sequencing, tolerances, and required clearances.
d. Shoring and bracing.
e. Quality-control program.
f. Coordination with building occupants.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, chemical composition, physical properties, test data, and mixing, preparation, project application types consisting of horizontal, vertical or overhead locations and application instructions.

B. Shop Drawings:

1. Shoring and Bracing: Provide Drawings or documentation to ensure that structure and temporary supports withstand the anticipated loads during construction and the effect of demolition on the capacity of the structure. Submit design calculations, sealed by an engineer licensed in state of Project, for shoring and bracing where required by the extent of structural repairs or removal of deteriorated concrete and subsequent replacement.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For concrete-maintenance specialist and manufacturers.

B. Material Certificates: For each type of portland cement and aggregate supplied for mixing or adding to products at Project site.

C. Product Test Reports: For each manufactured bonding agent, cementitious patching mortar, joint filler, crack-injection adhesive, polymer overlay, polymer sealer, and composite structural reinforcement, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Field quality-control reports.

E. Quality-Control Program: Submit before work begins.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Each manufactured bonding-agent, packaged patching-mortar, joint-filler, crack-injection-adhesive, corrosion-inhibiting-treatment, polymer-overlay, polymer-sealer, and composite-structural-reinforcement manufacturer must employ factory-authorized service representatives who are available for consultation and Project-site inspection and on-site assistance.

B. Quality-Control Program: Prepare a written plan for concrete maintenance to systematically demonstrate the ability of personnel to properly perform maintenance work, including each phase or process, protection of surrounding materials during operations, and control of debris and runoff during the Work. Describe in detail materials, methods, equipment, and sequence of operations to be used for each phase of the Work.

C. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94 requirements for production facilities and equipment.

1.7 MOCKUPS

A. Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Concrete Removal and Patching Mockup: Remove and repair an approximately 100 sq. in. area of deteriorated concrete wall.
2. Floor Joint Repair Mockup: Cut out and reinstall joints in two separate areas as indicated on Drawings.
3. Epoxy Crack Injection Mockup: Perform epoxy crack-injection material in two separate areas as indicated on Drawings.
4. Polymer-Overlay Mockup: Apply an approximately 50 sq. ft. area of polymer overlay.
5. Polymer Sealer Mockup: Apply an approximately 50 sq. ft. area of polymer sealer.
6. Composite Structural-Reinforcement Mockup: Apply composite structural reinforcement as indicated on Drawings.
7. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.

B. Store cementitious materials off the ground, under cover, and in a dry location.

C. Store aggregates covered and in a dry location; maintain grading and other required characteristics and prevent contamination.

1.9 FIELD CONDITIONS

A. Environmental Limitations for Epoxies: Do not apply when air and substrate temperatures are outside limits permitted by manufacturer. During hot weather, cool epoxy components before mixing, store mixed products in shade, and cool unused mixed products to retard setting. Do not apply to wet substrates unless approved by manufacturer.

1. Use only Class A epoxies when substrate temperatures are below or are expected to go below 40 deg F within eight hours.
2. Use only Class A or B epoxies when substrate temperatures are below or are expected to go below 60 deg F within eight hours.
3. Use only Class C epoxies when substrate temperatures are above and are expected to stay above 60 deg F for eight hours.

B. Cold-Weather Requirements for Cementitious Materials:
1. Comply with the following procedures:

a. When air temperature is below 40 deg F, heat patching-material ingredients and existing concrete to produce temperatures between 40 and 90 deg F.

b. When mean daily air temperature is between 25 and 40 deg F, cover completed Work with weather-resistant insulating blankets for 48 hours after repair or provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for 48 hours after repair.
c. When mean daily air temperature is below 25 deg F, provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for 48 hours after repair.

C. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures of 90 deg F and above.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. For repair products, obtain each color, grade, finish, type, and variety of product from single source and from single manufacturer with resources to provide products of consistent quality in appearance and physical properties.

2.2 BONDING AGENTS

A. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Manufactured product that consists of water-insensitive epoxy adhesive, portland cement, and water-based solution of corrosion-inhibiting chemicals that forms a protective film on steel reinforcement.

B. Epoxy Bonding Agent: ASTM C881 Type V bonding system, free of VOCs.

C. Latex Bonding Agent, Redispersible: Type I, ASTM C1059 or use at nonstructural and interior locations unless otherwise indicated.

D. Latex Bonding Agent, Nonredispersible: Type II, ASTM C1059 for use at structural and exterior locations and where indicated.

E. Mortar Scrub Coat: Mix consisting of 1 part portland cement and 1 part fine aggregate complying with ASTM C144, except 100 percent passing a No. 16 sieve.

2.3 PATCHING MORTAR

A. Patching Mortar Requirements:

1. Only use patching mortars that are recommended by manufacturer for each applicable horizontal, vertical, or overhead use orientation.
2. Coarse Aggregate for Patching Mortar: ASTM C33, Size No. 8, Class 5S washed aggregate. Add to patching-mortar mix only as permitted by patching-mortar manufacturer.

B. Job-Mixed Patching Mortar: 1 part portland cement and 2-1/2 parts fine aggregate complying with ASTM C144, except 100 percent passing a No. 16 sieve.

C. Cementitious Patching Mortar: Packaged, dry mix for repair of concrete.
1. Compressive Strength: Not less than 4500 psi at 28 days when tested in accordance with ASTM C109.

D. Rapid-Strengthening, Cementitious Patching Mortar: ASTM C928 packaged, dry mix for repair of concrete.
1. Compressive Strength: Not less than 4000 psi within three hours when tested in accordance with ASTM C109.

2.4 JOINT FILLER

A. Epoxy Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Shore A durometer hardness of at least 80 in accordance with ASTM D2240.

B. Polyurea Joint Filler: Two-component, semirigid, 100 percent solids, polyurea resin with a Shore A durometer hardness of at least 80 in accordance with ASTM D2240.

C. Color: Matching existing joint filler or as selected by Architect from full range of industry colors

2.5 EPOXY CRACK-INJECTION MATERIALS

A. Epoxy Crack-Injection Adhesive: ASTM C881, bonding system Type IV at structural locations and where indicated, Type I at other locations; free of VOCs.
1. Capping Adhesive: Product manufactured for use with crack-injection adhesive by same manufacturer.

2.6 CORROSION-INHIBITING MATERIALS

A. Corrosion-Inhibiting Treatment: Waterborne solution of alkaline corrosion-inhibiting chemicals for concrete-surface application that penetrates concrete by diffusion and forms a protective film on steel reinforcement.

2.7 POLYMER-OVERLAY MATERIALS

A. Polymer Overlay: Epoxy adhesive complying with ASTM C881, bonding system Type III, with surface-applied aggregate for skid resistance; free of VOCs.
1. Aggregate: ACI 503.3, oven-dried, washed silica sand.

2.8 POLYMER-SEALER MATERIALS

A. Epoxy Polymer Sealer: Low-viscosity epoxy, penetrating sealer and crack filler recommended by manufacturer for penetrating and sealing cracks in exterior concrete traffic surfaces; free of VOCs

1. Color: As selected by Architect from full range of industry colors.

B. Methacrylate Polymer Sealer: Low-viscosity, high-molecular-weight methacrylate, penetrating sealer and crack filler recommended by manufacturer for penetrating and sealing cracks in exterior concrete traffic surfaces; free of VOCs.
1. Color: As selected by Architect from full range of industry colors

2.9 COMPOSITE REINFORCEMENT MATERIALS

A. Composite Structural Reinforcement: Manufacturer's system consisting of carbon-fiber or glass-fiber reinforcement in the form of tow sheet with field-applied saturant or preimpregnated sheet and epoxy primers, fillers, adhesives, saturants, and topcoats, designed for use as externally bonded structural reinforcement for concrete.

2.10 MISCELLANEOUS MATERIALS

A. Curing Materials: For ready-mixed concrete or packaged repair materials.

B. Formwork Materials: Form-facing materials must comply with ACI 301 requirements.

C. Water: Potable.

D. Cleaning Agent: Commercial muriatic acid solution.

2.11 MIXES

A. General: Mix products, in clean containers, in accordance with manufacturer's written instructions.

1. Do not add water, thinners, or additives unless recommended by manufacturer.
2. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.
3. Do not mix more materials than can be used within time limits recommended by manufacturer. Discard materials that have begun to set.

B. Mortar Scrub Coat: Mix dry ingredients with enough water to provide consistency of thick cream.

C. Dry-Pack Mortar: Mix required type(s) of patching-mortar dry ingredients with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.

D. Concrete Materials: Comply with Section 033000 "Cast-in-Place Concrete."

E. Concrete Mixture Materials: Ready mixed.

1. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2. Portland Cement: ASTM C150, Type I, II, or III unless otherwise indicated.
3. Fly Ash: ASTM C618, Class C or F.
4. Slag Cement: ASTM C989, Grade 100 or 120.
5. Silica Fume: ASTM C1240 amorphous silica.
6. Aggregates: ASTM C330, nominal maximum aggregate size, gradation and types appropriate for the dimension of the repair area and project application.
7. Air-Entraining Admixture: ASTM C260.
8. Chemical Admixtures: Certified and as recommended by manufacturer for project applications to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

F. Repair Underlayment:

1. Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
2. Compressive Strength: Not less than 4100 psi at 28 days when tested in accordance with ASTM C109.

G. Repair Overlayment:

1. Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
2. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109.

H. Grout for Use with Preplaced Aggregate: Proportion in accordance with ASTM C938. Add grout fluidifier to mixing water followed by portland cement, pozzolan, and fine aggregate.

PART 3 - EXECUTION

3.1 CONCRETE MAINTENANCE

A. Have concrete-maintenance work performed only by qualified concrete-maintenance specialist.

B. Comply with manufacturers' written instructions for surface preparation and product application.

3.2 EXAMINATION

A. Notify Architect seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.

B. Locate areas of deteriorated or delaminated concrete using hammer or chain-drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries. At columns and walls, make boundaries level and plumb unless otherwise indicated.

C. Pachometer Testing: Locate at least three reinforcing bars using a pachometer, and drill test holes to determine depth of cover. Calibrate pachometer using depth of cover measurements, and verify depth of cover in removal areas using pachometer.

D. Perform surveys as the Work progresses to detect hazards resulting from concrete-maintenance work.

3.3 PREPARATION

A. Ensure that supervisory personnel are on-site and on duty when concrete-maintenance work begins and during its progress.

B. Protect persons, motor vehicles, surrounding surfaces of building being repaired, building site, plants, and surrounding buildings from harm resulting from concrete-maintenance work.

1. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
2. Use only proven protection methods appropriate to each area and surface being protected.
3. Provide temporary barricades, barriers, and directional signage to exclude public from areas where concrete-maintenance work is being performed.
4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during course of concrete-maintenance work.
5. Contain dust and debris generated by concrete-maintenance work and prevent it from reaching the public or adjacent surfaces.
6. Use water-mist sprinkling and other wet methods to control dust only with adequate, approved procedures and equipment that ensure that such water will not create a hazard or adversely affect other building areas or materials.
7. Protect floors and other surfaces along haul routes from damage, wear, and staining.
8. Provide supplemental sound-control treatment to isolate removal and dismantling work from other areas of the building.
9. Protect adjacent surfaces and equipment by covering them with heavy polyethylene film and waterproof masking tape or a liquid-strippable masking agent. If practical, remove items, store, and reinstall after potentially damaging operations are complete.
10. Neutralize and collect alkaline and acid wastes for disposal off Owner's property.
11. Dispose of debris and runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

C. Existing Drains: Prior to the start of concrete-maintenance work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin concrete-maintenance work in an area until the drainage system is in working order.

1. Prevent solids, such as aggregate or mortar residue, from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from concrete-maintenance work.
2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

D. Preparation for Concrete Removal: Examine construction to be repaired to determine best methods to safely and effectively perform concrete-maintenance work. Examine adjacent work to determine what protective measures will be necessary. Make explorations, probes, and inquiries as necessary to determine condition of construction to be removed in the course of repair.

1. Verify that affected utilities have been disconnected and capped.
2. Inventory and record the condition of items to be removed for reinstallation or salvage.
3. Provide and maintain shoring, bracing, and temporary structural supports as required to preserve stability and prevent unexpected or uncontrolled movement, settlement, or collapse of construction being demolished and construction and finishes to remain. Strengthen or add new supports when required during progress of removal work.

E. Reinforcing-Bar Preparation: Remove loose and flaking rust from exposed reinforcing bars by high-pressure water cleaning abrasive blast cleaning needle scaling orwire brushing until only tightly adhered light rust remains.

1. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in two or more adjacent bars, cut bars and remove and replace as indicated on Drawings.
2. Remove additional concrete as necessary to provide at least 3/4-inch clearance at existing and replacement bars.
3. Splice replacement bars to existing bars in accordance with ACI 318 by lapping, welding, or using mechanical couplings.

F. Preparation of Floor Joints for Repair: Saw-cut joints full width to edges and depth of spalls, but not less than 3/4 inch. Clean out debris and loose concrete; vacuum or blow clear with compressed air.

G. Surface Preparation for Corrosion-Inhibiting Treatment: Clean concrete to remove dirt, oils, films, and other materials detrimental to treatment application.

1. Use low-pressure water cleaning detergent scrubbing orsand blasting.
2. Allow surface to dry before applying corrosion-inhibiting treatment.

H. Surface Preparation for Overlays:

1. Remove delaminated material and deteriorated concrete surface material.
2. Roughen surface of concrete to produce a surface profile matching CSP 6 in accordance with ICRI 310.2.
3. Use sand blasting shot blasting scarifying needle scaling high-pressure water jetting scabbling flame blasting or milling.
4. Sweep and vacuum roughened surface to remove debris followed by low-pressure water cleaning.

I. Acidic Surface Preparation for Sealers: Acid etch surface of concrete to produce a surface profile matching CSP 1 in accordance with ICRI 310.2. Prepare surface for acid etching by detergent scrubbing to remove oils and films that may prevent acid penetration.

1. Remove excess acid solution, reaction products, and debris by squeegeeing or vacuuming.
2. Scrub surface with an alkaline detergent, rinse, and squeegee or vacuum.

3. Check acidity of surface with pH test paper and continue rinsing until pH is acceptable in accordance with sealer manufacturer's written instructions.
4. When pH is acceptable in accordance with sealer manufacturer's written instructions and surface is clean, vacuum dry.

J. Nonacidic Surface Preparation for Sealers: Clean concrete to remove dirt, oils, films, and other materials detrimental to sealer application.

1. Use shot blasting low-pressure water cleaning or detergent scrubbing.

K. Surface Preparation for Composite Structural Reinforcement: Clean concrete where reinforcement and epoxy patching mortar is to be placed by low-pressure water cleaning or detergent scrubbing to remove dirt, oils, films, and other materials detrimental to epoxy patching mortar.

1. Roughen surface of concrete by sand blasting.
2. Remove delaminated material and deteriorated concrete surface material.
3. Sweep and vacuum roughened surface to remove debris followed by low-pressure water cleaning.

3.4 REMOVAL OF CONCRETE

A. Do not overload structural elements with debris.

B. Saw-cut perimeter of areas indicated for removal to a depth of at least 1/2 inch. Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcement.

C. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.

D. Remove additional concrete if necessary to provide a depth of removal of at least 1/2 inch over entire removal area.

E. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least 3/4-inch clearance around bar.

F. Test areas where concrete has been removed by tapping with hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.

G. Provide surfaces with a fractured profile of at least 1/8 inch that are approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level unless otherwise directed.

H. Thoroughly clean removal areas of loose concrete, dust, and debris.

3.5 APPLICATION OF BONDING AGENTS

A. Epoxy-Modified, Cementitious Bonding and Anticorrosion System: Apply to reinforcing bars and concrete by stiff brush or hopper spray in accordance with manufacturer's written

instructions. Apply to reinforcing bars in two coats, allowing first coat to dry two to three hours before applying second coat. Allow to dry before placing patching mortar or concrete.

B. Epoxy Bonding System: Apply to reinforcing bars and concrete by brush, roller, or spray in accordance with manufacturer's written instructions, leaving no pinholes or other uncoated areas. Apply to reinforcing bars in at least two coats, allowing first coat to dry before applying second coat. Place patching mortar or concrete while epoxy is still tacky. If epoxy dries, recoat before placing patching mortar or concrete.

C. Latex Bonding Agent, Type I: Apply to concrete by brush roller or spray. Allow to dry before placing patching mortar or concrete.

D. Latex Bonding Agent, Type II: Mix with portland cement and scrub into concrete surface in accordance with manufacturer's written instructions. Place patching mortar or concrete while bonding agent is still wet. If bonding agent dries, recoat before placing patching mortar or concrete.

E. Mortar Scrub Coat for Job-Mixed Patching Mortar and Concrete: Dampen repair area and surrounding concrete 6 inches beyond repair area. Remove standing water and apply scrub coat with a brush, scrubbing it into surface and thoroughly coating repair area. If scrub coat dries, recoat before placing patching mortar or concrete.

F. Slurry Coat for Cementitious Patching Mortar: Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar mixed with latex bonding agent into substrate, filling pores and voids.

3.6 INSTALLATION OF PATCHING MORTAR

A. Place patching mortar as specified in this article unless otherwise recommended in writing by manufacturer or where dry-pack mortar is indicated.

1. Provide forms where necessary to confine patch to required shape.
2. Wet substrate and forms thoroughly and then remove standing water.

B. Pretreatment: Apply specified bonding agent.

C. General Placement: Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.

D. Coordinate minimum and maximum thicknesses in "Vertical Patching" and "Overhead Patching" paragraphs below with manufacturers' recommendations for selected patching materials.

E. Vertical Patching: Place material in lifts of not more than 2 inches or less than 1/4 inch. Do not feather edge.

F. Consolidation: After each lift is placed, consolidate material and screed surface.

G. Multiple Lifts: Where multiple lifts are used, score surface of lifts to provide a rough surface for placing subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.

H. Finishing: Allow surfaces of lifts that are to remain exposed to become firm and then finish to a surface matching adjacent concrete.

I. Curing: Wet-cure cementitious patching materials, including polymer-modified cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.

3.7 INSTALLATION OF DRY-PACK MORTAR

A. Use dry-pack mortar for deep cavities and where indicated. Place as specified in this article unless otherwise recommended in writing by manufacturer.

1. Provide forms where necessary to confine patch to required shape.
2. Wet substrate and forms thoroughly and then remove standing water.

B. Pretreatment: Apply specified bonding agent.

C. Place dry-pack mortar into cavity by hand, and compact tightly into place. Do not place more material at a time than can be properly compacted. Continue placing and compacting until patch is approximately level with surrounding surface.

D. After cavity is filled and patch is compacted, trowel surface to match profile and finish of surrounding concrete. A thin coat of patching mortar may be troweled into the surface of patch to help obtain required finish.

E. Wet-cure patch for not less than seven days by water-fog spray or water-saturated absorptive cover.

3.8 CONCRETE PLACEMENT

A. Place concrete in accordance with Section 033000 "Cast-in-Place Concrete" and as specified in this article.

B. Epoxy-Modified Pretreatment: Apply epoxy-modified, cementitious bonding and anticorrosion agent to reinforcement and concrete substrate.

C. Latex Pretreatment: Apply latex bonding agent to concrete substrate.

D. Standard Placement: Place concrete by form-and-pump method unless otherwise indicated.

1. Use vibrators to consolidate concrete as it is placed.
2. At unformed surfaces, screed concrete to produce a surface that when finished with patching mortar will match required profile and surrounding concrete.

E. Form-and-Pump Placement: Place concrete by form-and-pump method where indicated.

1. Design and construct forms to resist pumping pressure in addition to weight of wet concrete. Seal joints and seams in forms and where forms abut existing concrete.
2. Pump concrete into place from bottom to top, releasing air from forms as concrete is introduced. When formed space is full, close air vents and pressurize to 14 psi.

F. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.

G. Fill placement cavities with dry-pack mortar and repair voids with patching mortar. Finish to match surrounding concrete.

3.9 GROUTING PREPLACED AGGREGATE CONCRETE

A. Use grouted preplaced aggregate concrete where indicated for column and wall repairs. Place as specified in this article.

B. Design and construct forms to resist pumping pressure in addition to weight of wet grout. Seal joints and seams in forms and where forms abut existing concrete.

C. Apply epoxy-modified cementitious bonding and anticorrosion agent to reinforcement and concrete substrate.

D. Place aggregate in forms, consolidating aggregate in lifts as it is placed. Pack aggregate into upper areas of forms to achieve intimate contact with concrete surfaces.

E. Fill forms with water to thoroughly dampen aggregate and substrates. Drain water from forms before placing grout.

F. Pump grout into place at bottom of preplaced aggregate, forcing grout upward. Release air from forms at top as grout is introduced. When formed space is full and grout flows from air vents, close vents and pressurize to 14 psi.

G. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.

H. Repair voids with patching mortar and finish to match surrounding concrete.

3.10 APPLICATION OF EPOXY CRACK-INJECTION MATERIALS

A. Clean cracks with oil-free compressed air or low-pressure water to remove loose particles.

B. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond.

C. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.

D. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least 1/4 inch thick by 1 inch wider than crack.

E. Inject cracks wider than 0.003 inch to a depth of 8 inches.

F. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.

G. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.

3.11 APPLICATION OF CORROSION-INHIBITING MATERIALS

A. Apply corrosion-inhibiting treatment to surfaces indicated on Drawings, from wall to wall or curb to curb and from joint to joint in the perpendicular direction.

B. Apply by brush, roller, or airless spray in two coats at manufacturer's recommended application rate. Remove film of excess treatment by high-pressure washing before patching treated concrete or applying a sealer or overlay.

3.12 APPLICATION OF POLYMER-OVERLAY MATERIALS

A. Apply polymer overlay in accordance with ACI 503.3.

B. Apply to traffic-bearing surfaces, including parking areas and walks.

3.13 APPLICATION OF POLYMER-SEALER MATERIALS

A. Apply polymer sealer by brush, roller, or airless spray at manufacturer's recommended application rate.

B. Apply to traffic-bearing surfaces, including parking areas and walks.

3.14 INSTALLATION OF COMPOSITE REINFORCEMENT MATERIALS

A. Fiber Tow Sheet and Saturant: Unless otherwise recommended by manufacturer, install as follows:

1. Apply epoxy primer using brush or short nap roller to prepared concrete surfaces in areas where composite structural reinforcement will be applied.
2. After primer has set, patch surface defects with epoxy filler and allow to set before beginning reinforcement application.
3. Apply epoxy saturant to fiber tow sheet or primed and patched surface using roller. Apply fiber tow sheet to primed and patched surface while saturant is still wet, using pressure roller to remove air pockets. Remove paper backing from fiber tow sheet and apply additional epoxy to fully saturate tow sheet.
4. Apply additional layers using same procedure, fully saturating each layer with epoxy.
5. After saturant has cured, apply protective topcoat by brush roller or spray.

B. Preimpregnated Fiber Sheet: Unless otherwise recommended by manufacturer, install as follows:

1. Patch surface defects with epoxy mortar and allow to set before beginning reinforcement application.
2. Apply epoxy adhesive to a thickness of 1/16 inch to prepared concrete surfaces.
3. Clean fiber sheet with acetone or other suitable solvent and apply epoxy adhesive to a thickness of 1/16 inch.
4. Apply adhesive-coated fiber sheet to adhesive-coated concrete and roll with a hard rubber roller until fiber sheet is fully embedded in adhesive, air pockets are removed, and adhesive is forced out from beneath fiber sheet at edges.
5. Apply additional layers using same procedure.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Packaged, Cementitious Patching-Mortar Application: Five randomly selected sets of samples for each type of mortar required, tested in accordance with ASTM C928.
2. Job-Mixed Patching-Mortar Application: Five randomly selected sets of samples for each type of mortar required, tested for compressive strength in accordance with ASTM C109.
3. Concrete: As specified in Section 033000 "Cast-in-Place Concrete."
4. Grout for Preplaced Aggregate: Tested for compressive strength in accordance with ASTM C942.
    a. Testing Frequency: One sample for each 25 cu. yd. of grout or fraction thereof, but not less than one sample for each day's work.
5. Joint Filler: Core-drilled samples to verify proper installation.
    a. Testing Frequency: One sample for each 100 ft. of joint filled.
    b. Where samples are taken, refill holes with joint filler.
6. Epoxy Crack-Injection Materials: Core-drilled samples to verify proper installation.
    a. Testing Frequency: Three samples from mockup and one sample for each 100 ft. of crack injected.
    b. Where samples are taken, refill holes with epoxy mortar.
7. Product will be considered defective if it does not pass tests and inspections.

C. Manufacturers Field Service: Engage manufacturers' factory-authorized service representatives for consultation and Project-site inspection and to provide on-site assistance when requested by Architect.

1. Have manufacturers' factory-authorized service representatives perform the following number of Project-site inspections to observe progress and quality of the Work, distributed over the period of product installation, regardless of on-site assistance requested by Architect:
    a. Bonding-Agent and Packaged Patching-Mortar Installation: Three inspections.

b. Joint-Filler Installation: Two inspections.
c. Crack-Injection-Adhesive Preparation and Installation: Four inspections.
d. Corrosion-Inhibiting Treatment Installation: Two inspections.
e. Polymer-Overlay Installation: Two inspections.
f. Polymer Sealer: Two inspections.
g. Composite-Structural Reinforcement: Three inspections.

D. Prepare test and inspection reports.

END OF SECTION 030130

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Form-facing material for cast-in-place concrete.
2. Form liners.
3. Insulating concrete forms.
4. Shoring, bracing, and anchoring.

1.3 DEFINITIONS

A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.

B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction, movement, contraction, and isolation joints
c. Forms and form-removal limitations.
d. Shoring and reshoring procedures.
e. Anchor rod and anchorage device installation tolerances.

1.5 ACTION SUBMITTALS

A. Product Data: For each of the following:

1. Exposed surface form-facing material.
2. Concealed surface form-facing material.

3. Forms for cylindrical columns.
4. Pan-type forms.
5. Void forms.
6. Form liners.
7. Insulating concrete forms.
8. Form ties.
9. Waterstops.
10. Form-release agent.

B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.

a. Location of construction joints is subject to approval of the Engineer.

3. Indicate location of waterstops.
4. Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.
5. Indicate layout of insulating concrete forms, dimensions, course heights, form types, and details.

C. Samples:

1. For waterstops.
2. For Form Liners: 12-inch by 12-inch sample, indicating texture.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing and inspection agency.

B. Research Reports: For insulating concrete forms indicating compliance with International Code Council Acceptance Criteria AC353.

C. Field quality-control reports.

D. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

1.8 DELIVERY, STORAGE, AND HANDLING

A. Insulating Concrete Forms: Store forms off ground and under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).

B. Design, engineer, erect, shore, brace, and maintain insulating concrete forms in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design cross ties to transfer the effects of the following loads to the cast-in-place concrete core:

a. Wind Loads: As indicated on Drawings.

1) Horizontal Deflection Limit: Not more than 1/360 of the wall height.

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:

a. Plywood, metal, or other approved panel materials.
b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
1) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class.

1. Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation, with straight end forms.

2.3 INSULATING CONCRETE FORMS

A. Insulating Concrete Forms: Concrete-forming system complying with ASTM E2634, consisting of two panels of insulation connected with cross ties.
1. Insulation: ASTM C578, Type II, expanded polystyrene.

a. Thickness: Not less than 2-1/2 inches (64 mm) each face.
b. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1) Flame Spread: 25 or less.
2) Smoke Developed Index: 450 or less.

2.4 WATERSTOPS

A. Flexible Rubber Waterstops: U.S. Army Corps of Engineers CRD-C 513, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints, with factory fabricated corners, intersections, and directional changes.
1. Profile: Ribbed without center bulb.
2. Dimensions: 6 inches by 3/8 inch thick; nontapered.

B. Flexible PVC Waterstops: U.S. Army Corps of Engineers CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints, with factory fabricate corners, intersections, and directional changes.
1. Profile: Ribbed without center bulb.
2. Dimensions: 6 inches by 3/8 inch thick; nontapered.

2.5 RELATED MATERIALS

A. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

C. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

D. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form release agent for form liners shall be acceptable to form liner manufacturer.

E. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.

C. Limit concrete surface irregularities as follows:

1. Surface Finish-1.0: ACI 117 Class D, 1 inch.
2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
3. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.

D. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3. Install keyways, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1. Provide and secure units to support screed strips
2. Use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.

I. Chamfer exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

K. Form openings, chases, offsets, sinkages, keyways, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

L. Construction and Movement Joints:

1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
3. Place joints perpendicular to main reinforcement.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.

    a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls at 25’-0” on center maximum or as indicated on Drawings.

    a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
4. Clean embedded items immediately prior to concrete placement.

3.3 INSTALLATION OF WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.

1. Install in longest lengths practicable.
2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
3. Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 033000 "Cast-In-Place Concrete."
4. Secure waterstops in correct position at 12 inches on center.
5. Field fabricate joints in accordance with manufacturer's instructions using heat welding.

    a. Miter corners, intersections, and directional changes in waterstops.
    b. Align center bulbs.

6. Clean waterstops immediately prior to placement of concrete.
7. Support and protect exposed waterstops during progress of the Work.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.

1. Install in longest lengths practicable.
2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
3. Protect exposed waterstops during progress of the Work.

3.4 INSTALLATION OF INSULATING CONCRETE FORMS

A. Comply with ACI 301 and manufacturer's instructions.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Install forms in running bond pattern.

1. Align joints.
2. Align furring strips.

D. Construct forms tight to prevent loss of concrete mortar.

E. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

G. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

H. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

I. Shore insulating concrete forms to ensure stability and to resist stressing imposed by construction loads.

3.5 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work.

1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
2. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.

1. Align and secure joints to avoid offsets.
2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.6 SHORING AND RESHORING INSTALLATION

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.7 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Inspections:

1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

B. Related Requirements:
1. Section 030130 “Maintenance of Cast In Place Concrete”
2. Section 033000 “Cast In Place Concrete”

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction contraction and isolation joints.
c. Steel-reinforcement installation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Epoxy repair coating.
3. Zinc repair material.
4. Bar supports.
5. Mechanical splice couplers.
6. Structural thermal break insulated connection system.

B. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
3. For structural thermal break insulated connection system, indicate general configuration, insulation dimensions, tension bars, compression pads, shear bars, and dimensions.

C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

1. Location of construction joints is subject to approval of Engineer.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For testing and inspection agency.

B. Welding certificates.

1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M.

C. Material Certificates: For each of the following, signed by manufacturers:

1. Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
2. Dual-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."

D. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:

a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.

2. Mechanical splice couplers.

E. Field quality-control reports.

F. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage and to avoid damaging coatings on steel reinforcement.

1. Store reinforcement to avoid contact with earth.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615, Grade 60, deformed.

B. Headed-Steel Reinforcing Bars: ASTM A970.

C. Plain-Steel Welded-Wire Reinforcement: ASTM A1064, plain, fabricated from as-drawn steel wire into flat sheets.

D. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064, flat sheet.

E. Galvanized-Steel Welded-Wire Reinforcement: ASTM A1064, plain, fabricated from galvanized-steel wire into flat sheets.

2.2 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A615, Grade 60, plain-steel bars, ASTM A775 epoxy coated.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

D. Steel Tie Wire: ASTM A1064, annealed steel, not less than 0.0508 inch in diameter.

1. Finish: Plain.

2.3 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.
2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
2. Stagger splices in accordance with ACI 318.
3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions. Only use Mechanical Splice Couplers where specified on drawings or with written approval of engineer.

G. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."

a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed 12 inches.

2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Inspections:

1. Steel-reinforcement placement.
2. Steel-reinforcement mechanical splice couplers.
3. Steel-reinforcement welding.

C. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

END OF SECTION 032000

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete standards.
2. Concrete materials.
3. Admixtures.
4. Fiber reinforcement.
5. Vapor retarders.
6. Floor and slab treatments.
7. Liquid floor treatments.
8. Curing materials.
9. Accessories.
10. Repair materials.
11. Concrete mixture materials.
12. Concrete mixture class types.
13. Concrete mixing.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
3. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement or blended hydraulic cement alone or in combination with one or more of the following:

1. Fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cementitious Materials (w/cm) Ratio: The ratio by weight of mixing water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for inspections and acceptance testing of concrete at Project site.
c. Ready-mix concrete manufacturer.
d. Concrete Subcontractor.

2. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction joints, control joints, isolation joints, and joint-filler strips.
c. Semirigid joint fillers.
d. Vapor-retarder installation.
e. Anchor rod and anchorage device installation tolerances.
f. Cold- and hot-weather concreting procedures.
g. Concrete finishes and finishing.
h. Curing procedures.
i. Forms and form-removal limitations.
j. Shoring and reshoring procedures.
k. Methods for achieving specified floor and slab flatness and levelness.
l. Floor and slab flatness and levelness measurements.
m. Concrete repair procedures.
n. Concrete protection.
o. Initial curing of standard-cured and field curing of field-cured test cylinders (ASTM C31)
p. Protection of field cured field test cylinders.
q. Distribution of test reports.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Portland cement.
2. Blended hydraulic cement.
3. Performance-based hydraulic cement.
4. Fly ash.
5. Slag cement.
6. Silica fume.
7. Natural or other pozzolans.
8. Aggregates.
9. Ground calcium carbonate and aggregate mineral fillers.
10. Admixtures:

a. Include limitations of use. Admixtures that do not comply with reference ASTM International requirements must be submitted with test data for approval.

11. Fiber reinforcement.
12. Vapor retarders.
13. Floor and slab treatments.
14. Liquid floor treatments.
15. Curing materials.

16. Joint fillers.
17. Repair materials.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Compressive strength at 28 days or other age as specified.
3. Compressive strength required at stages of construction.
4. Durability exposure classes for Exposure Categories F, S, W, and C.
5. Maximum w/cm ratio.
6. Calculated equilibrium and fresh density for lightweight concrete.
7. Slump or slump flow limit.
8. Air content.
9. Nominal maximum aggregate size.
10. Steel-fiber reinforcement content.
11. Synthetic microfiber content.
12. Synthetic macrofiber content.
13. Intended placement method.
14. Submit adjustments to design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant changes.

C. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

a. Location of construction joints is subject to approval of the Engineer.

D. Samples: For manufacturer's standard colors for color pigment.

E. Concrete Schedule: For each location of each class of concrete indicated in "Concrete Mixture Class Types" Article, including the following:

1. Concrete class designation.
2. Location within Project.
3. Exposure class designation.
4. Formed surface finish designation and final finish.
5. Final finish for floors.
6. Floor treatment, if any.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following:

1. Cementitious materials.
2. Admixtures.

3. Fiber reinforcement.
4. Curing compounds.
5. Floor and slab treatments.
6. Bonding agents.
7. Adhesives.
8. Vapor retarders.
9. Semirigid joint filler.
10. Joint-filler strips.
11. Repair materials.

C. Material Test Reports: For the following:

1. Portland cement.
2. Blended hydraulic cement.
3. Performance-based hydraulic cement.
4. Fly ash.
5. Slag cement.
6. Silica fume.
7. Natural or other pozzolans.
8. Aggregates.
9. Ground calcium carbonate and aggregate mineral filler.
10. Admixtures.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances in accordance with ACI 117 and in compliance with ASTM E1155.

E. Research Reports:

1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
2. For sheet vapor retarder/termite barrier, showing compliance with ICC's Acceptance Criteria AC380.

F. Preconstruction Test Reports: For each mix design.

G. Field quality-control reports.

H. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94 requirements for production facilities and equipment.

1. Manufacturer's production facilities and delivery vehicles certified in accordance with NRMCA's certification requirements or equivalent approval by a State DOT.

B. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing that performs duties on behalf of the Architect/Engineer.

C. Field Quality-Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.

1. Include the following information in each test report:

a. Admixture dosage rates.
b. Slump.
c. Air content.
d. Seven-day compressive strength.
e. 28-day compressive strength.
f. Evaluation of permeability-reducing admixtures.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94 and ACI 301.

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 as follows:

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When air temperature has fallen to, or is expected to fall below 40 deg F during the protection period, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE STANDARDS

A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

A. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2. Obtain each type of admixture from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150, Type V, gray.
2. Blended Hydraulic Cement: ASTM C595, Type IL, portland-limestone cement.
3. Performance-Based Hydraulic Cement: ASTM C1157: Type HS, high sulfate resistance.
4. Pozzolans: ASTM C618, Class C, F, or N.
5. Slag Cement: ASTM C989, Grade 100 or 120.
6. Silica Fume: ASTM C1240.

C. Normal-Weight Aggregates:

1. Coarse Aggregate: ASTM C33, Class 3M
2. Maximum Coarse-Aggregate Size: 1 inch nominal.
3. Fine Aggregate: ASTM C33.
4. Recycled Aggregate: Provide documentation of characteristics of recycled aggregate and mechanical properties and durability of proposed concrete, which incorporates recycled aggregate to conform to appliable requirements for the class of concrete.
5. Alkali-Silica Reaction: Comply with one of the following for each aggregate used:

    a. Expansion Result of Aggregate: Not more than 0.04 percent at one year when tested in accordance with ASTM C1293.
    b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567. Do not use this option with fly ash with an alkali content greater than 4.0 percent. Submit supporting data for each aggregate showing expansion in excess of 0.10 percent when tested in accordance with ASTM C1260.
    c. Alkali Content in Concrete: Not to exceed 4 lb./cu. yd. for aggregate with expansion greater than or equal to 0.04 percent and less than 0.12 percent or 3 lb./cu. yd. for aggregate with expansion greater than or equal to 0.12 percent and less than 0.24 percent. Test aggregate reactivity in accordance with ASTM C1293. Calculate alkali content of concrete in accordance with ACI 301. Do not use this

option with natural pozzolan or fly ash that has a calcium oxide content greater than 18 percent or an alkali content greater than 4.0 percent; or for an aggregate with expansion at one year greater than or equal to 0.24 percent when tested in accordance with ASTM C1293.

2.3 ADMIXTURES

A. Air-Entraining Admixture: ASTM C260.

B. Chemical Admixtures: Do not use calcium chloride or admixtures containing calcium chloride in steel-reinforced concrete.

1. Water-Reducing Admixture: ASTM C494, Type A.
2. Retarding Admixture: ASTM C494, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494, Type G.
6. Admixtures with special properties, with documentation of claimed performance enhancement, ASTM C494, Type S.
7. Set-Accelerating Corrosion-Inhibiting Admixture: ASTM C1582.

8. Permeability-Reducing Admixture: ASTM C494, Type S, hydrophilic, permeability-reducing crystalline or colloidal silica admixture, capable of reducing water absorption of concrete exposed to hydrostatic pressure (PRAH).
   a. Permeability: No leakage when tested in accordance with U.S. Army Corps of Engineers CRD C48 at a hydraulic pressure of 200 psi for 14 days.

C. Mixing Water for Concrete Mixtures and Water Used to Make Ice: ASTM C1602. Include documentation of compliance with limits for alkalis, sulfates, chlorides, or solids content of mixing water from Table 2 in ASTM C1602.

2.4 VAPOR RETARDERS

A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A. Include manufacturer's recommended thickness and adhesive or pressure-sensitive tape.

B. Sheet Vapor Retarder/Termite Barrier: ASTM E1745, Class A, except with maximum water-vapor permeance of 0.03 perms; complying with ICC Acceptance Criteria AC380. Include manufacturer's recommended adhesive or pressure-sensitive tape.
1. Low-Temperature Flexibility: Pass at minus 15 deg F; ASTM D146.
2. Puncture Resistance: 224 lbf minimum; ASTM E154.
3. Water Absorption: 0.1 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D570.
4. Hydrostatic-Head Resistance: 231 ft. minimum; ASTM D5385.

2.5 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:

a. Ambient Temperature Below 50 deg F (10 deg C): Black.
b. Ambient Temperature between 50 and 85 deg F (10 and 29 deg C): Any color.
c. Ambient Temperature Above 85 deg F (29 deg C): White.

D. Curing Paper: 8 ft. wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.

E. Water: Potable water that does not cause staining of the surface.

F. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.

G. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B.

H. Clear, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating.

I. Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

J. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

2.6 ACCESSORIES

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 in accordance with ASTM D2240.

C. Bonding Agent: ASTM C1059/ Type II, nonredispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C881 two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:

1. Types I and II, nonload bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Floor Slab Protective Covering: 8 ft. wide cellulose fabric.

2.7 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150 portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested in accordance with ASTM C109.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C150 portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109.

2.8 CONCRETE MIXTURE MATERIALS

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.

1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland or hydraulic cement in concrete assigned to Exposure Class F3 as follows:

1. Fly Ash or Other Pozzolans: Not less than 15 percent or more than 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Silica Fume: 10 percent by mass.

4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
2. Use permeability-reducing admixture in concrete mixtures where indicated.

2.9 CONCRETE MIXTURE CLASS TYPES

A. Class A: Normal-weight concrete used for footings, grade beams, and tie beams.

1. Exposure Class: ACI 318 Class F1, Class S1, Class W1, Class C0.
2. Minimum Compressive Strength: As indicated at 28 days.
3. Maximum w/cm Ratio: 0.45
4. Slump Limit: 2 to 4 inches for concrete with water reducing admixture. 6 to 8 inches for concrete with high range water reducing admixture. "Slump Flow Limit" Subparagraph below is for self-consolidating concrete. Consider deleting and allow the Contractor to select a target slump flow in accordance with ASTM C1611, as permitted under ACI 301. If retaining subparagraph, retain slump flow limit from one of two options or revise to suit Project.
5. Slump Flow Limit: 22 inches, plus or minus 1-1/2 inches
6. Air Content:

    a. Exposure Class F1: 3.0 percent, plus or minus 1 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.

7. Limit water-soluble, chloride-ion content in hardened concrete to 0.1 percent by weight of cementitious materials.

B. Class B: Normal-weight concrete used for foundation walls.

1. Exposure Class: ACI 318 Class F1, Class S1, Class W1, Class C0.
2. Minimum Compressive Strength: As indicated at 28 days.
3. Maximum w/cm Ratio: 0.45
4. Slump Limit: 2 to 4 inches for concrete with water reducing admixture. 6 to 8 inches for concrete with high range water reducing admixture.
5. Slump Flow Limit: 22 inches, plus or minus 1.5 inches
6. Air Content:

    a. Exposure Class F1: 3.0 percent, plus or minus 1 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.

7. Limit water-soluble, chloride-ion content in hardened concrete to 0.1 percent by weight of cement.

8. Compressive strength or alternative methods of estimating in-place strength of concrete by maturity or other nondestructive testing with acceptable correlation between test results and concrete compressive strength.

C. Class C: Normal-weight concrete used for interior slabs-on-ground.

1. Exposure Class: ACI 318 Class F1, Class S1, Class W1, Class C0.
2. Minimum Compressive Strength: As indicated at 28 days.
3. Maximum w/cm Ratio: 0.45
4. Slump Limit: 2 to 4 inches for concrete with water reducing admixture. 6 to 8 inches for concrete with high range water reducing admixture.
5. Slump Flow Limit: 22 inches, plus or minus 1.5 inches
6. Air Content:

    a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

7. Limit water-soluble, chloride-ion content in hardened concrete to 0.1 percent by weight of cement.

D. Class J: Normal-weight concrete used for exterior retaining walls.

1. Exposure Class: ACI 318 Class F1, Class S1, Class W1, Class C0.
2. Minimum Compressive Strength: As indicated at 28 days.
3. Maximum w/cm Ratio: 0.45
1. Slump Limit: 2 to 4 inches for concrete with water reducing admixture. 6 to 8 inches (100 mm) for concrete with high range water reducing admixture.
2. Slump Flow Limit: 22 inches, plus or minus 1.5 inches.
3. Air Content:

    a. Exposure Class F1: 3.0 percent, plus or minus 1 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.

4. Limit water-soluble, chloride-ion content in hardened concrete to 0.1 percent by weight of cement.

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94 and furnish delivery ticket.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..

3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Daily access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 TOLERANCES

A. Comply with ACI 117.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install reglets to receive waterproofing and through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.5 INSTALLATION OF VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
2. Face laps away from exposed direction of concrete pour.
3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
4. Lap joints 6 inches and seal with manufacturer's recommended tape.
5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.

    a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides and sealing to vapor retarder.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

3.6 INSTALLATION OF CAST-IN-PLACE CONCRETE

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Water addition in transit or at the Project site must be in accordance with ASTM C94 and must not exceed the permitted amount indicated on the concrete delivery ticket.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.

    a. Do not use vibrators to transport concrete inside forms.
    b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.

c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.7 INSTALLATION OF JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2. Place joints perpendicular to main reinforcement.

a. Continue reinforcement across construction joints unless otherwise indicated.

3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls as indicated on Drawings. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
8. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints:

1. Install dowel bars and support assemblies at joints where indicated on Drawings.
2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.8 APPLICATION OF FINISHING FLOORS AND SLABS

A. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface. Use of an approved finishing aid is acceptable.
5. Do not apply troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:

a. Slabs on Ground:

1) Specified overall values of flatness, F_F 25; and of levelness, F_L 20; with minimum local values of flatness, F_F 17; and of levelness, F_L 15.
2) Specified overall values of flatness, F_F 35; and of levelness, F_L 25; with minimum local values of flatness, F_F 24; and of levelness, F_L 17.
3) Specified overall values of flatness, F_F 45; and of levelness, F_L 35; with minimum local values of flatness, F_F 30; and of levelness, F_L 24.
4) Specified overall values of flatness, F_F 50; and of levelness, F_L 35; with minimum local values of flatness, F_F 40; and of levelness, F_L 24.

b. Suspended Slabs:

1) Specified overall values of flatness, F_F 25; and of levelness, F_L 20; with minimum local values of flatness, F_F 17; and of levelness, F_L 15.
2) Specified overall values of flatness, F_F 35; and of levelness, F_L 20; with minimum local values of flatness, F_F 24; and of levelness, F_L 15.
3) Specified overall values of flatness, F_F 45; and of levelness, F_L 35; with minimum local values of flatness, F_F 30; and of levelness, F_L 24.

B. Trowel and Fine-Broom Finish: First apply a trowel finish to surfaces indicated on Drawings. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.

1. Coordinate required final finish with Architect before application.
2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

C. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with a fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish with Architect before application.

D. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate finish to concrete stair treads, platforms, and ramps, as indicated on Drawings.

1. Apply in accordance with manufacturer's written instructions and as follows:

a. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in one or two applications.
b. Tamp aggregate flush with surface, but do not force below surface.
c. After broadcasting and tamping, apply float finish.
d. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate.

E. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces in accordance with manufacturer's written instructions and as follows:

1. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. unless greater amount is recommended by manufacturer.
2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating.

3. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
4. After final floating, apply a trowel finish.
5. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

3.9 APPLICATION OF FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.

    a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
    b. Remove projections larger than 1 inch.
    c. Tie holes do not require patching.
    d. Surface Tolerance: ACI 117, Class D.
    e. Apply to concrete surfaces for metal lap pan deck formed surfaces and those surfaces that are buried or covered with subsequent installed surfaces.

2. ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.

    a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
    b. Remove projections larger than 1/4 inch.
    c. Patch tie holes.
    d. Surface Tolerance: ACI 117, Class B.
    e. Locations: Apply to concrete surfaces exposed to public view.

3. ACI 301 (ACI 301M) Surface Finish SF-3.0:

    a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
    b. Remove projections larger than 1/8 inch.
    c. Patch tie holes.
    d. Surface Tolerance: ACI 117 Class A.
    e. Locations: Apply to concrete surfaces exposed to public view.

B. Rubbed Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Smooth-Rubbed Finish:

    a. Perform no later than one day after form removal.
    b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
    c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
    d. Maintain required patterns or variances as shown on Drawings or to match design reference sample.

2. Grout-Cleaned Rubbed Finish:

    a. Clean concrete surfaces after contiguous surfaces are completed and accessible.
    b. Do not clean concrete surfaces as Work progresses.
    c. Mix 1 part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
    d. Wet concrete surfaces.
    e. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.
    f. Maintain required patterns or variances as shown on Drawings or to match design reference sample.

C. Abrasive-Blast Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi.
2. Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at the same age.
3. Surface Continuity:

    a. Perform abrasive-blast finishing as continuous operation, maintaining continuity of finish on each surface or area of Work.
    b. Maintain required patterns or variances in depths of blast to match design reference sample.

4. Abrasive Blasting:

    a. Abrasive-blast corners and edges of patterns carefully, using backup boards to maintain uniform corner and edge lines.
    b. Determine type of nozzle pressure and blasting techniques required to match field sample.
    c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match field sample, as follows:

        1) Brush Texture: Remove cement matrix to dull surface sheen and expose face of fine aggregate, with no significant reveal.
        2) Light Texture: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color, with maximum reveal of 1/16 inch.
        3) Medium Texture: Generally, expose coarse aggregate with slight reveal and with a maximum reveal of 1/4 inch.
        4) Heavy Texture: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter, with reveal range of 1/4 to 1/2 inch.

    d. Maintain required patterns or variances in reveal projection to match design reference sample.

D. High-Pressure Water-Jet Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of 4500 psi.
2. Coordinate with formwork removal to ensure that surfaces to be high-pressure water-jet finished are treated at same age for uniform results.
3. Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.
4. Maintain required patterns or variances in reveal projection to match design reference sample.

E. Bushhammer Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Perform bushhammer finish to concrete that has achieved a minimum compressive strength of 4500 psi.
2. Surface Continuity:

    a. Perform bushhammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.

3. Surface Cut:

    a. Maintain required depth of cut and general aggregate exposure.
    b. Use power tool with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.

4. Remove impressions of formwork and form facings with exception of tie holes.
5. Maintain required patterns or variances of cut as shown on Drawings or to match design reference sample.
6. Maintain control of concrete chips, dust, and debris in each Work area, limiting migration of airborne materials and dust by use of tarpaulins, windbreaks, or similar devices.

3.10 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling in:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to match color and texture with in-place construction exposed to view.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.

2. Construct concrete bases 4 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4500 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.

    a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    b. Cast anchor-bolt insert into bases.
    c. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.

1. Cast-in inserts and accessories, as shown on Drawings.
2. Screed, tamp, and trowel finish concrete surfaces.

3.11 APPLICATION OF CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h, calculated in accordance with ACI 305R, before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period as follows:

    a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
    b. Continuous Sprinkling: Maintain concrete surface continuously wet.
    c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
    d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.

e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

1) Recoat areas subject to heavy rainfall within three hours after initial application.
2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing after finishing concrete.
2. Interior Concrete Floors:

a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than 12 inches.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
b) Cure for not less than seven days.

3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following not in cold weather:

a) Water.
b) Continuous water-fog spray.

b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than 12 inches.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
b) Cure for not less than seven days.

3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

a) Water.
b) Continuous water-fog spray.

c. Floors to Receive Polished Finish: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than 12 inches.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

a) Water.
b) Continuous water-fog spray.

d. Floors To Receive Chemical Stain:

1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
3) Butt sides of curing paper tight; do not overlap sides of curing paper.
4) Leave curing paper in place for duration of curing period, but not less than 28 days.

e. Floors To Receive Urethane Flooring:

1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches and sealed in place.
3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.

4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

f. Floors To Receive Curing Compound:

1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Maintain continuity of coating, and repair damage during curing period.
4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

g. Floors To Receive Curing and Sealing Compound:

1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.12 INSTALLATION OF JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.

D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.13 INSTALLATION OF CONCRETE SURFACE REPAIRS

A. Defective Concrete:

1. Repair and patch defective areas when approved by Architect.
2. Remove and replace concrete that cannot be repaired and patched to meet specification requirements.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks in excess of 0.01 inch spalls, air bubbles exceeding surface finish limits, honeycombs, rock pockets, fins and other projections on the surface exceeding surface finish limits, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.

    a. Limit cut depth to 3/4 inch.
    b. Make edges of cuts perpendicular to concrete surface.
    c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
    d. Fill and compact with patching mortar before bonding agent has dried.
    e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.

    a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
    b. Compact mortar in place and match surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance, as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.

    a. Correct low and high areas.
    b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by adding patching mortar.

    a. Finish repaired areas to blend into adjacent concrete.

5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.

    a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
    b. Feather edges to match adjacent floor elevations.

6. Correct other low areas scheduled to remain exposed with repair topping.

    a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
    b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.

    a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
    b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
    c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
    d. Place, compact, and finish to blend with adjacent finished concrete.
    e. Cure in same manner as adjacent concrete.

8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.

    a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
    b. Dampen cleaned concrete surfaces and apply bonding agent.
    c. Place patching mortar before bonding agent has dried.
    d. Compact patching mortar and finish to match adjacent concrete.
    e. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.14 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency to be responsible for providing curing facility for initial curing of strength test specimens on-site and verifying that test specimens are cured in accordance with standard curing requirements in ASTM C31.
2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

a. Test reports to include reporting requirements of ASTM C31, ASTM C39, and ACI 301, including the following as applicable to each test and inspection:

1) Project name.
2) Name of testing agency.
3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
4) Name of concrete manufacturer.
5) Date and time of inspection, sampling, and field testing.
6) Date and time of concrete placement.
7) Location in Work of concrete represented by samples.
8) Date and time sample was obtained.
9) Truck and batch ticket numbers.
10) Design compressive strength at 28 days.
11) Concrete mixture designation, proportions, and materials.
12) Field test results of fresh concrete, including slump or slump flow, air content, temperature and density.
13) Information on storage and curing of samples at the Project site, including curing method and maximum and minimum temperatures during initial curing period.
14) Type of fracture and compressive break strengths at seven days and 28 days.

4. Provide a space and source of power or other resources for curing and access to test specimens by the testing agency.

C. Delivery Tickets: comply with ASTM C94.

D. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as determined by Architect.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172 to be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 150 cu. yd. or fraction thereof.

a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing is to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143:

a. One test at point of delivery for each composite sample, but not less than one test for each day's pour of each concrete mixture.
b. Perform additional tests as needed.

3. Slump Flow: ASTM C1611:

a. One test at point of delivery for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each concrete mixture.
b. Perform additional tests as needed.

4. Air Content: ASTM C231 pressure method, for normal-weight concrete; ASTM C173/C173M volumetric method, for structural lightweight concrete.

a. One test for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each concrete mixture.

5. Concrete Temperature: ASTM C1064:

a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample when strength test specimens are cast.

6. Concrete Density: ASTM C138:

a. One test for each composite sample when strength test specimens are cast.

7. Unit Weight: ASTM C138 density of fresh structural lightweight concrete.

a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture. The fresh density should be consistent with that associated with the equilibrium density within a tolerance of plus or minus 4 lb/ft.^{3}.

8. Compression Test Specimens: ASTM C31:

a. Cast and standard cure two sets of four 6 inches by 12-inches or 4-inch by 8-inch cylindrical specimens for each composite sample.
b. Cast, and field cure two sets of two standard cylindrical specimens for each composite sample.

9. Compressive-Strength Tests: ASTM C39.

a. Test one set of four standard cured specimens at seven days and one set of two specimens at 28 days.
b. Test one set of four field-cured specimens at seven days and one set of two specimens at 28 days.
c. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

10. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

11. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests of standard cured cylinders equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa) if specified compressive strength is 5000 psi (34.5 MPa), or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi (34.5 MPa).
12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
13. Additional Tests:

    a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
    b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42 or by other methods as directed by Architect.

        1) Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.7.6.3.

14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 24 hours of completion of floor finishing and promptly report test results to Architect.

3.15 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using floor slab protective covering.

END OF SECTION 033000

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units (CMU's).
2. Concrete facing brick.

1.2 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

1. Clay Masonry Unit Test: For each type of unit required, according to ASTM C 67 for compressive strength.
2. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
3. Mortar Test (Property Specification): For each mix required, according to ASTM C 109/C 109M for compressive strength**,** ASTM C 1506 for water retention, and ASTM C 91 for air content.
4. Mortar Test (Property Specification): For each mix required, according to ASTM C 780 for compressive strength.
5. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.

C. Samples for Verification: For each type and color of exposed masonry unit and colored mortar.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of product indicated. For masonry units include data on material properties.

B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

1.5 QUALITY ASSURANCE

A. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1.6 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

B. Integral Water Repellent: Provide units made with liquid polymeric, integral water repellent admixture that does not reduce flexural bond strength for exposed units and where indicated.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. ACM Chemistries; RainBloc.
    b. BASF Aktiengesellschaft; Rheopel Plus.
    c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.

C. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1500 psi.
2. Density Classification: Normal weight unless otherwise indicated.

D. Concrete Facing Brick: Ground Face, ASTM C 1634.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3750 psi.
2. Density Classification: Normal weight.
3. Sizes (Nominal Dimensions):

    a. Veneer- 4 inches wide by 8 inches high by 16 inches long.
    b. Sill block- 4inches wide by 8 inches high by 16 inches with chamfer.

4. Texture: Ground-face finish.

    a. Match Engineer’s samples.

5. Colors: As selected by Engineer from manufacturer's full range.

2.3 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C 91.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Capital Materials Corporation; Flamingo Color Masonry Cement.
    b. Cemex S.A.B. de C.V.; Brikset Type N.
    c. Essroc, Italcementi Group; Brixment or Velvet.
    d. Lafarge North America Inc.; Lafarge Masonry Cement.
    e. Lehigh Cement Company; Lehigh Masonry Cement.
    f. National Cement Company, Inc.; Coosa Masonry Cement.

E. Aggregate for Mortar: ASTM C 144.

1. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
2. White-Mortar Aggregates: Natural white sand or crushed white stone.
3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

F. Aggregate for Grout: ASTM C 404.

G. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for structural-clay tile facing units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's colors.

H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Euclid Chemical Company (The); Accelguard 80.
b. Grace Construction Products, W. R. Grace & Co. - Conn.; Morset.
c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.

I. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent by same manufacturer.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ACM Chemistries; RainBloc for Mortar.
b. BASF Aktiengesellschaft; Rheopel Mortar Admixture.
c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.

J. Water: Potable.

2.4 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Exterior Walls: Hot-dip galvanized, carbon steel.
2. Wire Size for Side Rods: 0.148-inch diameter.
3. Wire Size for Cross Rods: 0.148-inch diameter.
4. Wire Size for Veneer Ties: 0.148-inch diameter.
5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.5 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.

C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.

1. Wire: Fabricate from 3/16-inch-diameter, hot-dip galvanized steel wire.

D. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, hot-dip galvanized steel wire.
2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.187-inch diameter, hot-dip galvanized steel wire.

E. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.060-inch- thick, steel sheet, galvanized after fabrication and 0.105-inch- thick, steel sheet, galvanized after fabrication.
2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.187-inch or 0.25-inch diameter, hot-dip galvanized steel wire.
3. Corrugated Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch made from 0.060-inch thick, steel sheet, galvanized after fabrication and 0.105-inch- thick, steel sheet, galvanized after fabrication with dovetail tabs for inserting into dovetail slots in concrete and sized to extend to within 1 inch of masonry face.

F. Partition Top anchors: 0.105-inch- thick metal plate with 3/8-inch- diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

G. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.

H. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:

    a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.

2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.075-inch- thick steel sheet, galvanized after fabrication.
3. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.187-inch-diameter, hot-dip galvanized steel wire.
4. Contractor's Option: Unless otherwise indicated, provide any of the following types of anchors:
5. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Dayton Superior Corporation, Dur-O-Wal Division; D/A 213 or D/A 210 with D/A 700-708.
        2) Heckmann Building Products Inc.; 315-D with 316.
        3) Hohmann & Barnard, Inc.; DW-10HS or DW-10-X.
        4) Wire-Bond; 1004, Type III.

    b. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, having slotted holes for inserting wire tie.

6. Seismic Masonry-Veneer Anchors: Units consisting of a metal anchor section and a connector section designed to engage a continuous wire embedded in the veneer mortar joint.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Dayton Superior Corporation, Dur-O-Wal Division; D/A 213S.
        2) Hohmann & Barnard, Inc.; DW-10-X-Seismiclip.
        3) Wire-Bond; RJ-711 with Wire-Bond clip.

    b. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, having slotted holes for inserting connector section.
    c. Connector Section: Rib-stiffened, sheet metal bent plate, sheet metal clip, or wire tie and rigid PVC extrusion designed to engage continuous wire. Size connector to extend at least halfway through veneer but with at least 5/8-inch cover on outside face.
    d. Fabricate wire connector sections from 0.25-inch diameter, hot-dip galvanized, carbon-steel wire.

I. Anchor Bolts: Headed steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.6 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
2. Metal Sealant Stop: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.

B. Flexible Flashing: Use one of the following unless otherwise indicated:

1. Copper-Laminated Flashing: 5-oz./sq. ft. copper sheet bonded between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) Advanced Building Products Inc.; Copper Fabric Flashing.
2) Dayton Superior Corporation, Dur-O-Wal Division; Copper Fabric Thru-Wall Flashing.
3) Hohmann & Barnard, Inc.; H & B C-Fab Flashing.

2. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.030 inch.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) Advanced Building Products Inc.; Peel-N-Seal.
2) Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
3) Dayton Superior Corporation, Dur-O-Wal Division; Dur-O-Barrier Thru-Wall Flashing.
4) Fiberweb, Clark Hammerbeam Corp.; Aquaflash 500.
5) Grace Construction Products, W. R. Grace & Co. - Conn.; Perm-A-Barrier Wall Flashing.
6) Heckmann Building Products Inc.; No. 82 Rubberized-Asphalt Thru-Wall Flashing.

C. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; formulated from neoprene, urethane or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Use one of the following unless otherwise indicated:

1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
        2) Heckmann Building Products Inc.; No. 85 Cell Vent.
        3) Hohmann & Barnard, Inc.; Quadro-Vent.

2. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Mortar Net USA, Ltd.; Mortar Net Weep Vents.

3. Vinyl Weep Hole/Vent: T-shaped units made from flexible PVC, consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color selected by Engineer.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Hohmann & Barnard, Inc.; #343 Louvered Weep Hole.
        2) Williams Products, Inc.; Williams-Goodco Brick Vent.
        3) Wire-Bond; Louvered Weepholes.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Advanced Building Products Inc.; Mortar Break.
b. Archovations, Inc.; CavClear Masonry Mat.
c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
d. Mortar Net USA, Ltd.; Mortar Net.

2. Provide one of the following configurations:

a. Strips, full-depth of cavity and 10 inches high, with dovetail shaped notches 7 inches deep.
b. Strips, not less than 3/4 inch thick and 10 inches high, with dimpled surface designed to catch mortar droppings and prevent weep holes from clogging with mortar.
c. Sheets or strips full depth of cavity and installed to full height of cavity.

2.8 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Diedrich Technologies, Inc.
b. EaCo Chem, Inc.
c. ProSoCo, Inc.

2.9 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime mortar unless otherwise indicated.
3. For exterior masonry, use portland cement-lime mortar.
4. For reinforced masonry, use portland cement-lime mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270 Property Specification Type S, to meet performance requirements.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Pigments shall not exceed 5 percent of masonry cement by weight.
3. Application: Use pigmented mortar for exposed mortar joints with the following units:

    a. Decorative CMUs.
    b. Concrete facing brick.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Engineer's sample.
2. Application: Use colored aggregate mortar for exposed mortar joints with the following units:

    a. Decorative CMUs.
    b. Concrete facing brick.

F. Grout for Unit Masonry: Comply with ASTM C 476.

1. Perform compressive strength tests of grout in accordance with ASTM C 1019 by an independent testing laboratory acceptable to the Engineer.
2. One (1) strength test shall be the average of three (3) specimens from the same sample, tested at 28 days
3. Cost of tests shall be paid by the Contractor.
4. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
5. Proportion grout in accordance with ASTM C 476, for specified 28-day compressive strength indicated, but not less than 2000 psi.
6. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.
7. Fly ash additives are not allowed.
8. Use within 90 minutes after addition of mixing water.
9. Mix for minimum of 5 minutes after ingredients are added and until uniform mix is attained. Grout shall have sufficient water added to produce pouring consistency without segregation.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.2 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

D. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

E. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.5 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.6 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.7 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to wall framing with masonry-veneer anchors to comply with the following requirements:

1. Fasten screw-attached and seismic anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Embed connector sections and continuous wire in masonry joints. Provide not less than 2 inches of air space between back of masonry veneer and face of sheathing.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than 16 inches o.c. vertically and 32 inches o.c. horizontally with not less than 1 anchor for each 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

3.8 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated to divert water to the exterior.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.

2. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
3. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.
4. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.

C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use open head joints to form weep holes.
2. Space weep holes 24 inches o.c. unless otherwise indicated.
3. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.

D. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

E. Install vents in head joints in exterior wythes at spacing indicated. Use open head joints to form vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.9 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 48 inches.
3. Place grout lifts such that cold joints in the grout occur at least 16 inches away from cast-in-place anchor bolts or the anticipated locations of post-installed anchors.

3.10 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Level 1 special inspections according to the "International Building Code."

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.

F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

G. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

H. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.

I. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.11 REPAIRING, POINTING, AND CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
2. Protect surfaces from contact with cleaner.
3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
4. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.12 MASONRY WASTE DISPOSAL

A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Do not dispose of masonry waste as fill within 18 inches of finished grade.

B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel materials.
2. Shrinkage-resistant grout.
3. Prefabricated building columns.
4. Shear stud connectors.

B. Related Requirements:

1. Section 053100 "Steel Decking" for field installation of shear stud connectors through deck.
2. Section 055000 "Metal Fabrications" for miscellaneous steel fabrications and other steel items not defined as structural steel.
3. Section 099123 "Interior Painting" painting requirements.
4. Section 133419 "Metal Building Systems" for structural steel.

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Protected Zone: Structural members or portions of structural members indicated as "protected zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

D. Demand-Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the seismic-load-resisting system and which are indicated as "demand critical" or "seismic critical" on Drawings.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data:

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Shear stud connectors.
4. Anchor rods.
5. Threaded rods.
6. Forged-steel hardware.
7. Slide bearings.
8. Prefabricated building columns.
9. Shop primer.
10. Galvanized-steel primer.
11. Etching cleaner.
12. Galvanized repair paint.
13. Shrinkage-resistant grout.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members and connections of the seismic-load-resisting system.
6. Indicate locations and dimensions of protected zones.
7. Identify demand-critical welds.
8. Identify members not to be shop primed.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1 for each welded joint whether prequalified or qualified by testing, including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand-critical welds.

D. Delegated Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, fabricator, shop-painting applicators, and testing agency.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural-steel materials, including chemical and physical properties.

E. Product Test Reports: For the following:

1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shear stud connectors.

F. Survey of existing conditions.

G. Source quality-control reports.

H. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).

B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.

C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1.

1. Welders and welding operators performing work on bottom-flange, demand-critical welds are to pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G are to be considered separate processes for welding personnel qualification.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of the following specifications and documents:

1. ANSI/AISC 303.
2. ANSI/AISC 341.
3. ANSI/AISC 360.
4. RCSC's "Specification for Structural Joints Using High-Strength Bolts."

B. Connection Design Information:

1. Option 1: Connection designs have been completed and connections indicated on the Drawings.

C. Moment Connections: Type FR, fully restrained.

D. Construction: Moment frame.

2.2 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A992

B. Channels, Angles, M-Shapes: ASTM A36

C. Channels, Angles, S-Shapes: ASTM A36

D. Plate and Bar: ASTM A36

E. Corrosion-Resisting (Weathering) Structural-Steel Shapes, Plates, and Bars: ASTM A588/A588M, 50 ksi

F. Cold-Formed Hollow Structural Sections: ASTM A500, Grade C structural tubing.

G. Corrosion-Resisting (Weathering), Cold-Formed Hollow Structural Sections: ASTM A847 structural tubing.

H. Steel Pipe: ASTM A53, Type E or Type S, Grade B.

1. Weight Class: Standard.
2. Finish: Galvanized.

I. Steel Castings: ASTM A216, Grade WCB, with supplementary requirement S11.

J. Steel Forgings: ASTM A668.

K. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-3, compressible-washer type with plain finish.

B. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125, Grade A490 , Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, Type 490-3, compressible-washer type with plain finish.

C. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: Hot-dip zinc coating.
2. Direct-Tension Indicators: ASTM F959, Type 325-1, compressible-washer type with mechanically deposited zinc coating finish.

D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 3, heavy-hex head assemblies, consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: Plain.

E. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.

2.4 RODS

A. Unheaded Anchor Rods: ASTM F1554, Grade 55, weldable.

1. Configuration: Straight.
2. Nuts: ASTM A563 heavy-hex carbon steel.
3. Plate Washers: ASTM A36/A36M carbon steel.

4. Washers: ASTM F436, Type 1, hardened carbon steel.
5. Finish: Hot-dip zinc coating, ASTM A153, Class C

B. Headed Anchor Rods: ASTM F1554, Grade 55, weldable, straight.

1. Nuts: ASTM A563 heavy hex carbon steel.
2. Plate Washers: ASTM A36/A36M carbon steel.
3. Washers: ASTM F436, Type 1, hardened carbon steel.
4. Finish: Hot-dip zinc coating, ASTM A153, Class C.

C. Threaded Rods: ASTM A36/A36M.

1. Nuts: ASTM A63 heavy-hex carbon steel.
2. Washers: ASTM F436, Type 1, hardened carbon steel.
3. Finish: Hot-dip zinc coating, ASTM A153, Class C.

2.5 FORGED-STEEL STRUCTURAL HARDWARE

A. Clevises and Turnbuckles: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1035.

B. Eye Bolts and Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1030.

C. Sleeve Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1018.

2.6 PRIMER

A. Steel Primer:

1. Comply with Section 099123 "Interior Painting."
2. SSPC-Paint 23, latex primer.
3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.7 SHRINKAGE-RESISTANT GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.8 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel in accordance with ASTM A6 and maintain markings until structural-steel framing has been erected.
4. Mark and match-mark materials for field assembly.
5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP 1.

F. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1 and manufacturer's written instructions.

G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.

H. Welded-Steel Door Frames: Build up welded-steel doorframes attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches o.c. unless otherwise indicated on Drawings.

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.9 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1 and AWS D1.8 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.10 PREFABRICATED BUILDING COLUMNS

A. Fire-Resistance Ratings: Provide prefabricated building column listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing in accordance with ASTM E119.

1. Fire-Resistance Rating: As indicated on Drawings.

2.11 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2.12 SHOP PRIMING

A. Shop prime steel surfaces, except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces unless indicated to be painted.
6. Corrosion-resisting (weathering) steel surfaces.
7. Surfaces enclosed in interior construction.

B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 2.
2. SSPC-SP 3.
3. SSPC-SP 7 (WAB)/NACE WAB-4.
4. SSPC-SP 14 (WAB)/NACE WAB-8.
5. SSPC-SP 11.
6. SSPC-SP 6 (WAB)/NACE WAB-3.
7. SSPC-SP 10 (WAB)/NACE WAB-2.
8. SSPC-SP 5 (WAB)/NACE WAB-1.
9. SSPC-SP 8.

C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner or in accordance with SSPC-SP 16.

D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.13 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.

1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
2. Bolted Connections: Inspect and test shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

    a. Liquid Penetrant Inspection: ASTM E165.
    b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    c. Ultrasonic Inspection: ASTM E164.
    d. Radiographic Inspection: ASTM E94.

4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1 for stud welding and as follows:

    a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear stud connector.
    b. Conduct tests in accordance with requirements in AWS D1.1 on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.

5. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.

1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

B. Baseplates, Bearing Plates, and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Pretension anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.

C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.

1. Joint Type: Bolts that are part of the Seismic Force Resisting System shall be Pretensioned according to Table 8.1 of the RCSC as indicated on the contract drawings. Faying surfaces shall meet Slip critical connection requirements in accordance with AISC 341 and as indicated on contract drawings. All other connections shall be snug tight unless noted otherwise.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

C. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1 and manufacturer's written instructions.

3.5 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with ANSI/AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 REPAIR

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780.

B. Touchup Painting:

1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

2. Cleaning and touchup painting are specified in "Section 099123 "Interior Painting."

3.7 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

1. Bolted Connections: Inspect and test bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1.

a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1 and the following inspection procedures, at testing agency's option:

1) Liquid Penetrant Inspection: ASTM E165.
2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
3) Ultrasonic Inspection: ASTM E164.
4) Radiographic Inspection: ASTM E94.

3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1 for stud welding and as follows:

a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
b. Conduct tests according to requirements in AWS D1.1 on additional shear connectors if weld fracture occurs on shear connectors already tested.

END OF SECTION 051200

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof deck.
2. Acoustical roof deck.
3. Noncomposite form deck.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
3. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Roof deck.
2. Noncomposite form deck.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

C. Test and Evaluation Reports:

1. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

a. Power-actuated mechanical fasteners.

2. Research Reports: For steel deck, from ICC-ES showing compliance with the building code.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

E. Qualification Statements: For welding personnel and testing agency.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with SDI QA/QC and the following welding codes:

1. AWS D1.1.
2. AWS D1.3.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store products in accordance with SDI MOC3. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck in accordance with AISI S100.

B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.

2.2 ROOF DECK

A. Fabrication of Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:

a. Color: Manufacturer's standard.

2. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 50, G90 (Z275) zinc coating.
3. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 50, G60 (Z180) zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

    a. Color: Manufacturer's standard.

4. Aluminum-Zinc-Alloy-Coated Steel Sheet: ASTM A792, Structural Steel (SS), Grade 33 minimum, AZ50 aluminum-zinc-alloy coating.
5. Deck Profile: As indicated.
6. Profile Depth: 1-1/2 inches.
7. Design Uncoated-Steel Thickness: 0.0359 inch.
8. Span Condition: As indicated.
9. Side Laps: Interlocking seam.

2.3 ACCESSORIES

A. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile indicated.

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch thick, with factory-punched hole of 3/8-inch minimum diameter.

J. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.

K. Galvanizing Repair Paint: ASTM A780.

L. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories in accordance with SDI C, SDI NC, and SDI RD, as applicable; manufacturer's written instructions; and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install in accordance with deck manufacturer's written instructions.

J. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1 and manufacturer's written instructions.

3.3 INSTALLATION OF ROOF DECK

A. Fasten roof-deck panels to steel supporting members as indicated on drawings.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 12 inches, and as follows:

1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.

2. Mechanically clinch or button punch.
3. Fasten with a minimum of 1-1/2-inch long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped 2 inches minimum.

D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels in accordance with deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

E. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive in accordance with manufacturer's written instructions to ensure complete closure.

F. Sound-Absorbing Insulation: Installation into topside ribs of deck as specified in.

3.4 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

B. Repair Painting:

1. Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
2. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
3. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099123 "Interior Painting."
4. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099123 "Interior Painting."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Special inspections and qualification of welding special inspectors for cold-formed steel floor and roof deck in accordance with quality-assurance inspection requirements of SDI QA/QC.

a. Field welds will be subject to inspection.

2. Steel decking will be considered defective if it does not pass tests and inspections.

3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:

    a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
    b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors that are already tested.

C. Prepare test and inspection reports.

END OF SECTION 053100

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Load-bearing wall framing.
2. Exterior non-load-bearing wall framing.
3. Interior non-load-bearing wall framing.
4. Floor joist framing.
5. Roof rafter framing.
6. Ceiling joist framing.
7. Soffit framing.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
2. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Cold-formed steel framing materials.
2. Load-bearing wall framing.
3. Exterior non-load-bearing wall framing.
4. Interior non-load-bearing wall framing.
5. Vertical deflection clips.
6. Single deflection track.
7. Double deflection track.
8. Drift clips.
9. Floor joist framing.
10. Roof-rafter framing.
11. Ceiling joist framing.
12. Soffit framing.
13. Post-installed anchors.
14. Power-actuated anchors.
15. Sill sealer gasket.
16. Sill sealer gasket/termite barrier.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Delegated Design Submittal: For cold-formed steel framing including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Include reactions and loads that will be imparted on the supporting structure.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Certificates: For each type of code-compliance certification for studs and tracks.

D. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

E. Research Reports:

1. For nonstandard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
2. For sill sealer gasket/termite barrier, showing compliance with ICC-ES AC380.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association or the Steel Stud Manufacturers Association.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

E. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI S202.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, to design Cold-Formed Metal Framing including but not limited to framing members, connections and attachments to structure. The qualified professional engineer shall be licensed in the state of the project.

B. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing complies with AISI S100 and ASTM C955.

C. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.2 COLD-FORMED STEEL FRAMING MATERIALS

A. Framing Members, General: Comply with ASTM C955 for conditions indicated.

B. Steel Sheet: ASTM A1003, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

1. Grade: ST50H (ST340H).
2. Coating: G60 (Z180), A60 (ZF180), AZ50 (AZM150), or GF30 (ZGF90).

C. Steel Sheet for Vertical Deflection and Drift Clips: ASTM A653, structural steel, zinc coated, of grade and coating as follows:

1. Grade: 50 (340), Class 1.
2. Coating: G60 (Z180).

2.3 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch (1.37 mm).
2. Flange Width: 1-3/8 inches (35 mm).

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: Matching steel studs.
2. Flange Width: 1-1/4 inches.

C. Vertical Deflection Clips, Exterior: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch (1.37 mm).
2. Flange Width: 1 inch (25 mm) plus the design gap for one-story structures and 1 inch (25 mm) plus twice the design gap for other applications.

E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

a. Minimum Base-Metal Thickness: 0.0538 inch (1.37 mm).
b. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.

2. Inner Track: Of web depth indicated, and as follows:

a. Minimum Base-Metal Thickness: 0.0538 inch (1.37 mm).

F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.4 INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch (0.84 mm).
2. Flange Width: 1-3/8 inches (35 mm).

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch (0.84 mm).
2. Flange Width: 1-1/4 inches.

C. Vertical Deflection Clips, Interior: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm).
2. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.

E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

a. Minimum Base-Metal Thickness: 0.0329 inch (0.84 mm).
b. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.

2. Inner Track: Of web depth indicated, and as follows:

a. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm).

F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.5 SOFFIT FRAMING

A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch (1.37 mm).
2. Flange Width: 1-5/8 inches (41 mm), minimum.

2.6 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole-reinforcing plates.
11. Backer plates.

2.7 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36, zinc coated by hot-dip process according to ASTM A123.

B. Anchor Bolts: ASTM F1554, Grade 55, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153, Class C.

C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 as appropriate for the substrate.

1. Uses: Securing cold-formed steel framing to structure.
2. Type: Torque-controlled adhesive anchor or adhesive anchor.
3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.8 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A780 or SSPC-Paint 20.

B. Cement Grout: Portland cement, ASTM C150, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107, and with a fluid consistency and 30-minute working time.

D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

E. Sill Sealer Gasket: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

F. Sill Sealer Gasket/Termite Barrier: Minimum 68-mil nominal thickness, self-adhering sheet consisting of 64 mils of rubberized asphalt laminated on one side to a 4-mil- thick, polyethylene-film reinforcement, and with release liner on adhesive side.
   1. Physical Properties:
      a. Peel Adhesion: 17.0 lb/in of width when tested in accordance with ASTM D412.
      b. Low-Temperature Flexibility: Pass at minus 25 deg F when tested in accordance with ASTM D146.
      c. Water Vapor Permeance: 0.05 perm maximum when tested in accordance with ASTM E96, Method B.
      d. Resistance to Termite Penetration: Comply with ICC-ES AC380.

2.9 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

   1. Fabricate framing assemblies using jigs or templates.
   2. Cut framing members by sawing or shearing; do not torch cut.
   3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
   4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sill sealer gasket at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

E. Install sill sealer gasket/termite barrier in accordance with manufacturer's written instructions at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 INSTALLATION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.

3.5 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

3.6 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.7 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous steel framing and supports.
2. Shelf angles.
3. Metal ladders.
4. Miscellaneous steel trim.
5. Metal bollards.
6. Loose bearing and leveling plates.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:
1. Fasteners.
2. Shop primers.
3. Shrinkage-resisting grout.
4. Prefabricated building columns.
5. Slotted channel framing.
6. Manufactured metal ladders.
7. Metal bollards.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design ladders.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

D. Rolled-Stainless Steel Floor Plate: ASTM A793.

E. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.

F. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

G. Zinc-Coated Steel Wire Rope: ASTM A741.

1. Wire Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

H. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: 1-5/8 by 1-5/8 inches unless otherwise indicated.
2. Material: Galvanized steel, ASTM A653/A653M, commercial steel, Type B Grade 33 with G90 (Z275) coating; 0.108-inch nominal thickness.
3. Material: Cold-rolled steel, ASTM A1008/A1008M, commercial steel, Type B Grade 33 0.0966-inch minimum thickness; hot-dip galvanized after fabrication.

I. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

J. Aluminum Extrusions: ASTM B221 (ASTM B221M), Alloy 6063-T6.

K. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.

L. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

M. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).

N. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or UNS No. C84400 (leaded semired brass).

O. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening aluminum, stainless steel or nickel silver.
2. Provide bronze fasteners for fastening bronze.

B. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

C. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).

D. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

B. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

C. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

D. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

G. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

H. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 8 inches from ends and corners of units and 24 inches o.c.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

B. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.

1. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at 24 inches o.c.

C. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

2.7 PREFABRICATED BUILDING COLUMNS

A. General: Provide prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell. Fabricate connections to comply with details shown or as needed to suit type of structure indicated.

B. Fire-Resistance Ratings: Provide prefabricated building columns listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing in accordance with ASTM E119.

2.8 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inchesfrom ends and 24 inches o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.
2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize shelf angles located in exterior walls.

D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.9 METAL LADDERS

A. General:

1. Comply with ANSI A14.3.

B. Aluminum Ladders:
1. Space side rails 16 inches apart unless otherwise indicated.

2. Side rails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches deep, 3/4 inch wide, and 1/8 inch thick.
3. Rungs: Extruded-aluminum tubes, 1-1/4" square and not less than 1/8 inch thick, with ribbed tread surfaces.
4. Method of attachment: Per drawings.

2.10 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Prime exterior miscellaneous steel trim with zinc-rich primer.

2.11 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 80 steel pipe, 1/4-inch wall-thickness steel shapes, as indicated.

B. Fabricate bollards with 3/8-inch- thick, steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.

C. Fabricate sleeves for bollard anchorage from steel or stainless steel pipe or tubing with 1/4-inch-thick, steel or stainless steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.

D. Prime steel bollards with zinc-rich primer.

2.12 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Prime plates with zinc-rich primer.

2.13 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Galvanize loose steel lintels located in exterior walls.

C. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.14 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.15 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

2.16 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with universal shop primer.

C. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor shelf angles securely to existing construction.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

3.3 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with ANSI/AISC 360, "Specifications for Structural Steel Buildings," and with requirements applicable to listing and labeling for fire-resistance rating indicated.

3.4 INSTALLATION OF METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

B. Anchor bollards to existing construction with anchor bolts. Provide four 3/4-inch bolts at each bollard unless otherwise indicated.

1. Embed anchor bolts at least 4 inches in concrete.

C. Anchor bollards in concrete. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.

D. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

E. Fill bollards solidly with concrete, mounding top surface to shed water.

3.5 INSTALLATION OF BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.6 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

SECTION 064116 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad architectural cabinets and countertops.
2. Cabinet hardware and accessories.
3. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.
4. Refer to Section 123661.16 – Solid Surfacing for selective cabinet countertops

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product including information showing compliance with 2019 California Green Building Standards Code where applicable.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Apply AWI Quality Certification or WI Certified Compliance Program label to Shop Drawings.

C. Samples: For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and Installer.

B. Research reports.

C. Field quality control reports.

1.5 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: AWI Quality Certification Program or WI Certified Compliance Program certificates.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program or Licensed participant in WI's Certified Compliance Program.

B. Installer Qualifications: Manufacturer of products, Licensed participant in AWI's Quality Certification Program or Licensed participant in WI's Certified Compliance Program.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL CABINET MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by a company participating in AWI's Quality Certification Program or Licensed participant in WI's Certified Compliance Program.

2.2 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.

1. Provide labels and certificates from AWI or WI certification program indicating that woodwork complies with requirements of grades specified.

B. Architectural Woodwork Standards Grade: Custom.

C. Type of Construction: Frameless.

D. Door and Drawer-Front Style: Reveal overlay.

1. Reveal Dimension: 1/**2** inch.

E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.

F. Laminate Manufacturers offering products meeting requirements include but are not limited to the following:

1. Arborite
2. Formica
3. Nevamar
4. Wilsonart

G. Laminate Cladding for Exposed Surfaces:

1. Horizontal Surfaces: Grade HGS.
2. Postformed Surfaces: Grade HGP.
3. Vertical Surfaces: Grade HGS.
4. Edges: PVC T-mold matching laminate in color, pattern, and finish.
5. Pattern Direction: Vertically for drawer fronts, doors, and fixed panel.

H. Plastic Laminate Clad Countertops: Grade HGS. Fabricate as detailed and per AWI / WI standards.

I. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

J. Drawer Construction: Fabricate with exposed fronts fastened to sub-front with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

K. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated by laminate manufacturer's designations.
2. Match Architect's sample.
3. As selected by Architect from laminate manufacturer's full range in the following categories:

a. Solid colors, matte finish.
b. Solid colors with core same color as surface, matte finish.
c. Wood grains, matte finish.
d. Patterns, matte finish.

2.3 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Wood Moisture Content: 4 to 9 percent.

B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
2. Particleboard (Medium Density): ANSI A208.1, Grade M-2-Exterior Glue].
3. Softwood Plywood: DOC PS 1, medium-density overlay.
4. Thermoset Decorative Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2.4 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 087100 "Door Hardware."

B. Butt Hinges: 2-3/4-inch, five-knuckle steel hinges made from 0.095-inch thick metal, and as follows:
   1. Semi-concealed Hinges for Overlay Doors: ANSI/BHMA A156.9, B01521.

C. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 170 degrees of opening, self-closing.

D. Back-Mounted Pulls: ANSI/BHMA A156.9, B02011.

E. Wire Pulls: Back mounted, solid metal 4 inches long, 5/16 inch in diameter.

F. Catches: Magnetic catches, ANSI/BHMA A156.9, B03141

G. Adjustable Shelf Standards and Supports: ANSI/BHMA A156.9, B04071; with shelf rests, B04081.

H. Drawer Slides: ANSI/BHMA A156.9.

   1. Grade 1 and Grade 2: Side mounted and extending under bottom edge of drawer.

      a. Type: Full extension.
      b. Material: Zinc-plated steel with polymer rollers.

   2. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-extension type; zinc-plated-steel ball-bearing slides.
   3. For drawers not more than 3 inches high and not more than 24 inches wide, provide Grade 2.
   4. For drawers more than 3 inches high, but not more than 6 inches high and not more than 24 inches wide, provide Grade 1HD-100.
   5. For drawers more than 6 inches high or more than 24 inches wide, provide Grade 1HD-100.
   6. For computer keyboard shelves, provide Grade 1HD-100.
   7. For trash bins not more than 20 inches high and 16 inches wide, provide Grade 1HD-100.

I. Slides for Sliding Glass Doors: ANSI/BHMA A156.9, B07063; aluminum.

J. Door Locks: ANSI/BHMA A156.11, E07121.

K. Drawer Locks: ANSI/BHMA A156.11, E07041.

L. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.

M. Grommets for Cable Passage: 2-inch OD, molded-plastic grommets and matching plastic caps with slot for wire passage.

   1. Color: Black.

N. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.

1. Satin Stainless Steel: ANSI/BHMA 630.

O. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.5 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

C. Adhesive for Bonding Plastic Laminate: Contact cement.

1. Adhesive for Bonding Edges: As recommended by Manufacturer.
2. Adhesives General: Comply with VOC limits as described in the 2019 California Green Building Standards Code.

2.6 FABRICATION

A. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

B. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

C. Install glass to comply with applicable requirements in Section 088000 "Glazing" and in GANA's "Glazing Manual."

1. For glass in frames, secure glass with removable stops.
2. For exposed glass edges, polish and grind smooth.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

B. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.

C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.

D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.

1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish and toggle bolts through metal backing or metal framing behind wall finish.

3.2 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through AWI's Quality Certification Program or WI's Certified Compliance Program certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.

1. Inspection entity shall prepare and submit report of inspection.

END OF SECTION 064116

SECTION 071113 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied, cut-back-asphalt dampproofing.
2. Cold-applied, emulsified-asphalt dampproofing.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. VOC Content: Products shall comply with VOC content limits as defined by the 2019 California Green Building Standards Code.

2.2 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. ChemMasters, Inc.
2. Henry Company.
3. Karnak Corporation.

B. Trowel Coats: ASTM D4586/D4586M, Type I, Class 1, fibered.

C. Brush and Spray Coats: ASTM D4479/D4479M, Type I, fibered or nonfibered.

2.3 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. ChemMasters, Inc.
2. Henry Company.
3. Karnak Corporation.

B. Trowel Coats: ASTM D1227, Type II, Class 1.

C. Fibered Brush and Spray Coats: ASTM D1227, Type II, Class 1.

D. Brush and Spray Coats: ASTM D1227, Type III, Class 1.

2.4 AUXILIARY MATERIALS

A. Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

B. Emulsified-Asphalt Primer: ASTM D1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.

C. Protection Course: Extruded-polystyrene board insulation, unfaced, ASTM C578, Type X, 1/2 inch thick minimum.

PART 3 - EXECUTION

3.1 APPLICATION, GENERAL

A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless otherwise indicated.

1. Apply dampproofing to provide continuous plane of protection.
2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.

B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches over outside face of footing.

1. Extend dampproofing 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where indicated as "reinforced," by embedding an 8-inch- wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

3.2 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Concrete Foundations: Apply two brush or spray coats at not less than 1.25 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat or one trowel coat at not less than 4 gal./100 sq. ft.

3.3 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Concrete Foundations: Apply two brush or spray coats at not less than 1.5 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat or one trowel coat at not less than 4 gal./100 sq. ft.

3.4 PROTECTION COURSE INSTALLATION

A. Install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.

END OF SECTION 071113

SECTION 079100 – WATER REPELLENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes penetrating water-repellent treatments for the following vertical and horizontal surfaces:

1. CMU
2. Precast Architectural Concrete

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

PART 2 - PRODUCTS

2.1 PENETRATING WATER REPELLENTS

A. Silane, Penetrating Water Repellent: Clear, containing 20 percent or more solids of alkyltrialkoxysilanes; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 100 g/L or less of VOCs.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.

1. Verify that surfaces are clean and dry according to water-repellent manufacturer's requirements. Check moisture content in representative locations by method recommended by manufacturer.
2. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
3. Verify that required repairs are complete, cured, and dry before applying water repellent.

B. Test pH level according to water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.

3.2 PREPARATION

A. New Construction and Repairs: Allow concrete and other cementitious materials to age before application of water repellent, according to repellent manufacturer's written instructions.

B. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to water-repellent manufacturer's written instructions.

C. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.

1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

3.3 APPLICATION

A. Apply coating of water repellent on surfaces to be treated using low-pressure spray to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.

3.4 CLEANING

A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Correct damage to work of other trades caused by water-repellent application.

B. Comply with manufacturer's written cleaning instructions.

END OF SECTION 071900

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass-fiber blanket insulation.
2. Refer to Section 075323 - EPDM Roofing for roof insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:
1. Glass-fiber blanket insulation.

1.3 INFORMATIONAL SUBMITTALS

A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.

1. Sign, date, and post the certification in a conspicuous location on Project site.

B. Product test reports.

C. Research reports.

PART 2 - PRODUCTS

2.1 GLASS-FIBER BLANKET INSULATION

A. Glass-Fiber Blanket Insulation, Unfaced: ASTM C665, Type I; passing ASTM E136 for combustion characteristics.

1. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
2. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
3. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.2 ACCESSORIES

A. Insulation for Miscellaneous Voids:

1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.

2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Install insulation with manufacturer's R-value label exposed after insulation is installed.

D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.2 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft..
2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

END OF SECTION 072100

SECTION 072600 - VAPOR RETARDERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polyethylene vapor retarders.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for under-slab vapor retarders.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

PART 2 - PRODUCTS

2.1 POLYETHYLENE VAPOR RETARDERS

A. Polyethylene Vapor Retarders: ASTM D4397, 10-mil- thick sheet, with maximum permeance rating of 0.1 perm.

PART 3 - EXECUTION

3.1 INSTALLATION OF VAPOR RETARDERS ON FRAMING

A. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives, vapor retarder fasteners, or other anchorage system as recommended by manufacturer. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.

B. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs and sealing with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Locate all joints over framing members or other solid substrates.

C. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.

D. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

END OF SECTION 072600

SECTION 074113.16 - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standing-seam metal roof panels.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.

C. Samples: For each type of metal panel indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Warranties: Sample of special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.
2. Deflection Limits: For wind loads, no greater than 1/180 of the span.

B. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS

A. Manufacturer/Product: Basis of Design Product is AEPSpan’s SpanSeam Metal Roofing Panel. Other Manufacturers offering products meeting requirements include but are not limited to the following:

1. Atas
2. Centria
3. MBCI

B. Description: Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using

concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.

1. Size: 16” width x required length.
2. Thickness: 22 gauge
3. Seam height: 2” after seaming
4. Pencil Ribs: 6 inches on center with striated pattern.
5. Sealant: Factory-applied butyl mastic.
6. Factory notch panels.
7. Comply with ASTM E1514.
8. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation; structural quality. Pre-painted by the coil-coating process to comply with ASTM A755/A755M.
9. Panel Finish: DuraTech 5000 Polyvinylidine Fluoride; 70% Kynar 500 or Hylar 5000 with 0.15-0.20 mil corrosion-resistant primer and 0.70-0.80 mil finish coat. Concealed Finish: White or light-colored acrylic or polyester backer finish.
10. Color: As selected by Architect from Manufacturer’s full range.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or pre-molded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Gutter: Formed from same material as roof panels according to SMACNA's "Architectural Sheet Metal Manual." Finish to match metal roof panels. Provide screened top to prevent debris accumulation meeting regional location requirements for CALFIRE. Gutter shall be open ended.

E. Panel Fasteners: Self-tapping screws designed to withstand design loads.

F. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are non-staining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/2 inch wide and 1/8 inch thick.
2. Joint Sealant: ASTM C920; as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.4 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Miscellaneous Supports: Install sub-framing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.2 INSTALLATION OF STANDING SEAM METAL ROOF PANELS

A. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

1. Install clips to supports with self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.

B. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

C. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.3 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION 074113.16

SECTION 074213.13 - FORMED METAL WALL AND SOFFIT PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concealed-fastener, lap-seam metal wall panels.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.

C. Samples: For each type of metal panel indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Warranties: Samples of special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/180

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 CONCEALED-FASTENER, LAP-SEAM METAL WALL & SOFFIT PANELS

A. Provide factory-formed metal panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.

B. Basis of Design Product: AEP Span’s Prestige metal siding and soffit panel. Other Manufacturers offering similar products include but are not limited to the following:

1. Centria
2. Fabral
3. Kingspan
4. Metal Sales

C. Description: Factory-formed concealed fastener metal wall and soffit panel system.

1. Size: 12” width x up to 40’

2. Thickness: 22 gage
3. Reveal: 0”
4. Pencil Ribs: 2 equally spaced
5. Materials: Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation; structural quality. Pre-painted by the coil-coating process to comply with ASTM A755/A755M.
6. Exterior Finish: Two-coat fluoropolymer or three-coat fluoropolymer
7. Color: As selected by Engineer from manufacturer's full range.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A792/A792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, end-walls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are non-staining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/2 inch wide and 1/8 inch thick.
2. Joint Sealant: ASTM C920; as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.4 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.5 FINISHES

A. Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621 Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat or
2. Three-Coat Fluoropolymer: AAMA 621 Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat.
3. Concealed Finish: White or light-colored acrylic or polyester backer finish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Miscellaneous Supports: Install sub-framing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.2 INSTALLATION

A. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.

1. Lap ribbed or fluted sheets one full rib. Apply panels and associated items true to line for neat and weathertight enclosure.
2. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
3. Flash and seal panels with weather closures at perimeter of all openings.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners

where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

3.3 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION 074213.13

SECTION 075419 - POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Adhered polyvinyl chloride (PVC) roofing system.
2. Accessory roofing materials.
3. Substrate board.
4. Roof insulation.
5. Insulation accessories and cover board.
6. Walkways.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.

B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation thickness and slopes.
5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Roof membrane and flashing, of color required.
8. Walkway pads or rolls, of color required.

C. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

B. Product Test Reports: For roof membrane and insulation, tests performed by independent qualified testing agency indicating compliance with specified requirements.

C. Field quality-control reports.

D. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: A qualified manufacturer that is listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.
2. Installers: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.

B. Impact Resistance: Roof membrane to resist impact damage when tested according to ASTM D3746, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

C. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

D. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897:

1. Zone 1 (Roof Area Field): 43 lbf/sq. ft.; Minimum Wind Uplift Rating 1-90.
2. Zone 2 (Roof Area Perimeter): 55 lbf/sq. ft.; Minimum Wind Uplift Rating 1-120.
    a. Location: From roof edge to 0.60*H inside roof edge.
3. Zone 3 (Roof Area Corners): 72 lbf/sq. ft.; Minimum Wind Uplift Rating 1-150.
    a. Location: 0.60*H in each direction from building corner.

E. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

1. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 MH.

F. Energy Star Listing: Roofing system to be listed on the DOE's Energy Star "Roof Products Qualified Product List" for low-slope roof products.

G. Energy Performance: Roofing system to have an initial solar reflectance of not less than 0.63 and an emissivity of not less than 0.75 when tested in accordance with ANSI/CRRC S100.

H. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class C; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

I. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.2 POLYVINYL CHLORIDE (PVC) ROOFING

A. PVC Sheet Type III: ASTM D4434/D4434M, fabric reinforced.

1. Thickness: 60 mils.
2. Exposed Face Color: White.

2.3 ACCESSORY ROOFING MATERIALS

A. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.

1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as PVC sheet.

C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

D. Bonding Adhesive: Manufacturer's standard, water based.

E. Water-Based, Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard water-based, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.

F. Low-Rise, Urethane, Fabric-Backed Membrane Adhesive: Roof system manufacturer's standard spray-applied, low-rise, two-component urethane adhesive formulated for compatibility and use with fabric-backed membrane roofing.

G. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

H. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.

I. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.4 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Thickness: Type X, 5/8 inch.

B. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: 5/8 inch.

C. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.5 ROOF INSULATION

A. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

1. Size: 48 by 48 inches.

B. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: Match roof insulation.
2. Minimum Thickness: 1/2 inch.
3. Slope:
    a. Roof Field: Varies; minimum 1/2" inch per foot unless otherwise indicated on Drawings.
    b. Saddles and Crickets: minimum 1/4 inch per foot unless otherwise indicated on Drawings.

2.6 INSULATION ACCESSORIES AND COVER BOARD

A. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening base layout of roof insulation to substrate, and acceptable to roofing system manufacturer.

B. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:

1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
2. Full-spread, spray-applied, low-rise, two-component urethane adhesive.

C. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, Type-X, water-resistant gypsum board.

1. Thickness: 1/2 inch.
2. Surface Finish: Fiberglass facer.

D. Fiber-Reinforced Gypsum Roof Board: ASTM C1278/C1278M, Type-X, cellulosic-fiber reinforced, water-resistant gypsum board.

1. Thickness: 1/2 inch.

E. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

2.7 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch thick and acceptable to roofing system manufacturer.

1. Size: Approximately 36 by 60 inches.
2. Color: Contrasting with roof membrane.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."

3.2 PREPARATION

A. Perform fastener-pullout tests according to roof system manufacturer's written instructions.

1. Submit test result within 24 hours of performing tests.

a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

3.3 INSTALLATION OF ROOFING, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches (610 mm) in adjacent rows.

1. At steel roof decks, install substrate board at right angle to flutes of deck.
    a. Locate end joints over crests of steel roof deck.
2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel deck according to recommendations in [FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.

3.5 INSTALLATION OF INSULATION

A. Coordinate installing roofing system components, so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Installation Over Metal Decking (Over Substrate Board):

1. Install base layer of insulation with joints staggered not less than 24 inches in adjacent rows, end joints staggered not less than 12 inches (305 mm) in adjacent rows and with long joints continuous at right angle to flutes of decking.
    a. Locate end joints over crests of decking.
    b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    c. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.

d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).

1) Trim insulation so that water flow is unrestricted.

e. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
f. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
g. Mechanically attach base layer of insulation and substrate board using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.

1) Fasten insulation according to requirements in FM Approvals' RoofNav for specified Windstorm Resistance Classification.
2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.

a. Staggered end joints within each layer not less than 24 inches (610 mm) in adjacent rows.
b. Install with long joints continuous and with end joints staggered not less than 12 inches (305 mm) in adjacent rows.
c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
d. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
f. Trim insulation so that water flow is unrestricted.
g. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
h. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
i. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

1) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
2) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.6 INSTALLATION OF COVER BOARDS

A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks
2. At internal roof drains, conform to slope of drain sump.
3. Cut and fit cover board tight to nailers, projections, and penetrations.

4. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows.

   a. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place. Per Manufacturer's standard installation instructions.

B. Place plates on insulation in required fastening patterns to achieve FM rating and secure in accordance with manufacturer's instructions.

1. Install plates and fasteners tight and flat to substrate with no dimpling, and with fastener extending 1 inch (25 mm) minimum into roof deck; do not overdrive fasteners.

3.7 INSTALLATION OF ADHERED ROOF MEMBRANE

A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.

B. Unroll roof membrane and allow to relax before installing.

C. Accurately align roof membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.

E. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.

F. Apply roof membrane with side laps shingled with slope of roof deck where possible.

G. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.

H. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.8 INSTALLATION OF BASE FLASHING

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.9 INSTALLATION OF WALKWAYS

A. Flexible Walkways: Install walkway products according to manufacturer's written instructions.

1. Install flexible walkways at the following locations:
    a. Perimeter of each rooftop unit.
    b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
    c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
    d. Top and bottom of each roof access ladder.
    e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
    f. Locations indicated on Drawings.
    g. As required by roof membrane manufacturer's warranty requirements.
2. Provide 6-inch (76-mm) clearance between adjoining pads.
3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.

C. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

3.10 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075419

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Formed roof-drainage sheet metal fabrications.
   2. Formed low-slope roof sheet metal fabrications.
   3. Formed wall sheet metal fabrications.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

B. Product Data: For each of the following

   1. Underlayment materials.
   2. Elastomeric sealant.
   3. Butyl sealant.
   4. Metal and finishes.

C. Shop Drawings: For sheet metal flashing and trim.

   1. Include plans, elevations, sections, and attachment details.
   2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
   3. Include identification of material, thickness, weight, and finish for each item and location in Project.
   4. Include details for forming, including profiles, shapes, seams, and dimensions.
   5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
   6. Include details of termination points and assemblies.
   7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
   8. Include details of roof-penetration flashing.
   9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
   10. Include details of special conditions.
   11. Include details of connections to adjoining work.

D. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

B. Special warranty.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1.6 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. SPRI Wind Design Standard: Manufacture and install copings/roof edge flashing capable of resisting the design wind pressure:

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint

sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 (Z275) coating designation or aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation, Grade 40 (Grade 275)]; pre-painted by coil-coating process to comply with ASTM A755/A755M.

1. Surface: Smooth, flat.
2. Exposed Coil-Coated Finish:

    a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions, or
    b. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Color: As indicated on the drawings or as selected by Engineer from Manufacturer’s full color product range.
4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

C. Lead Sheet: ASTM B749 lead sheet.

2.3 UNDERLAYMENT MATERIALS

A. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.

B. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.

1. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F or lower.

C. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

    a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
    c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2. Fasteners for Zinc-Coated (Galvanized or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C920, elastomeric polyurethane, polysulfide, or silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

G. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

H. Reglets: Where indicated, provide units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with

1. Material: Stainless steel, 0.0188 inch thick.
2. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
3. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
4. Accessories:

a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.

2.5 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.

1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, non-expansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Seams:

1. Fabricate nonmoving seams with flat-lock seams.
2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Material: Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 (Z275) coating designation or aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation, Grade 40 (Grade 275)]; pre-painted by coil-coating process to comply with ASTM A755/A755M.

1. Surface: Smooth, flat.
2. Exposed Coil-Coated Finish:

    a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions, or
    b. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Color: As indicated on the drawings or as selected by Engineer from Manufacturer’s full color product range.
4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

B. Gutters, downspouts and collectors: Fabricate to dimensions shown on plans and according to SMACNA's "Architectural Sheet Metal Manual" requirements.

C. Connect downspouts to storm drainage system per plan.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof Edge Flashing and Fascia Cap: Fabricate in minimum 96-inch-long, but not exceeding 12-foot- long sections. Furnish with 6-inch-wide, joint cover plates. Shop fabricate interior and exterior corners**.**

1. Fabricate from the following materials:

    a. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch.

B. Copings: Fabricate in minimum 96-inch-long, but not exceeding 12-foot-long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, fasten and seal watertight. Shop fabricate interior and exterior corners.

1. Fabricate from the following materials:
    a. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch thick.

C. Base Flashing: Shop fabricate interior and exterior corners.]Fabricate from the following materials:
1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

D. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
   1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

E. Roof-Penetration Flashing: Fabricate from the following materials:
   1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

2.8 INSTALLATION, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

   1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
   2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
   3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
   4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
   5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
   6. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
   7. Do not field cut sheet metal flashing and trim by torch.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

   1. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

   1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
   2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
   3. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 3/4 inch for wood screws and not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated.

    a. Embed hooked flanges of joint members not less than 1 inch into sealant.
    b. Form joints to completely conceal sealant.
    c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
    d. Adjust setting proportionately for installation at higher ambient temperatures.

        1) Do not install sealant-type joints at temperatures below 40 deg F.

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

G. Rivets: Rivet joints where necessary for strength.

2.9 INSTALLATION OF ROOF-DRAINAGE SYSTEM

A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Downspouts:

1. Join sections with 1-1/2-inch telescoping joints.
2. Provide hangers with fasteners designed to hold downspouts securely to walls.
3. Locate hangers at top and bottom and at approximately 60 inches o.c.

2.10 INSTALLATION OF ROOF FLASHINGS

A. Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard.

1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

C. Copings:

1. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.

1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
2. Extend counterflashing 4 inches over base flashing.
3. Lap counterflashing joints minimum of 4 inches.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with Roof Manufacturer’s recommended sealant and clamp flashing to pipes that penetrate roof.

2.11 INSTALLATION OF WALL FLASHINGS

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing and reglets with installation of wall-opening components such as windows, doors, and louvers.

2.12 INSTALLATION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

2.13 CLEANING

A. Clean off excess sealants.

2.14 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 076200

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof curbs.
2. Equipment supports.
3. Roof hatches.
4. Safety Equipment
5. Roof walk pads

1.2 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.

B. Shop Drawings: For roof accessories.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within **10** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ROOF CURBS

A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded

or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.

B. Manufacturers: Manufacturers offering products meeting requirements include but are not limited to the following:
   1. Bilco
   2. Dayton
   3. RCS
   4. Thybar

C. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

D. If available, provide product produced by same manufacturer as mechanical equipment that it is scheduled to support.

E. Material:Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet, 0.052 inch minimum thickness.

   1. Finish: Two-coat fluoropolymer, Baked enamel or powder coat finish.
   2. Color: As selected by Architect from manufacturer's full range.

F. Construction:

   1. Curb Profile: Manufacturer's standard compatible with roofing system.
   2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
   3. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
   4. Top Surface: Level top of curb, with roof slope accommodated.
   5. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
   6. Insulation: Factory insulated with 1-1/2-inch- thick glass-fiber board insulation.
   7. Liner: Same material as curb, of manufacturer's standard thickness and finish.
   8. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
   9. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch-equired for curb.
   10. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

2.2 EQUIPMENT SUPPORTS

A. Equipment Supports: Where indicated or required, provide rail-type metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements; with welded corner joints, and integrally formed structure-mounting flange at bottom.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Material: Zinc-coated (galvanized), Aluminum-zinc alloy-coated steel sheet, 0.052 inch thick.

1. Finish: Two-coat fluoropolymer or Baked enamel or powder coat finish.
2. Color: As selected by Architect from manufacturer's full range.

D. Construction:

1. Curb Profile: Manufacturer's standard compatible with roofing system.
2. Insulation: Factory insulated with 1-1/2-inch-thick glass-fiber board insulation.
   a. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
3. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to meet wind uplift requirements.
4. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch-thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
5. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
6. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
7. Fabricate equipment supports to minimum height of 12 inches above roofing surface unless otherwise indicated.
8. Sloping Roofs: Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

2.3 ROOF HATCHES

A. Manufacturer/Product: Basis of Design Product is Bilco’s Model E Roof Hatch – Ladder Access. Other Manufacturers offering products meeting requirements include but are not limited to:
1. Acudor
2. Babcock Davis
3. Elmdor
4. Milcor

B. Description: 36" x 36". Includes counter-balanced cover design for one-hand operation. Fully gasketed and insulated construction for weather resistance. Available in galvanized steel construction.

2.4 ROOF HATCH SAFETY RAILING SYSTEM

A. Manufacturer/Product: Basis of Design Product is Bilco’s Bil-Guard 2.0 Model RL2-E for 36x36 roof hatch. Other Manufacturers offering products meeting requirements include but are not limited to:

1. Acudor
2. Babcock Davis
3. Elmdor
4. Milcor

B. Description: 3-sided aluminum rail construction with powder coat paint finish and hinged latching safety gate surrounding access hatch.
   1. Comply OSHA 29 CFR 1910.29
   2. Standard self-closing and latching gate feature ensures that the opening is protected at all times.
   3. Non-penetrating attachment attaches directly to the roof hatch cap flashing
   4. High visibility safety yellow color
   5. Corrosion resistant construction with 5-year warranty

2.5 METAL MATERIALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 (Z275) coating designation.
   1. Exposed Coil-Coated Finish: Pre-painted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

      a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.

   2. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
   3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, AZ50 (AZM150) coated.
   1. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

      a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.

   2. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
   3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

C. Aluminum Sheet: ASTM B209 (ASTM B209M), manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.

1. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

D. Aluminum Extrusions and Tubes: ASTM B221 (ASTM B221M), manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.

E. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.

F. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.

G. Steel Tube: ASTM A500/A500M, round tube.

H. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.

I. Steel Pipe: ASTM A53/A53M, galvanized.

2.6 ROOF WALKWAY PADS

A. Provide Roofing Manufacturer’s standard pads or pads recommended by the Roofing Manufacturer in writing. Install and space so that pads allow for drainage.

2.7 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 1, thickness as indicated.

C. Glass-Fiber Board Insulation: ASTM C726, nominal density of 3 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F, thickness as indicated.

D. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

E. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

F. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

G. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

H. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify dimensions of roof openings for roof accessories. Install roof accessories according to manufacturer's written instructions.

1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum and stainless steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.

C. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

D. Roof Pad Installation: Follow Manufacturer’s written directions.

3.2 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting."

C. Clean exposed surfaces according to manufacturer's written instructions.

D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Silicone joint sealants.
   2. Urethane joint sealants.
   3. Immersible joint sealants.
   4. Mildew-resistant joint sealants.
   5. Latex joint sealants.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples: For each kind and color of joint sealant required.

C. Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.
   3. Joint-sealant formulation.
   4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports including VOC content showing compliance with State of California limits.

B. Field-adhesion-test reports.

C. Sample warranties.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C1021 to conduct the testing indicated.

1.6 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Verify with the Manufacturer of the material/product being sealed that the proposed sealant is compatible with their product/system. The Manufacturer may have specific recommendations or preferences on sealant selection. Generally, follow the Manufacturers' recommendations and where it differs from this specification, state this in the sealant product submittal.

B. Environmental Compliance: Sealants shall meet the VOC limits of the Authority having jurisdiction.

C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANT – JS#1

A. Silicone, S, NS, 50, NT: Single-component, non-sag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. GE Construction Sealants; Momentive Performance Materials Inc.
      b. Pecora Corporation.
      c. Sika Corporation; Joint Sealants.
   2. Locations/uses: General purpose concealed interior/exterior sealant.

2.3 URETHANE JOINT SEALANT – JS#2

A. Urethane, S, NS, 25, T-NT, M, G, A, O: Single-component, non-sag, traffic and nontraffic-use, plus 100 \ percent and minus 50 percent movement capability, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use T, NT, G, A, O, M.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Bostik, Inc.
b. Pecora Corporation.
c. Sika Corporation; Joint Sealants.

2. Locations/uses: General purpose exposed interior/exterior sealant. Color: match adjacent materials.

2.4 IMMERSIBLE JOINT SEALANT – JS#3

A. Urethane, Immersible, S, NS, 25, T, NT, I: Immersible, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T, NT, and I.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. BASF Corporation.
   b. Pecora Corporation.
2. Locations/uses: General purpose exposed interior/exterior wet areas sealant. Color: match adjacent materials.

2.5 MILDEW-RESISTANT JOINT SEALANT – JS#4

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth. Acrylic Latex and Siliconized Latex. Use in restrooms and showers for vertical and horizontal joints. Color: Match adjacent material color.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. DAP
   b. GE
2. Locations/uses: General purpose exposed interior wet areas sealant. Color: match adjacent materials.

2.6 LATEX JOINT SEALANT – JS#5

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. May National Associates (SIKA)
   b. Pecora Corporation
   c. Sherwin-Williams Company
2. Locations/uses: General purpose exposed interior dry areas sealant. Color: match adjacent materials.

2.7 METAL BUILDING SEALANTS

A. Refer to Section 133419 “Metal Building Systems”.

2.8 JOINT-SEALANT BACKING

A. Cylindrical Sealant Backings: ASTM C1330, Type C, closed-cell material with a surface skin and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Adfast.
      b. Alcot Plastics Ltd.
      c. BASF Corporation.

B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.9 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

   1. Remove laitance and form-release agents from concrete.
   2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces.

3.2 INSTALLATION OF JOINT SEALANTS

A. General: Comply with ASTM C1193 and joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   1. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.

3.3 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
   1. Extent of Testing: Test completed and cured sealant joints as follows:
      a. Perform a minimum of two tests for each joint type, materials and job condition present.
   2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Interior standard steel doors and frames.
2. Exterior standard steel doors and frames.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Field quality control reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Manufacturers offering products meeting requirements include but are not limited to the following:

a. Ceco Door
b. Curries Company
c. Custom Metal Products
d. Gensteel Doors
e. Mesker Door Inc.

2.2 PERFORMANCE REQUIREMENTS

A. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.37 deg Btu/F x h x sq. ft when tested according to ASTM C518.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Standard-Duty Doors and Frames: ANSI/SDI A250.8, Level 1; ANSI/SDI A250.4, Level C.

1. Locations: All Interior Doors.

2. Doors:

   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: 1-3/4 inches.
   c. Face: Metallic-coated steel sheet, minimum thickness of 0.032 inch.
   d. Edge Construction: Model 1, Full Flush.
   e. Core: Manufacturer's standard
   f. Fire-Rated Core: Manufacturer's standard.

3. Frames:

   a. Materials: Metallic-coated steel sheet, minimum thickness of 0.042 inch.
   b. Sidelites, Transom and Relite Frames: Fabricated from same thickness material as adjacent door frame.
   c. Construction: Face welded.

2.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.

1. Locations: All exterior doors unless scheduled otherwise.

2. Doors:

   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: 1-3/4 inches.
   c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 (ZF180) coating.
   d. Edge Construction: Model 1, Full Flush
   e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
   f. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.

g. Core: Manufacturer's standard meeting required insulation values.

3. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 (ZF180) coating.
b. Construction: Face welded.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
3. Postinstalled Expansion Anchor: Minimum 3/8-inch-diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.6 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

G. Glazing: Comply with requirements in Section 088000 "Glazing."

2.7 FABRICATION

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite, Transom Bar and Relite Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with square stops unless otherwise indicated.
2. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
3. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
4. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.8 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

    a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
    b. Install frames with removable stops located on secure side of opening.
2. Floor Anchors: Secure with post-installed expansion anchors.

    a. Floor anchors may be set with power-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.

3. Solidly pack mineral-fiber insulation inside frames.
4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
5. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

B. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8 guide specification indicated.
2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors according to NFPA 105.

C. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Inspections: Inspect each installation to verify conformance with specification and satisfactory functional operation.

B. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

C. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.4 REPAIR

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes access doors and frames for walls and ceilings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of access door and frame and for each finish specified.

C. Product Schedule: For access doors and frames. Use same designations indicated on Drawings.

1.3 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of applicable room name and number in which access door is located.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection and temperature-rise limit ratings indicated, according to NFPA 252 or UL 10B.

2.2 ACCESS DOORS AND FRAMES

A. Manufacturer: Manufacturers offering products meeting requirements include but are not limited to the following”

1. Babcock-Davis
2. J.L. Industries, Inc.
3. Larsen’s Manufacturing Company
4. Milcor

B. Flush Access Doors with Exposed Flanges

1. Description: Face of door flush with frame, with exposed flange and concealed hinge.
2. Locations: Typical for most wall and ceilings.
3. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage primed.
4. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch, 16 gage factory primed.

5. Stainless Steel Sheet for Door at wet locations only: Nominal 0.062 inch 16 gage, ASTM A480/A480M No. 4 finish.
6. Frame Material at wet locations: Same material, thickness, and finish as door.
7. Latch and Lock: Cam latch, screwdriver operated.

2.3 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

D. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, Type 316. Remove tool and die marks and stretch lines, or blend into finish.

E. Stainless Flat Bars: ASTM A666, Type 316. Remove tool and die marks and stretch lines, or blend into finish.

F. Frame Anchors: Same material as door face.

G. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.4 FABRICATION

A. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

B. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.

C. Latch and Lock Hardware:

1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.

2.5 FINISHES

A. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Adjust doors and hardware, after installation, for proper operation.

3.2 FIELD QUALITY CONTROL

A. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

B. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

END OF SECTION 083113

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum-framed storefront systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
2. Include point-to-point wiring diagrams.

C. Samples: For each type of exposed finish required.

D. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams.

1.4 INFORMATIONAL SUBMITTALS

A. Energy Performance Certificates: NFRC-certified energy performance values from manufacturer.

B. Product test reports.

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked-enamel, powder-coat, or organic finishes within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

a. Thermal stresses transferring to building structure.
b. Glass breakage.
c. Noise or vibration created by wind and thermal and structural movements.

d. Loosening or weakening of fasteners, attachments, and other components.
e. Failure of operating units.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.

D. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to /175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch .

a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.

E. Structural: Test according to ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Water Penetration under Static Pressure: Test according to ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. (480 Pa).

G. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor):

a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.41 Btu/sq. ft. x h x deg F as determined according to NFRC 100.

2. Solar Heat-Gain Coefficient (SHGC):

a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.26 as determined according to NFRC 200.

3. Air Leakage:

a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft. when tested according to ASTM E283.
b. Entrance Doors: Air leakage of not more than 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.

4. Condensation Resistance Factor (CRF):

a. Fixed Glazing and Framing Areas: CRF for the system of not less than 35 as determined according to AAMA 1503.
b. Entrance Doors: CRF of not less than 57 as determined according to AAMA 1503.

H. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for appropriate Wind Zone for basic protection.

1. Large-Missile Test: For glazing located within 30 feet of grade.

I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 STOREFRONT SYSTEMS

A. Manufacturer: Basis of Design Product/Manufacturer is Kawneer’s 501T Framing System. Manufacturers offering similar products meeting requirements included but are not limited to the following:

1. Arcadia
2. EFCO
3. US Aluminum
4. Wausau

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Exterior Framing Construction: Thermally broken, exterior glazed.
2. Glazing System: Retained mechanically with gaskets on four sides.
3. Finish: Baked-enamel or powder-coat finish.
4. Fabrication Method: Field-fabricated stick system.
5. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
6. Steel Reinforcement: As required by manufacturer.

C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.

2.3 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: As recommended by manufacturer.

2.4 MATERIALS

A. Sheet and Plate: ASTM B209 (ASTM B209M).

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221 (ASTM B221M).

C. Extruded Structural Pipe and Tubes: ASTM B429/B429M.

D. Structural Profiles: ASTM B308/B308M.

E. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

F. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.

2.5 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from interior for vision glass and exterior for metal panels.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.6 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: As selected by Engineer from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Seal perimeter and other joints watertight unless otherwise indicated.

G. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.

I. Install joint filler behind sealant as recommended by sealant manufacturer.

J. Install components plumb and true in alignment with established lines and grades.

3.2 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 088000 "Glazing."

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed entrances and storefronts.

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.

a. Perform a minimum of two tests in areas as directed by Engineer.

2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.

a. Perform a minimum of two tests in areas as directed by Architect.

3. Water Penetration: ASTM E1105 at a minimum uniform static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.

C. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 084113

SECTION 085113 - ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Aluminum transaction windows for control booths.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

C. Samples: For each exposed product finish color.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Sample warranties.

1.4 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.

   1. Warranty Period:

      a. Window: 10 years from date of Substantial Completion.
      b. Glazing Units: Five years from date of Substantial Completion.
      c. Aluminum Finish: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 WINDOW PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: AAMA certified.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: CW
2. Minimum Performance Grade: 30

C. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 52.

D. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F ambient; 180 deg F material surfaces.

E. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 1 basic protection.

1. Large-Missile Test: For glazing located within 30 feet of grade.
2. Small-Missile Test: For glazing located between 30 feet above grade.

2.2 ALUMINUM SINGLE SLIDING AUTOMATIC TRANSACTION WINDOW

A. Manufacturer/Product: Basis of Design is Quikserv's Self-Closing Transaction Window (similar to IF-4035E). Other Manufacturers offering similar products meeting requirements may submit company and product information for review and approval.

B. Type: Sliding/fully automatic opening, closing and latching. Sash glides on a top-hung ball bearing system.

C. Size: Custom size. Refer to drawings.

D. Slide direction: Refer to drawings.

E. Features:
1. Shipped fully assembled and ready to install
2. Warranty backed with Nationwide Service Centers
3. Weather-resistant and sealed to protect from the elements
4. Corrosion-resistant material: anodized aluminum and #304-#3 finish stainless steel
5. Security locking systems
6. Maximum security hook-bolt locks
7. Automatically locks every time the door closes to prevent outside penetration
8. Right or left-hand units (refer to Drawings)
9. Manual operation functional during power outages.

F. Frames and Sashes: Aluminum extrusions complying with AMA/WDMA/CSA 101/I.S.2/A440.

G. Glazing System: Polycast BR bullet-resistant acrylic glazing

1. Thickness: 1.25”
2. U.L. Designation: 752, Level 1
3. Coating: Polycast SAR Super Abrasion-Resistant Coating
4. Tints: None, clear

H. Hardware, General: Provide manufacturer's standard corrosion-resistant hardware sized to accommodate sash weight and dimensions.

1. Exposed Hardware Color and Finish: As selected by Engineer from manufacturer's full range.

I. Horizontal-Sliding Window Hardware:

1. Sill Cap/Track: Designed to comply with performance requirements indicated and to drain to the exterior.
2. Locks and Latches: Operated from the inside only.
3. Roller Assemblies: Low-friction design.

J. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.

K. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components. Do not use exposed fasteners

L. Aluminum Frames: Complying with SMA 1004 or SMA 1201.

M. Aluminum Finish: Custom Kynar or baked enamel painted finish.

2.3 FABRICATION

A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Glaze aluminum windows in the factory.

C. Weather strip each operable sash to provide weathertight installation.

D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

E. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.4 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
1. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating;

Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.

2. High-Performance Organic Finish (Two or Three-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.

3. Color and Gloss: Match Engineer's sample.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

E. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

F. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

G. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

END OF SECTION 085113

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes: Finish Hardware for door openings, except as otherwise specified herein.

1. Door hardware for steel and aluminum doors and frames.
2. Keyed cylinders as indicated.

B. Related Sections:

1. Division 8: Metal Doors and Frames.
2. Division 8: Aluminum Framed Entrances and Storefronts
3. Division 26: Electrical (for power and communications)

C. References: Comply with applicable requirements of the following standards. Where these standards conflict with other specific requirements, the most restrictive shall govern.

1. Builders Hardware Manufacturing Association (BHMA)
2. NFPA 101 Life Safety Code
3. ANSI-A156 – Various Performance Standards for Finish Hardware
4. UL10C – Positive Pressure Fire Test of Door Assemblies
5. ANSI-A117.1 – Accessible and Usable Buildings and Facilities
6. DHI /ANSI A115.IG – Installation Guide for Doors and Hardware
7. IBC – International Building Code as adopted by AHJ

D. Intent of Hardware Groups

1. Should items of hardware not definitely specified be required for completion of the Work, furnish such items of type and quality comparable to adjacent hardware and appropriate for service required.
2. Where items of hardware aren’t definitely or correctly specified, are required for completion of the Work, a written statement of such omission, error, or other discrepancy to be submitted to Architect, prior to date specified for receipt of bids for clarification by addendum; or, furnish such items in the type and quality established by this specification, and appropriate to the service intended.

1.2 SUBSTITUTIONS:

A. Items specified in this section are products which are of acceptable design.

B. Do not substitute products without Architect's written prior approval per Division 1. Requests for approval shall be submitted by factory authorized distributor firms representing the products proposed for substitution. Items that are noted to allow no substitution are matching existing materials and the owner’s material inventory for servicing the facility.

1.3 SUBMITTALS:

A. Comply with Division 1.

B. Special Submittal Requirements: Combine submittals of this Section with Sections listed below to ensure the "design intent" of the system/assembly is understood and can be reviewed together.

C. Product Data: Manufacturer's specifications and technical data including the following:

1. Detailed specification of construction and fabrication.
2. Manufacturer's installation instructions.
3. Submit 6 copies of catalog cuts with hardware schedule.
4. Provide 9001-Quality Management and 14001-Environmental Management for products listed in Materials Section 2.2

D. Shop Drawings - Hardware Schedule: Submit 6 complete reproducible copy of detailed hardware schedule in a vertical format.

1. List groups and suffixes in proper sequence.
2. Completely describe door and list architectural door number.
3. Manufacturer, product name, and catalog number.
4. Function, type, and style.
5. Size and finish of each item.
6. Mounting heights.
7. Explanation of abbreviations and symbols used within schedule.

E. Templates: Submit templates and "reviewed Hardware Schedule" to door and frame supplier and others as applicable to enable proper and accurate sizing and locations of cutouts and reinforcing.

1. Templates, wiring diagrams and "reviewed Hardware Schedule" of electrical terms to electrical for coordination and verification of voltages and locations.

F. Contract Closeout Submittals: Comply with Division 1 including specific requirements indicated.

1. Operating and maintenance manuals: Submit 3 sets containing the following.

a. Complete information in care, maintenance, and adjustment, and data on repair and replacement parts, and information on preservation of finishes.
b. Catalog pages for each product.
c. Name, address, and phone number of local representative for each manufacturer.
d. Parts list for each product.

2. Copy of final hardware schedule, edited to reflect, "As installed".
3. Copy of final keying schedule
4. One set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

1.4 QUALITY ASSURANCE

A. Comply with Division 1.

1. Statement of qualification for distributor and installers.
2. Statement of compliance with regulatory requirements and single source responsibility.

3. Distributor's Qualifications: Firm with 3 years experience in the distribution of commercial hardware.

    a. Distributor to employ full time Architectural Hardware Consultants (AHC) for the purpose of scheduling and coordinating hardware and establishing keying schedule.
    b. Hardware Schedule shall be prepared and signed by an AHC.

4. Installer's Qualifications: Firm with 3 years experienced in installation of similar hardware to that required for this Project, including specific requirements indicated.
5. Regulatory Label Requirements: Provide testing agency label or stamp on hardware for labeled openings.

    a. Provide UL listed hardware for labeled and 20-minute openings in conformance with requirements for class of opening scheduled.
    b. Underwriters Laboratories requirements have precedence over this specification where conflict exists.

6. Single Source Responsibility: Except where specified in hardware schedule, furnish products of only one manufacturer for each type of hardware.
7. Provide hardware for all openings, whether specified or not, in compliance with NFPA Standard No. 80, proper operation and local building code requirements. Where required, provide only hardware which has been tested and listed by UL or FM for types and sizes of doors required and complies with requirements of door and door frame labels. Label hardware, as required, for compliance with pressure testing criteria as dictated in IBC.
8. Provide hardware which meets or exceeds handicap accessibility per local building code requirements. Conform to the Americans with Disabilities Act (ADA) of 1990 as amended by the D.O.J. September 15, 2010, as adopted by the Authority Having Jurisdiction (AHJ).

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Comply with Division 1.

1. Deliver products in original unopened packaging with legible manufacturer's identification.
2. Package hardware to prevent damage during transit and storage.
3. Mark hardware to correspond with "reviewed hardware schedule".
4. Deliver hardware to door and frame manufacturer upon request.

B. Storage and Protection: Comply with manufacturer's recommendations.

1.6 PROJECT CONDITIONS:

A. Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements indicated, as necessary for the proper installation and function, regardless of omissions or conflicts in the information on the Contract Documents.

B. Review Shop Drawings for doors and entrances to confirm that adequate provisions will be made for the proper installation of hardware.

1.7 WARRANTY:

A. Refer to Conditions of the Contract

B. Manufacturer's Warranty:

1. Closers: Lifetime
2. Exit Devices: Five Years
3. Locksets & Cylinders: Three years
4. All other Hardware: Two years.

1.8 OWNER'S INSTRUCTION:

A. Instruct Owner's personnel in operation and maintenance of hardware units.

1.9 MAINTENANCE:

A. Extra Service Materials: Deliver to Owner extra materials from same production run as products installed. Package products with protective covering and identify with descriptive labels. Comply with Division 1 Closeout Submittals Section.

1. Special Tools: Provide special wrenches and tools applicable to each different or special hardware component.
2. Maintenance Tools: Provide maintenance tools and accessories supplied by hardware component manufacturer.
3. Delivery, Storage and Protection: Comply with Owner's requirements for delivery, storage and protection of extra service materials.

B. Approximately six months after the acceptance of hardware in each area, the hardware installer shall:
1. Return to the project and re-adjust every item of hardware to restore proper function of doors and hardware.
2. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
3. Replace hardware items which have deteriorated or failed due to faulty design, materials or installation of hardware units.
4. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware and submit to the Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. The following manufacturers are approved subject to compliance with requirements of the Contract Documents. Approval of manufacturers other than those listed shall be in accordance with Division 1.

Item:	Manufacturer:	Approved:
Hinges	Stanley	Bommer, McKinney
Locksets	Best 45H	None
Cylinders	Best Patented	None
Closers	Dorma 8916	Best HD7016

Protection Plates	Trimco	Burns, Rockwood
Door Stops	Trimco	Burns, Rockwood
Threshold & Gasketing	National Guard	Reese, Zero

2.2 MATERIALS:

A. Hinges: Shall be Five Knuckle Ball bearing hinges

1. Template screw hole locations
2. Bearings are to be fully hardened.
3. Bearing shell is to be consistent shape with barrel.
4. Minimum of 2 permanently lubricated non-detachable bearings on standard weight hinge and 4 permanently lubricated bearing on heavy weight hinges.
5. Equip with easily seated, non-rising pins.
6. Non-Removable Pin screws shall be slotted stainless steel screws.
7. Hinges shall be full polished, front, back and barrel.
8. Hinge pin is to be fully plated.
9. Bearing assembly is to be installed after plating.
10. Sufficient size to allow 180-degree swing of door
11. Furnish five knuckles with flush ball bearings
12. Provide hinge type as listed in schedule.
13. Furnish 3 hinges per leaf to 7-foot 6-inch height. Add one for each additional 30 inches in height or fraction thereof.
14. Tested and approved by BHMA for all applicable ANSI Standards for type, size, function and finish

B. Mortise Type Locks and Latches:

1. Tested and approved by BHMA for ANSI A156.13, Series 1000, Operational Grade 1, Extra-Heavy Duty, Security Grade 2 and be UL10C.
2. Furnish UL or recognized independent laboratory certified mechanical operational testing to 4 million cycles minimum.
3. Provide 9001-Quality Management and 14001-Environmental Management.
4. Fit ANSI A115.1 door preparation
5. Functions and design as indicated in the hardware groups
6. Solid, one-piece, 3/4-inch (19mm) throw, anti-friction latchbolt made of self-lubricating stainless steel
7. Deadbolt functions shall have 1 inch (25mm) throw bolt made of hardened stainless steel
8. Latchbolt and Deadbolt are to extend into the case a minimum of 3/8 inch (9.5mm) when fully extended
9. Auxiliary deadlatch to be made of one piece stainless steel, permanently lubricated
10. Provide sufficient curved strike lip to protect door trim
11. Lever handles must be of forged or cast brass, bronze or stainless steel construction and conform to ANSI A117.1. Levers that contain a hollow cavity are not acceptable
12. Lock shall have self-aligning, thru-bolted trim
13. Levers to operate a roller bearing spindle hub mechanism
14. Mortise cylinders of lock shall have a concealed internal setscrew for securing the cylinder to the lockset. The internal setscrew will be accessible only by removing the core, with the control key, from the cylinder body.
15. Spindle to be designed to prevent forced entry from attacking of lever

16. Provide locksets with 7-pin removable and interchangeable core cylinders
17. Each lever to have independent spring mechanism controlling it
18. Core face must be the same finish as the lockset.

C. Cylinders:

1. Provide the necessary cylinder housings, collars, rings & springs as recommended by the manufacturer for proper installation.
2. Provide the proper cylinder cams or tail piece as required to operate all locksets and other keyed hardware items listed in the hardware sets.
3. Coordinate and provide as required for related sections.
4. Provide cylinder cores as required to convert any existing cores to a new Best Cormax patented key system as directed by the required keying meeting.

D. Door Closers shall:

1. Tested and approved by BHMA for ANSI 156.4, Grade 1
2. UL10C certified
3. Provide 9001-Quality Management and 14001-Environmental Management.
4. Closer shall have extra-duty arms and knuckles
5. Conform to ANSI 117.1
6. Maximum 2 7/16-inch case projection with non-ferrous cover
7. Separate adjusting valves for closing and latching speed, backcheck, and delayed action
8. Provide adapter plates, shim spacers and blade stop spacers as required by frame and door conditions
9. Full rack and pinion type closer with 1½"/36MM minimum bore
10. Mount closers on non-public side of door, unless otherwise noted in specification
11. Closers shall incorporate the manufacturer's adjustable delayed action feature.
12. Closers shall be non-handed and multi-sized.

E. Door Stops: Provide a dome floor or wall stop for every opening as listed in the hardware sets.

1. Wall stop and floor stop shall be wrought bronze, brass or stainless steel.
2. Provide fastener suitable for wall construction.
3. Coordinate reinforcement of walls where wall stop is specified.
4. Provide dome stops where wall stops are not practical. Provide spacers or carpet riser for floor conditions encountered

F. Silencers: Furnish silencers on all interior frames, 3 for single doors, 2 for pairs. Omit where any type of seals occur.

2.3 FINISH:

A. Designations used in Schedule of Finish Hardware - 3.05, and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18 including coordination with traditional U.S. finishes shown by certain manufacturers for their products

B. Powder coat door closers to match other hardware, unless otherwise noted.

C. Aluminum items shall be finished to match predominant adjacent material. Seals to coordinate with frame color.

2.4 KEYS AND KEYING:

A. Provide keyed brass construction cores and keys during the construction period. Construction control and operating keys and core shall not be part of the Owner's permanent keying system or furnished in the same keyway (or key section) as the Owner's permanent keying system. Permanent cores and keys (prepared according to the accepted keying schedule) will be furnished to the Owner.

B. Cylinders, removable and interchangeable core system: Best standard 7-pin.

C. Permanent keys and cores: Stamped with the applicable key mark for identification. These visual key control marks or codes will not include the actual key cuts. Permanent keys will also be stamped "Do Not Duplicate."

D. Transmit Grand Masterkeys, Masterkeys and other Security keys to Owner by Registered Mail, return receipt requested.

E. Furnish keys in the following quantities:

1. 2 each Grand Masterkeys
2. 4 each Masterkeys
3. 2 each Change keys each keyed core
4. 10 each Construction Keys
5. 1 each Construction Control keys
6. 1 each Permanent Control Keys

F. The Owner, or the Owner's agent, will install permanent cores and return the construction cores to the Hardware Supplier. Construction cores and keys remain the property of the Hardware Supplier.

G. Keying Schedule: Arrange for a keying meeting, and programming meeting with Architect Owner and hardware supplier, and other involved parties to ensure locksets and locking hardware, are functionally correct and keying and programming complies with project requirements. Furnish 3 typed copies of keying and programming schedule to Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of conditions: Examine doors, frames, related items and conditions under which Work is to be performed and identify conditions detrimental to proper and or timely completion.

1. Do not proceed until unsatisfactory conditions have been corrected.

3.2 HARDWARE LOCATIONS:

A. Mount hardware units at heights indicated in the following publications except as specifically indicated or required to comply with the governing regulations.

1. Recommended Locations for Builder’s Hardware for Standard Steel Doors and Frames, by the Door and Hardware Institute (DHI).

2. Recommended locations for Architectural Hardware for flush wood doors (DHI).

3. WDMA Industry Standard I.S.-1A-04, Industry Standard for Architectural wood flush doors.

3.3 INSTALLATION:

A. Install each hardware item per manufacturer's instructions and recommendations. Do not install surface mounted items until finishes have been completed on the substrate. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

B. Conform to local governing agency security ordinance.

C. Install Conforming to ICC/ANSI A117.1 Accessible and Usable Building and Facilities.

1. Adjust door closer sweep periods so that from the open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the landing side of the door.

D. Installed hardware using the manufacturers fasteners provided. Drill and tap all screw holes located in metallic materials. Do not use “Riv-Nuts” or similar products.

3.4 FIELD QUALITY CONTROL AND FINAL ADJUSTMENT

A. Contractor/Installers, Field Services: After installation is complete, contractor shall inspect the completed door openings on site to verify installation of hardware is complete and properly adjusted, in accordance with both the Contract Documents and final shop drawings.

1. Check and adjust closers to ensure proper operation.

2. Check latchset, lockset, and exit devices are properly installed and adjusted to ensure proper operation.

a. Verify levers are free from binding.
b. Ensure latchbolts and dead bolts are engaged into strike and hardware is functioning.

3. Report findings, in writing, to architect indicating that all hardware is installed and functioning properly. Include recommendations outlining corrective actions for improperly functioning hardware if required.

B. Approximately six months after the acceptance of hardware in each area, the hardware installer shall:

1. Return to the project and re-adjust every item of hardware to restore proper function of doors and hardware.
2. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.

3. Replace hardware items which have deteriorated or failed due to faulty design, materials or installation of hardware units.
4. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware and submit to the Architect.

3.5 SCHEDULE OF FINISH HARDWARE:

List of Manufacturers

BE	Best Access Systems	Locks, Cylinders
CR	Corbin Russwin	Locks, Cylinders
N	Norton	Closers
DM	Dorma USA	Closers
NA	National Guard	Weatherstrip, Thresholds
ST	Stanley	Hinges
TR	Trimco	Flat Goods, Door Stops

Finish Codes

Code	Description
626/652	Satin Chromium Plated
630	Satin Stainless Steel
689	Painted Aluminum

Option List

Code	Description
VIN	Occupancy Indicator (Best)
CS	Counter Sinking of Kick and Mop Plates (Trimco)
B4E	Beveled 4 Edges - Kick Plates (Trimco)
SSMS/EA	Stainless Machine Screws/Expansion Anchors (NGP)
SMS-TEKS	Self-Drilling Sheet Metal Screws (NGP)

SET #1 -Door 101A, 101B, 102B

3	Hinges	CB199 4 1/2 X 4 1/2 NRP	630	McKinney
1	Mortise Lockset	ML2051 LWA CLS7	626	CR
1	Closer	8501	689	Norton
1	Gasketing	700 NA SMS-TEKS		NA
1	Door Sweep	200 NA SMS-TEKS		NA
1	Threshold	2005AT x36”		NA

SET #2 - Door (Toilet)

3	Hinges	CB179 4 1/2 X 4 1/2	652	ST
1	Privacy Set	ML 2069 LWA CL37	636	CR
1	Closer	8501	689	Norton
1	Wall Bumper	409	630	Rockwood
1	Gasketing	5040 B		NA

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass products.
2. Insulating glass.
3. Glazing sealants.
4. Glazing tapes.
5. Miscellaneous glazing materials.

1.2 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For glass.

B. Product test reports.

C. Preconstruction adhesion and compatibility test report.

D. Sample warranties.

1.6 QUALITY ASSURANCE

A. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

1.7 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: Five years from date of Substantial Completion.

C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:

1. Design Wind Pressures: As indicated on Drawings.
2. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.

B. Windborne-Debris-Impact Resistance: Exterior glazing shall pass ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for applicable Wind Zone for basic protection.

1. Large-Missile Test: For glazing located within 30 feet of grade.

C. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F.
2. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
3. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

2.2 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. NGA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
3. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than thickness indicated and compatible with storefront system.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.3 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.

B. Tinted Annealed Float Glass: ASTM C1036, Type I, Class 2 (tinted), Quality-Q3.

C. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

D. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

E. Reflective- and Low-E-Coated Vision Glass: ASTM C1376.

F. Ceramic-Coated Vision Glass: ASTM C1048, Condition C, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3; and complying with Specification No. 95-1-31 in NGA's "Engineering Standards Manual."

G. Ceramic-Coated Spandrel Glass: ASTM C1048, Type I, Condition B, Quality-Q3.

H. Silicone-Coated Spandrel Glass: ASTM C1048, Type I, Condition C, Quality-Q3.

I. Reflective- and Low-E-Coated Spandrel Glass: ASTM C1376, Kind CS.

2.4 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.

1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
2. Perimeter Spacer: Manufacturer's standard spacer material and construction.
3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.5 GLAZING SEALANTS

A. General:

1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

B. Neutral-Curing Silicone Glazing Sealant, Class 100/50: Complying with ASTM C920, Type S, Grade NS, Use NT.

C. Neutral-Curing Silicone Glazing Sealant, Class 50: Complying with ASTM C920, Type S, Grade NS, Use NT.

D. Neutral-Curing Silicone Glazing Sealant, Class 25: Complying with ASTM C920, Type S, Grade NS, Use NT.

E. Acid-Curing Silicone Glazing Sealant, Class 25: Complying with ASTM C920, Type S, Grade NS, Use NT.

2.6 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; non-staining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where required.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.7 MISCELLANEOUS GLAZING MATERIALS

A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

B. Setting Blocks, Spacers and Edge Blocks:

1. Type recommended in writing by sealant or glass manufacturer.

C. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

3.2 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Apply heel bead of elastomeric sealant.

F. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.3 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.4 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.5 CLEANING AND PROTECTION

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

3.6 GLASS SCHEDULE

A. INSULATED VISION GLAZING ASSEMBLY (GL-1)

1. Manufacturer/Product: Basis of Design Product is Guardian Glass's insulated vision glazing system. Other Manufacturers offering similar products meeting requirements include:
    a. Pilkington
    b. PPG Industries
    c. Saint Gobain

B. Description:

1. Outboard Lite: Guardian SunGuard SNE 50/25 (#2) HT on 6mm Clear Fully Tempered.
2. Space: ½ inch, air filled
3. Inboard Lite: 4mm Clear Tempered laminated with 0.060 inch Clear PVB to 4mm Clear Tempered.
4. Visible Light Transmittance: 47 percent
5. Reflection Out: 19 percent
6. SHGC: 0.25
7. U-Value: 0.28
8. Overall thickness: 1-1/8 inch

C. INSULATED SPANDREL GLAZING ASSEMBLY (GL-2)

1. Manufacturer/Product: Basis of Design Product is Guardian Glass's insulated spandrel glazing system. Other Manufacturers offering similar products meeting requirements include:
    a. Pilkington
    b. PPG Industries
    c. Saint Gobain
2. Description:
3. Outboard Lite: Guardian SunGuard SNE 50/25 (#2) HT on 6mm Clear Fully Tempered.
4. Space: ½ inch, air filled
5. Inboard Lite: 6mm Clear Fully Tempered with Warm Gray Ceramic Frit or Opaci-Coat 300 on the #4 surface, full coverage.
6. Overall thickness: 1 inch

END OF SECTION 088000

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.
2. Suspension systems for interior ceilings and soffits.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

B. Evaluation reports for embossed, high-strength steel studs and tracks, firestop tracks, post-installed anchors and power-actuated fasteners.

1.4 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
2. Protective Coating: ASTM A653/A653M, G40 (Z120) hot-dip galvanized unless otherwise indicated.

B. Studs and Tracks: ASTM C645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.
1. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection 0.0147 inch.
2. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide **one of** the following:

1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to tracks while allowing 1-1/2-inch minimum vertical movement.

2. Single Long-Leg Track System: ASTM C645 top track with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
3. Double-Track System: ASTM C645 top outer tracks, inside track with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
4. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

D. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Steel Thickness: 0.0179 inch.

F. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch- wide flanges.

1. Depth: 1-1/2 inches unless indicated otherwise.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches 0.068-inch- thick, galvanized steel.

G. Hat-Shaped, Rigid Furring Channels: ASTM C645.

1. Minimum Base-Steel Thickness: 0.0179 inch unless indicated otherwise.
2. Depth: 7/8 inch unless indicated otherwise.

H. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.

1. Configuration: hat shaped.

I. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges.

1. Depth: 3/4 inch unless indicated otherwise.
2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch.
3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

J. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-steel thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch-diameter wire.

B. Hanger Attachments to Concrete:

1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC58 or AC308 as appropriate for the substrate.

a. Uses: Securing hangers to structure.
b. Type: adhesive anchor.
c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941 (ASTM F1941M), Class Fe/Zn 5, unless otherwise indicated.
d. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1), Group 2 (A4), stainless-steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).

C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.

E. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch-wide flanges.

1. Depth: 2-1/2 inches unless otherwise indicated.

F. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.

2. Steel Studs and Tracks: ASTM C645.

    a. Minimum Base-Steel Thickness: 0.0147 inch unless otherwise indicated.
    b. Depth: 1-5/8 inches unless otherwise indicated.

3. Hat-Shaped, Rigid Furring Channels: ASTM C645, 7/8 inch deep.

    a. Minimum Base-Steel Thickness: 0.0179 inch unless otherwise indicated.
    b. Resilient Furring Channels: 1/2-inch-deep members designed to reduce sound transmission.
    c. Configuration: Hat shaped.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide one of the following:

1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.2 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in assembly.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

    a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

E. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. Z-Shaped Furring Members:

1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring

channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.3 INSTALLING CEILING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

    a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum interfere with locations of hangers required to support standard suspension members, install supplemental members and hangers in the form of trapezes or equivalent devices.

    a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Flat Hangers: Secure to structure, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel roof deck.
6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Gypsum wallboard.
2. Gypsum board, Type X.
3. Gypsum ceiling board.
4. Mold-resistant gypsum board.
5. Cementitious backer units.
6. Interior trim.
7. Joint treatment materials.
8. Laminating adhesive.
9. Sound-attenuation blankets.
10. Acoustical sealant.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Gypsum Wallboard: ASTM C1396/C1396M.

1. Thickness: 1/2 inch .
2. Long Edges: Tapered for prefilling.

B. Gypsum Board, Type X: ASTM C1396/C1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered for prefilling.

C. Gypsum Ceiling Board: ASTM C1396/C1396M.

1. Thickness: 1/2 inch.
2. Long Edges: Tapered.

D. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

E. Glass-Mat Gypsum Sheathing Board: ASTM C1177/C1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges.

1. Core: As indicated, Type X.

2.4 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.

1. Thickness: As indicated.
2. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.5 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
2. Shapes:

    a. Cornerbead.
    b. LC-Bead: J-shaped; exposed long flange receives joint compound.
    c. L-Bead: L-shaped; exposed long flange receives joint compound.
    d. U-Bead: J-shaped; short flange does not receive joint compound.
    e. Expansion (control) joint.

2.6 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Exterior Gypsum Soffit Board: Paper.
3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
4. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use all-purpose compound.

    a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use all-purpose compound.
4. Finish Coat: For third coat, use all-purpose compound.

D. Joint Compound for Tile Backing Panels:

1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.7 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

E. Acoustical Sealant: As recommended by gypsum wallboard manufacturer.

F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

PART 3 - EXECUTION

3.1 INSTALLATION AND FINISHING OF PANELS

A. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

B. Comply with ASTM C840.

C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

D. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

E. Prefill open joints and damaged surface areas.

F. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

G. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile.
3. Level 3: Where indicated on Drawings.
4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

    a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

H. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.

I. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

J. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.2 APPLYING TEXTURE FINISHES

A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.

3.3 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 092900

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall and Floor tile
2. Porcelain tile.
3. Tile backing panels.
4. Crack isolation membrane.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer is a Five-Star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
2. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.
3. Installer employs only Ceramic Tile Education Foundation Certified Installers or installers recognized by the U.S. Department of Labor as Journeyman Tile Layers for Project.
4. Installer employs at least one installer for Project that has completed the Advanced Certification for Tile Installers (ACT) certification for installation of mud floors, membranes shower receptors, and large format tile.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide Standard-grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.2 TILE PRODUCTS

A. Tile Type T-1: Floor Tile

1. Manufacturer/Product: Basis of Design Product is Daltile's "Uniform Concrete – Matt". Other Manufacturers offering similar products may submit product information for approval.
2. Composition: Porcelain
3. Finish: Matt
4. Field Size: ¼"x24"x24"
5. Color: "Beige UC-11".

B. Ceramic Tile Type T-2: Wall Tile

1. Manufacturer/Product: Basis of Design Product is Daltile's "Uniform Concrete – Matt". Other Manufacturers offering similar products may submit product information for approval.
2. Composition: Porcelain
3. Finish: Matt
4. Field Size: ¼"x12"x24"
5. Color: "Beige UC-11".
6. Accessory Tiles:

    a. Cove Base: 6"x12" matching wall tile.
    b. Bullnose Trim: 3"x24" matching wall tile

2.3 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 or ASTM C1325, Type A.

1. Thickness: As indicated.

2.4 CRACK ISOLATION MEMBRANE

A. General: Manufacturer's standard product selected from the following, that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch nominal thickness.

C. PVC Sheet: PVC heat-fused on both sides to facings of nonwoven polyester; 0.040-inch nominal thickness.

D. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and fabric reinforcement.

E. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.

2.5 ALTERNATIVE SETTING MATERIALS

A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.

B. Standard Dry-Set Mortar (Thinset): ANSI A118.1.

1. For wall applications, provide nonsagging mortar.

C. Modified Dry-Set Mortar (Thinset): ANSI A118.4.

1. Provide prepackaged, dry-mortar mix to which only water must be added at Project site.
2. Provide prepackaged, dry-mortar mix combined with liquid-latex additive at Project site.
3. For wall applications, provide nonsagging mortar.

D. Improved Modified Dry-Set Mortar (Thinset): ANSI A118.15.

1. Provide prepackaged, dry-mortar mix combined with liquid-latex additive at Project site.
2. For wall applications, provide nonsagging mortar.

E. EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar (Thinset): ANSI A118.11.

1. Provide prepackaged, dry-mortar mix combined with liquid-latex additive at Project site.

F. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3.

2.6 GROUT MATERIALS

A. Water-Cleanable Epoxy Grout: ANSI A118.3 with a VOC content of 65 g/L or less.

2.7 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Floor Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
    a. Tile floors in wet areas.
    b. Tile floors consisting of tiles 8 by 8 inches or larger.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for

straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

E. Joint Widths: Unless otherwise indicated, install tile with the joint widths recommended by the tile Manufacturer in writing:

F. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

G. Floor Sealer: Apply floor sealer to grout joints according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

H. Install tile backing panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

I. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

END OF SECTION 093013

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes acoustical panels and exposed suspension systems for interior ceilings.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

C. Delegated-Design Submittal: For seismic restraints for ceiling systems.

1. Include design calculations for seismic restraints including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Research reports.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for ceiling systems.

B. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class A according to ASTM E1264.
2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL PANELS

A. Manufacturer/Product: Basis of Design Product Armstrong Ceiling and Wall Solutions' Cirrus 538 acoustical panel. Manufacturers offering products meeting requirements include but are not limited to the following:

1. American Gypsum
2. CertainTeed Corp
3. USG Corp

B. Acoustical Panel Standard: Manufacturer's standard panels according to ASTM E1264.

C. Description:

1. Texture: Medium non-directional
2. Composition: Mineral Fiber
3. Color: White
4. Size: 24" x 24"
5. Edge Profile: Beveled Tegular 9/16 for interface with 9/16" exposed tee grid.
6. Noise Reduction Coefficient (NRC): ASTM C-423 classified – UL label.
7. Ceiling Attenuation Class (CAC): ASTM C-1414 classified – UL label.
8. Flame Spread: ASTM E-1264: Class A UL
9. Light Reflectance (LR) White Panel: ASTM E-1477: 0.85

2.3 METAL SUSPENSION SYSTEM

A. Manufacturer/Product: Basis of Design Product Armstrong Ceiling and Wall Solutions' SUPRAFINE ML 9/16" Exposed Tee Metal Suspension System. Manufacturers offering products meeting requirements include but are not limited to the following:

1. American Gypsum
2. CertainTeed Corp
3. USG Corp

B. Metal Suspension-System Standard: Manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C635/C635M.

C. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 (Z90) coating designation; with prefinished 9/16-inch- wide metal caps on flanges.

1. Structural Classification: Heavy-duty system.
2. End Condition of Cross Runners: Per Manufacturer’s recommendation.
3. Face Design: Flat, flush
4. Cap Material: Galvanized steel.
5. Cap Finish: Baked polyester paint (white).

2.4 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

B. Hold-Down Clips: Manufacturer's standard hold-down.

C. Impact Clips: Manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.

D. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical panels in place during a seismic event.

2.5 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners. Perimeter closure shall have a minimum width of 2”.

PART 3 - EXECUTION

3.1 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated.

B. Layout openings for penetrations centered on the penetrating items.

3.2 INSTALLATION

A. Install acoustical panel ceilings according to ASTM C636/C636M**,** seismic design requirements, and manufacturer's written instructions.

B. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
3. Arrange directionally patterned acoustical panels as follows:

    a. As indicated on reflected ceiling plans.
    b. Install panels with pattern running in one direction parallel to short axis of space.
    c. Install panels in a basket-weave pattern.

4. Install hold-down, impact and seismic clips spaced according to panel manufacturer's written instructions unless otherwise indicated.

3.3 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform inspections.

1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.

END OF SECTION 095113

SECTION 096513 – RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoset-rubber base.
2. Thermoplastic-rubber base.
3. Rubber molding accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers offering products meeting requirements include but are not limited to the following:

1. Armstrong
2. Burke
3. Flexco
4. Johnsonite
5. Roppe
6. Tarkett

2.2 THERMOSET-RUBBER BASE

A. Product Standard: ASTM F1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).

1. Style and Location:

a. Style: Cove where indicated.

B. Thickness: 0.125 inch.

C. Height: 4 inches.

D. Lengths: Coils in manufacturer's standard length.

E. Outside Corners: Job formed.

F. Inside Corners: Job formed or preformed.

G. Colors: Black/Brown unless otherwise indicated.

2.3 THERMOPLASTIC-RUBBER BASE

A. Product Standard: ASTM F1861, Type TP (rubber, thermoplastic).

1. Group: Solid, homogeneous
2. Style and Location:

a. Style: Cove

B. Thickness: 0.125 inch.

C. Height: 4 inches.

D. Lengths: Coils in manufacturer's standard length.

E. Outside Corners: Job formed.

F. Inside Corners: Job formed or preformed.

G. Colors: Black/Brown unless otherwise indicated.

2.4 RUBBER MOLDING ACCESSORY

A. Description: Rubber nosings, caps, reducer strips and transition strips

B. Profile and Dimensions: As indicated or as selected by Engineer from full product line.

C. Locations: Provide rubber accessories in areas indicated and as required for a complete flooring installation.

D. Colors and Patterns: As indicated or as selected by Engineer from full product line.

2.5 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient

C. Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.

D. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient stair-tread manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 10 pH.
4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft, and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

    a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient products until materials are the same temperature as space where they are to be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.2 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. Preformed Corners: Install preformed corners before installing straight pieces.

G. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

    a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

    a. Miter or cope corners to minimize open joints.

3.3 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Stair Accessories:

1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
2. Tightly adhere to substrates throughout length of each piece.
3. For treads installed as separate, equal-length units, install to produce a flush joint between units.

C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Floor Polish: Remove soil, adhesive, and blemishes from resilient stair treads before applying liquid floor polish.

1. Apply two coat(s).

C. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rubber floor tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and pattern specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation.

PART 2 - PRODUCTS

2.1 RUBBER FLOOR TILE

A. Manufacturer/Product: Basis of Design Product is Norament Grano from Nora by Interface. Other Manufacturers offering similar products include but are not limited to:
1. Burke
2. Roppe

B. Tile Standard: ASTM F1344, Type IB and Grade 2.

C. Hardness: Grade 2, minimum hardness of 70, measured using Shore, Type A durometer according to ASTM D2240.

D. Wearing Surface: Smooth.

E. Thickness: 0.14 inch.

F. Size: Approximately 39”x39”.

G. Colors and Patterns: Mottled/speckled pattern required. To be selected by Architect from full product line.

2.2 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

    a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.2 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay tiles square with room axis.

C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

1. Lay tiles in pattern of colors and sizes indicated.

D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.

G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

H. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

I. Clean thoroughly according to Manufacturer’s instructions.

END OF SECTION 096519

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of paint systems on interior substrates:

1. Concrete.
2. Concrete masonry units (CMUs).
3. Steel and iron.
4. Wood.
5. Gypsum board.

1.2 DEFINITIONS

A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.

B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.

F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.

B. Samples: For each type of paint system and in each color and gloss of topcoat.

1.4 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Engineer will select one surface to represent surfaces and conditions for application of each paint system.

a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.

2. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Engineer at no added cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Manufacturers offering products meeting requirements include but are not limited to the following:

1. Benjamin Moore & Co.
2. Kelly-Moore Paint Co.
3. PPG Paints
4. Sherwin Williams

B. Products: Subject to compliance with requirements, provide MPI approved products listed in the Interior Painting Schedule for the paint category indicated.

2.2 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Sustainability Requirements: Comply with SCAQMD Rules for VOC content.

C. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

D. Colors: As selected by Engineer from manufacturer's full range.

1. Approximately ten percent of surface area will be painted with deep tones.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. CMU: 12 percent.
2. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 INTERIOR PAINTING SCHEDULE

A. CMU Substrates:

1. Latex System MPI INT 4.2A:
    a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
    b. Intermediate Coat: Latex, interior, matching topcoat.

c. Topcoat: Latex, interior, semi-gloss (MPI Gloss Level 5), MPI #54.

B. Gypsum Board Substrates:

1. Latex over Latex Sealer System MPI INT 9.2A:

a. Prime Coat: Primer sealer, latex interior MPI #50.

b. Intermediate Coat: Latex, interior, matching topcoat.

c. Topcoat: Latex, interior, semi-gloss (MPI Gloss Level 5), MPI #54.

C. Steel Substrates – Office and Administrative Areas:

1. Latex over Shop-Applied Quick-Drying Shop Primer System MPI INT 5.1X:

a. Prime Coat: Primer, quick dry, for shop application, MPI #275.

b. Intermediate Coat: Latex, interior, matching topcoat.

c. Topcoat: Latex, interior, semi-gloss (MPI Gloss Level 5), MPI #54.

END OF SECTION 099123

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of high-performance coating systems.

1. Exterior Substrates:
   a. Steel.
   b. Galvanized metal.

1.2 DEFINITIONS

A. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.

B. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

C. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.

B. Sustainable Design Submittals:

1. Evidence showing system products comply with SCAQMD VOC Rules.

C. Samples: For each type of coating system and in each color and gloss of topcoat indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS/PRODUCTS

A. Subject to compliance with requirements, Manufacturers of high-performance coating systems listed in MPI Standards and in the Exterior High-Performance Coating Schedule may submit systems for possible acceptance and incorporation into the Work.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
3. Products shall be of same manufacturer for each coat in a coating system.

C. Sustainable Design Requirements: Comply with SCAQMD Rules for VOC content.

D. Colors: As selected by Architect from manufacturer's full range.

E. Corrosion Resistant Epoxy Resin Coating

1. Chemical, corrosion, and wear resistant epoxy coating for waterproofing, corrosion protection, and containment of water and aqueous chemicals. Concrete must exhibit minimum of 3,625 psi compressive strength and be free of all contaminants such as dirt, oil, grease, coatings and surface treatments, etc. Apply as required per manufacturer’s written recommendations. Apply epoxy as recommended by manufacturer for exterior applications. Basis of design product: Sika USA Sikafloor-263 SL. Contact Sika USA for additional information. Consult manufacturer for vertical application modifications and instructions.
    a. Use on the following areas: Exterior concrete containment area at the Household Hazardous Waste Area. All exposed concrete to be coated including but not limited to containment slab, containment curbs, equipment pads, exposed concrete piers.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

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1. Coordinate shop primer selection and application with requirements of high-performance coating system.
2. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

B. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Steel Substrates: Contractor may select from all of the following systems but must utilize a system that meets the SCAQMD VOC Rules.

1. Epoxy System MPI EXT 5.1F:

a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
b. Intermediate Coat: Epoxy, high build, low gloss, MPI #108.
c. Topcoat: Epoxy, gloss, MPI #77.

2. Pigmented Polyurethane over Epoxy System MPI EXT 5.1H:

a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
b. Intermediate Coat: Epoxy, gloss, MPI #77.
c. First and Second Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6), MPI #72.

3. Pigmented Polyurethane over High-Build Epoxy System MPI EXT 5.1J:

a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
b. Intermediate Coat: Epoxy, high build, low gloss, MPI #108.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6), MPI #72.

4. Pigmented Polyurethane over Epoxy Zinc-Rich Primer System MPI EXT 5.1P:

a. Prime Coat: Primer, zinc rich, epoxy, MPI #20.
b. Intermediate Coat: Epoxy, gloss, MPI #77.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6), MPI #72.

5. Pigmented Polyurethane over Epoxy Zinc-Rich Primer and High-Build Epoxy System MPI EXT 5.1G:

a. Prime Coat: Primer, zinc rich, epoxy, MPI #20.
b. Intermediate Coat: Epoxy, high build, low gloss, MPI #108.
c. First and Second Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6), MPI #72.

B. Galvanized-Metal Substrates:

1. Epoxy System MPI EXT 5.3C:

a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.

b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss, MPI #77.

2. Pigmented Polyurethane over Epoxy Primer System MPI EXT 5.3L:

a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
b. Intermediate Coat: Polyurethane, two component, pigmented, gloss matching topcoat.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6), MPI #72.

END OF SECTION 099600

SECTION 101423 - PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panel signs.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For panel signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.

C. Sign Schedule: Submit schedule identifying each sign location and content.

D. Samples: For each exposed product and for each color and texture.

1.3 INFORMATIONAL SUBMITTALS

A. Product cut sheets indicating materials, finishes, colors and the like.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design"and ICC A117.1. Comply with ADA 28 CFR Part 36 regulations

2.2 PANEL SIGNS

A. Manufacturers: Manufacturers offering products meeting requirements include but are not limited to the following:

1. ACE Sign Systems
2. APCO Graphics
3. Best Sign Systems
4. Inpro Corporation
5. Signs and Decal Corp
6. Vomar Products Inc.

B. Panel Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Laminated-Sheet Signs: (ADA) Plastic face sheet with raised graphics laminated to plastic backing sheet to produce composite sheet.
   a. Surface-Applied, Raised Graphics: Applied polymer characters and Braille.

2. Engraved Plastic-Laminate Sign: (non-ADA) Plastic-laminate face laminated to contrasting phenolic core to produce composite sheet.

   a. Engraved Graphics: Characters engraved through plastic-laminate face sheet to expose contrasting phenolic core.
   b. Plastic-Laminate Color and Pattern: As selected by Engineer from manufacturer's full range.

3. Sign-Panel Perimeter: Finish edges smooth.

   a. Edge Condition: Beveled or Bullnosed.
   b. Corner Condition in Elevation: As indicated on Drawings.

4. Mounting: Two-face tape.

2.3 PANEL-SIGN MATERIALS

A. Acrylic Sheet: ASTM D4802, Type UVF (UV filtering) – non-glare, polycarbonate Sheet: Coated, mar-resistant, UV-stabilized polycarbonate, with coating on both sides – non-glare or Manufacturer’s standard plastic sheet material.

B. Plastic thickness: 60mil.

C. Braille: Letters/numbers/pictograms raised 1/32”.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:

B. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

B. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.

PART 3 - EXECUTION

3.1 SIGN SCHEDULE

A. Room Signs:

1. Provide (1) sign at each interior door. Text to be provided by Owner.
2. Provide accessibility signs at restroom door consistent with ADA and Chapter 11 -Accessibility, California Building Code.

3.2 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Mounting Methods:

1. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

C. Remove temporary protective coverings and strippable films as signs are installed.

END OF SECTION 101423

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Washroom accessories.
2. Underlavatory guards.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 WARRANTY

A. Manufacturer's Special Warranty for Hand Dryers: Manufacturer agrees to repair or replace hand dryers that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Structural Performance: Design accessories and fasteners to comply with the following requirements:

1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.

2.2 WASHROOM ACCESSORIES

A. Manufacturer: Manufacturers offering products meeting requirements include but are not limited to the following:

1. ASI
2. Bobrick
3. Bradley
4. Murdock

B. Toilet Tissue (Roll) Dispenser: Basis of Design Product is Bobrick's B-4288 Surface-mounted Multi-roll Toilet Tissue Dispenser.

1. Description: Satin-finish stainless steel unit with stainless steel dispensing mechanism. Flush tumbler lock. Holds two rolls up to 5 1/4" diameter (1800 sheets). Extra roll automatically drops in place when bottom roll is depleted. Theft-resistant, heavy-duty spindles. Unit 6 1/16" W, 11" H, 5 15/16" D.
2. Mounting: Surface mounted.

C. Automatic Paper Towel (Roll) Dispenser: Basis of Design Product is Bobrick's B-72974 Automatic Universal Surface-mounted Roll Towel Dispenser.

1. Description: Durable plastic construction; translucent navy cover. Locking cabinet. Unit 12 3/8″ W, 15 1/4″ H, 9 1/2″ D. Operates with 4 "D" alkaline batteries (not included) or 6-volt DC power supply.
2. Mounting: Surface mounted.

D. Freestanding Waste Receptacle: Basis of Design Product: Bobrick's B-2280 Floor-standing Waste Receptacle with open top.

1. Description: Satin-finish stainless steel. Open top. Vinyl wall bumper, rubber feet. Liner hooks. Capacity: 21-gal. (79.5-L). Unit 14-7/8" x 14-7/8" at top, 29-1/4" high.

E. Surface-Mounted Waste Receptacle with liner: Basis of Design Product is Bobrick's B-277 Contura Series.

1. Description:Satin stainless steel. Capacity 12.75 gallons. Hemmed top edges and Linermate liner.
2. Size: 15"W x 23"H x 8.5"D

F. Combination Towel (Roll) Dispenser/Waste Receptacle: Basis of Design Product is Bobrick's B-39617 Recessed Convertible Paper Towel Dispenser/Waste Receptacle.

1. Description: Unit includes convertible universal, roll paper towel module and 18-gallon waste receptacle. Satin-finish stainless steel. Seamless beveled flange. "Touch-free" pull-towel mechanism dispenses 12″ length per pull of universal roll paper towels. Accommodates 8″ wide, up to 8″ diameter rolls, 800 ft long, plus 3 1/2″ diameter stub roll with automatic transfer. Removable waste receptacle is locked into cabinet. Rough Wall Opening: 16″ W, 54-3/4″ H, 4″ min. depth.
2. Mounting: Recessed with projecting dispenser and receptacle.

G. Wall-mount Soap Dispenser: Basis of Design Product is Bobrick's B-2013 Automatic Wall-mounted Foam Soap Dispenser.

1. Description: Tank is satin-finish stainless steel with view fill window. Valve dispenses foam soaps with motion activation. Capacity: 27-fl oz. Unit 4-1/4" W, 9-9/16" H.

2. Designed for hands-free operation and dispensing soap in foam form.
3. Mounting: Surface mounted.

H. Grab Bars: Basis of Design Product is Bobrick's B-5806 Straight Grab Bars.

1. Description: 1-1/4″ diameter tubing. Satin-Finish, slip-resistant surface stainless steel grab bar for bath/shower/toilet compartment. Snap Flange.
2. Mounting: Flanges with concealed fasteners.

I. Sanitary-Napkin Disposal Unit: Basis of Design Product is Bobrick's B-270 Surface-mounted Sanitary Napkin Disposal.

1. Description: Satin-finish stainless steel. Cover is drawn, one-piece construction; secured to cabinet with full-length stainless steel piano-hinge. Capacity: 1.0-gal. Unit 7 1/2" W, 10" H, 3 13/16" D.
2. Mounting: Surface mounted.

J. Seat-Cover Dispenser: Basis of Design Product is Bobrick's B-4221 Surface-mounted Seat-cover Dispenser.

1. Description: Satin-finish stainless steel. Dispenses 250 single- or half-fold toilet seat covers or one box. Fills from bottom. Unit 15 3/4" W, 11" H, 2" D. Allow 5" minimum clearance from bottom of dispenser to top of any horizontal projection for filling dispenser from below unit.
2. Mounting: Surface mounted.

K. Mirror Unit: Basis of Design Product is Bobrick's B-165 Series Channel Frame Mirror.

1. Description: One-piece, 1/2″ x 1/2″ x 3/8″ channel-frame. Type 430 stainless steel with bright-polished finish. Mitered corners. Frame screw permits easy replacement of glass. No. 1 quality, 1/4″ glass mirror; warranted against silver spoilage for 15 years. Galvanized steel back. Secured to concealed wall hanger with theft-resistant mounting
2. Size: 24"W x 36"H unless otherwise indicated.

L. Hook: Basis of Design Product is: Bobrick's B-6827 Hat and Coat Hook.

1. Description: Satin stainless steel. Flange is 2" x 2" (50 x 50mm). Hook 1" W, 6 1/2" H (25 x 165mm); projects 31/16" (80mm) from wall. Concealed wall plate.

2.3 UNDERLAVATORY GUARDS

A. Underlavatory Guard: Manufacturers offering products meeting requirements include but are not limited to the following:

1. Buckaroos Inc.
2. Plumberex Specialty Products
3. TrueBro/IPS
4. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
5. Material and Finish: Antimicrobial, molded plastic, white.

2.4 FABRICATION

A. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

1. Remove temporary labels and protective coatings.

B. Grab Bars: Install to comply with specified structural-performance requirements.

END OF SECTION 102800

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-protection cabinets for portable fire extinguishers.

1.2 PREINSTALLATION CONFERENCE

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fire-protection cabinets.

C. Samples: For each type of exposed finish required.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

2.2 FIRE-PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.

B. Manufacturers: Manufacturers offering products meeting requirements include but are not limited to the following:
   1. Babcock-Davis
   2. Guardian Fire Equipment
   3. JL Industries
   4. Larsens Manufacturing
   5. Nystrom

C. Cabinet Construction: Nonrated, One-hour fire rated or Two-hour fire rated depending on fire rating of wall assembly.

   1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch- thick cold-rolled steel sheet lined with minimum 5/8-inch-thick fire-barrier material. Provide factory-drilled mounting holes.

D. Cabinet Material: Cold-rolled steel sheet.

E. Semi-recessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).

   1. Square-Edge Trim: 1-1/4- to 1-1/2-inch backbend depth.
   2. Rolled-Edge Trim: 2-1/2-inch backbend depth.

F. Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall with no trim.

G. Cabinet Trim Material: Steel sheet.

H. Door Material: Steel sheet.

I. Door Style: Fully glazed panel with frame.

J. Door Glazing: Tempered float glass (clear).

K. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

L. Accessories:

   1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
   2. Break-Glass Strike: Manufacturer's standard metal strike, complete with chain and mounting clip, secured to cabinet.
   3. Break-Glass Door Handle: Manufacturer's standard, integral to glass with the words "PULL TO BREAK GLASS" applied to handle.

4. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
5. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.

    a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."

        1) Location: Applied to cabinet door.

M. Materials:

1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.

    a. Finish: Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.
    b. Color: As selected by Engineer from manufacturer's full range.
2. Tempered Break Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 1.5 mm thick.

2.3 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Prepare recesses for semi-recessed fire-protection cabinets as required by type and size of cabinet and trim style.

B. Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

C. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

END OF SECTION 104413

SECTION 105113 - METAL LOCKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Knocked-down lockers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For metal lockers.

   1. Include plans, elevations, sections, and attachment details.
   2. Include locker identification system and numbering sequence.

C. Samples: Metal ships for each color available.

1.4 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.

   1. Warranty Period for Knocked-Down Metal Lockers: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: For lockers indicated to be accessible, comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design".

2.2 KNOCKED-DOWN LOCKERS

A. Manufacturers: Manufacturers offering products meeting requirements include but are not limited to the following:

1. Lyon Workspace Products
2. PENCO Products Inc.
3. Republic Storage Systems

B. Type/size: Single-tier Standard type - 12”W x 72” H x 18”D.

C. Doors: One piece; fabricated from 0.075-inch nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.

1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches wide; welded to inner face of doors.
2. Stiffeners: Manufacturer's standard full-height stiffener fabricated from 0.048-inch nominal-thickness steel sheet; welded to inner face of doors.
3. Door Style: Vented panel as follows:

    a. Louvered Vents: No fewer than six louver openings at top and bottom for single-tier lockers.

D. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops, Bottoms, and any Intermediate Dividers: 0.024-inch nominal thickness, with single bend at sides.
2. Backs and Sides: 0.024-inch nominal thickness, with full-height, double-flanged connections.
3. Shelves: 0.024-inch nominal thickness, with double bend at front and single bend at sides and back.

E. Frames: Channel formed; fabricated from 0.060-inch nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

F. Hinges:

1. Hinges: Manufacturer's standard, steel, continuous or knuckle type.

G. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in key locks, or padlocks; positive automatic latching and pre-locking.

    a. Latch Hooks: Equip doors 48 inches and higher with three latch hooks and doors less than 48 inches high with two latch hooks; fabricated from 0.105-inch nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
    b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism.

H. Door Handle and Latch for Lockers: Stainless steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.

I. Locks: Combination padlocks.

J. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch high.

K. Hooks: Manufacturer's standard ball-pointed hooks, aluminum or steel; zinc plated.

L. Coat Rods: Manufacturer's standard.

M. Continuous Zee Base: Fabricated from manufacturer's standard thickness, but not less than 0.060-inch nominal-thickness steel sheet.

1. Height: 4 inches.

N. Continuous Sloping Tops: Fabricated from 0.048-inch nominal-thickness steel sheet.

1. Closures: Vertical end type.

O. Individual Sloping Tops: Fabricated from 0.024-inch nominal-thickness steel sheet.

P. Recess Trim: Fabricated from 0.048-inch nominal-thickness steel sheet.

Q. Filler Panels: Fabricated from 0.048-inch nominal-thickness steel sheet.

R. Finished End Panels: Fabricated from 0.024-inch nominal-thickness steel sheet.

S. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.

T. Finish: Baked enamel or powder coat.

1. Color: As selected by Engineer from manufacturer's full range.

2.3 FABRICATION

A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.

B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.

C. Equipment: Provide each locker with an identification plate and the following equipment:

1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.
2. Coat Rods: For each compartment of each locker.

D. Knocked-Down Construction: Fabricate metal lockers by assembling on project site or alternatively at the plant prior to shipping using manufacturer's nuts, bolts, screws, or rivets.

E. Accessible Lockers: Provide (1). Fabricate as follows:

1. Locate bottom shelf no lower than 15 inches above the floor.
2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor. Provide one end locker of this type.

F. Continuous Zee Base: Fabricated in lengths as long as practical to enclose base and base ends; finished to match lockers.

G. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.

H. Individual Sloping Tops: Fabricated in width to fit one locker frame in lieu of flat locker tops; with integral back; finished to match lockers. Provide wedge-shaped divider panels between lockers.

I. Recess Trim: Fabricated with minimum 2-1/2-inch face width and in lengths as long as practical; finished to match lockers.

J. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.

K. Finished End Panels: Fabricated to conceal unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of non-recessed metal lockers; finished to match lockers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lockers level, plumb, and true; shim as required, using concealed shims.

1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c.. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
2. Anchor single rows of metal lockers to walls near top and bottom of lockers
3. Anchor back-to-back metal lockers to floor.

B. Knocked-Down Lockers: Assemble with manufacturer's standard fasteners, with no exposed fasteners on door faces or face frames.

C. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.

1. Attach recess trim to recessed metal lockers with concealed clips.
2. Attach filler panels with concealed fasteners.
3. Attach sloping-top units to metal lockers, with closures at exposed ends.
4. Attach finished end panels using fasteners only at perimeter to conceal exposed ends of non-recessed metal lockers.

END OF SECTION 105113

MASA Architectural Canopies

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EXTRUDECK Canopy System

General Notes to Specifier

This master specification section has been prepared by MASA Architectural Canopies for use in the preparation of a product specification section covering pre-engineered canopies consisting of extruded aluminum framing, supports, and decking. Contact MASA for specifications to other products.

Optional text to be determined as necessary by the user is found within parentheses ( ) notation.
e.g.: (Section 09 000)

Sustainable requirements sections should be included for projects requiring LEED certification.
For additional information on LEED, visit the U.S. Green Building Council website at www.usgbc.org.

MASA has compiled and categorized its numerous color choices and accessories into an easy to select format located at www.architecturalcanopies.com ….select Downloads and make your choice.

For assistance on the use of the products in this section, contact MASA's product support team by calling 800-761-7446, by email at information@architecturalcanopies.com or visit their website at www.architecturalcanopies.com

SECTION 10 73 00

CANOPIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Building supported, pre-engineered metal canopies including fascia channels, decking, tension rods, and attachment hardware.

B. Related Sections:
1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. Aluminum Association (AA)DAF 45 - Designation System for Aluminum Finishes.

B. American Architectural Manufacturers Association (AAMA)
1. 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Architectural Extrusions and Panels.

C. American Society of Civil Engineers (ASCE) 7-16 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.

D. ASTM International (ASTM)
1. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
2. B429 - Standard Specification for Aluminum-Alloy Extruded Pipe and Tube.
3. A36 Standard Mild Steel Specification
4. A50/A53 Standards for Structural steel

1.3 SYSTEM DESCRIPTION

A. Design Requirements: Design canopy system to withstand:
1. Standards for wind pressure, snow load, and drifting snow load in accordance with current adopted form of the International Building code or accepted requirements of local municipality.

1.4 SUBMITTALS

A. Submittals for Review:
1. Shop Drawings signed and sealed by a licensed engineer in the state of CA: Indicate system components, dimensions, attachments, and accessories.
2. Structural calculations signed and sealed by a licensed engineer in the state of CA justifying the capability of the structural framing and fasteners to resist the design loads.
3. Samples:
   a. 3 x 3 inch coating samples in specified color.
   b. 6 inch long fascia profile sample showing profile and standard finish.
   c. 6 inch decking samples showing profile and standard finish.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 5 years' experience in installation of similar products.

1. (Mockup: Provide mockup of canopy system including all framing members, supports, decking, hanger rods, and attachments at location selected by architect.)

PART 2 – PRODUCTS

2.1 MANUFACTURER

A. Approved Manufacturers
   1. MAPES Industries, Inc.
   2. MASA Architectural Canopies

B. Acceptable alternates:

Interested manufacturers must furnish full details of proposed product, engineering calculations on all sections involved, physical samples of all shapes and finishes, a list of installations similar in size and design, and must have a minimum of five years' experience in manufacturing and installing glazed canopy systems.

2.2 MATERIALS

A. Aluminum Extrusions:
   1. ASTM B221& ASTM B429 6063-T5 alloy and temper.
B. Hardware:
   1. All fasteners shall be stainless steel or zinc coated for corrosion resistance.

2.3 COMPONENTS

A. Framing:
   1. Type: Extruded aluminum "J" channel fascia
   2. Size: 8" x .125"

B. Canopy Supports: Extruded Aluminum Canopy Support "I" Beam

C. Decking: 3" x 6" x .090" Interlocking Extruded aluminum flat soffit decking

D. Attachment; As required to meet final conditions

E. Custom Fascia Profiles: (4" Crown) (3" Crown) (8" Industrial) (12" Industrial)

F. Other Components: other components as indicated or as required for system attachment and performance.

2.4 FABRICATION

A. Fabricate canopy system in accordance with approved Shop Drawings.

B. Canopies to be pre-assembled and welded by. Where pre-assembled canopies are too large for transport mechanical field assembly will be accepted.

C. Drainage system to be concealed type. Coordinate with Architect. Covered surfaces direct water to field drilled drain, to be coordinated at site.

2.5 FINISHES

A. Aluminum:

B. Pre- Treatment: Pre-treat to ASTM D1730 type B, Method 5 using a multi stage chromate process or an approved chrome- free pretreatment process approved by powder coat manufacturer for optimized weather resistance.

1. Type AAMA 2603 Thermosetting Polyester Resin-based Powder
2. Source: Tiger Drylac powder coating or equivalent.
3. Color: (color) to be selected by architect from

PART 3 - EXECUTION

3.1 FIELD DIMENSIONS

A. Field verify dimensions of supporting structure at site of installation prior to fabrication.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved Shop Drawings.

B. Install components plumb and level, in proper plane, free from warp and twist.

C. Anchor system to building components; provide adequate clearance for movement caused by thermal expansion and contraction and wind loads.

3.3 ADJUSTING

A. Touch up minor scratches and abrasions on finished surfaces to match original finish.
B. Clean with mild, non-abrasive solution and a cotton cloth under low pressure.

END OF SECTION

SECTION 113013 - RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cooking appliances.
2. Refrigeration appliances.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Field quality-control reports.

C. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Special Warranties: Manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 MICROWAVE OVENS

A. Manufacturer/Product: Basis of Design Product is GE's 1.6 Cu. Ft. Countertop Microwave Oven Model #: JES1657DMBB. Manufacturers offering products meeting requirements include but are not limited to the following:

1. LG
2. Panasonic
3. Toshiba
4. Sharp

B. Description:
1. 1.6 cu. ft. capacity
2. Sensor cooking controls
3. Weight and time defrost
4. Dimensions: 12 7/8 H x 21 3/4 W x 17 3/4 D
5. Freestanding countertop Model – Black.

2.3 REFRIGERATOR/FREEZERS

A. Manufacturer/Product: Basis of Design Product is GE's ENERGY STAR® 19.2 Cu. Ft. Top-Freezer Refrigerator Model #GTE19DTNRWW. Other Manufacturers offering similar products include but are not limited to the following:

1. Frigidaire
2. Kenmore
3. LG
4. Maytag
5. Whirlpool

B. Description/Features:
1. LED lighting
2. Adjustable wire shelves
3. Upfront temperature controls regulate both fresh food and freezer sections
4. ADA-compliant
5. Large 13.59 cu. ft. fresh-food capacity
6. 5.57 cu. ft. freezer capacity
7. Clear crisper drawers
8. Gallon door storage bins
9. Dairy compartment
10. Wire freezer shelf
11. Icemaker-ready
12. Approximate Dimensions (in.) - 66-3/8 in. H x 29-3/4 in. W x 34-1/2 in. D
13. Limited 1-year entire appliance warranty

PART 3 - EXECUTION

3.1 INSTALLATION

A. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections.

1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
2. Operational Test: After installation, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.

END OF SECTION 113013

SECTION 122113 - HORIZONTAL LOUVER BLINDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Horizontal louver blinds with aluminum slats.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For horizontal louver blinds, include fabrication and installation details.

C. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 HORIZONTAL LOUVER BLINDS, ALUMINUM SLATS

A. Manufacturer/Product: Basis of Design Product is Levelor’s Riviera Metal Blinds. Manufacturers offering products meeting requirements include but are not limited to the following:

1. Bali
2. Graber
3. Hunter Douglas

B. Description:

1. Slats: Aluminum; alloy and temper recommended by producer for type of use and finish indicated; with crowned profile and radius corners.
2. Width: 1 inch.
3. Thickness: Manufacturer's standard for contract commercial blinds.
4. Features:
   a. Lift-Cord Rout Holes: Minimum size required for lift cord and located near back (outside) edge of slat to maximize slat overlap and minimize light gaps between slats.
   b. Headrail: Formed steel or extruded aluminum; long edges returned or rolled. Headrails fully enclose operating mechanisms on three sides.

c. Manual Lift Mechanism:
d. Lift-Cord Lock: Variable; stops lift cord at user-selected position within blind full operating range.
e. Operator: Extension of lift cord(s) through lift-cord lock mechanism to form cord pull.

5. Manual Tilt Mechanism: Enclosed worm-gear mechanism and linkage rod that adjusts ladders.

a. Tilt: Full.
b. Operator: Clear-plastic wand.

6. Manual Lift-Operator and Tilt-Operator Lengths: Length required to extend to 48 inches above floor level when blind is fully closed.
7. Manual Lift-Operator and Tilt-Operator Locations: Manufacturer's standard.

C. Bottom Rail: Formed-steel or extruded-aluminum tube that secures and protects ends of ladders and lift cords and has plastic- or metal-capped ends.

1. Type: Manufacturer's standard.

D. Ladders: Braided cord.

E. Valance: Manufacturer's standard.

F. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.

G. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard.

H. Colors, Textures, Patterns, and Gloss:

1. Slats: As selected by Engineer from manufacturer's full range.
2. Components: Provide rails, cords, ladders, and materials exposed to view matching or coordinating with slat color unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Confirm location and configuration of blinds, wands and pull chords in the field prior to submitting shop drawings and fabricating units.

B. Install horizontal louver blinds level and plumb, aligned and centered on openings, and aligned with adjacent units according to manufacturer's written instructions.

1. Locate so exterior slat edges are not closer than 1/2 inch from interior faces of glazing frames through full operating ranges of blinds.
2. Install mounting and intermediate brackets to prevent deflection of headrails.

3. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.

C. Adjust horizontal louver blinds to operate free of binding or malfunction through full operating ranges.

D. Clean horizontal louver blind surfaces after installation according to manufacturer's written instructions.

3.2 SCHEDULE: Refer to Drawings.

END OF SECTION 122113

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid surface material countertops.
2. Solid surface material backsplashes.
3. Solid surface material end splashes.
4. Solid surface material apron fronts.
5. Solid surface material window sills.

1.2 ACTION SUBMITTALS

A. Product Data: For countertop materials.

B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

C. Samples: For each type of material exposed to view.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.

B. Manufacturers: Manufacturers offering products meeting requirements include but are not limited to the following:

1. Avonite
2. Formica
3. WilsonArt

C. Delete option in "Type" Subparagraph below if 1/4-inch- (6.4-mm-) thick material is not used.
1. Type: Provide Standard type
2. Colors and Patterns: As selected by Engineer from manufacturer's full range unless otherwise indicated.

D. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.

E. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 COUNTERTOP FABRICATION

A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."

1. Grade: Custom

B. Configuration: Refer to Drawings.

C. Countertops: 1/2-inch thick, solid surface material with front edge built up with same material.

D. Backsplashes: 1/2-inch-thick, solid surface material.

E. Joints: Fabricate countertops without joints where possible.

F. Joints: Where necessary, fabricate countertops in sections for joining in field**.**

G. Cutouts and Holes:

1. Undercounter Plumbing Fixtures: Make cutouts for fixtures using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

2.3 INSTALLATION MATERIALS

A. Adhesive: Product recommended by solid surface material manufacturer.

B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fasten sub-tops to cabinets by screwing through sub-tops into corner-blocks of base cabinets. Shim as needed to align sub-tops in a level plane.

B. Secure countertops to sub-tops with adhesive according to solid surface material manufacturer's written instructions.

C. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.

D. Install backsplashes and end splashes by adhering to wall and countertops with adhesive.

E. Install aprons to backing and countertops with adhesive.

F. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to

finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

G. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

SECTION 133410 – NONSTRUCTURAL COMPONENT AND CLADDING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section specifies the anchorage, bracing, and support requirements for equipment and other nonstructural components.
    a. Mechanical equipment and distribution systems.
    b. Electrical equipment and distribution systems.
    c. Solar panels and solar arrays.
    d. Alarms and fire suppression systems.
    e. Communication and data systems.
    f. Signs and electronic displays.
    g. Roof and wall cladding.
    h. Glazing and glass.
    i. Partitions.
    j. Nonstructural wall elements.
    k. Ceiling and suspended ceilings.
    l. Foundations for mechanical and electrical equipment not specifically detailed on the Drawings.

B. In the event of conflict with requirements in other Sections, the more stringent criteria shall apply.

1.2 COORDINATION

A. Coordinate installation requirements of nonstructural architectural, mechanical, and electrical components with the supporting structure. Provide all necessary anchorage, bracing, support, and other items as required to complete the Work.

1.3 ACTION SUBMITTALS

A. Delegated-Design Submittal: For equipment and other nonstructural component anchorage, bracing, and support including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Include reactions and loads that will be imparted on the supporting structure.

B. Shop Drawings: Show fabrication and installation details for each component. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items including any required bracing. Indicate components by others.

C. Component Certification: Manufacturer’s certification that the component is seismically qualified by either analysis, testing, or experience data in accordance with the requirements of ASCE/SEI 7 Chapter 13.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For delegated design professional engineer.

B. A list of all discrete mechanical and electrical components and distribution systems subject to the requirements of this Section.

C. A list of all architectural components and claddings subject to the requirements of this Section.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, to design nonstructural components including anchorage, bracing, supports, and attachment to the structure. This includes all architectural, mechanical and electrical components unless support and attachment of the component is explicitly detailed on the structural drawings. The qualified professional engineer shall be licensed in the state of the project.

B. Structural Performance: Nonstructural components shall be designed to withstand the effects of gravity and lateral loads and stresses within the limits and under the conditions specified in current edition of the International Building Code and ASCE/SEI 7. This includes dead and live loads and wind and seismic loads where applicable.

C. Seismic Performance: Nonstructural components shall be designed to withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. Site specific criteria includes the following:

      a. Risk Category = II
      b. Component Importance Factor / Ip = 1.0 unless noted otherwise
      c. Mapped MCE_R at Short Periods / Ss = 1.97
      d. Mapped MCE_R at One Second Period / S1 = 0.783
      e. Site Class = B
      f. Design Spectral Response Acceleration at Short Periods / SDS = 1.182
      g. Design Spectral Response Acceleration at One Second Period / SD1 = 0.418
      h. Seismic Design Category = E
      i. Response Modification Coefficient and Amplification Factors: In accordance with ASCE/SEI 7 Sections 13.5 or 13.6.

   2. The component Importance Factor, Ip, shall be taken as 1.5 if any of the following conditions apply:

      a. The component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems and egress stairways.
      b. The component conveys, supports, or otherwise contains toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the Authority Having Jurisdiction and is sufficient to pose a threat to the public if released.

c. The component is in or attached to a Risk Category IV structure, and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.
d. The component conveys, supports, or otherwise contains hazardous substances and is attached to a structure or portion thereof classified by the Authority Having Jurisdiction as a hazardous occupancy.

3. Discrete mechanical and electrical components that are positively attached to the structure are exempt from seismic design requirements provided that either:

a. The component weighs 400lbs or less, the center of mass is located 4 ft or less above the adjacent floor level, flexible connections are provided between the component and associated ductwork, piping, and conduit, and the component Importance Factor, Ip, is equal to 1.0.
b. The component weighs 20lbs or less or, in the case of distributed systems, 5lbs/ft or less.

4. Distribution systems in the exceptions for conduit, cable tray, and raceways in ASCE/SEI 7 Section 13.6.5, duct systems in ASCE/SEI 7 13.6.6 and piping and tubing systems in ASCE/SEI 7 13.6.7.3 are exempt from seismic design requirements. Where in-line components, such as valves, in-line suspended pumps, and mixing boxes require independent support, they shall be addressed as discrete components and shall be braced considering the tributary contribution of the attached distribution system.

D. Wind Performance: Equipment and nonstructural components shall be anchored and braced to withstand the effects of wind determined according to ASCE/SEI 7. Site specific criteria includes the following:

1. Nominal Design Wind Speed / Vasd = 72 mph
2. Ultimate Design Wind Speed / Vult = 92 mph
3. Risk Category = II
4. Wind Importance Factor / Iw = 1.0
5. Exposure Category = C

2.2 MATERIALS AND FABRICATION

A. Attachments and supports shall be constructed of materials and products suitable for the application and shall be fabricated and installed in accordance with the material specifications in other applicable Sections, as shown on the Drawings, or where not otherwise specified or shown in accordance with industry standards.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 133410

SECTION 133419 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel framing.
2. Metal roof panels.
3. Metal wall panels.
4. Foamed-insulation-core metal wall panels.
5. Metal soffit panels.
6. Thermal insulation.
7. Personnel doors and frames.
8. Horizontal sliding doors.
9. Windows.
10. Translucent panels.
11. Accessories.

1.2 DEFINITIONS

A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in standards referenced by this Section.

1.3 COORDINATION

A. Coordinate sizes and locations of concrete foundations and casting of anchor-rod inserts into foundation walls and footings. Anchor rod installation, concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to metal building systems including, but not limited to, the following:

a. Condition of foundations and other preparatory work performed by other trades.
b. Structural load limitations.
c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.

d. Required tests, inspections, and certifications.
e. Unfavorable weather and forecasted weather conditions and impact on construction schedule.

2. Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:

a. Compliance with requirements for purlin and rafter conditions, including flatness and attachment to structural members.
b. Structural limitations of purlins and rafters during and after roofing.
c. Flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
d. Temporary protection requirements for metal roof panel assembly during and after installation.
e. Roof observation and repair after metal roof panel installation.

3. Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:

a. Compliance with requirements for support conditions, including alignment between and attachment to structural members.
b. Structural limitations of girts and columns during and after wall panel installation.
c. Flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
d. Temporary protection requirements for metal wall panel assembly during and after installation.
e. Wall observation and repair after metal wall panel installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of metal building system component.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Metal roof panels.
b. Metal wall panels.
c. Foamed-insulation-core metal panels.
d. Metal soffit panels.
e. Thermal insulation and vapor-retarder facings.
f. Personnel doors and frames.
g. Windows.
h. Translucent roof panels.
i. Roof ventilators.
j. Louvers.

B. Shop Drawings: Indicate components by others. Include full building plan, elevations, sections, details and the following:

1. Anchor-Rod Plans: Submit anchor-rod plans and templates before foundation work begins. Include location, diameter, and minimum required projection of anchor rods required to attach metal building to foundation. Indicate column reactions at each location.
2. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.

    a. Show provisions for attaching mezzanines, roof curbs, service walkways, platforms, and pipe racks.

3. Metal Roof and Wall Panel Layout Drawings: Show layouts of panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, clip spacing, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.

    a. Show roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, and items mounted on roof curbs.
    b. Show wall-mounted items including personnel doors, vehicular doors, windows, louvers, and lighting fixtures.
    c. Show translucent panels.

4. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches (1:8):

    a. Flashing and trim.
    b. Gutters.
    c. Downspouts.
    d. Service walkways.

C. Samples for Initial Selection: For units with factory-applied finishes.

D. Samples for Verification: For the following products:

1. Panels: Nominal 12 inches (300 mm) long by actual panel width. Include fasteners, closures, and other exposed panel accessories.
2. Flashing and Trim: Nominal 12 inches (300 mm) long. Include fasteners and other exposed accessories.
3. Vapor-Retarder Facings: Nominal 6-inch- (150-mm-) square Samples.
4. Windows: Full-size, nominal 12-inch- (300-mm-) long frame Samples showing typical profile.
5. Accessories: Nominal 12-inch- (300-mm-) long Samples for each type of accessory.

E. Door Schedule: For doors and frames. Use same designations indicated on Drawings. Include details of reinforcement.

1. Door Hardware Schedule: Include details of fabrication and assembly of door hardware. Organize schedule into door hardware sets indicating complete designations of every item required for each door or opening.
2. Keying Schedule: Detail Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

F. Delegated Design Submittals: For metal building systems.

1. Include analysis data indicating compliance with performance requirements and design data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For erector and manufacturer.

B. Welding certificates.

C. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

1. Name and location of Project.
2. Order number.
3. Name of manufacturer.
4. Name of Contractor.
5. Building dimensions including width, length, height, and roof slope.
6. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
7. Governing building code and year of edition.
8. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).
9. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
10. Building-Use Category: Indicate category of building use and its effect on load importance factors.

D. Erector Certificates: For qualified erector, from manufacturer.

E. Material Test Reports: For each of the following products:

1. Structural steel including chemical and physical properties.
2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shop primers.
5. Nonshrink grout.

F. Source quality-control reports.

G. Field quality-control reports.

H. Surveys: Show final elevations and locations of major members. Indicate discrepancies between actual installation and the Contract Documents. Have surveyor who performed surveys certify their accuracy.

I. Sample Warranties: For special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panel finishes and door hardware to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Accreditation: Manufacturer's facility accredited according to IAS AC472, "Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems."
2. Engineering Responsibility: Preparation of comprehensive engineering analysis and Shop Drawings by a professional engineer who is legally qualified to practice in jurisdiction where Project is located.

B. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

D. Land Surveyor Qualifications: A professional land surveyor who practices in jurisdiction where Project is located and who is experienced in providing surveying services of the kind indicated.

E. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical wall area as shown on Drawings.
2. Build mockups for typical wall metal panel including accessories.

a. Size: 48 inches (1200 mm) long by 48 inches (1200 mm).

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of

water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Protect foam-plastic insulation as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
3. Complete installation and concealment of foam-plastic materials as rapidly as possible in each area of construction.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with panel installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty on Metal Panel Finishes: Manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 25 years from date of Substantial Completion.

B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that leak or otherwise fail to remain weathertight within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 SYSTEM DESCRIPTION

A. Provide a complete, integrated set of mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced

movement, and exposure to weather without failure or infiltration of water into building interior.

B. Primary-Frame Type:

1. Rigid Clear Span: Solid-member, structural-framing system without interior columns.
2. Truss-Frame Clear Span: Truss-member, structural-framing system without interior columns.

C. End-Wall Framing:

1. Manufacturer's standard, for buildings not required to be expandable, consisting of primary frame, capable of supporting one-half of a bay design load, and end-wall columns.
2. Engineer end walls to be expandable. Provide primary frame, capable of supporting full-bay design loads, and end-wall columns.

D. Secondary-Frame Type: Manufacturer's standard purlins and joists and partially inset-framed girts.

E. Eave Height: Manufacturer's standard height, as indicated by nominal height on Drawings.

F. Bay Spacing: As indicated on Drawings.

G. Roof Slope: As indicated on Drawings .

H. Roof System: Manufacturer's standard metal roof panels.

I. Exterior Wall System: Manufacturer's standard metal wall panels.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal building system.

B. Structural Performance: Metal building systems to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual."
1. Deflection and Drift Limits:

a. Design metal building system assemblies to withstand serviceability design loads without exceeding deflections and drift limits recommended in AISC Steel Design Guide No. 3 "Serviceability Design Considerations for Steel Buildings."

C. Seismic Performance: Metal building system to withstand the effects of earthquake motions determined according to ASCE/SEI 7.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Fire-Resistance Ratings: Where assemblies are indicated to have a fire-resistance rating, provide metal panel assemblies identical to those of assemblies tested for fire resistance per ASTM E119 or ASTM E108 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory," FM Global's "Approval Guide," or from the listings of another qualified testing agency.

F. Fire Propagation Characteristics: Exterior wall assemblies containing foam plastics pass NFPA 285 fire test.

G. Structural Performance for Metal Roof Panels: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.

H. Air Infiltration for Metal Wall Panels: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa).

I. Water Penetration for Metal Wall Panels: No water penetration when tested according to ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft. (137 Pa).

J. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 60.

K. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A- 90.

2.4 STRUCTURAL-STEEL FRAMING

A. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings."

B. Bolted Connections: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts."

C. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.

D. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafters, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.

a. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Architect.

2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
3. Truss-Frame, Clear-Span Frames: Rafter frames fabricated from joist girders, and I-shaped column sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
4. Frame Configuration: Single gable or One-directional, sloped.
5. Exterior Column: Uniform depth or Tapered.
6. Rafter: Uniform depth or Tapered.

E. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly to comply with the following:

1. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates; or C-shaped, cold-formed, structural-steel sheet.
2. End-Wall Rafters: C-shaped, cold-formed, structural-steel sheet; or I-shaped sections fabricated from shop-welded, built-up steel plates or structural-steel shapes.

F. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, prepainted with coil coating, to comply with the following:

1. Purlins:

a. C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch- (64-mm-) wide flanges.
b. Steel joists of depths indicated on Drawings.

2. Girts: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees from flange, with minimum 2-1/2-inch- (64-mm-) wide flanges.

3. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
4. Flange Bracing: Minimum 2-by-2-by-1/8-inch (51-by-51-by-3-mm) structural-steel angles or 1-inch- (25-mm-) diameter, cold-formed structural tubing to stiffen primary-frame flanges.
5. Sag Bracing: Minimum 1-by-1-by-1/8-inch (25-by-25-by-3-mm) structural-steel angles.

6. Base or Sill Angles: Manufacturer's standard base angle, minimum 3-by-2-inch (76-by-51-mm), fabricated from zinc-coated (galvanized) steel sheet.
7. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
8. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.
9. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

G. Canopy Framing: Manufacturer's standard structural-framing system, designed to withstand required loads; fabricated from shop-welded, built-up steel plates or structural-steel shapes. Provide frames with attachment plates and splice members, factory drilled for field-bolted assembly.

1. Type: As indicated.

H. Bracing: Provide adjustable wind bracing using any method as follows:

1. Rods: ASTM A36/A36M; ASTM A572/A572M, Grade 50 (345); or ASTM A529/A529M, Grade 50 (345); minimum 1/2-inch- (13-mm-) diameter steel; threaded full length or threaded a minimum of 6 inches (152 mm) at each end.
2. Cable: ASTM A475, minimum 1/4-inch- (6-mm-) diameter, extra-high-strength grade, Class B, zinc-coated, seven-strand steel; with threaded end anchors.
3. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.
4. Rigid Portal Frames: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
5. Fixed-Base Columns: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
6. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.

I. Anchor Rods: Headed anchor rods as indicated in Anchor Rod Plan for attachment of metal building to foundation.

J. Materials:

1. W-Shapes: ASTM A992/A992M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
3. Plate and Bar: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55 (345 or 380); or ASTM A529/A529M, Grade 50 or 55 (345 or 380).
4. Structural-Steel Sheet: Hot-rolled, ASTM A1011/A1011M, Structural Steel (SS), Grades 30 through 55 (205 through 380), or High-Strength Low-Alloy Steel (HSLAS) or High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F), Grades 45 through 70 (310 through 480); or cold-rolled, ASTM A1008/A1008M, Structural Steel (SS), Grades 25 through 80 (170 through 550), or HSLAS, Grades 45 through 70 (310 through 480).

5. Metallic-Coated Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80 (230 through 550), or HSLAS or HSLAS-F, Grades 50 through 80 (340 through 550); with G60 (Z180) coating designation; mill phosphatized.
6. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80 (230 through 550), or HSLAS or HSLAS-F, Grades 50 through 80 (340 through 550); with G90 (Z275) coating designation.
    b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, SS, Grade 50 or 80 (340 or 550); with Class AZ50 (AZM150) coating.

7. Joist Girders: Manufactured according to "Standard Specifications for Joist Girders," in SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for primary framing.
8. Steel Joists: Manufactured according to "Standard Specifications for Open Web Steel Joists, K-Series," in SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders"; with steel-angle, top- and bottom-chord members, and end- and top-chord arrangements as indicated on Drawings and required for secondary framing.
9. Non-High-Strength Bolts, Nuts, and Washers: ASTM A307, Grade A, carbon-steel, hex-head bolts; ASTM A563 (ASTM A563M) carbon-steel hex nuts; and ASTM F844 plain (flat) steel washers.

    a. Finish: Plain.

10. High-Strength Bolts, Nuts, and Washers, Grade A325 (Grade A325M): ASTM F3125/F3125M, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

    a. Finish: Plain.

11. High-Strength Bolts, Nuts, and Washers, Grade A490 (Grade A490M): ASTM F3125/F3125M, Type 1, heavy-hex steel structural bolts or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
12. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1 hardened carbon-steel washers.

    a. Finish: Plain.

13. Unheaded Anchor Rods: ASTM F1554, Grade 55 or greater, as required by anchorage calculations.

    a. Configuration: Straight.
    b. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.

c. Plate Washers: ASTM A36/A36M carbon steel.
d. Washers: ASTM F436 (ASTM F436M) hardened carbon steel.
e. Finish: Plain.

14. Headed Anchor Rods: ASTM F1554, Grade 55 or greater, as required by anchorage calculations.

a. Configuration: Straight.
b. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
c. Plate Washers: ASTM A36/A36M carbon steel.
d. Washers: ASTM F436 (ASTM F436M) hardened carbon steel.
e. Finish: Plain.

15. Threaded Rods: ASTM A36/A36M.

a. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
b. Washers: ASTM F436 (ASTM F436M) hardened carbon steel.
c. Finish: Plain.

K. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.

1. Clean and prepare in accordance with SSPC-SP2.
2. Coat with manufacturer's standard primer. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil (0.025 mm).

a. Prime secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil (0.013 mm) on each side.

2.5 METAL ROOF PANELS

A. Standing-Seam, Vertical-Rib, Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced or flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch (0.61-mm) nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

a. Exterior Finish: Three-coat fluoropolymer.
b. Color: As indicated by manufacturer's designations.

2. Clips: One-piece fixed to accommodate thermal movement.
3. Joint Type: Panels snapped together.
4. Panel Coverage: 16 inches (406 mm).
5. Panel Height: 2 inches (51 mm).

B. Standing-Seam, Trapezoidal-Rib, Metal Roof Panels: Formed with raised trapezoidal ribs at panel edges and intermediate stiffening ribs symmetrically spaced or flat pan between ribs;

designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch (0.61-mm) nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: Three-coat fluoropolymer.
    b. Color: As indicated by manufacturer's designations.

2. Clips: One-piece fixed to accommodate thermal movement.
3. Joint Type: Panels snapped together.
4. Panel Coverage: 24 inches (610 mm).
5. Panel Height: 3 inches (76 mm).
6. Uplift Rating: UL 60.

C. Exposed Fastener, Tapered-Rib, Metal Roof Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced or flat pan between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch (0.61-mm) nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: Three-coat fluoropolymer.
    b. Color: As indicated by manufacturer's designations.

2. Major-Rib Spacing: 12 inches (305 mm) o.c.
3. Panel Coverage: 36 inches (914 mm).
4. Panel Height: 1.125 inches (29 mm).

D. Exposed-Fastener, Tapered-Rib, Metal Liner Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced or flat pan between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch (0.61-mm) nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: Three-coat fluoropolymer.
    b. Color: As indicated by manufacturer's designations.

2. Major-Rib Spacing: 12 inches (305 mm) o.c.
3. Panel Coverage: 36 inches (914 mm).
4. Panel Height: 1.25 inches (32 mm).

E. Finishes:

1. Exposed Coil-Coated Finish:

a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
b. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
c. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a minimum dry film thickness of 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.6 METAL SOFFIT PANELS

A. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.

B. Metal Soffit Panels: Match profile and material of metal roof panels.

1. Finish: Match finish and color of metal roof panels.

C. Exposed-Fastener, Tapered-Rib-Profile, Metal Soffit Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced or flat pan between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch (0.61-mm) nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

a. Exterior Finish: Three-coat fluoropolymer.
b. Color: As indicated by manufacturer's designations.

2. Major-Rib Spacing: 12 inches (305 mm) o.c.
3. Panel Coverage: 36 inches (914 mm).
4. Panel Height: 1.125 inches (29 mm).

D. Concealed-Fastener, Flush-Profile, Metal Soffit Panels: Formed with vertical panel edges and a single wide recess, centered between panel edges or flush surface; with flush joint between panels; with 1-inch- (25-mm-) wide flange for attaching interior finish; designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps.

1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch (0.61-mm) nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Exterior Finish: Fluoropolymer.
    b. Color: As indicated by manufacturer's designations.

2. Panel Coverage: 12 inches (305 mm).
3. Panel Height: 1.5 inches (38 mm).

2.7 THERMAL INSULATION

A. Faced Metal Building Insulation: ASTM C991, Type II, glass-fiber-blanket insulation; 0.5-lb/cu. ft. (8-kg/cu. m) density; 2-inch- (51-mm-) wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

B. Unfaced Metal Building Insulation: ASTM C991, Type I, or NAIMA 202, glass-fiber-blanket insulation; 0.5-lb/cu. ft. (8-kg/cu. m) density; 2-inch- (51-mm-) wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

C. Mineral-Fiber-Blanket Insulation: ASTM C665, type indicated below; consisting of fibers manufactured from glass, slag wool, or rock wool.

1. Nonreflective Faced: Type II (blankets with nonreflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
2. Reflective Faced: Type III (blankets with reflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
3. Unfaced: Type I (blankets without membrane covering), passing ASTM E136 for combustion characteristics.

D. Faced, Polyisocyanurate Board Insulation: ASTM C1289, Type I (foil facing), Class 2, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core. Provide units tested for interior exposure without an approved thermal barrier.

E. Retainer Strips: For securing insulation between supports, 0.025-inch (0.64-mm) nominal-thickness, formed, metallic-coated steel or PVC retainer clips colored to match insulation facing.

F. Vapor-Retarder Facing: ASTM C1136, with permeance not greater than 0.02 perm (1.15 ng/Pa x s x sq. m) when tested according to ASTM E96/E96M, Desiccant Method.
1. Composition:

    a. White metallized-polypropylene film facing, fiberglass scrim reinforcement, and kraft-paper backing.
    b. Aluminum foil facing, elastomeric barrier coating, fiberglass scrim reinforcement, and kraft-paper backing.

c. White polypropylene or vinyl film facing, fiberglass scrim reinforcement, and metallized-polyester film backing.
d. White polypropylene film facing and fiberglass-polyester-blend fabric backing.

G. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.8 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
2. Clips: Manufacturer's standard, formed from steel or stainless steel sheet, designed to withstand negative-load requirements.
3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from steel, stainless steel sheet or nylon-coated aluminum sheet.
4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match adjacent metal panels.

1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.

D. Gutters: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2438-mm-) long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."

1. Gutter Supports: Fabricated from same material and finish as gutters.
2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.

E. Downspouts: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot- (3-m-) long sections, complete with formed elbows and offsets.

1. Mounting Straps: Fabricated from same material and finish as gutters.

F. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

G. Materials:

1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
2. Fasteners for Metal Roof Panels:

   a. Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless steel cap or zinc-aluminum-alloy head and EPDM sealing washer.
   b. Self-drilling, Type 410 stainless steel or self-tapping, Type 304 stainless steel or zinc-alloy-steel hex washer head, with EPDM washer under heads of fasteners bearing on weather side of metal panels.

3. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
4. Blind Fasteners: High-strength aluminum or stainless steel rivets.
5. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
6. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
7. Metal Panel Sealants:

   a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene-compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.
   b. Joint Sealant: ASTM C920; one part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.9 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly.

1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members to be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.

C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

1. Make shop connections by welding or by using high-strength bolts.
2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
4. Weld clips to frames for attaching secondary framing if applicable, or punch for bolts.
5. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary framing with specified primer after fabrication.

D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll forming or break forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

1. Make shop connections by welding or by using non-high-strength bolts.
2. Shop Priming: Prepare uncoated surfaces for shop priming according to SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication.

E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

2.10 SOURCE QUALITY CONTROL

A. Special Inspection: Owner will engage a qualified special inspector to perform source quality control inspections and to submit reports.

1. Accredited Manufacturers: Special inspections will not be required if fabrication is performed by an IAS AC472-accredited manufacturer approved by authorities having jurisdiction to perform such Work without special inspection.

a. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed according to Contract requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.

1. Engage land surveyor to perform surveying.

C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

A. Erect metal building system according to manufacturer's written instructions and drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

C. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt type and joint type specified.

a. Joint Type: Snug tightened or pretensioned as required by manufacturer.

G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
2. Locate and space wall girts to suit openings such as doors and windows.
3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.

H. Steel Joists and Joist Girders: Install joists, girders, and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders," joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Joint Installation:

a. Bolt joists to supporting steel framework using carbon-steel bolts unless otherwise indicated.
b. Bolt joists to supporting steel framework using high-strength structural bolts unless otherwise indicated. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.
c. Weld joist seats to supporting steel framework.

5. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

I. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.

1. Tighten rod and cable bracing to avoid sag.
2. Locate interior end-bay bracing only where indicated.

J. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

K. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.4 METAL PANEL INSTALLATION, GENERAL

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Examination: Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.

1. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.

D. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.

a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.

2. Install metal panels perpendicular to structural supports unless otherwise indicated.
3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Locate metal panel splices over structural supports with end laps in alignment.
6. Lap metal flashing over metal panels to allow moisture to run over and off the material.

E. Lap-Seam Metal Panels: Install screw fasteners using power tools with controlled torque adjusted to compress EPDM washers tightly without damage to washers, screw threads, or metal panels. Install screws in predrilled holes.

1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.

F. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

G. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types recommended by metal panel manufacturer.

1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.5 METAL ROOF PANEL INSTALLATION

A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.

1. Install ridge and hip caps as metal roof panel work proceeds.
2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint, at location and spacing and with fasteners recommended by manufacturer.

1. Install clips to supports with self-drilling or self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so that clip, metal roof panel, and factory-applied sealant are completely engaged.
5. Rigidly fasten eave end of metal roof panels and allow ridge end free movement for thermal expansion and contraction. Predrill panels for fasteners.
6. Provide metal closures at peaks rake edges rake walls and each side of ridge and hip caps.

C. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with exposed fasteners at each lapped joint, at location and spacing recommended by manufacturer.

1. Provide metal-backed sealing washers under heads of exposed fasteners bearing on weather side of metal roof panels.

2. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
3. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels, on side laps of ribbed or fluted metal panels, and elsewhere as needed to make metal panels weatherproof to driving rains.
4. At metal panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

D. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

E. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.6 METAL SOFFIT PANEL INSTALLATION

A. Provide metal soffit panels the full width of soffits. Install panels perpendicular to support framing.

B. Flash and seal metal soffit panels with weather closures where panels meet walls and at perimeter of all openings.

3.7 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil-canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Tie downspouts to underground drainage system indicated.

E. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.8 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform field quality control special inspections and to submit reports.

B. Product will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Touchup Painting:

1. After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing, bearing plates, and accessories.

a. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or by SSPC-SP 3, "Power Tool Cleaning."
b. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

D. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 133419

SECTION 220523

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Gate valves.
2. Ball valves.

B. Related Sections:
1. Section 220529 - Hangers and Supports for Plumbing Piping and Equipment: Product and installation requirements for pipe hangers and supports.
2. Section 220700 - Plumbing Insulation: Product and installation requirements for insulation for valves.
3. Section 221100 - Facility Water Distribution: Product and installation requirements for piping, piping specialties, and equipment used in domestic water systems.
4. Section 221300 - Facility Sanitary Sewerage: Product and installation requirements for piping, piping specialties, and equipment used in sanitary waste and vent systems.
5. Section 221400 - Facility Storm Drainage: Product and installation requirements for piping, piping specialties, and equipment used in storm drainage systems.

1.02 REFERENCES

A. ASTM International:

1. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

B. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
2. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
3. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
4. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.03 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of valves.

C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.05 QUALITY ASSURANCE

A. For drinking water service, provide valves complying with NSF 61.

B. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum years documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.

B. Do not install valves underground when bedding is wet or frozen.

1.10 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five year manufacturer warranty for valves excluding packing.

1.11 EXTRA MATERIALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for extra materials.

PART 2 - PRODUCTS

2.01 GATE VALVES

A. Manufacturers:
   1. Crane
   2. Jenkins
   3. Smith
   4. Substitutions: Section 016000 - Product Requirements.

B. 2 inches and Smaller: MSS SP 80, Class 125, bronze body, bronze trim, threaded bonnet, non-rising stem,, inside screw with back-seating stem, split wedge disc, solder or threaded ends.

C. 2-1/2 inches and Larger: MSS SP 70, Class 125, cast iron body, bronze trim, bolted bonnet, non-rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.02 BALL VALVES

A. Manufacturers:
   1. Crane
   2. Jenkins
   3. SmithSubstitutions: Section 016000 - Product Requirements.

B. 2 inches and Smaller: MSS SP 110, 400 psi WOG, one piece bronze body, chrome plated brass ball, regular port, teflon seats, blow-out proof stem, solder or threaded ends with union, lever handle.

C. 2 inches and Smaller: 150 psi at 73 degrees F water temperature, maximum service temperature: 140 degrees F ASTM D1785 PVC body and ball, double lever handle, EPDM seals, teflon seats, regular port, single union type with socket ends.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify piping system is ready for valve installation.

3.02 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted.

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Install 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

D. Install valves with clearance for installation of insulation and allowing access.

E. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 083113.

F. Refer to Section 220529 for pipe hangers.

G. Refer to Section 220700 for insulation requirements for valves.

H. For installation of valves in domestic water systems refer to Section 221100.

I. For installation of valves in sanitary systems refer to Section 221300.

J. For installation of valves in storm systems refer to Section 221400.

3.03 VALVE APPLICATIONS

A. Install ball or gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.

B. Install ball or globe valves for throttling, bypass, or manual flow control services.

C. Install ball and gate valves in domestic water systems for shut-off service.

D. Install ball valves in domestic water systems for throttling service.

E. Install ball and gate valves in sanitary systems for shut-off service.

F. Install ball and gate valves in storm water systems for shut-off service.

END OF SECTION

SECTION 220529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Sleeves.
6. Mechanical sleeve seals.
7. Formed steel channel.

B. Related Sections:

1. Section 031000 - Concrete Forming and Accessories: Execution requirements for placement of inserts and sleeves in concrete forms specified by this section.
2. Section 033000 - Cast-In-Place Concrete: Execution requirements for placement of concrete housekeeping pads specified by this section.
3. Section 079200 - Joint Protection: Product requirements for sealant materials for placement by this section.
4. Section 099123 - Painting and Coating: Product and execution requirements for painting specified by this section.
5. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment: Product and execution requirements for vibration isolators.
6. Section 221100 - Facility Water Distribution: Execution requirements for placement of hangers and supports specified by this section.
7. Section 221300 - Facility Sanitary Sewerage: Execution requirements for placement of hangers and supports specified by this section.
8. Section 221400 - Facility Storm Drainage: Execution requirements for placement of hangers and supports specified by this section.

1.02 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

C. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

D. FM Global:

1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Underwriters Laboratories Inc.:

1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

G. Intertek Testing Services (Warnock Hersey Listed):

1. WH - Certification Listings.

1.03 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.04 SYSTEM DESCRIPTION

1.05 PERFORMANCE REQUIREMENTS

1.06 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

C. Product Data:

1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers. Submit sizing methods sealed by a registered professional engineer.

E. Manufacturer's Installation Instructions:

1. Hangers and Supports: Submit special procedures and assembly of components.
2. Firestopping: Submit preparation and installation instructions.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Firestopping Engineering Judgments: For conditions not covered by UL or WH listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.07 QUALITY ASSURANCE

A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.

1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.

B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.

1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.

E. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

F. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

G. Maintain one copy of each document on site.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum 3 years documented experience.

1.09 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.

B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.

C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

D.

1.12 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.13 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for pipe hangers and supports.

PART 2 - PRODUCTS

A. Plumbing Piping - DWV:

1. Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.

B. Plumbing Piping - Water:

1. Conform to ASME B31.9 MSS SP58 MSS SP69 MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.

9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, Carbon-steel ring.

2.02 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.03 INSERTS

A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.04 FLASHING

A. Metal Flashing: 26 gage thick galvanized steel.

B. Metal Counterflashing: 22 gage thick galvanized steel.

C. Lead Flashing:

1. Waterproofing: 5 lb./sq. ft sheet lead.
2. Soundproofing: 1 lb./sq. ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.05 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sealant: Acrylic; refer to Section 079200.

2.06 MECHANICAL SLEEVE SEALS

A. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.07 FORMED STEEL CHANNEL

A. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.02 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Install damming materials to arrest liquid material leakage.

D. Obtain permission from Architect/Engineer before using powder-actuated anchors.

E. Do not drill or cut structural members.

F. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.03 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.04 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.1 ASME B31.5 ASME 31.9 ASTM F708 MSS SP 58 MSS SP 69 MSS SP 89.

B. Support horizontal piping as scheduled.

C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

H. Support riser piping independently of connected horizontal piping.

I. Provide copper plated hangers and supports for copper piping.

J. Design hangers for pipe movement without disengagement of supported pipe.

K. Prime coat exposed steel hangers and supports. Refer to Section 099200. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

L. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 220700.

3.05 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. sing templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

B. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

3.06 INSTALLATION - FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.

B. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

C. Seal floor drains watertight to adjacent materials.

D. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.07 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with stuffing insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install chrome plated steel escutcheons at finished surfaces.

3.08 FIELD QUALITY CONTROL

A. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

3.09 CLEANING

A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

B. Clean adjacent surfaces of firestopping materials.

3.10 PROTECTION OF FINISHED WORK

A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

3.11 SCHEDULES

A. Pipe Hanger Spacing:

1. Pipe Material: Copper tube.

    a. Size: 1-1/4 inches and smaller.
    b. Maximum Hanger Spacing: 6 feet
    c. 1/2 inch

2. Pipe Material: Copper tube.

    a. Size: 1-1/2 inches and larger.
    b. Maximum Hanger Spacing: 10 feet
    c. 1/2 inch

3. Pipe Material: PVC.
    a. Maximum Hanger Spacing: 4 feet
    b. 3/8 inch

4. Pipe Material: Steel.

    a. Size: 3 inches and smaller.
    b. Maximum Hanger Spacing: 12 feet
    c. 1/2 inch

5. Pipe Material: Steel.

    a. Size: 4 inches and larger.
    b. Maximum Hanger Spacing: 12 feet
    c. 5/8 inch

END OF SECTION

SECTION 220553

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

B. Related Sections:

1. Section 099000 - Painting and Coating: Execution requirements for painting specified by this section.

1.02 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit manufacturers catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.05 QUALITY ASSURANCE

A. Conform to NFPA 99 requirements for labeling and identification of medical gas piping systems and accessories.

B. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

C. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.08 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.09 EXTRA MATERIALS

A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 - PRODUCTS

2.01 NAMEPLATES

A. Manufacturers:

1. Craftmark Pipe Markers.
2. Kolbi Pipe Marker Co.
3. Pipemarker.com; Brimar Industries, Inc.
4. Seton Identification Products; a Brady Corporation company.
5. Substitutions: Section 016000 - Product Requirements.

B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.02 TAGS

A. Metal Tags:

1. Manufacturers:

a. Brady ID.
b. Craftmark Pipe Markers.
c. Kolbi Pipe Marker Co.
d. Marking Services, Inc.
e. Pipemarker.com; Brimar Industries, Inc.
f. R & R Identification Co.
g. Seton Identification Products; a Brady Corporation company.
h. Substitutions: Section 016000 - Product Requirements.

2. Aluminum with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

B. Information Tags:

1. Manufacturers:

a. Brady ID.
b. Seton Identification Products; a Brady Corporation company.
c. Substitutions: Section 016000 - Product Requirements.

2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.

C. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame plastic laminated.

1. Kolbi Pipe Marker Co.
2. Marking Services, Inc.
3. Pipemarker.com; Brimar Industries, Inc.
4. R & R Identification Co.

2.03 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers

1. Manufacturers:

a. Brady ID.
b. Craftmark Pipe Markers.
c. Marking Services, Inc.
d. R & R Identification Co.
e. Seton Identification Products; a Brady Corporation company.
f. Substitutions: Section 016000 - Product Requirements.

2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Underground Pipe Markers

1. Manufacturers:

a. Kolbi Pipe Marker Co.
b. Marking Services, Inc.
c. Pipemarker.com; Brimar Industries, Inc.
d. Rhino Marking and Protection Systems.
e. Seton Identification Products; a Brady Corporation company.
f. Substitutions: Section 016000 - Product Requirements.

2. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.04 CEILING TACKS

A. Manufacturers:

1. Marking Services, Inc.
2. R & R Identification Co.
3. Seton Identification Products; a Brady Corporation company.
4. Substitutions: Section 016000 - Product Requirements.

B. Description: Steel with 3/4 inch diameter color-coded head.

C. Color code as follows:

1. Plumbing valves: Green.

2.05 LABELS

A. Manufacturers:

1. Brady ID.
2. Seton Identification Products; a Brady Corporation company.
3. Substitutions: Section 016000 - Product Requirements.

B. Description: Laminated Mylar, size 1.9 x 0.75 inches, adhesive backed with printed identification and bar code.

2.06 LOCKOUT DEVICES

A. Lockout Hasps:

1. Manufacturers:

a. Brady ID.
b. Master Lock Company, LLC.
c. Substitutions: Section 016000 - Product Requirements.

2. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

B. Valve Lockout Devices:

1. Manufacturers:

a. Brady ID.
b. Master Lock Company, LLC.
c. Substitutions: Section 016000 - Product Requirements.

2. Nylon device preventing access to valve operator, accepting lock shackle.

PART 3 - EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

A. Install identifying devices after completion of coverings and painting.

B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

D. Install tags using corrosion resistant chain. Number tags consecutively by location.

E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

F. Identify water heaters, pumps, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.

G. Identify control panels and major control components outside panels with plastic nameplates.

H. Identify valves in main and branch piping with tags.

I. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

J. Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 220700

PLUMBING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Plumbing piping insulation, jackets and accessories.
2. Plumbing equipment insulation, jackets and accessories.

B. Related Sections:
1. Section 099200 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.

1.02 REFERENCES

A. ASTM International:
1. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
2. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
3. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
4. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
5. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
6. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
7. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
8. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
9. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
10. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
11. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
12. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, 80, and 120.
13. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
14. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

1.03 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

D. Maintain one copy of each document on site.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years [documented] experience.

1.06 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.

B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.09 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for man made fiber.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Glass Fiber and Mineral Fiber Insulation

1. Manufacturers:

a. CertainTeed LLC; Saint-Gobain North America.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Manson Insulation Inc.
e. Owens Corning.
f. Substitutions: Section 016000 - Product Requirements.

B. Closed Cell Elastomeric Insulation

1. Manufacturers:

a. Aeroflex USA.
b. Armacell LLC.
c. K-Flex USA.

d. Substitutions: Section 016000 - Product Requirements.

2.02 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.
5. Operating Temperature Range: 0 to 650 degrees F.

B. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

2.03 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:

1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

B. Aluminum Pipe Jacket:

1. ASTM B209.
2. Thickness: inch thick sheet.
3. Finish: Smooth.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum. 0.010 inch thick stainless steel.

C. Field Applied Glass Fiber Fabric Jacket System:

1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:

a. Cloth: Untreated; 9 oz/sq yd weight.
b. Blanket: 1.0 lb/cu ft density.
c. Weave: 5 x 5.

3. Indoor Vapor Retarder Finish:

a. Cloth: Untreated; 9 oz/sq yd weight.
b. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

C. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

D. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self adhesive closure. Thickness to match pipe insulation.

E. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

F. Adhesives: Compatible with insulation.

2.05 EQUIPMENT INSULATION

A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.

1. Thermal Conductivity: 0.023 at 75 degrees F.
2. Operating Temperature Range: 0 to 450 degrees F.
3. Density: 1.5 pound per cubic foot.

B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied aluminum foil jacket.

1. Thermal Conductivity: [0.24] [0.023] at 75 degrees F.
2. Operating Temperature Range: 0 to 450 degrees F.
3. Density: [3.0] [4.2] pound per cubic foot.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

2.06 EQUIPMENT INSULATION JACKETS

A. Vapor Retarder Jacket:

1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

2.07 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Adhesives: Compatible with insulation.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Verify piping and equipment has been tested before applying insulation materials.

C. Verify surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 078400 for penetrations of assemblies with fire resistance rating greater than one hour.

C. Piping Systems Conveying Fluids Below Ambient Temperature:

1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:

1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Hot Piping Systems:

1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

F. Inserts and Shields:

1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.

    a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
    b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.

3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

G. Insulation Terminating Points:

1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
3. Condensate Piping: Insulate entire piping system and components to prevent condensation.

H. Closed Cell Elastomeric Insulation:

1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer's recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

I. Prepare pipe insulation for finish painting. Refer to Section 099200.

3.03 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:

1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids 140 degrees F Or Less:

1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

G. Cover glass fiber, and cellular foam insulation with aluminum jacket.

H. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

I. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

J. Prepare equipment insulation for finish painting. Refer to Section 099000.

3.04 SCHEDULES

A. Water Supply Services Piping Insulation Schedule:

1. Domestic Hot Water Supply:

a. Type: P-1.
b. Thickness:

1) Pipe Size 1-1/4 Inches and Smaller: 0.5 inch.
2) Pipe Size 1-1/2 Inches and Larger: 1.0 inch.

2. Domestic Cold Water:

a. Type: P-1.
b. Thickness:

1) Pipe Size 1-1/4 Inches and Smaller: 0.5 inch.

2) Pipe Size 1-1/2 Inches and Larger: 1.0 inch.

B. Drainage Services Piping Insulation Schedule:

1. Storm Piping - Horizontal Above Ground Within Building:

a. Type: P-1.
b. Thickness: 1 inch.

2. Sanitary Sewer Piping - Horizontal and Vertical Above Ground within Building if PVC Piping is Used:

a. Type: P-1.
b. Thickness: 1 inch.

C. Equipment Insulation Schedule:

1. Roof Drain Bodies:

a. Type: E-2.
b. Thickness: 1 inch.

END OF SECTION

SECTION 221100

FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Domestic water piping, within 5 feet of building.
   2. Domestic water piping, above grade.
   3. Unions and flanges.
   4. Backflow preventers.

B. Related Sections:

   1. Section 033000 - Cast-In-Place Concrete: Execution requirements for placement of
   2. Section 099123 - Painting and Coating: Product and execution requirements for painting specified by this section.
   3. Section 220523 - General-Duty Valves for Plumbing Piping: Product requirements for valves for placement by this section.
   4. Section 220529 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports for placement by this section.
   5. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment: Product requirements for vibration isolators for placement by this section.
   6. Section 220553 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification and valve tags for placement by this section.
   7. Section 220700 - Plumbing Insulation: Product and execution requirements for pipe insulation.
   8. Section 260010 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.02 REFERENCES

A. American National Standards Institute:

   1. ANSI Z21.22 - Relief Valves for Hot Water Supply Systems.

B. American Society of Mechanical Engineers:

   1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
   2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   3. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
   4. ASME B31.9 - Building Services Piping.
   5. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.

C. American Society of Sanitary Engineering:

1. ASSE 1010 - Performance Requirements for Water Hammer Arresters.
2. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.
3. ASSE 1012 - Performance Requirements for Backflow Preventer with Intermediate Atmospheric Vent.
4. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.

D. ASTM International:

1. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
2. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
3. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
4. ASTM D2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
5. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
6. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
7. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
8. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

E. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

F. American Water Works Association:

1. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
2. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
3. AWWA C702 - Cold-Water Meters - Compound Type.
4. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
5. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

G. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

H. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

I. Plumbing and Drainage Institute:

1. PDI WH201 - Water Hammer Arrester Standard.

J. Underwriters Laboratories Inc.:

1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
2. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

1.03 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturer's catalog information.
2. Hangers and Supports: Submit manufacturers catalog information including load capacity.
3. Domestic Water Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.

C. Manufacturer's Installation Instructions: Submit installation instructions for pumps, valves and accessories.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of valves and equipment.

C. Operation and Maintenance Data: Submit spare parts list, exploded assembly views and recommended maintenance intervals.

1.05 QUALITY ASSURANCE

A. For drinking water service, provide valves complying with NSF 61.

B. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Product storage and handling requirements.

B. Accept valves and equipment on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Section 016000 - Product Requirements.

B. Do not install underground piping when bedding is wet or frozen.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for domestic water piping.

1.12 EXTRA MATERIALS

A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two<_____ packing kits for each size valve.

PART 2 - PRODUCTS

2.01 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Copper Tubing: ASTM B88, Type K, annealed.

1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
2. Joints: Compression connection or Brazed, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

B. Polyethylene Pipe: ASTM D2239 SIDR 19, or ASTM D2447 Schedule 40.

1. Fittings: ASTM D2609, Polyethylene.
2. Joints: Mechanical with stainless steel clamps.

2.02 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tubing: ASTM B88, Type K, drawn.

1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder

a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, enamel coated, compatible with copper tubing sizes, to engage and lock designed to permit some angular deflection, contraction, and expansion.
b. Gasket: Elastomer composition for operating temperature range from minus 30 degrees F to 180degrees F.
c. Accessories: Stainless steel bolts, nuts, and washers.

B. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized, rolled grooved ends.

1. Fittings: ASTM A395/A395M and ASTM A536 ductile iron, grooved ends.
2. Joints: Grooved mechanical couplings meeting ASTM F1476.

a. Housing Clamps: ASTM A395 and ASTM A536 ductile iron, enamel coated, compatible with steel piping sizes, rigid or flexible type.
b. Gasket: Elastomer composition for operating temperature range from minus 30 degrees F to 180degrees F.
c. Accessories: Stainless steel bolts, nuts, and washers.

2.03 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:

1. Ferrous Piping: Class 150, malleable iron, threaded.
2. Copper Piping: Class 150, bronze unions with brazed joints.

3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
4. guided bronze disc, stainless steel spring and screws, flanged ends.

2.04 PIPE HANGERS AND SUPPORTS: See section 220523.

2.05 WATER PRESSURE REDUCING VALVES

A. Manufacturers:
   1. Zurn
   2. Watts

B. Substitutions: Section 016000 - Product Requirements.

C. 2 inches and Smaller: MSS SP 80, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded and single union ends.

D. 2 inches and Larger: MSS SP 85, cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged.

2.06 STRAINERS

A. 2 inch and Smaller: Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

B. 1-1/2 inch to 4 inch: Class 125, flanged iron body, Y pattern with 1/16-inch stainless steel perforated screen.

2.07 BACKFLOW PREVENTERS

A. Manufacturers:
   1. Watts
   2. Zurn

B. Substitutions: Section 016000 - Product Requirements.

C. Reduced Pressure Backflow Preventers:

   1. Comply with ASSE 1013.
   2. Bronze body, with bronze internal parts and stainless steel springs.
   3. Two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve opening under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

2.08 WATER HAMMER ARRESTORS

A. ASSE 1010; stainless steel construction, bellows type sized in accordance with PDI WH-201.

B. Pre-charged suitable for operation in temperature range 34 to 250 degrees F and maximum 150 psi working pressure.

2.09 UNDERGROUND PIPE MARKERS: See section 220553.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

3.03 INSTALLATION - HANGERS AND SUPPORTS: See section 220529.

3.04 INSTALLATION - BURIED PIPING SYSTEMS

A. Verify connection to existing piping system size, location, and invert are as indicated on Drawings.

B. Establish elevations of buried piping with not less than 2 ft of cover.

C. Establish minimum separation of 10’ from other services piping in accordance with code.

D. Remove scale and dirt on inside of piping before assembly.

E. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.

F. Install pipe on prepared bedding.

G. Route pipe in straight line.

H. Install pipe to allow for expansion and contraction without stressing pipe or joints.

I. Install shutoff and drain valves at locations indicated on Drawings in accordance with Section 220523.

J. Install plastic ribbon tape continuous over top of pipe. above pipe line.Refer to Section 220553.

K. Pipe Cover and Backfilling:
   1. Maintain optimum moisture content of fill material to attain required compaction density.
   2. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 4 inches compacted layers to 12 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
   3. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
   4. Do not use wheeled or tracked vehicles for tamping.

3.05 INSTALLATION - ABOVE GROUND PIPING

A. Install non-conducting dielectric connections wherever jointing dissimilar metals.

B. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

C. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.

D. Group piping whenever practical at common elevations.

E. Slope piping and arrange systems to drain at low points.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 210516.

G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 220700.

H. Provide access where valves and fittings are not accessible.

I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

J. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 099123.

K. Install domestic water piping in accordance with ASME B31.9.

L. Sleeve pipes passing through partitions, walls and floors. Refer to Section 220529.

M. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.

N. Install unions downstream of valves and at equipment or apparatus connections.

O. Install valves with stems upright or horizontal, not inverted.

P. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

Q. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

R. Install ball valves for throttling, bypass, or manual flow control services.

S. Provide ball valves adjacent to equipment when functioning to isolate equipment.

T. Install potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibs.

U. Pipe relief from valves, back-flow preventers and drains to nearest floor drain.

V. Test backflow preventers in accordance with ASSE 5013 and 5015.

3.06 INSTALLATION - SERVICE CONNECTIONS

A. Provide new water service complete with approved reduced pressure double check back-flow preventer and water meter with by-pass valves and strainer.

B. Provide 18 gage galvanized sheet metal sleeve around service main to 6 inch above floor and 6 feet minimum below grade. Size for minimum of 2 inches of loose batt insulation stuffing.

3.07 FIELD QUALITY CONTROL

A. Section 017000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test domestic water piping system in accordance with applicable code.

3.08 CLEANING

A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

B. Prior to starting work, verify system is complete, flushed and clean.

C. Verify pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

D. Inject disinfectant, free chlorine in liquid, powder and tablet or gas form, throughout system to obtain residual from 50 to 80 mg/L.

E. Bleed water from outlets to obtain distribution and test for disinfectant residual at minimum 15 percent of outlets.

F. Maintain disinfectant in system for 24 hours.

G. When final disinfectant residual tests less than 25 mg/L, repeat treatment.

H. Flush disinfectant from system until residual concentration is equal to incoming water or 1.0 mg/L.

I. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.09 SCHEDULES

A. Pipe Hanger Spacing:

1. Pipe Material: Copper tube.

    a. Size: 1-1/4 inches and smaller.
    b. Maximum Hanger Spacing: 6 feet
    c. 1/2 inch

2. Pipe Material: Copper tube.

    a. Size: 1-1/2 inches and larger.
    b. Maximum Hanger Spacing: 10 feet
    c. 1/2 inch

3. Pipe Material: Steel.

    a. Size: 3 inches and smaller.
    b. Maximum Hanger Spacing: 12 feet
    c. 1/2 inch

4. Pipe Material: Steel.

    a. Size: 4 inches and larger.
    b. Maximum Hanger Spacing: 12 feet
    c. 5/8 inch

END OF SECTION

SECTION 221300

FACILITY SANITARY SEWERAGE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Sanitary sewer piping buried within 5 feet of building.
2. Sanitary sewer piping above grade.
3. Unions and flanges.
4. Floor drains.
5. Cleanouts.

B. Related Sections:

1. Section 033000 - Cast-In-Place Concrete: Execution requirements for placement of concrete specified by this section.
2. Section 099123 - Painting and Coating: Product and execution requirements for painting specified by this section.
3. Section 220523 - General-Duty Valves for Plumbing Piping: Product requirements for valves for placement by this section.
4. Section 220529 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports for placement by this section.
5. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment: Product requirements for vibration isolators for placement by this section.
6. Section 220553 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification for placement by this section.
7. Section 220700 - Plumbing Insulation: Product and execution requirements for pipe insulation.
8. Section 260010 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.02 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME A112.21.1 - Floor Drains.
2. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
2. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

3. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
4. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
5. ASTM A536 - Standard Specification for Ductile Iron Castings.
6. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
7. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
8. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
9. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
10. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
11. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
12. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
13. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
14. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
15. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
16. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
17. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

C. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
4. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
6. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
7. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.03 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes for sewage-ejectors, and manholes.

C. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
2. Sanitary Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.

D. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of equipment and clean-outs.

C. Operation and Maintenance Data: Submit frequency of treatment required for interceptors. Include, spare parts lists, exploded assembly views for pumps and equipment.

1.05 QUALITY ASSURANCE

A. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Product storage and handling requirements.

B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Section 016000 - Product Requirements.

B. Do not install underground piping when bedding is wet or frozen.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

1.12 EXTRA MATERIALS

A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 - PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D1785, Schedule 80, polyvinyl chloride (PVC) material, bell and spigot style solvent sealed joint ends.

1. Fittings: ASTM D2467, Schedule 80, PVC.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 Solvent cement.

2.02 SANITARY SEWER PIPING, ABOVE GRADE

A. PVC Pipe: ASTM D1785 Schedule 80 or ASTM D2241 SDR-26 for not less than 150 psi pressure rating, polyvinyl chloride (PVC) material.

1. Fittings: ASTM D2467, Schedule 80, PVC.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 Solvent cement.

2.03 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:
1. PVC Piping: PVC.

B. Flanges for Pipe 2-1/2 inches and Larger:
   1. PVC Piping: PVC flanges.
   2. Gaskets: 1/16 inch thick preformed neoprene gaskets.

C. PVC Pipe Materials: For connections to equipment and valves with threaded connections, furnish solvent-weld socket to screwed joint adapters and unions, or ASTM D2464, Schedule 80, threaded, PVC pipe.

2.04 PIPE HANGERS AND SUPPORTS: See section 220529

2.05 FLOOR DRAINS

A. Manufacturers:
   1. Zurn
   2. Watts
   3. Mifab
   4. Substitutions: Section 016000 - Product Requirements.

B. Floor Drain (FD-1): ASME A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer with polished bronze funnel.

C. .

2.06 CLEANOUTS

A. Manufacturers:
   1. Zurn
   2. Watts
   3. Mifab
   4. Substitutions: Section 016000 - Product Requirements.

B. Exterior Surfaced Areas (CO-1): Round cast nickel bronze access frame and non-skid cover.

C. Exterior Unsurfaced Areas (CO-2): Line type with lacquered cast iron body and round epoxy coated cover wit gasket.

D. Interior Finished Floor Areas (CO-3): Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round scored cover with gasket in service areas and round depressed cover with gasket to accept floor finish in finished floor areas.

E. Interior Finished Wall Areas (CO-4): Line type with lacquered cast iron body and round epoxy coated cover with gasket, and round stainless steel access cover secured with machine screw.

F. Interior Unfinished Accessible Areas (CO-5): Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.03 INSTALLATION - BURIED PIPING SYSTEMS

A. Verify connection to existing piping system size, location, and invert are as indicated on Drawings.

B. Establish elevations of buried piping with not less than 2 ft of cover.

C. Establish minimum separation of 10’ from potable water piping in accordance with the code.

D. Remove scale and dirt on inside of piping before assembly.

E. Install pipe to elevation as indicated on Drawings.

F. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.

G. Install pipe on prepared bedding.

H. Route pipe in straight line.

I. Install trace wire continuous over top of pipe. above pipe line. Refer to Section 220553.

J. Pipe Cover and Backfilling:
   1. Maintain optimum moisture content of fill material to attain required compaction density.

2. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 4 inches compacted layers to 12 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
3. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
4. Do not use wheeled or tracked vehicles for tamping.

3.04 INSTALLATION - ABOVE GROUND PIPING

A. Establish invert elevations, slopes for drainage to 1/4 inch per foot minimum. Maintain gradients.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Provide clearances at cleanout for snaking drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

F. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

G. Install piping to maintain headroom. Do not spread piping, conserve space.

H. Group piping whenever practical at common elevations.

I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 210516.

J. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 220700.

K. Provide access where valves and fittings are not accessible.

L. Install piping penetrating roofed areas to maintain integrity of roof assembly.

M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

N. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 099000.

O. Install bell and spigot pipe with bell end upstream.

P. Sleeve pipes passing through partitions, walls and floors.

Q. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section 220529.

3.05 FIELD QUALITY CONTROL

A. Section 017000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test sanitary waste and vent piping system in accordance with applicable code and local authority having jurisdiction.

3.06 SCHEDULES

A. Pipe Hanger Spacing:

1. Pipe Material: PVC.
    a. Maximum Hanger Spacing: 4 feet
    b. 3/8 inch

END OF SECTION

SECTION 221400

FACILITY STORM DRAINAGE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Storm water piping buried within 5 feet of building.
2. Storm water piping above grade.
3. Unions and flanges.
4. Roof drains.

B. Related Sections:

1. Section 033000 - Cast-in-Place Concrete: Execution requirements for placement of concrete specified by this section.
2. Section 099123 - Painting and Coating: Execution requirements for painting material specified by this section.
3. Section 220523 - General-Duty Valves for Plumbing Piping: Product requirements for valves for placement by this section.
4. Section 220529 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports for placement by this section.
5. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment: Product requirements for vibration isolators for placement by this section.
6. Section 220553 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification for placement by this section.
7. Section 220700 - Plumbing Insulation: Product and execution requirements for pipe insulation.
8. Section 260010 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.02 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME A112.21.2M - Roof Drains.
2. ASTM D1785 - Standard Specification for (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
3. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
4. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
5. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

6. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
7. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
8. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
9. ASTM F679 - Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
10. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

B. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.03 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes for sump-pumps, catch basins and manholes.

C. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
2. Storm Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.

D. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of equipment and cleanouts.

C. Operation and Maintenance Data: Submit spare parts lists, exploded assembly views for pumps and equipment.

1.05 QUALITY ASSURANCE

A. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Product storage and handling requirements.

B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Section 016000 - Product Requirements.

B. Do not install underground piping when bedding is wet or frozen.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

1.12 EXTRA MATERIALS

A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 - PRODUCTS

2.01 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D2665 or ASTM D3034 SDR 26, polyvinyl chloride (PVC) material.

1. Fittings: PVC, ASTM D2665 or ASTM D3034.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.02 STORM WATER PIPING, ABOVE GRADE

A. PVC Pipe: ASTM D2665 or ASTM D3034 SDR 26, polyvinyl chloride (PVC) material.

1. Fittings: ASTM D2665 or ASTM D3034, PVC.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.03 UNIONS AND FLANGES

A. Unions for Pipe 2 Inches and Smaller:
1. PVC Piping: PVC.

B. Flanges for Pipe 2-1/2 Inches and Larger:
1. PVC Piping: PVC flanges.
2. Gaskets: 1/16 inch thick preformed neoprene gaskets.

C. PVC Pipe Materials: For connections to equipment and valves with threaded connections, furnish solvent-weld socket to screwed joint adapters and unions, or ASTM D2464, Schedule 80, threaded, PVC pipe.

2.04 PIPE HANGERS AND SUPPORTS: See Section 220529.

2.05 ROOF DRAINS

A. Roof Drain (RD-1):

1. Assembly: ASME A112.21.2M.
2. Body: Lacquered cast iron with sump.
3. Strainer: Removable cast metal dome with vandal proof screws.
4. Accessories: Coordinate with roofing type, refer to Section 075419

a. Membrane flange and membrane clamp with integral gravel stop.
b. Adjustable under deck clamp.
c. Roof sump receiver.
d. Waterproofing flange.
e. Controlled flow weir.

f. Leveling frame.
g. Adjustable extension sleeve for roof insulation.
h. Perforated or slotted ballast guard extension for inverted roof.
i. Perforated stainless steel ballast guard extension.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.03 INSTALLATION - BURIED PIPING SYSTEMS

A. Verify connection to drywell size, location, and invert are as indicated on Drawings.

B. Establish elevations of buried piping with not less than 2 ft of cover.

C. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.

D. Install pipe on prepared bedding.

E. Route pipe in straight line.

F. Install trace wire continuous over top of pipe above pipe line; Refer to Section 220553.

G. Pipe Cover and Backfilling:
1. Maintain optimum moisture content of fill material to attain required compaction density.
2. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 4 inches compacted layers to 12 inches minimum cover over top of jacket. Compact to 95 percent maximum density.

3. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
4. Do not use wheeled or tracked vehicles for tamping.

3.04 INSTALLATION - ABOVE GROUND PIPING

A. Establish invert elevations, slopes for drainage to 1/4 inch per foot minimum. Maintain gradients.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Provide clearance at cleanout for snaking drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Install non-conducting dielectric connections wherever jointing dissimilar metals.

F. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

G. Install piping to maintain headroom. Group piping to conserve space.

H. Group piping whenever practical at common elevations.

I. Support cast iron drainage piping at every joint.

J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

K. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 220700.

L. Provide access where valves and fittings are not accessible.

M. Install piping penetrating roofed areas to maintain integrity of roof assembly.

N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

O. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 099123.

P. Install bell and spigot pipe with bell end upstream.

Q. Sleeve pipes passing through partitions, walls and floors. Refer to Section 220529.

R. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section 220529.

3.05 FIELD QUALITY CONTROL

A. Section 017000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test storm drainage piping system according to applicable code and local authority having jurisdiction.

3.06 SCHEDULES

A. Pipe Hanger Spacing:

1. Pipe Material: PVC.

a. Maximum Hanger Spacing: 4 feet.
b. Hanger Rod Diameter: 3/8 inch.

END OF SECTION

SECTION 221414 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PVC pipe and fittings.

B. Related Requirements:

1. Section 221429 "Sump Pumps" for storm drainage pumps.
2. Section 334200 "Stormwater Conveyance" for storm drainage piping outside the building.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For controlled-flow roof drainage system. Include calculations, plans, sections, elevations, and details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certificate is based and their installation requirements.

C. Field Quality-Control Reports: Inspection reports signed by authorities having jurisdiction.

1.4 QUALITY ASSURANCE

A. Provide materials bearing label, stamp, or other markings of specified testing agency.

1.5 FIELD CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Engineer and/or Construction Manager no fewer than two days in advance of proposed interruption of storm drainage service.
2. Do not proceed with interruption of storm drainage service without Engineer and/or Construction Manager permission.

1.6 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Pipe:
1. NSF Marking: Comply with NSF 14 for plastic piping components. Include marking with "NSF-dwv" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
2. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.
3. Cellular-Core PVC Pipe: ASTM F891, Schedule 40.

B. PVC Socket Fittings:
1. Standard: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
2. NSF Marking: Comply with NSF 14 for plastic piping components. Include marking with "NSF-dwv" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

C. Adhesive Primer: ASTM F656.

D. Solvent Cement: ASTM D2564.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

B. Install piping as indicated unless deviations from layout are approved on coordination drawings.

C. Install piping in concealed locations.

1. Piping installed in equipment rooms, service areas, and where indicated may be exposed.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

L. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.

1. Do not change direction of flow more than 90 degrees.
2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of drainage piping in direction of flow is prohibited.

M. Lay buried building piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

N. Install piping at the following minimum slopes unless otherwise indicated.

1. Building Storm Drain: **1/4 inch per foot (2 percent)** downward in direction of flow for piping NPS 3 (DN 80) and smaller; downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Horizontal Storm Drainage Piping: 1 **percent** downward in direction of flow.

O. Install engineered controlled-flow drain specialties and storm drainage piping in locations indicated.

1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

P. Plumbing Specialties:

1. Install backwater valves in storm drainage gravity-flow piping.

a. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

2. Install cleanouts in storm drainage gravity-flow piping in accessible locations.

a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."

3. Install drains in storm drainage gravity-flow piping.

a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

S. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.

1. Cut threads full and clean using sharp dies.

2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

    a. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    c. Do not use pipe sections that have cracked or open welds.

E. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

G. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendices.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendices.

H. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

    a. Provide axial restraint for pipe and fittings **5 inches (125 mm)** and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
    b. Provide rigid sway bracing for pipe and fittings **4 inches (100 mm)** and larger, upstream and downstream of all changes in direction 45 degrees and greater.
    c. Provide rigid sway bracing for pipe and fittings **5 inches (125 mm)** and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: Unshielded, nonpressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric unions.

3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric nipples.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES

A. General valve installation requirements for general-duty valve installations are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sump pump discharge.
2. Install **gate** for piping NS 2 (DN 50) and smaller.
3. Install **gate** valve for piping NPS 2-1/2 (DN 65) and larger.

C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Install backwater valves in accessible locations.
3. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
2. Install horizontal backwater valves with cleanout cover flush with floor.
3. Comply with requirements for backwater valves, cleanouts, and drains specified in Section 221423 "Storm Drainage Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed storm drainage piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

3. Test Procedure:

a. Test storm drainage piping on completion of roughing-in.
b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa).
c. From 15 minutes before inspection starts until completion of inspection, water level must not drop.
d. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials.

    a. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

3.10 PROTECTION

A. Protect piping and drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day and when work stops.

C. Repair damage to adjacent materials caused by storm drainage piping installation.

3.11 PIPING SCHEDULE

A. Underground storm drainage piping **NPS 6 (DN 150)** and smaller shall be any of the following:

1. Extra heavy, cast-iron soil pipe and fittings; joints.
2. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.
3. ABS pipe, ABS socket fittings, and solvent-cemented joints.
4. PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

B. Underground, storm drainage piping **NPS 8 (DN 200)** and larger is to be any of the following:

1. Extra heavy, cast-iron soil pipe and fittings; joints.
2. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.
3. PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

END OF SECTION 221414

SECTION 221414 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PVC pipe and fittings.

B. Related Requirements:
1. Section 334200 "Stormwater Conveyance" for storm drainage piping outside the building.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For controlled-flow roof drainage system. Include calculations, plans, sections, elevations, and details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certificate is based and their installation requirements.

C. Field Quality-Control Reports: Inspection reports signed by authorities having jurisdiction.

1.4 QUALITY ASSURANCE

A. Provide materials bearing label, stamp, or other markings of specified testing agency.

1.5 FIELD CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Engineer and/or Construction Manager no fewer than two days in advance of proposed interruption of storm drainage service.
2. Do not proceed with interruption of storm drainage service without Engineer and/or Construction Manager permission.

1.6 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Pipe:
1. NSF Marking: Comply with NSF 14 for plastic piping components. Include marking with "NSF-dwv" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
2. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.
3. Cellular-Core PVC Pipe: ASTM F891, Schedule 40.

B. PVC Socket Fittings:
1. Standard: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
2. NSF Marking: Comply with NSF 14 for plastic piping components. Include marking with "NSF-dwv" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

C. Adhesive Primer: ASTM F656.

D. Solvent Cement: ASTM D2564.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

B. Install piping as indicated unless deviations from layout are approved on coordination drawings.

C. Install piping in concealed locations.

1. Piping installed in equipment rooms, service areas, and where indicated may be exposed.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

L. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.

1. Do not change direction of flow more than 90 degrees.
2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of drainage piping in direction of flow is prohibited.

M. Lay buried building piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

N. Install piping at the following minimum slopes unless otherwise indicated.

1. Building Storm Drain: **1/4 inch per foot (2 percent)** downward in direction of flow for piping NPS 3 (DN 80) and smaller; downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Horizontal Storm Drainage Piping: 1 **percent** downward in direction of flow.

O. Install engineered controlled-flow drain specialties and storm drainage piping in locations indicated.

1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

P. Plumbing Specialties:

1. Install backwater valves in storm drainage gravity-flow piping.

a. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

2. Install cleanouts in storm drainage gravity-flow piping in accessible locations.

a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."

3. Install drains in storm drainage gravity-flow piping.

a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

S. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.

1. Cut threads full and clean using sharp dies.

2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

    a. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    c. Do not use pipe sections that have cracked or open welds.

E. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

G. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendices.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendices.

H. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

    a. Provide axial restraint for pipe and fittings **5 inches (125 mm)** and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
    b. Provide rigid sway bracing for pipe and fittings **4 inches (100 mm)** and larger, upstream and downstream of all changes in direction 45 degrees and greater.
    c. Provide rigid sway bracing for pipe and fittings **5 inches (125 mm)** and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: Unshielded, nonpressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric unions.

3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric nipples.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES

A. General valve installation requirements for general-duty valve installations are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:
1. Install **gate** for piping NS 2 (DN 50) and smaller.
2. Install **gate** valve for piping NPS 2-1/2 (DN 65) and larger.

C. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Install backwater valves in accessible locations.
3. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
2. Install horizontal backwater valves with cleanout cover flush with floor.
3. Comply with requirements for backwater valves, cleanouts, and drains specified in Section 221423 "Storm Drainage Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed storm drainage piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Test Procedure:

    a. Test storm drainage piping on completion of roughing-in.
    b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa).
    c. From 15 minutes before inspection starts until completion of inspection, water level must not drop.
    d. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials.

a. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

3.10 PROTECTION

A. Protect piping and drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day and when work stops.

C. Repair damage to adjacent materials caused by storm drainage piping installation.

3.11 PIPING SCHEDULE

A. Underground storm drainage piping **NPS 6 (DN 150)** and smaller shall be any of the following:

1. Extra heavy, cast-iron soil pipe and fittings; joints.
2. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.
3. ABS pipe, ABS socket fittings, and solvent-cemented joints.
4. PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

B. Underground, storm drainage piping **NPS 8 (DN 200)** and larger is to be any of the following:

1. Extra heavy, cast-iron soil pipe and fittings; joints.
2. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.
3. PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

END OF SECTION 221414

SECTION 223300

ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Commercial electric water heaters.

B. Related Sections:

   1. Section 033000 - Cast-in-Place Concrete: Execution requirements for concrete housekeeping pads specified by this Section.
   2. Section: 221100 - Facility Water Distribution: Supply connections to domestic water heaters.
   3. Section 260010 - Equipment Wiring Connections: Execution requirements for electric connections specified by this Section.

1.02 REFERENCES

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

   1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

B. American Society of Mechanical Engineers:

   1. ASME PTC 25 - Pressure Relief Devices.
   2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

1.03 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate heat exchanger dimensions, size of taps, and performance data. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, taps, and drains.

C. Product Data: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Submit electrical characteristics and connection locations.

D. Manufacturer's Installation Instructions: Submit mounting and support requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit replacement part numbers and availability.

1.05 QUALITY ASSURANCE

A. Conform to ASME Section VIII for construction of water heaters. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.

B. Water Heater Performance Requirements: Equipment efficiency not less than prescribed by ASHRAE 90.1.

C. Maintain one copy of each document on Site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Products storage and handling requirements.

B. Accept water heaters on Site in original labeled cartons. Inspect for damage.

C. Protect tanks with temporary inlet and outlet caps. Maintain caps in place until installation.

1.09 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five-year manufacturer warranty for domestic water heaters.

PART 2 - PRODUCTS

2.01 ELECTRIC TANK TYPE WATER HEATERS

A. Manufacturers:
   1. HUBBEL
   2. HAWS
   3. Substitutions: Section 016000 - Product Requirements.

B. Type: Automatic, electric, vertical storage.

C. Capacity:

   1. Storage Capacity: 120 gal.
   2. Heating Element Size: See drawings
   3. Maximum Working Pressure: 150 psig.

D. The electric water heater shall be a 119 gallon capacity vertical carbon steel tank lined with ½" thick Hydrastone cement to ensure maximum operating life at elevated temperatures. Heater shall not require any type of anodic protection.

E. Tank inlet and outlet water connections shall be a minimum of 1-1/4" NPT non-ferrous copper-silicon/brass. Steel tank tapings will not be acceptable.

F. Tank shall be covered by a minimum 3" thick polyurethane foam insulation to minimize stand-by heat loss over the life of the system. Due to the increased cost of operation, systems with less than 3" insulation will not be acceptable.

G. Tepid water temperature control shall be provided by an integrally piped and packaged thermostatic mixing valve. Valve shall be specifically designed, tested and manufacture-designated for use in emergency safety drench applications. Delivery water set point shall be 85º F. (Optional 75º F temperature available.)

H. Temperature safety system shall consist of a diaphragm operated valve actuator to ensure a continuous delivery flow of tepid water. The valve shall monitor pressure on both cold and hot inlets. On loss of cold water pressure the valve shall prevent delivery of hot water to prevent scalding. On loss of hot water pressure, the valve shall allow the full ANSI required flow of cold water to the emergency safety fixture.

I. The system shall be supplied complete with all electrical operating controls. Safety devices and accessories shall include but not be limited to:
   1. Low watt density immersion heating element
   2. Adjustable immersion temperature controller
   3. Safety high limit switch with manual reset
   4. Dial temperature and pressure gauge
   5. ASME temperature and pressure relief valve
   6. Automatic air vent valve

2.02 ELECTRIC TANKLESS WATER HEATERS

A. Manufacturers:

   1. Lochinvar
   2. Chronomite
   3. Rheem
   4. Substitutions: Section 016000 - Product Requirements.

B. Type: Factory-assembled and wired, electric, tankless water heater.

C. Controls: Digital microprocessing temperature control capable of maintaining outlet temperature.

D. Element: Replaceable cartridge insert type, nickel chrome material.

E. Maximum operating pressure of 150 PSI.

2.03 ELECTRICAL CHARACTERISTICS AND COMPONENTS: SEE DRAWINGS.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Maintain manufacturer's recommended clearances around and over water heaters.

B. Install the following piping accessories. Refer to Section 221100.

C. Install discharge piping from relief valves and drain valves to nearest floor drain.

D. Install water heater trim and accessories furnished loose for field mounting.

E. Install electrical devices furnished loose for field mounting.

F. Install control wiring between water heater control panel and field mounted control devices.

3.02 SCHEDULES: See Drawings

END OF SECTION

SECTION 224000

PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Water closets.
2. Lavatories.
3. Sinks.
4. Emergency combination shower with eye and face wash.

B. Related Sections:

1. Section 079200 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this Section.
2. Section 221100 - Facility Water Distribution: Supply connections to plumbing fixtures.
3. Section 221300 - Facility Sanitary Sewerage: Waste connections to plumbing fixtures.
4. Section 260010 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this Section.

1.02 REFERENCES

A. American National Standards Institute:

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.

B. American Society of Mechanical Engineers:

1. ASME A112.6.1 - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
2. ASME A112.18.1 - Plumbing Fixture Fittings.
3. ASME A112.19.1M - Enameled Cast Iron Plumbing Fixtures.
4. ASME A112.19.2M - Vitreous China Plumbing Fixtures.
5. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
6. ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
7. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals.

1.03 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

C. Manufacturer's Installation Instructions: Submit installation methods and procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.

1. Water Efficiency Certificates:

a. Certify plumbing fixture flow rates.

1.04 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit fixture, trim, exploded view, and replacement parts lists.

1.05 QUALITY ASSURANCE

A. Provide products requiring electrical connections listed and classified by UL as suitable for purpose specified and indicated.

B. Provide plumbing fixture fittings according to ASME A112.18.1 that prevent backflow from fixture into water distribution system.

C. Maintain one copy of each document on Site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Product storage and handling requirements.

B. Accept fixtures on Site in factory packaging. Inspect for damage.

C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.09 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five-year manufacturer warranty for plumbing fixtures.

1.10 EXTRA MATERIALS

A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 - PRODUCTS

2.01 FLUSH VALVE WATER CLOSETS

A. Manufacturers:
   1. Kohler
   2. American Standard
   3. Zurn
   4. Substitutions: Section 016000 - Product Requirements.

B. Bowl: ASME A112.19.2M; floor mounted, siphon jet 17-inch bowl height, ADA accessible vitreous china closet bowl, with elongated rim, 1-1/2-inch top spud, china bolt caps.

C. Seat: Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, with cover,.

2.02 LAVATORIES

A. Manufacturers:
   1. Kohler
   2. American Standard
   3. Zurn
   4. Substitutions: Section 016000 - Product Requirements.

B. Vitreous China Wall Hung Basin: ASME A112.19.2M; vitreous china wall hung lavatory 18 by 20 inches minimum, with 4-inch high back, drillings on 4-inch centers, rectangular basin with splash lip, front overflow, and soap depression.

C. Supply Fitting: ASME A112.18.1; chrome-plated combination supply fitting with pop-up waste, water economy aerator with maximum 2.0 gpm flow, indexed handles or single lever handle.

D. Waste Fittings: ASME A112.18.2 or ASTM F 409.

E. For public hand washing facilities, provide tempered water through regulating device conforming to ASSE 1070.

F. Accessories:

1. Chrome-plated 17-gage brass P-trap with clean-out plug and arm with escutcheon.
2. Screwdriver stops.
3. Flexible supplies.
4. Trap and waste insulated and offset to meet ADA compliance.

G. Wall Mounted Carrier: ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, concealed arm supports, bearing plate and studs.

2.03 SINKS

A. Manufacturers:
1. Kohler
2. American Standard
3. Zurn
4. Substitutions: Section 016000 - Product Requirements.

B. Single Compartment Bowl: ASME A112.19.3; 18-gage thick, Type 304 stainless steel. Self-rimming and undercoated, with 1-1/2-inch stainless-steel drain, ledge back drilled for trim.

C. Trim: ASME A112.18.1; chrome-plated brass supply with high rise swing spout, vandal proof water economy aerator with maximum 2.2 gpm flow, indexed lever handles and retractable spray.

D. Accessories: Chrome-plated 17-gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver stop, flexible supplies.

2.04 EMERGENCY COMBINATION SHOWER WITH EYE AND FACE WASH

A. Manufacturers:
1. Haws
2. Guardian
3. Uline

4. Substitutions: Section 016000 - Product Requirements.

B. Shower: ANSI Z358.1; free standing, self- cleaning, non-clogging 8-inch diameter plastic drench shower head, instant action stay open valve actuated by rigid stainless-steel pull rod.

C. Eyewash: ANSI Z358.1; stainless-steel bowl with elbow, 1-1/4-inch stainless-steel pipe pedestal with floor flange, instant action stay open valve actuated by push flag, twin spray heads with face spray ring, dust cover assembly, wall mount bracket, and tailpiece and chrome-plated brass P-trap.

D. Supply and Waste Piping: 1-1/4-inch stainless-steel pipe pedestal with floor flange.

E. Furnish universal emergency sign.

F. Furnish corrosion resistant coating.

G. Unit shall include thermostatically controlled electric heat traced cable protected by 1" (2.5 cm) insulation and an ABS plastic jacket that prevents freezing down to ambient temperatures of -30° F.

H. Heat trace maximum draw 130 watts at 120 volt.

2.05 LAVATORY INSULATION KIT

A. Product Description: Where Lavatories are noted to be insulated for ADA compliance, furnish the following: Safety Covers conforming to ANSI A177.1 and consisting of insulation kit of molded closed cell vinyl construction, 3/16 inch thick, white color, for insulating tailpiece, P-trap, valves, and supply piping. Furnish with weep hole and angle valve access covers.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Verify walls and floor finishes are prepared and ready for installation of fixtures.

C. Verify electric power is available and of correct characteristics.

D. Confirm millwork is constructed with adequate provision for installation of counter top lavatories and sinks.

3.02 PREPARATION

A. Rough-in fixture piping connections according to minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome-plated rigid or flexible supplies to fixtures with screwdriver stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall carriers and bolts.

E. Seal fixtures to wall and floor surfaces with sealant as specified in Section 079200, color to match fixture.

F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

G. For ADA accessible water closets, install flush valve with handle to wide side of stall.

3.04 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop-drawings. Confirm location and size of fixtures and openings before rough in and installation.

3.05 ADJUSTING

A. Section 017000 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.06 CLEANING

A. Section 017000 - Execution and Closeout Requirements: Final cleaning.

B. Clean plumbing fixtures and equipment.

3.07 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 017000 - Execution and Closeout Requirements: Protecting installed construction.

B. Do not permit use of fixtures before final acceptance.

3.08 SCHEDULES

A. Fixture Mounting Heights:

1. Water Closet:

a. Standard: 15 inches to top of bowl rim.
b. Accessible: 18 inches to top of seat.

2. Water Closet Flush Valves:

a. Standard: 11 inches min. above bowl rim.
b. Recessed: 10 inches min. above bowl rim.

3. Lavatory:

a. Standard: 31 inches to top of basin rim.
b. Accessible: 34 inches to top of basin rim.

B. Fixture Rough-In:

1. Water Closet Flush Valve:

a. Cold: 1 inch.
b. Waste: 3 inches.
c. Vent: 1-1/2 inches.

2. Lavatory:

a. Hot: 1/2 inch.
b. Cold: 1/2 inch.
c. Waste: 1-1/2 inches.
d. Vent: 1-1/4 inches.

3. Sink:

a. Hot: 1/2 inch.
b. Cold: 1/2 inch.
c. Waste: 1-1/2 inches.
d. Vent: 1-1/4 inches.

END OF SECTION

SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes single- and three-phase motors for application on equipment provided under other sections.

B. Related Sections:

1. Section 260526 - Grounding and Bonding for Electrical Systems.
2. Section 260553 - Identification for Electrical Systems.

1.02 REFERENCES

A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. National Electrical Manufacturers Association:

1. NEMA MG 1 - Motors and Generators.

C. International Electrical Testing Association:

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.03 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.04 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Product storage and handling requirements.

B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.

C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.

D. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.01 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

A. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.

B. Single Phase Motors:

1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
2. Voltage: 115 / 208 volts, single phase, 60 Hz.

C. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.02 SOURCE QUALITY CONTROL

A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 - EXECUTION

3.01 EXISTING WORK

A. Disconnect and remove abandoned motors

B. Maintain access to existing motors and other installations remaining active and requiring access. Modify installation or provide access panel.

C. Clean and repair existing motors to remain or are to be reinstalled.

3.02 INSTALLATION

A. Install securely on firm foundation. Mount ball bearing motors in accordance with motor manufacturer's requirements.

B. Install engraved plastic nameplates in accordance with Section 260553.

C. Ground and bond motors in accordance with Section 260526.

3.03 FIELD QUALITY CONTROL

A. Section 017000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION

SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Equipment curbs.
6. Sleeves.
7. Mechanical sleeve seals.
8. Formed steel channel.
9. Equipment bases and supports.

B. Related Requirements:
1. Section 033000 - Cast-in-Place Concrete: Placement of concrete housekeeping pads as required by this Section.
2. Section 079200 - Joint Protection: Sealant materials for placement by this Section.
3. Section 099123 - Painting and Coating: Painting as required by this Section.
4. Section 220700 - Plumbing Insulation: Piping and accessory insulation as required by this Section.

1.02 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): The material used to seal or stuff or an assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire-rated construction.

1.03 REFERENCE STANDARDS

A. American Welding Society:

1. AWS D1.1/D1.1M - Structural Welding Code - Steel.

B. ASME International:

1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
3. ASME B31.9 - Building Services Piping.

C. ASTM International:

1. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
2. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.
3. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

D. FM Global:

1. FM - Approval Guide.

E. Intertek Testing Services (Warnock Hersey Mark):

1. WH-ETL - Product Directory.

F. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

G. UL:

1. UL - Fire-resistance-rated Systems and Products.
2. UL 263 - Fire Tests of Building Construction and Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.

1.04 PREINSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.05 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Hangers and Supports: Submit manufacturer's catalog information, including load capacity.
2. Firestopping: Submit information on product characteristics, performance, and limitations.

C. Shop Drawings:

1. Indicate system layout with location, including critical dimensions and sizes.

2. Indicate pipe hanger and support locations, and detail of trapeze hangers.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Delegated Design Submittals:

1. Submit signed and sealed Shop Drawings with design calculations and assumptions for load-carrying capacity of trapeze, multiple-pipe, and riser support hangers.
2. Submit sizing methods and calculations sealed by a registered professional engineer (P.E.).

F. Manufacturer Instructions:

1. Hangers and Supports: Submit special procedures and assembly of components.
2. Firestopping: Submit preparation and installation instructions.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Qualifications Statements:

1. Submit qualifications for manufacturer, installer, and licensed professional.
2. Welders: Qualify procedures and personnel according to AWS D1.1/D1.1M.

1.06 QUALITY ASSURANCE

A. Through-Penetration Firestopping of Fire-Rated Assemblies:

1. Comply with UL 1479 or ASTM E814.
2. Positive Pressure Differential:

a. As required to achieve fire F-ratings and temperature T-ratings as indicated on Drawings, but not less than one hour.
b. Minimum 0.10 inch wg.

3. Wall Penetrations: Fire F-ratings as indicated on Drawings, but not less than one hour.
4. Floor and Roof Penetrations:

a. Fire F-ratings and temperature T-ratings as indicated on Drawings, but not less than one hour.
b. Floor Penetrations within Wall Cavities: T-rating not required.

B. Through-Penetration Firestopping of Non-fire-rated Floor and Roof Assemblies:

1. Materials: Resist free passage of flame and products of combustion.
2. Noncombustible Penetrating Items: Connecting maximum three stories.
3. Penetrating Items: Materials approved by authorities having jurisdiction for connecting maximum two stories.

C. Fire-Resistive Joints in Fire-Rated Floor, Roof, and Wall Assemblies:

1. Comply with ASTM E1966 or UL 2079.
2. As required to achieve fire-resistance rating as indicated on Drawings for assembly in which joint is installed.

D. Fire-Resistive Joints between Floor Slabs and Exterior Walls:

1. Comply with ASTM E119.
2. Positive Pressure Differential:

a. As required to achieve fire F-ratings and temperature T-ratings as indicated on Drawings for floor assembly.
b. Minimum 0.10 inch wg.

E. Surface-Burning Characteristics:

1. Maximum 25/450 flame-spread/smoke-developed index.
2. Testing: Comply with ASTM E84.

F. Welding of Hanger and Support Attachments to Building Structure: Comply with AWS D1.1/D1.1M.

G. Perform Work according to standards.

H. Maintain 1 copy of each standard affecting Work of this Section on Site.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

C. Welders: AWS qualified within previous 12 months for employed weld types.

D. Licensed Professional: P.E. experienced in design of specified Work and licensed at Project location.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.09 AMBIENT CONDITIONS

A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Minimum Conditions:

1. Do not apply firestopping materials if temperature of substrate material and ambient air is below 60 degrees F.
2. Maintain this minimum temperature before, during, and for minimum three days after installation of firestopping materials.

C. Provide ventilation in areas to receive solvent cured materials.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.01 DESCRIPTION

A. Firestopping Materials:

1. Comply with ASTM E119, ASTM E814, UL 263, and UL 1479.
2. Adjacent Construction:

a. Achieve fire ratings as indicated on Drawings for adjacent construction.
b. Minimum Fire Rating: One hour.

2.02 PERFORMANCE AND DESIGN CRITERIA

A. Firestopping:

1. Comply with UL for fire-resistance ratings and surface-burning characteristics.
2. Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

2.03 PIPE HANGERS AND SUPPORTS

A. Refrigerant Piping:

1. Conform to ASME B31.5 ASTM F708.
2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron or Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 Inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 Inches and Smaller: Cast iron hook.
6. Wall Support for Pipe Sizes 4 Inches and Larger: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Copper-plated carbon-steel ring.

B. Accessories:

1. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuously threaded.

2.04 INSERTS

A. Description:

1. Malleable iron case with galvanized steel shell and expander plug for threaded connection.
2. Lateral adjustment, top slot for reinforcing rods, and lugs for attaching to forms.
3. Size: To suit threaded hanger rods.

2.05 FLASHING

A. Metal Flashing:

1. Material: Galvanized steel.
2. Thickness: 26 gage.

B. Metal Counterflashing:

1. Material: Galvanized steel.
2. Thickness: 22 gage.

C. Sheet Lead Flashing:

1. Waterproofing: 5 psf.
2. Soundproofing: 1 psf.

D. Flexible Flashing:

1. Material:

a. Sheet butyl.
b. Compatible with roofing.

2. Thickness: 47 mils.

E. Caps:

1. Material: Steel.
2. Minimum Thickness:

a. 22 gage.
b. 16 gage at fire-resistive elements.

2.06 SLEEVES

A. Pipes through Non-fire-rated Floors:

1. Material: Galvanized steel.
2. Thickness: 18 gage.

B. Pipes through Non-fire-rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18-gage galvanized steel.

C. Round Ductwork: Galvanized steel.

D. Rectangular Ductwork: Galvanized steel or wood.

E. Sealant:

1. As specified in Section 079000 - Joint Protection.
2. Material: Acrylic.

2.07 MECHANICAL SLEEVE SEALS

A. Description:

1. Type: Modular mechanical.
2. Configuration: Interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve.
3. Connection: Bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and insulation.

2.08 FORMED STEEL CHANNEL

A. Description:

1. Material: Galvanized 12-gage steel.
2. Thickness: 12 gage.
3. Hole Spacing: 1-1/2 inches o.c.

2.09 FIRESTOPPING

A. Description:

1. Various types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements.
2. Provide only one type for each similar application.
3. Silicone Elastomeric Firestopping: Multiple-component silicone elastomeric compound and compatible silicone sealant.
4. Foam Firestopping Compounds: Multiple-component foam compound.
5. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
6. Fiber Stuffing and Sealant Firestopping: Composite of mineral-fiber stuffing insulation with silicone elastomer for smoke stopping.
7. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless-steel jacket, joined with collars, and penetration sealed with flanged stops.
8. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
9. Firestop Pillows: Formed mineral-fiber pillows.

B. Color: Dark gray.

2.10 FIRESTOPPING ACCESSORIES

A. Primer: Type as recommended by firestopping manufacturer for specific substrate surfaces and as suitable for required fire ratings.

B. Permanent Dam Material:

1. Mineral fiberboard.
2.

3.
4. Plywood or particle board.
5.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. General:

1. Furnish UL-listed products.
2. Select products with rating not less than rating of wall or floor being penetrated.

E. Nonrated Surfaces:

1. Covering for Openings in Occupied Areas Where Piping is Exposed: Stamped-steel, chrome-plated, hinged, split-ring escutcheons, or floor or ceiling plates.
2. Exterior Wall Openings below Grade: Furnish mechanical sealing device to continuously fill annular space between piping and cored opening or waterstop-type wall sleeve.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that openings are ready to receive sleeves.

C. Verify that openings are ready to receive firestopping.

3.02 PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that may affect bond of firestopping material.

C. Remove incompatible materials that may affect bond.

D. Install damming materials to arrest liquid material leakage.

E. Obtain permission from Architect/Engineer before using powder-actuated anchors.

F. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.03 INSTALLATION

A. Inserts:

1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
4. If concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. If inserts are omitted, drill through concrete slab from below and provide through bolt with recessed square steel plate and nut flush with top of slab.

B. Pipe Hangers and Supports:

1. Comply with ASME B31.1 B31.5 B31.9.
2. Support horizontal piping as scheduled following END OF SECTION.
3. Minimum Hanger Spacing: 1/2 inch between finished covering and adjacent Work.
4. Place hangers within 12 inches of each horizontal elbow.
5. Minimum Vertical Hanger Adjustment: 1-1/2 inches.
6. Support vertical piping at every floor.
7. If piping is installed in parallel and at same elevation, provide multiple-pipe or trapeze hangers.
8. Support riser piping independently of connected horizontal piping.
9. Provide copper-plated hangers and supports for copper piping.
10. Design hangers for pipe movement without disengagement of supported pipe.
11. Painting and Coating:

    a. Prime coat exposed steel hangers and supports as specified in Section 099123 - Painting and Coating.
    b. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

12. Insulation:

    a. Provide clearance in hangers and from structure and other equipment for installation of insulation.
    b. As specified in Section 220700 - Plumbing Insulation.

C. Equipment Bases and Supports:

1. Provide housekeeping pads of concrete as specified in Section 033000 - Cast-in-Place Concrete.
2. Minimum Size: 3-1/2 inches thick and extending 6 inches beyond supported equipment.
3. Use templates furnished with equipment to install equipment anchor bolts and accessories.
4. Supports:

    a. Material: Steel members.

b. Brace and fasten with flanges bolted to structure.

5. Provide rigid anchors for pipes after vibration isolation components are installed as specified in 210548 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment.

D. Flashing:

1. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weatherproofed or waterproofed walls, floors, and roofs.
2. For sound control, provide acoustical-lead flashing around ducts and pipes penetrating equipment rooms.

3. Storm Collars:

a. Adjust storm collars tight to pipe with bolts and calk around top edge.
b. Install storm collars above roof jacks.
c. Screw vertical flange section to face of curb.

E. Sleeves:

1. Exterior Watertight Entries: Seal with mechanical sleeve seals.
2. Set sleeves in position in forms and provide reinforcing around sleeves.
3. Sizing:

a. Size sleeves large enough to allow for movement due to expansion and contraction.
b. Provide for continuous insulation wrapping.

4. Extend sleeves through floors 1 inch above finished floor level, and calk sleeves.
5. Spaces:

a. If piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent Work with stuffing firestopping insulation and calk airtight.
b. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
c. Install chrome-plated steel escutcheons at finished surfaces.

F. Firestopping:
1. Install material at fire-rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items requiring firestopping.
2. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
3. Apply firestopping material to uniform density and texture and in sufficient thickness to achieve required fire and smoke rating.
4. Placement: Compress fibered material to maximum 40 percent of its uncompressed size.
5. Dam Material: Remove after firestopping material has cured.

6. Fire-Rated Surfaces:

    a. Seal opening at floor, wall, partition, ceiling, and roof.
    b. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
    c. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
    d. Pack void with backing material.
    e. Seal ends of sleeve with UL-listed fire-resistive silicone compound to meet fire rating of structure being penetrated.

7. If cable tray, bus, cable bus, conduit, wireway, trough, and penetrate fire-rated surface, install firestopping product according to manufacturer instructions.
8. Nonrated Surfaces:

    a. Seal opening through non-fire-rated wall, partition, floor, ceiling, and roof opening.
    b. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
    c. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
    d. Install type of firestopping material as recommended by manufacturer.

9. Occupied Spaces:

    a. Install escutcheons, floor plates, or ceiling plates where conduit penetrates non-fire-rated surfaces in occupied spaces.
    b. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.

10. Exterior Wall Openings below Grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place according to manufacturer instructions.
11. Interior Partitions:
    a. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.04 FIELD QUALITY CONTROL

A. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.05 CLEANING

A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

B. Clean adjacent surfaces of firestopping materials.

3.06 PROTECTION

A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

3.07 ATTACHMENTS

A. Pipe Hanger Spacing:

1. Pipe Material: Copper tube.

    a. Size: 1-1/4 inches and smaller.
    b. Maximum Hanger Spacing: 6 feet.
    c. Hanger Rod Diameter: 1/2 inch.

2. Pipe Material: Copper tube.

    a. Size: 1-1/2 inches and larger.
    b. Maximum Hanger Spacing: 10 feet.
    c. Hanger Rod Diameter: 1/2 inch.

3. Pipe Material: PVC.

    a. Maximum Hanger Spacing: 4 feet.
    b. Hanger Rod Diameter: 3/8 inch.

4. Pipe Material: Steel.

    a. Size: 3 inches and smaller.
    b. Maximum Hanger Spacing: 12 feet.
    c. Hanger Rod Diameter: 1/2 inch.

5. Pipe Material: Steel.

    a. Size: 4 inches and larger.
    b. Maximum Hanger Spacing: 12 feet.
    c. Hanger Rod Diameter: 5/8 inch.

END OF SECTION

SECTION 230548

VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Vibration isolators.
   2. Duct sound attenuators.

B. Related Requirements:

   1. Section 033000 - Cast-in-Place Concrete: Execution requirements for placement of isolators in floating floor slabs specified by this Section and product requirements for concrete for placement by this Section.
   2. Section 079200 - Joint Protection: Product requirements for joint sealers specified for placement by this Section.
   3. Section 089119 - Louvers: Product requirements for acoustic wall louvers.
   4. Section 230529 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports.
   5. Section 230593 - Testing, Adjusting, and Balancing for HVAC: Requirements for sound and vibration measurements performed independent of this Section.
   6. Section 233100 - HVAC Ducts and Casings: Vibration isolation devices for ducts and casings.
   7. Section 233300 - Air Duct Accessories: Product requirements for both solid and flexible duct connectors for duct sound attenuators specified for placement by this Section.

1.02 REFERENCE STANDARDS

A. Air Movement and Control Association International, Inc.:

   1. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

B. Air-Conditioning, Heating, and Refrigeration Institute:

   1. AHRI 575 - Method of Measuring Machinery Sound within an Equipment Space.

C. American National Standards Institute:

   1. ANSI S1.4 - Specification for Sound Level Meters.
   2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
   3. ANSI S1.13 - Measurement of Sound Pressure Levels in Air.
   4. ANSI S12.60 - Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools.

D. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 68 - Laboratory Method of Testing to Determine the Sound Power in a Duct.
2. ASHRAE Handbook - HVAC Applications.

E. ASTM International:

1. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
2. ASTM E477 - Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
3. ASTM E596 - Standard Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures.

F. Sheet Metal and Air Conditioning Contractors' National Association:

1. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.03 PREINSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.04 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit schedule of vibration isolator type with location and load on each.
2. Submit manufacturer catalog information indicating materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.

C. Shop Drawings:

1. Indicate static and dynamic load of both inertia bases and vibration isolators.
2. Indicate assembly, materials, thickness, dimensional data, pressure losses, acoustical performance, layout, and connection details for fabricated sound attenuation products.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions indicating that maximum room sound levels are not exceeded.

F. Manufacturer Instructions:

1. Submit special procedures and setting dimensions.

2. Indicate installation requirements maintaining integrity of sound isolation.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports: Certify that sound isolation installation is complete and complies with instructions.

I. Qualifications Statements:

1. Submit qualifications for manufacturer, installer, and licensed professional.
2. Submit manufacturer's approval of installer.

1.05 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents:
1. Record actual locations of hangers including attachment points.

1.06 QUALITY ASSURANCE

A. Perform Work according to AMCA 300 ANSI S1.13 AHRI 575 standards and ASHRAE 68 recommendations.

B. Maintain 1 copy of each standard affecting Work of this Section on Site.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum [three] years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.09 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN CRITERIA

A. Provide vibration isolation devices on motor-driven equipment over 0.5 hp, plus connected piping and ductwork.

B. Minimum Static Deflection of Isolators:

1. Basement - Under 20 hp.
    a. 400 to 600 rpm: 1.0 inch
    b. 600 to 800 rpm: 0.5 inch
    c. 800 to 900 rpm: 0.2 inch
    d. 1,100 to 1,500 rpm: 0.15 inch
    e. Over 1,500 rpm: 0.1 inch

C. Consider upper floor locations critical unless otherwise indicated.

2.02 INERTIA BASES

A. Structural Bases:

1. Design: Sufficiently rigid to prevent misalignment or undue stress on machine and to transmit design loads to isolators and snubbers.
2. Construction: Welded structural steel with gusset brackets, supporting equipment, and motor with motor slide rails.

B. Concrete Inertia Bases:

1. Minimum Mass: 1.5 times weight of isolated equipment.

2. Construction: Structured steel channel perimeter frame, with gusset brackets and anchor bolts, adequately reinforced, and concrete filled.
3. Connecting Point: Reinforced to connect isolators and snubbers to base.
4. Concrete:

    a. Type: Reinforced.
    b. Compressive Strength: 3,000 psi.

2.03 VIBRATION ISOLATORS

A. Restrained Spring Isolators:

1. Spring Isolators:

    a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
    b. Code: Color-code springs based on load carrying capacity.

2. Springs:

    a. Minimum Horizontal Stiffness: 75 percent of vertical stiffness.
    b. Working Deflection: Between 30 and 60 percent of maximum deflection.

3. Spring Mounts: Furnish leveling devices, minimum 0.25-inchthick neoprene sound pads, and zinc chromate-plated hardware.
4. Sound Pads:

    a. Size: Based on minimum deflection of 0.05 inch.

5. As specified for neoprene pad isolators.
6. Restraints: Furnish mounting frame and limit stops.

7.

B. Spring Hangers:

1. Spring Isolators:

    a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
    b. Code: Color-code springs based on load carrying capacity.

2. Springs:

    a. Minimum Horizontal Stiffness: 75 percent of vertical stiffness.
    b. Working Deflection: Between 30 and 60 percent of maximum deflection.

3. Housings: Incorporate neoprene isolation pad as specified for neoprene pad isolators.
4. Misalignment: Capable of 20-degree hanger rod misalignment.

C. Neoprene Pad Isolators:

1. Rubber or neoprene-waffle pads.

a. Hardness: 30 durometer.
b. Minimum Thickness: 1/2 inch.
c. Maximum Loading: 40 psi.
d. Rib Height: Not greater than 0.7 times width.

2. Configuration: Single layer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that equipment, ductwork, and piping are installed before starting Work of this Section.

3.02 PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Existing Work:

1. Provide access to existing piping and ductwork and other installations remaining active and requiring access.
2. Extend existing piping and ductwork installations using materials and methods compatible with existing electrical installations.

3.03 INSTALLATION

A. Install isolation for motor-driven equipment.

B. Bases:

1. Steel: Provide 1 inch of clearance between housekeeping pad and base.
2. Concrete Inertia: Provide 2 inches of clearance between housekeeping pad and base.

C. Make equipment level.

D. Install spring hangers without binding.

E. Isolators:

1. Closed Spring Isolators: Adjust such that side stabilizers are clear under normal operating conditions.
2. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height; when full load is applied, adjust isolators to load to allow shim removal.

F. Support piping connections to isolated equipment resiliently to nearest flexible pipe connector.

3.04 FIELD QUALITY CONTROL

A. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Inspect isolated equipment after installation and submit report, including static deflections.

C. Sound Measurements: As specified in Section 230593 - Testing, Adjusting, and Balancing for HVAC.

3.05 ATTACHMENTS

A. Pipe Isolation Schedule:

1. Isolated Distance from Equipment:

a. Pipe Size 1 inch: 120 pipe diameters.
b. Pipe Size 2 inches: 90 pipe diameters.
c. Pipe Size 3 inches: 80 pipe diameters.
d. Pipe Size 4 inches: 75 pipe diameters.
e. Pipe Size 6 inches: 60 pipe diameters.

B. Equipment Isolation Schedule:

1. Air-Cooled Condensing Units:

a. Base:

1) Type: Concrete
2) Thickness: 3 inches.

2. Air-Conditioning Units:

a. Isolator:

1) Type: Restrained Spring.
2) Deflection: See Schedule..

END OF SECTION

SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

B. Related Sections:

1. Section 099000 - Painting and Coating: Execution requirements for painting specified by this section.

1.02 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit manufacturers catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.05 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

B. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.08 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.09 EXTRA MATERIALS

A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 - PRODUCTS

2.01 NAMEPLATES

A. Nameplates

1. Manufacturers:
   a. Craftmark Pipe Markers.

b. Kolbi Pipe Marker Co.
c. Pipemarker.com; Brimar Industries, Inc.
d. Seton Identification Products; a Brady Corporation company.
e. Substitutions: Section 016000 - Product Requirements.

B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.02 TAGS

A. Metal Tags

1. Manufacturers:

a. Brady ID.
b. Craftmark Pipe Markers.
c. Kolbi Pipe Marker Co.
d. Marking Services, Inc.
e. Pipemarker.com; Brimar Industries, Inc.
f. R & R Identification Co.
g. Seton Identification Products; a Brady Corporation company.
h. Substitutions: Section 016000 - Product Requirements.

B. Information Tags

1. Manufacturers:

a. Brady ID.
b. Seton Identification Products; a Brady Corporation company.
c. Substitutions: Section 016000 - Product Requirements.

2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.

C. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.03 STENCILS

A. Stencils

1. Manufacturers:
a. Kolbi Pipe Marker Co.
b. Marking Services, Inc.
c. Pipemarker.com; Brimar Industries, Inc.
d. R & R Identification Co.
e. Substitutions: Section 016000 - Product Requirements.

B. Stencils: With clean cut symbols and letters of following size:

1. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inches high letters.
2. Ductwork and Equipment: 1-3/4 inches high letters.

C. Stencil Paint: As specified in Section 099000, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.04 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers

1. Manufacturers:

a. Brady ID.
b. Craftmark Pipe Markers.
c. Marking Services, Inc.
d. R & R Identification Co.
e. Seton Identification Products; a Brady Corporation company.
f. Substitutions: Section 016000 - Product Requirements.

2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

2.05 CEILING TACKS

A. Ceiling Tacks

1. Manufacturers:

a. Kolbi Pipe Marker Co.
b. Marking Services, Inc.
c. Pipemarker.com; Brimar Industries, Inc.
d. Rhino Marking and Protection Systems.
e. Seton Identification Products; a Brady Corporation company.
f. Substitutions: Section 016000 - Product Requirements.

B. Description: Steel with 3/4 inch diameter color-coded head.

C. Color code as follows:

1. HVAC equipment: Yellow.
2. Fire dampers/smoke dampers: Red.
3. Plumbing valves: Green.
4. Heating/cooling valves: Blue.

2.06 LABELS

A. Labels:

1. Manufacturers:
   a. Brady ID.
   b. Seton Identification Products; a Brady Corporation company.
   c. Substitutions: Section 016000 - Product Requirements.

B. Description: Laminated Mylar, size 1.9 x 0.75 inches, adhesive backed with printed identification and bar code.

2.07 LOCKOUT DEVICES

A. Lockout Hasps

1. Manufacturers:

   a. Brady ID.
   b. Master Lock Company, LLC.
   c. Substitutions: Section 016000 - Product Requirements.

2. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

B. Valve Lockout Devices

1. Manufacturers:

   a. Brady ID.
   b. Master Lock Company, LLC.
   c. Substitutions: Section 016000 - Product Requirements.

2. Steel device preventing access to valve operator, accepting lock shackle.

PART 3 - EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 099000 for stencil painting.

3.02 INSTALLATION

A. Apply stencil painting in accordance with Section 099000.

B. Install identifying devices after completion of coverings and painting.

C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

E. Install tags using corrosion resistant chain. Number tags consecutively by location.

F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

G. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Identify valves in main and branch piping with tags.

J. Identify air terminal units and radiator valves with numbered tags.

K. Tag automatic controls, instruments, and relays. Key to control schematic.

L. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

M. For exposed natural gas lines other than steel pipe, attach yellow pipe labels with "GAS" in black lettering, at maximum 5 foot spacing.

N. Identify ductwork with plastic nameplates or stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

O. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Testing adjusting, and balancing of air systems.
2. Testing adjusting, and balancing of refrigerating systems.
3. Measurement of final operating condition of HVAC systems.
4. Sound measurement of equipment operating conditions.
5. Vibration measurement of equipment operating conditions.

1.02 REFERENCES

A. Associated Air Balance Council:

1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

C. Natural Environmental Balancing Bureau:

1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

D. Testing Adjusting and Balancing Bureau:

1. TABB - International Standards for Environmental Systems Balance.

1.03 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Prior to commencing Work, submit proof of latest calibration date of each instrument.

C. Test Reports: Indicate data on forms prepared following ASHRAE 111, NEBB Report forms, or TABB Report Forms.

D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms , Copy of NEBB Certificate of Conformance Certification or TABB International Quality Assurance program guarantee.

F. Submit draft copies of report for review prior to final acceptance of Project.

G. Furnish reports in soft cover, letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.04 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of balancing valves and rough setting.

C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with ASHRAE 111, NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems, and TABB International Quality Assurance program.

B. Maintain one copy of each document on site.

C. Prior to commencing Work, calibrate each instrument to be used.

1.06 QUALIFICATIONS

A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience Certified by NEBB or TABB.

1.07 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.08 SEQUENCING

A. Section 011000 - Summary: Work sequence.

B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.09 SCHEDULING

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

PART 2 - PRODUCTS

2.01 Not Used.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Verify systems are complete and operable before commencing work. Verify the following:

1. Systems are started and operating in safe and normal condition.
2. HVAC control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Service and balancing valves are open.

3.02 PREPARATION

A. Furnish instruments required for testing, adjusting, and balancing operations.

B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.03 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.04 ADJUSTING

A. Section 017000 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Verify recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.

E. Report defects and deficiencies noted during performance of services, preventing system balance.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.

H. Check and adjust systems approximately six months after final acceptance and submit report.

3.05 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities at site altitude.

B. Make air flow rate measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain:

1. Space temperatures within 2 degrees F.
2. Minimal objectionable drafts.

E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.

F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. At modulating damper locations, take measurements and balance at extreme conditions.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches differential static pressure between spaces.

M.

3.06 SCHEDULES

A. Partial list ofEquipment Requiring Testing, Adjusting, and Balancing:
   1. Air Cooled Refrigerant Condensers.
   2. Fan Coil Units.
   3. Fans.
   4. Air Filters.
   5. Air Inlets and Outlets.

B. Report Forms

   1. Title Page:

      a. Name of Testing, Adjusting, and Balancing Agency
      b. Address of Testing, Adjusting, and Balancing Agency
      c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
      d. Project name
      e. Project location
      f. Project Architect
      g. Project Engineer
      h. Project Contractor
      i. Project altitude
      j. Report date

   2. Summary Comments:

a. Design versus final performance
b. Notable characteristics of system
c. Description of systems operation sequence
d. Summary of outdoor and exhaust flows to indicate building pressurization
e. Nomenclature used throughout report
f. Test conditions

3. Instrument List:

a. Instrument
b. Manufacturer
c. Model number
d. Serial number
e. Range
f. Calibration date

4. Electric Motors:

a. Manufacturer
b. Model/Frame
c. HP/BHP and kW
d. Phase, voltage, amperage; nameplate, actual, no load
e. RPM
f. Service factor
g. Starter size, rating, heater elements
h. Sheave Make/Size/Bore

5. Air Cooled Condenser:

a. Identification/number
b. Location
c. Manufacturer
d. Model number
e. Serial number
f. Entering DB air temperature, design and actual
g. Leaving DB air temperature, design and actual
h. Number of compressors

6. Return Air/Outside Air Data:

a. Identification/location
b. Design air flow
c. Actual air flow
d. Design return air flow
e. Actual return air flow
f. Design outside air flow
g. Actual outside air flow
h. Return air temperature
i. Outside air temperature

j. Required mixed air temperature
k. Actual mixed air temperature
l. Design outside/return air ratio
m. Actual outside/return air ratio

7. Exhaust Fan Data:

a. Location
b. Manufacturer
c. Model number
d. Serial number
e. Air flow, specified and actual
f. Total static pressure (total external), specified and actual
g. Inlet pressure
h. Discharge pressure
i. Sheave Make/Size/Bore
j. Number of Belts/Make/Size
k. Fan RPM

8. Duct Traverse:

a. System zone/branch
b. Duct size
c. Area
d. Design velocity
e. Design air flow
f. Test velocity
g. Test air flow
h. Duct static pressure
i. Air temperature
j. Air correction factor

9. Duct Leak Test:

a. Description of ductwork under test
b. Duct design operating pressure
c. Duct design test static pressure
d. Duct capacity, air flow
e. Maximum allowable leakage duct capacity times leak factor
f. Test apparatus

1) Blower
2) Orifice, tube size
3) Orifice size
4) Calibrated

g. Test static pressure
h. Test orifice differential pressure
i. Leakage

10. Air Distribution Test Sheet:

    a. Air terminal number
    b. Room number/location
    c. Terminal type
    d. Terminal size
    e. Area factor
    f. Design velocity
    g. Design air flow
    h. Test (final) velocity
    i. Test (final) air flow
    j. Percent of design air flow

11. Sound Level Report:

    a. Location
    b. Octave bands - equipment off
    c. Octave bands - equipment on
    d. RC level - equipment on

12. Vibration Test:

    a. Location of points:

        1) Fan bearing, drive end
        2) Fan bearing, opposite end
        3) Motor bearing, center (when applicable)
        4) Motor bearing, drive end
        5) Motor bearing, opposite end
        6) Casing (bottom or top)
        7) Casing (side)
        8) Duct after flexible connection (discharge)
        9) Duct after flexible connection (suction)

    b. Test readings:

        1) Horizontal, velocity and displacement
        2) Vertical, velocity and displacement
        3) Axial, velocity and displacement

    c. Normally acceptable readings, velocity and acceleration
    d. Unusual conditions at time of test
    e. Vibration source (when non-complying)

END OF SECTION

SECTION 230700

HVAC INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. HVAC piping insulation, jackets and accessories.
2. HVAC equipment insulation, jackets and accessories.
3. HVAC ductwork insulation, jackets, and accessories.

B. Related Sections:
1. Section 099000 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.

1.02 REFERENCES

A. ASTM International:
1. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
2. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
3. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
4. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
5. .
6. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
7. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
8. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
9. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
10. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
11. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
12. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
13. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
14. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

15. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.

B. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.03 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

D. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.

E. Maintain one copy of each document on site.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.06 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.

B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.09 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for man made fiber.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Glass Fiber and Mineral Fiber Insulation

1. Manufacturers:

a. John Mansville.
b. CertainTeed LLC; Saint-Gobain North America.
c. Knauf Insulation.

d. Manson Insulation Inc.
e. Owens Corning.
f. Substitutions: Section 016000 - Product Requirements.

B. Closed Cell Elastomeric Insulation

1. Manufacturers:

a. Aeroflex USA.
b. Armacell LLC.
c. K-Flex USA.
d. Substitutions: Section 016000 - Product Requirements.

2.02 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

B. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

2.03 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:

1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

B. Aluminum Pipe Jacket:

1. ASTM B209.
2. Thickness: 0.016 inch thick sheet.
3. Finish: Smooth.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 1/2 inch wide; 0.016 inch thick aluminum.

C. Field Applied Glass Fiber Fabric Jacket System:

1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:

a. Cloth: Untreated; 9 oz/sq yd weight.
b. Blanket: 1.0 lb/cu ft density.
c. Weave: 5 x 5.

3. Indoor Vapor Retarder Finish:

a. Cloth: Untreated; 9 oz/sq yd weight.
b. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.

2.05 DUCTWORK INSULATION

A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Maximum Operating Temperature: 250 degrees F.
3. Density: 1.0 pound per cubic foot.

B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied all service facing meeting ASTM C1136, Type II.

1. Thermal Conductivity: 0.24 at 75 degrees F.
2. Density: 2.25 pound per cubic foot.

2.06 DUCTWORK INSULATION JACKETS

A. Vapor Retarder Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
3. Secure with pressure sensitive tape.

B. Canvas Duct Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

2.07 DUCTWORK INSULATION ACCESSORIES

A. Vapor Retarder Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

B. Vapor Retarder Lap Adhesive: Compatible with insulation.

C. Adhesive: Waterproof, ASTM E162 fire-retardant type.

D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

E. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

F. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

G. Adhesives: Compatible with insulation.

H. Membrane Adhesives: As recommended by membrane manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Verify piping, equipment and ductwork has been tested before applying insulation materials.

C. Verify surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions.

C. Piping Systems Conveying Fluids Below Ambient Temperature:

1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Inserts and Shields:

1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.

    a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
    b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.

3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

E. Insulation Terminating Points:
1. Condensate Piping: Insulate entire piping system and components to prevent condensation.

F. Closed Cell Elastomeric Insulation:

1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturers recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

G. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.

H. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o?clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

I. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

J. Prepare pipe insulation for finish painting. Refer to Section 099000.

3.03 INSTALLATION - DUCTWORK SYSTEMS

A. Duct dimensions indicated on Drawings are finished inside dimensions.

B. Insulated ductwork conveying air below ambient temperature:

1. Provide insulation with vapor retarder jackets.
2. Finish with tape and vapor retarder jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.

D. External Glass Fiber Duct Insulation:

1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
2. Secure insulation without vapor retarder with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

3.04 SCHEDULES

A. Cooling Services Piping Insulation Schedule:

1. Condensate Piping from Cooling Coils:

    a. Type: P-5.
    b. Thickness: 0.5 inch

2. Refrigerant Suction:

    a. Type: P-5.
    b. Thickness: 0.5 inch

3. Refrigerant Hot Gas:

    a. Type: P-5.
    b. Thickness: 0.5 inch

B. Ductwork Insulation Schedule:

1. Outside Air Intake:

    a. Type: D-2.
    b. Thickness: 1.5 inch

2. Equipment Casings:

    a. Type: D-2.
    b. Thickness: 1.5 inch

3. Supply Ducts - Externally Insulated, Installed Thickness:

    a. Type: D-1.
    b. Thickness: 1.0 inches

4. Return Ducts - Externally Insulated, Installed Thickness:

    a. Type: D-1.
    b. Thickness: 1.0 inches

5. Exhaust Ducts Within 10 feet of Exterior Openings, Installed Thickness:

    a. Type: D-1.
    b. Thickness: [1.0] [1.5] inches

END OF SECTION

SECTION 232300

REFRIGERANT PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Refrigerant piping.
2. Unions, flanges, and couplings.
3. Bedding and cover materials.

B. Related Sections:

1. Section 051200 - Structural Steel Framing: Product requirements for touch-up painting of structural steel.
2. Section 052100 - Steel Joist Framing: Product requirements for touch-up painting of steel joists.
3. Section 099123 - Painting and Coating: Product requirements for painting for placement by this section.
4. Section 230529 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, for placement by this section.
5. Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolation for placement by this section.
6. Section 230553 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
7. Section 230700 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.

1.02 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 495 - Refrigerant Liquid Receivers.
2. ARI 710 - Liquid-Line Driers.
3. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Dryers.
4. ARI 750 - Thermostatic Refrigerant Expansion Valves.
5. ARI 760 - Solenoid Valves for Use with Volatile Refrigerants.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

C. American Society of Mechanical Engineers:

1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
3. ASME B31.5 - Refrigeration Piping.
4. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
5. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
6. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.

E. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

F. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

G. Underwriters Laboratories Inc.:

1. UL 429 - Electrically Operated Valves.

1.03 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.

B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.

C. Provide pipe hangers and supports in accordance with ASME B31.5, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.

D. Flexible Connectors: Use at or near compressors where piping configuration does not absorb vibration.

1.04 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.

C. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories.
2. Valves: Submit manufacturer's catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturer's catalog information including load capacity.
4. Refrigerant Specialties: Submit manufacturer's catalog information including capacity, component sizes, rough-in requirements, and service sizes for the following:

    a. Refrigerant moisture and liquid indicators.
    b. Refrigerant strainers.
    c. Refrigerant pressure regulators.
    d. Refrigerant pressure relief valves.
    e. Refrigerant filter-driers.
    f. Refrigerant solenoid valves.
    g. Refrigerant expansion valves.
    h. Electronic expansion valves.

D. Test Reports: Indicate results of refrigerant leak test, and piping system pressure test.

E. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

F. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

G. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.05 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of valves, equipment and refrigerant accessories.

C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.

B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

C. Maintain one copy of each document on site.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.

B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years' documented experience.

1.08 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Product storage and handling requirements.

B. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.

C. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Section 016000 - Product Requirements.

B. Do not install underground piping when bedding is wet or frozen.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 COORDINATION

A. Section 013000 - Administrative Requirements: Requirements for coordination.

1.13 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

B. MAINTENANCE MATERIALS

C. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.

D. Furnish two refrigerant oil test kits each containing everything required for conducting one test.

1.14 EXTRA MATERIALS

A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two refrigerant filter-dryer cartridges of each type.

PART 2 - PRODUCTS

2.01 REFRIGERANT PIPING

A. Copper Tubing: ASTM B280, drawn.

1. Fittings: ASME B16.22 wrought copper.
2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.02 UNIONS, FLANGES, AND COUPLINGS

A. 2 inches and Smaller:

1. Ferrous Piping: 150 psig malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. 2-1/2 inches and Larger:

1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Copper Piping: Bronze.
3. Gaskets: 1/16 inch thick preformed neoprene.

C. Grooved and Shouldered Pipe End Couplings:

1. Housing Clamps: Malleable iron galvanized to engage and lock designed to permit some angular deflection, contraction, and expansion.
2. Sealing Gasket: C-shape elastomer composition for operating temperature range from -30 degrees F to 230 degrees F.
3. Accessories: Steel bolts, nuts, and washers.

D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.03 REFRIGERANT MOISTURE AND LIQUID INDICATORS

A. Indicators:

1. Port: Single, UL listed.
2. Body: Copper or brass, flared or solder ends.
3. Sight glass: Color-coded paper moisture indicator with removable element cartridge and plastic cap.
4. Maximum working pressure: 500 psig
5. Maximum working temperature: 200 degrees F.

2.04 VALVES

A. Ball Valves:

1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass seal cap, chrome plated ball, stem with neoprene ring stem seals, soldered or threaded ends.
2. Maximum working pressure: 500 psig.
3. Maximum working temperature: 300 degrees F.

B. Service Valves:

1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends.
2. Maximum working pressure: 500 psig.

C. Refrigerant Check Valves:
1. Globe Type:

a. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc.
b. Maximum working pressure: 425 psig.
c. Maximum working temperature: 300 degrees F.

2. Straight Through Type:

a. Spring, neoprene seat.
b. Maximum working pressure: 500 psig.
c. Maximum working temperature: 250 degrees F.

2.05 REFRIGERANT STRAINERS

A. Straight Line or Angle Line Type:

1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass.
2. Maximum working pressure: 430 psig.

B. Straight Line, Non-Cleanable Type:

1. Steel shell, copper plated fittings, stainless steel wire screen.

2.06 REFRIGERANT PRESSURE REGULATORS

A. Brass body, stainless steel diaphragm, direct acting pilot operated with remote pressure pilot, adjustable over 0 to 80 psig range, for maximum working pressure of 450 psig.

2.07 REFRIGERANT PRESSURE RELIEF VALVES

A. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; for standard 235 psig setting; selected to ASHRAE 15.

2.08 REFRIGERANT FILTER-DRIERS

A. Replaceable Cartridge Angle Type:

1. Shell: ARI 710, UL listed, brass, removable cap, for maximum working pressure of 350 psig
2. Filter Cartridge: Pleated media with integral end rings, stainless steel support.
3. Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina.
4. Wax Removal Cartridge: Molded bonded core of activated charcoal with integral gaskets.

B. Permanent Straight Through Type:

1. ARI 710, UL listed, steel shell with molded desiccant filter core, for maximum working pressure of 350 psig.

2.09 REFRIGERANT SOLENOID VALVES

A. Valve: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly, integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psig. Stem designed to allow manual operation in case of coil failure.

B. Coil Assembly: UL 429, UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box.

2.10 REFRIGERANT EXPANSION VALVES

A. Angle or Straight Through Type: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, mechanical pressure limit (maximum operating pressure MOP feature), adjustable superheat setting, replaceable inlet strainer, with replaceable capillary tube and remote sensing bulb and remote bulb well.

B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and oversized at part load.

2.11 ELECTRONIC EXPANSION VALVES

A. Valve:

1. Brass bodies with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.

B. Evaporation Control System:

1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, pre-selection allowance for electrical defrost and hot gas bypass.

C. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.12 REFRIGERANT RECEIVERS

A. Internal Diameter 6 inch and Smaller: ARI 495, UL listed, steel, brazed; 400 psig maximum pressure rating, with taps for inlet, outlet, and pressure relief valve.

B. Internal Diameter 6 inch and Larger: ARI 495, welded steel, tested and stamped in accordance with ASME Section VIII; 400 psig with taps for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.03 INSTALLATION - INSERTS

A. Provide inserts for placement in concrete forms.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.04 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install hangers and supports in accordance with ASME B31.5, ASTM F708, and MSS SP 89.

B. Support horizontal piping hangers as scheduled.

C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

F. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.

G. Provide copper plated hangers and supports for copper piping.

H. Prime coat exposed steel hangers and supports in accordance with Section 099000. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

I. Install pipe hangers and supports in accordance with Section 230529.

3.05 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Route piping parallel to building structure and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space.

C. Group piping whenever practical at common elevations.

D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 230529.

E. Install pipe identification in accordance with Section 230553.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Provide access where valves and fittings are not exposed.

H. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

I. Flood refrigerant piping system with nitrogen when brazing.

J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds. Refer to Section 051200.

K. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 099000.

L. Install valves with stems upright or horizontal, not inverted.

M. Insulate piping; refer to Section 230700.

N. Provide replaceable cartridge filter-dryers, with isolation valves and bypass with valve.

O. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

P. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

Q. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

R. Provide electrical connection to solenoid valves. Refer to Section 260503.

S. Fully charge completed system with refrigerant after testing.

T. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.

U. Install refrigerant piping in accordance with ASME B31.5.

3.06 INSTALLATION - REFRIGERANT SPECIALTIES

A. Refrigerant Liquid Indicators:

1. Install line size liquid indicators in main liquid line downstream of condenser.
2. When receiver is provided, install line size liquid indicators in liquid line downstream of receiver.
3. Install line size liquid indicators downstream of liquid solenoid valves.

B. Refrigerant Valves:

1. Install service valves on compressor suction and discharge.
2. Install gage taps at compressor inlet and outlet.
3. Install gage taps at hot gas bypass regulators, inlet and outlet.
4. Install check valves on compressor discharge.
5. Install check valves on condenser liquid lines on multiple condenser systems.
6. Install refrigerant charging valve in liquid line between receiver shut-off valve and expansion valve.

C. Strainers:

1. Install line size strainer upstream of each automatic valve.

2. Where multiple expansion valves with integral strainers are used, install single main liquid-line strainer.
3. On steel piping systems, install strainer in suction line.
4. Install shut-off valves on each side of strainer.

D. Install pressure relief valves on ASME receivers. Install relief valve discharge piping to terminate outdoors.

E. Filter-Dryers:

1. Install permanent filter-dryers in low temperature systems.
2. Install permanent filter-dryer in systems containing hermetic compressors.
3. Install replaceable cartridge filter-dryer vertically in liquid line adjacent to receivers.
4. Install replaceable cartridge filter-dryer upstream of each solenoid valve.

F. Solenoid Valves:

1. Install in liquid line of systems operating with single pump-out or pump-down compressor control.
2. Install in liquid line of single or multiple evaporator systems.
3. Install in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.

3.07 FIELD QUALITY CONTROL

A. Section 017000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test refrigeration system in accordance with ASME B31.5.

C. Pressure test refrigeration system with dry nitrogen to 200 psig. Perform final tests at 27 inches vacuum and 200 psig using electronic leak detector.

D. Repair leaks.

E. Retest until no leaks are detected.

3.08 SCHEDULES

A. Copper Tube Hanger Spacing:

1. Pipe Size 1/2 Inch:

a. Maximum Hanger Spacing: 5 feet.
b. Hanger Rod Diameter: 3/8 inch.

2. Pipe Size 3/4 Inch:

a. Maximum Hanger Spacing: 5 feet.
b. Hanger Rod Diameter: 3/8 inch.

3. Pipe Size 1 Inch:

a. Maximum Hanger Spacing: 6 feet.
b. Hanger Rod Diameter: 3/8 inch.

4. Pipe Size 1-1/4 Inches:

a. Maximum Hanger Spacing: 7 feet.
b. Hanger Rod Diameter: 3/8 inch

5. Pipe Size 1-1/2 Inches:

a. Maximum Hanger Spacing: 8 feet.
b. Hanger Rod Diameter: 3/8 inch.

6. Pipe Size 2 Inches:

a. Maximum Hanger Spacing: 8 feet.
b. Hanger Rod Diameter: 3/8 inch.

END OF SECTION

SECTION 233100

HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Duct materials.
2. Flexible ducts.
3. Single-wall, spiral round ducts.
4. Transverse duct connection system.
5. Casings.
6. Ductwork fabrication.
7. Duct cleaning.

B. Related Requirements:

1. Section 033000 - Cast-in-Place Concrete: Requirements for concrete curbs as specified in this Section.
2. Section 099123 - Painting and Coating: Requirements for painting or coating as specified in this Section.
3. Section 233300 - Air Duct Accessories: Requirements for duct accessories as specified in this Section.

1.02 REFERENCE STANDARDS

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE Handbook - Fundamentals.

B. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.
2. AWS D1.2 - Structural Welding Code - Aluminum.
3. AWS D9.1 - Sheet Metal Welding Code.

C. ASTM International:

1. ASTM A36 - Standard Specification for Carbon Structural Steel.
2. ASTM A90 - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
3. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

4. ASTM A568 - Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
5. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
6. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
7. ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
8. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
9. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
10.
11. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
12. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. International Code Council:

1. International Energy Conservation Code (IECC).
2. International Mechanical Code (IMC).

E. NFPA:

1. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

F. Sheet Metal and Air Conditioning Contractors' National Association:

1. SMACNA 016 - HVAC Air Duct Leakage Test Manual.
2. SMACNA 1966 - HVAC Duct Construction Standards - Metal and Flexible.

G. UL:

1. UL 181 - Factory-Made Air Ducts and Air Connectors.
2. UL 181A - Closure Systems for Use With Rigid Air Ducts.

1.03 PREINSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.04 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for duct materials, duct connectors, and duct fittings.

C. Shop Drawings:

1. Submit duct fabrication drawings, drawn to scale not smaller than ¼ inch equals 1 foot, on sheets same size as Contract Drawings, indicating following:

a. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other Work.
b. Duct layout that further indicates pressure classifications and sizes in plan view; exhaust duct systems that further indicate classification of materials handled as specified in this Section.
c. Fittings.
d. Reinforcing details and spacing.
e. Seam and joint construction details.
f. Penetrations through fire-rated and other walls.
g. Hangers and supports, including methods for vibration isolation and building and duct attachment.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

F. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for following:

1. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
2. Materials, fabrication, assembly, and spacing of hangers and supports.
3. Sheet metal thicknesses.
4. Joint and seam construction and sealing.
5. Reinforcement details and spacing.

G. Test and Evaluation Reports: Indicate pressure tests performed, including date, section tested, test pressure, and leakage rate according to SMACNA 016.

H. Manufacturer Instructions:

1. Submit detailed instructions on installation requirements, including storage and handling procedures.
2. Submit special procedures for glass-fiber ducts.

I. Qualifications Statements:

1. Submit qualifications for manufacturer, installer, and licensed professional.
2. Submit manufacturer's approval of installer.
3. Welders: Qualify procedures and personnel according to AWS D1.1 for hangers and supports, AWS D1.2for aluminum supports, and AWS D9.1 for duct joint and seam welding.

1.05 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents:

1. Record actual locations of ducts and duct fittings.
2. Record changes in fitting location and type.
3. Show additional fittings used.

1.06 QUALITY ASSURANCE

A. Perform Work according to SMACNA 1884 and 1966.

B. Construct ductwork to NFPA 90A, NFPA 90B, and NFPA 96 standards.

C. Perform Work according to standards.

D. Maintain 1 copy of each standard affecting Work of this Section on Site.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.

C. Welders: AWS qualified within previous 12 months for employed weld types.

D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed at Project location.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.09 AMBIENT CONDITIONS

A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Minimum Conditions: Do not install duct sealant when temperatures are less than those recommended by sealant manufacturer.

C. Subsequent Conditions: Maintain temperatures during and after installation of duct sealant.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for ducts.

PART 2 - PRODUCTS

2.01 DUCTS

A. Performance and Design Criteria:

1. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission of Architect/Engineer.
2. Size round ducts installed in place of rectangular ducts according to ASHRAE Handbook - Fundamentals.

B. Materials:

C. Galvanized-Steel Ducts:

1. Material: ASTM A653 galvanized-steel sheet.
2. Quality: Lock forming.
3. Finish: G60 zinc coating according to ASTM A90.

D. Fasteners: Rivets, bolts, or sheet metal screws.

E. Hanger Rod:

1. Material: Galvanized steel.
2. Comply with ASTM A36.
3. Type: Threaded both ends.

2.02 FLEXIBLE DUCTS

A. Description:

1. UL-labeled multiple layers of aluminum laminate supported by helical-wound spring steel wire.
2. Pressure Rating: 10-inch wg positive and 1.0-inch negative.
3. Maximum Velocity: 4,000 fpm.
4. Temperature Range: Minus 20 to plus 210 degrees F.

2.03 SINGLE-WALL, SPIRAL ROUND DUCTS

A. Description:

1. UL 181, Class 1, round spiral lockseam duct.
2. Material: Galvanized steel.

B. Minimum Duct Wall Thicknesses:

1. Diameter 2 to 14 Inches26 gage.16 to 26 Inches24 gage.28 to 36 Inches22 gage.38 to 50 Inches20 gage.52 to 60 Inches18 gage.

C. Minimum Fittings Wall Thicknesses:

1. Diameter 2 to 14 Inches24 gage.16 to 26 Inches22 gage.28 to 36 Inches20 gage.38 to 50 Inches20 gage.52 to 60 Inches18 gage.

2.04 CASINGS

A. Fabricate casings according to SMACNA 1966 and construct for indicated operating pressures.

B. Doors:

1. Reinforce access door frames with steel angles tied to horizontal and vertical plenum supporting angles.

2. Furnish hinged access doors where indicated or required for access to equipment for cleaning and inspection.

2.05 FABRICATION

A. Rectangular Ducts:

1. According to SMACNA 1966 and as indicated on Drawings.
2. Provide duct material, gages, reinforcing, and sealing for indicated operating pressures.

B. Round Ducts:

1. According to SMACNA 1966 and as indicated on Drawings.
2. Seams: Longitudinal.
3. Provide duct material, gages, reinforcing, and sealing for indicated operating pressures.

C. Tees, Bends, and Elbows:

1. Minimum Radius:

a. 1-1/2 times centerline duct width.
b. If not possible or if rectangular elbows are used, provide airfoil turning vanes.

2. If acoustical lining is indicated, furnish turning vanes of perforated metal with glass-fiber insulation.

D. Divergence:

1. Increase duct sizes gradually, not exceeding 15 degrees of divergence wherever possible.
2. Upstream of Equipment: Maximum 30 degrees.
3. Downstream of Equipment: Maximum 45 degrees.

E. Welding:

1. Continuously Welded Round and Oval Duct Fittings: Two gages heavier than duct gages according to SMACNA 1966.
2. Cemented Slip Joints:

a. Minimum 4 inches.
b. Brazed or electric welded.

3. Prime coat welded joints.

F. Takeoffs:

1. Provide standard 45-degree lateral wye takeoffs.
2. If not possible due to space limitations, provide 90-degree conical tee connections.

G. Sealing:

1. Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems, or tape.
2. Sealants, Mastics, and Tapes: Comply with UL 181A and provide products bearing appropriate UL 181A markings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify sizes of equipment connections before fabricating transitions.

3.02 PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Obtain manufacturer's inspection and acceptance of fabrication and installation at beginning of installation.

C. Install temporary closures of metal or taped PE on open ductwork to prevent construction dust from entering ductwork system.

3.03 INSTALLATION

A. Install and seal ducts according to SMACNA 1966.

B. Glass-Fiber-Reinforced Ducts: Comply with SMACNA 1884.

C. Insulated Flexible Duct Fittings:

1. Join each flexible duct section to main trunk duct through sheet metal fittings.
2. Material: Galvanized steel.
3. Equip fittings with factory-installed volume damper having positive locking regulator.
4. Provide insulation guard with fittings installed in lined ductwork.

D. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8 inches and smaller.

E. Hanger and Supports:

1. Fabricate and support ducts according to SMACNA 1884 and 1966.

2. Threaded Rods: Provide double nuts and lock washers.
3. Building Attachments:

    a. Provide concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
    b. If possible, install concrete inserts before placing concrete.
    c. Powder-Actuated Concrete Fasteners:

        1) Use only for slabs more than 4 inches thick.
        2) Install after concrete is placed and completely cured.
        3) Do not use powder-actuated concrete fasteners for seismic restraints.

4. Hanger Spacing:

    a. Comply with SMACNA 1884 and [**1966**].
    b. Install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
    c. Extend strap supports down both sides of ducts and turn under bottom at least 1 inch.
    d. Secure hanger to sides and bottom of ducts with sheet metal screws.

5. Hangers Exposed to View: Provide threaded rod and angle or channel supports.
6. Vertical Ducts:

    a. Support with steel angles or channel secured to sides of duct with welds, bolts, sheet metal screws, or blind rivets.
    b. Support at each floor and at maximum intervals of 16 feet.

7. Upper Attachments:

    a. Attach to structures.
    b. Selection and Sizing: Provide pull-out, tension, and shear capacities as required for supported loads and building materials.

8. Penetrations:

    a. Avoid penetrations of ducts with hanger rods.
    b. If unavoidable, provide airtight rubber grommets at penetrations.

F. Connect flexible ducts to metal ducts with liquid adhesive and tape.

G. Plenum Doors:

1. Location: 6 to 12 inches above floor.
2. Arrange door swing such that fan static pressure holds door in closed position.

H. Exhaust Outlet Locations:

1. Minimum Distance from Property Lines: 3 feet.

2. Minimum Distance from Building Openings: 3 feet.
3. Minimum Distance from Outside Air Intakes: 10 feet.

I. Interface with Other Work:

1. Install openings in ductwork as required to accommodate thermometers and controllers.
2. Install pitot tube openings for testing of systems, complete with metal can with spring device or screw to prevent air leakage.
3. If openings are provided in insulated ductwork, install insulation material inside metal ring.
4. Connect diffusers or light troffer boots to low-pressure ducts with 5-foot maximum length of flexible duct held in place with strap or clamp.
5. Connect air outlets and inlets to supply ducts directly or with 5-foot maximum length of flexible duct; do not use flexible duct to change direction.

3.04 FIELD QUALITY CONTROL

A. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Testing:

1. Ductwork Designed for 3-Inch wg above Ambient Pressure:

a. Pressure test minimum 25 percent of ductwork after duct cleaning but before duct insulation is applied or ductwork is concealed.
b. Comply with SMACNA 016.
c. Maximum Allowable Leakage: According to IECC.

3.05 CLEANING

A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

B. Clean duct system and force air at high velocity through duct to remove accumulated dust.

C. To obtain sufficient airflow, clean one half of system completely before proceeding to other half.

D. Vacuuming:

1. Clean duct systems with high-power vacuum machines.
2. Install access openings into ductwork for cleaning purposes.

E. Protect sensitive equipment with temporary filters or bypass during cleaning.

3.06 ATTACHMENTS

A. Ductwork Material Schedule:
   1. Supply - Systems with Cooling Coils: Steel, aluminum
   2. Return and Relief : Steel or aluminum.
   3. General Exhaust: Steel or aluminum.
   4. Outside Air Intake: Steel.
   5. Intake and Exhaust: Steel.

B. Ductwork Pressure Class Schedule:

   1. Constant Volume Supply: 1-inch wg, regardless of velocity.
   2. Variable-Volume, Variable-Temperature Supply: 1-inch wg, regardless of velocity.
   3. Return and Relief: 1/2-inch wg.
   4. General Exhaust: 1/2-inch wg.

END OF SECTION

SECTION 233400

HVAC FANS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Ceiling fans.

B. Related Sections:
   1. Section 230513 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
   2. Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for resilient mountings and snubbers for fans for placement by this section.
   3. Section 230700 - HVAC Insulation: Product requirements for power ventilators for placement by this section.
   4. Section 233100 - HVAC Ducts and Casings: Product requirements for hangers for placement by this section.
   5. Section 233300 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
   6. Section 260010 - Equipment Wiring Connections: Execution and product requirements for connecting equipment specified by this section.

1.02 REFERENCES

A. American Bearing Manufacturers Association:

   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:

   1. AMCA 99 - Standards Handbook.
   2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
   3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
   4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
   5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

C. American Refrigeration Institute:

   1. ARI 1060 - Air-to-Air Energy Recovery Ventilation Equipment Certification Equipment Program.

D. ASTM International:

1. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.

E. National Electrical Manufacturers Association:

1. NEMA MG 1 - Motors and Generators.
2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

F. Underwriters Laboratories Inc.:

1. UL 705 - Power Ventilators.

1.03 PERFORMANCE REQUIREMENTS

A. Wind-Borne Debris Loads: Design louvers located within 30 feet of grade to withstand ASTM E1996; large missile impact test.

1.04 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.

C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit fan manufacturer instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.05 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.06 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300,and bear AMCA Certified Sound Rating Seal.

C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

D. Balance Quality: Conform to AMCA 204.

E. Maintain one copy of each document on site.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience.

1.08 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Product storage and handling requirements.

B. Protect motors, shafts, and bearings from weather and construction dust.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish three year manufacturer's warranty for fans.

1.12 MAINTENANCE SERVICE

A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance service.

PART 2 - PRODUCTS

2.01 CEILING FANS

A. Manufacturers:
   1. Greenheck
   2. Ruskin
   3. Substitutions: Section 016000 - Product Requirements.

B. Centrifugal Fan Unit: Direct driven with galvanized steel housing lined with 1/2 inch acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge opening, integral outlet duct collar.

C. Disconnect Switch: Fan mounted toggle switch for thermal overload protected motor.

D. Grille: Painted steel.

E. Wheel: Centrifugal forward curved type constructed of injection molded or polypropylene resin.

F. Motor: Open drip proof type with permanently lubricated sealed bearings and thermal overload protection.

G. Accessories:

   1. Wall cap with damper, round duct inlet.
   2. Eave elbow.
   3. Rubber-in-shear vibration isolator.
   4. Ceiling radiation damper.
   5. Fan speed controller.
   6. Time delay relay.

H. Performance: See Drawings.

I. Electrical Characteristics and Components: See Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

3.02 INSTALLATION

A. Provide backdraft dampers on outlet from cabinet and ceiling fans and as indicated on Drawings.

B. Install safety screen where inlet or outlet is exposed.

3.03 MANUFACTURER'S FIELD SERVICES

A. Section 014000 - Quality Requirements: Requirements for manufacturers field services.

B. Furnish services of factory trained representative for minimum of one day to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.04 CLEANING

A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

B. Vacuum clean coils and inside of fan cabinet.

3.05 DEMONSTRATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate fan operation and maintenance procedures.

3.06 PROTECTION OF FINISHED WORK

A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Do not operate fans for until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

3.07 SCHEDULES

END OF SECTION

SECTION 233700

AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Diffusers.
2. Grilles.
3. Louvers.

B. Related Sections:
1. Section 089119 - Louvers: Wall Louvers.
2. Section 099123 - Painting and Coating: Execution and product requirements for Painting of ductwork visible behind outlets and inlets specified by this section.
3. Section 233300 - Air Duct Accessories: Volume dampers for inlets and outlets.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.

C. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.03 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

C. Test Reports: Rating of air outlet and inlet performance.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of air outlets and inlets.

1.05 QUALITY ASSURANCE

A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.

B. Test and rate louver performance in accordance with AMCA 500.

C. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.08 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

1.09 EXTRA MATERIALS

A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 - PRODUCTS

2.01 RECTANGULAR CEILING DIFFUSERS

A. Manufacturers:
   1. Titus
   2. Greenheck
   3. Substitutions: Section 016000 - Product Requirements.

B. Type: Square, adjustable pattern, stamped, multi-core diffuser to discharge air in four-way pattern with sector baffles where indicated.

C. Frame: Surface mount type. In plaster ceilings, furnish plaster frame and ceiling frame.

D. Fabrication: Aluminum with baked enamel off-white finish.

E. Accessories: Radial opposed-blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.02 PERFORATED FACE CEILING DIFFUSERS

A. Manufacturers:
   1. Titus
   2. Greenheck
   3. Substitutions: Section 016000 - Product Requirements.

B. Type: Perforated face with fully adjustable pattern and removable face.

C. Frame: Surface mount type. In plaster ceilings, furnish plaster frame and ceiling frame.

D. Fabrication: Steel with steel or aluminum frame and baked enamel off-white finish.

E. Accessories: Radial opposed-blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.03 LOUVERS

A. Louvers: As specified in Section 089100.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Verify inlet and outlet locations.

C. Verify ceiling systems are ready for installation.

3.02 INSTALLATION

A. Install diffusers to ductwork with airtight connection.

B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly. Refer to Section 233300.

C. Paint visible portion of ductwork behind air outlets and inlets matte black. Refer to Section 099000.

D. Do not locate air registers, diffusers or grilles in floors of toilet or bathing rooms.

3.03 INTERFACE WITH OTHER PRODUCTS

A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.04 SCHEDULES: See Drawings.

END OF SECTION

SECTION 238126

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Air handling unit (Light Commercial up to 5 Tons).

2. Condensing unit (Light Commercial up to 5 Tons).

B. Related Sections:

1. Section 033000 - Cast-In-Place Concrete: Execution requirements for concrete foundations specified by this section.
2. Section 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment: Vibration isolators.
3. Section 232300 - Refrigerant Piping: Execution requirements for connection to refrigerant piping specified by this section.
4. Section 233300 - Air Duct Accessories: Flexible connections.
5. Section 260519 - Equipment Wiring Connections: Electrical connection to units.

1.02 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
3. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. ASTM International:

1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

D. National Electrical Manufacturers Association:

1. NEMA MG 1 - Motors and Generators.

E. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.03 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit data indicating:

1. Cooling and heating capacities.
2. Dimensions.
3. Weights.
4. Rough-in connections and connection requirements.
5. Duct connections.
6. Electrical requirements with electrical characteristics and connection requirements.
7. Controls.
8. Accessories.

C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

E. Manufacturer's Field Reports: Submit start-up report for each unit.

1.04 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of controls installed remotely from units.

C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.05 QUALITY ASSURANCE

A. Performance Requirements: , Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI 210/240.

B. Cooling Capacity: Rate in accordance with ARI 210/240.

C. Sound Rating: Measure in accordance with ARI 270.

D. Insulation and adhesives: Meet requirements of NFPA 90A.

E. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience.

1.07 PRE-INSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

C. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.

D. Protect units from weather and construction traffic by storing in dry, roofed location.

1.09 COORDINATION

A. Section 013000 - Administrative Requirements: Requirements for coordination.

B. Coordinate installation of condensing units with concrete pad.

C. Coordinate installation of air handling units with building structure.

1.10 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for compressors.

1.11 MAINTENANCE SERVICE

A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance service.

B. Furnish service and maintenance of equipment for one year from Date of Substantial Completion. Include maintenance items as shown in manufacturer's operating and maintenance data, including filter replacements, fan belt replacement, and controls checkout and adjustments.

C. Furnish 24-hour emergency service on breakdowns and malfunctions for this maintenance period. Furnish capability of response time within 10 hours.

1.12 MAINTENANCE MATERIALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Furnish one set for each unit of filters.

PART 2 - PRODUCTS

2.01 SPLIT SYSTEM AIR CONDITIONING UNITS

A. Manufacturers:
   1. Trane
   2. Greenheck
   3. Daikin
   4. Substitutions: Section 016000 - Product Requirements.

B. Product Description: Split system consisting of air handling unit and condensing unit including cabinet, evaporator fan, refrigerant cooling coil, compressors, refrigeration circuits, condenser, air filters, controls, air handling unit accessories, condensing unit accessories, and refrigeration specialties.

2.02 AIR HANDLING UNIT (LIGHT COMMERCIAL UP TO 5 TONS)

A. Configuration: Horizontal air delivery..

B. Cabinet:

   1. Panels: Constructed of galvanized steel with baked enamel finish. Access Panels: Located on both sides of unit. Furnish with duct collars on inlets and outlets.
   2. Insulation: Factory applied to each surface to insulate entire cabinet. 1/2 inch thick aluminum foil faced glass fiber with edges protected from erosion.

C. Evaporator Fan: Forward curved centrifugal type, resiliently mounted with adjustable belt drive and high efficiency motor complying with NEMA MG1, Type 1. Motor permanently lubricated with built-in thermal overload protection.

D. Evaporator Coil: Constructed of copper tubes expanded onto aluminum fins. Factory leak tested under water. Removable, PVC construction, double-sloped drain pan with piping connections on both sides.

E. Refrigeration System: Single refrigeration circuits controlled by factory installed thermal expansion valve.

F. Air Filters: 1 inch 25 to 30 percent efficiency based on ASHRAE 52.1.

G. Air Handling Unit Accessories:

1. Discharge Plenum: with construction and finish matching unit casing. Integral grille of aluminum construction and adjustable louvers.
2. Return Air Grille: mounted in return air opening of aluminum construction and fixed louvers.
3. Mounting Subbase with construction and finish matching unit casing.
4. Vibration Isolators: Spring type.

2.03 CONDENSING UNIT (LIGHT COMMERCIAL UP TO 5 TONS)

A. General: Factory assembled and tested air cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.

B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, motors, and drives.

C. Compressor: Single refrigeration circuit with rotary or hermetic reciprocating type compressors, resiliently mounted, with positive lubrication, and internal motor overload protection.

D. Condenser Coil: Constructed of copper tubing mechanically bonded to aluminum fins, factory leak and pressure tested.

E. Controls: Furnish operating and safety controls including high and low pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.

F. Condenser Fans and Drives: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Permanently lubricated ball bearing type motors with built-in thermal overload protection. Furnish high efficiency fan motors.

G. Condensing Unit Accessories: Furnish the following accessories:

1. Time delay relay.
2. Anti-short cycle timer.
3. Disconnect switch.
4. Vibration isolators.
5. Hot gas bypass kit.
6. Coil with corrosion resistant coating capable of withstanding salt spray test of 1000 hours in accordance with ASTM B117.
7. Condenser Coil Guard: Condenser fan openings furnished with PVC coated steel wire safety guards.
8. Suction and discharge pressure gauges.

H. Refrigeration specialties: Furnish the following:

1. Charge of compressor oil.
2. Holding charge of refrigerant.
3. Replaceable core type filter drier.
4. Liquid line sight glass and moisture indicator.
5. Shut-off valves on suction and liquid piping.
6. Liquid line solenoid valve.
7. Charging valve.
8. Oil level sight glass.
9. Crankcase heater.
10. Hot gas muffler.
11. Pressure relief device.

I. Refrigerant: Furnish charge of refrigerant R-410A.

2.04 CONTROLS

A. Thermostat: 7 day programmable electronic space thermostat with two stage heating and two stage cooling with manual and automatic changeover and heating setback and cooling setup capability. Furnish system selector switch off-heat-auto-cool.

2.05 CAPACITY: See Drawings:

2.06 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: In accordance with Section 260010 and the following:

B. Disconnect Switch: Factory mounted, non-fused type, interlocked with access door, accessible from outside unit, with power lockout capability.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify concrete pad for condensing unit is ready for unit installation.

3.02 INSTALLATION - AIR HANDLING UNIT

A. Install air handling units on vibration isolators. Refer to Section 230548.

B. Install floor mounted units on concrete housekeeping pads at least 3-1/2 inches high and 6 inches wider than unit. Refer to Section 033000.

C. Connect air handling units to supply and return ductwork with flexible connections. Refer to Section 233300.

D. Install condensate piping with trap and route from drain pan to condensate drainage system.

E. Install components furnished loose for field mounting.

F. Install connection to electrical power wiring in accordance with Section 260010.

3.03 INSTALLATION - CONDENSING UNIT

A. Install condensing units on vibration isolators. Refer to Section 230548.

B. Install units on concrete foundations. Refer to Section 033000.

C. Install refrigerant piping from unit to condensing unit. Install refrigerant specialties furnished with unit. Refer to Section 232300.

D. Evacuate refrigerant piping and install initial charge of refrigerant.

E. Install electrical devices furnished loose for field mounting.

F. Install control wiring between air handling unit, condensing unit, and field installed accessories.

G. Install connection to electrical power wiring in accordance with Section 260503.

3.04 MANUFACTURER'S FIELD SERVICES

A. Section 014000 - Quality Requirements: Requirements for manufacturers field services.

B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.05 CLEANING

A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

B. Vacuum clean coils and inside of unit cabinet.

C. Install new throwaway filters in units at Substantial Completion.

3.06 DEMONSTRATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate air handling unit operation and maintenance.

C. Demonstrate starting, maintenance, and operation of condensing unit.

D. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

3.07 PROTECTION OF FINISHED WORK

A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Do not operate air handling units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

3.08 SCHEDULES: See Drawings.

END OF SECTION

SECTION 260010 – SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Supplemental requirements applicable to the Work specified in Division 26. This Section is also referenced by related Work specified in other Divisions.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

1. 8P8C: An 8-position 8-contact modular jack.
2. A: Ampere, unit of electrical current.
3. AC or ac: Alternating current.
4. AFCI: Arc-fault circuit interrupter.
5. AIC: Ampere interrupting capacity.
6. AL, Al, or ALUM: Aluminum.
7. ASD: Adjustable-speed drive.
8. ATS: Automatic transfer switch.
9. AWG: American wire gauge; see ASTM B258.
10. BAS: Building automation system.
11. BIL: Basic impulse insulation level.
12. BIM: Building information modeling.
13. CAD: Computer-aided design or drafting.
14. CATV: Community antenna television.
15. CB: Circuit breaker.
16. CO/ALR: Copper-aluminum, revised.
17. COPS: Critical operations power system.
18. CU or Cu: Copper.

19. CU-AL or AL-CU: Copper-aluminum.

20. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.

21. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.

22. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).

23. dBm: Decibel absolute power with respect to 1 mW.

24. DC or dc: Direct current.

25. DCOA: Designated critical operations area.

26. DDC: Direct digital control (HVAC).

27. EGC: Equipment grounding conductor.

28. ELV: Extra-low voltage.

29. EMF: Electromotive force.

30. EMI: Electromagnetic interference.

31. EPM: Electrical preventive maintenance.

32. EPS: Emergency power supply.

33. EPSS: Emergency power supply system.

34. ESS: Energy storage system.

35. EV: Electric vehicle.

36. EVPE: Electric vehicle power export equipment.

37. EVSE: Electric vehicle supply equipment.

38. fc: Footcandle, an internationally recognized unit of illuminance equal to one lumen per square foot or 10.76 lx. The simplified conversion 1 fc = 10 lx in the Specifications is common practice and considered adequate precision for building construction activities. When there are conflicts, lux is the primary unit; footcandle is specified for convenience.

39. FLC: Full-load current.

40. ft: Foot.

41. ft-cd: Foot-candle, the antiquated U.S. Standard unit of illuminance, equal to one international candle measured at a distance of one foot, which was superseded in 1948 by

the unit "footcandle" after the SI unit candela (cd) replaced the international candle; see "fc,"

42. GEC: Grounding electrode conductor.

43. GFCI: Ground-fault circuit interrupter.

44. GFPE: Ground-fault protection of equipment.

45. GND: Ground.

46. HACR: Heating, air conditioning, and refrigeration.

47. HDPE: High-density polyethylene.

48. HID: High-intensity discharge.

49. HP or hp: Horsepower.

50. HVAC: Heating, ventilating, and air conditioning.

51. Hz: Hertz.

52. IBT: Intersystem bonding termination.

53. inch: Inch. To avoid confusion, the abbreviation "in." is not used.

54. IP: Ingress protection rating (enclosures); Internet protocol (communications).

55. IR: Infrared.

56. IS: Intrinsically safe.

57. IT&R: Inspecting, testing, and repair.

58. ITE: Information technology equipment.

59. kAIC: Kiloampere interrupting capacity.

60. kcmil or MCM: One thousand circular mils.

61. kV: Kilovolt.

62. kVA: Kilovolt-ampere.

63. kVAr or kVAR: Kilovolt-ampere reactive.

64. kW: Kilowatt.

65. kWh: Kilowatt-hour.

66. LAN: Local area network.

67. lb: Pound (weight).

68. lbf: Pound (force).

69. LCD: Liquid-crystal display.

70. LCDI: Leakage-current detector-interrupter.

71. LED: Light-emitting diode.

72. Li-ion: Lithium-ion.

73. lm: Lumen, the SI derived unit of luminous flux.

74. LNG: Liquefied natural gas.

75. LP-Gas: Liquefied petroleum gas.

76. LRC: Locked-rotor current.

77. LV: Low voltage.

78. lx: Lux, the SI derived unit of illuminance equal to one lumen per square meter.

79. m: Meter.

80. MCC: Motor-control center.

81. MDC: Modular data center.

82. MG set: Motor-generator set.

83. MIDI: Musical instrument digital interface.

84. MLO: Main lugs only.

85. MV: Medium voltage.

86. MVA: Megavolt-ampere.

87. mW: Milliwatt.

88. MW: Megawatt.

89. MWh: Megawatt-hour.

90. NC: Normally closed.

91. Ni-Cd: Nickel-cadmium.

92. Ni-MH: Nickel-metal hydride.

93. NIU: Network interface unit.

94. NO: Normally open.

95. NPT: National (American) standard pipe taper.

96. OCPD: Overcurrent protective device.

97. ONT: Optical network terminal.

98. PC: Personal computer.

99. PCS: Power conversion system.

100. PCU: Power-conditioning unit.

101. PF or pf: Power factor.

102. PHEV: Plug-in hybrid electric vehicle.

103. PLC: Programmable logic controller.

104. PLFA: Power-limited fire alarm.

105. PoE: Power over Ethernet.

106. PV: Photovoltaic.

107. PVC: Polyvinyl chloride.

108. pW: Picowatt.

109. RFI: (electrical) Radio-frequency interference; (contract) Request for interpretation.

110. RMS or rms: Root-mean-square.

111. RPM or rpm: Revolutions per minute.

112. SCADA: Supervisory control and data acquisition.

113. SCR: Silicon-controlled rectifier.

114. SPD: Surge protective device.

115. sq.: Square.

116. SWD: Switching duty.

117. TCP/IP: Transmission control protocol/Internet protocol.

118. TEFC: Totally enclosed fan-cooled.

119. TR: Tamper resistant.

120. TVSS: Transient voltage surge suppressor.

121. UL: (standards) Underwriters Laboratories, Inc.; (product categories) UL, LLC.

122. UL CCN: UL Category Control Number.

123. UPS: Uninterruptible power supply.

124. USB: Universal serial bus.

125. UV: Ultraviolet.

126. V: Volt, unit of electromotive force.

127. V(ac): Volt, alternating current.

128. V(dc): Volt, direct current.

129. VA: Volt-ampere, unit of complex electrical power.

130. VAR: Volt-ampere reactive, unit of reactive electrical power.

131. VFC: Variable-frequency controller.

132. VOM: Volt-ohm-multimeter.

133. VPN: Virtual private network.

134. VRLA: Valve regulated lead acid; also called "sealed lead acid (SLA)" or "valve regulated sealed lead acid."

135. W: Watt, unit of real electrical power.

136. Wh: Watt-hour, unit of electrical energy usage.

137. WPT: Wireless power transfer.

138. WPTE: Wireless power transfer equipment.

139. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.

2. EMT-A: Aluminum electrical metallic tubing.

3. EMT-S: Steel electrical metallic tubing.

4. EMT-SS: Stainless steel electrical metallic tubing.

5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit.
7. EPEC-40: Schedule 40 electrical HDPE underground conduit.
8. EPEC-80: Schedule 80 electrical HDPE underground conduit.
9. EPEC-A: Type A electrical HDPE underground conduit.
10. EPEC-B: Type B electrical HDPE underground conduit.
11. ERMC: Electrical rigid metal conduit.
12. ERMC-A: Aluminum electrical rigid metal conduit.
13. ERMC-S: Steel electrical rigid metal conduit.
14. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
15. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
16. ERMC-SS: Stainless steel electrical rigid metal conduit.
17. FMC: Flexible metal conduit.
18. FMC-A: Aluminum flexible metal conduit.
19. FMC-S: Steel flexible metal conduit.
20. FMT: Steel flexible metallic tubing.
21. FNMC: Flexible nonmetallic conduit. See "LFNC."
22. HDPE: See EPEC.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.
29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.

31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.

32. PVC: Rigid PVC conduit.

33. PVC-40: Schedule 40 rigid PVC conduit.

34. PVC-80: Schedule 80 rigid PVC Conduit.

35. PVC-A: Type A rigid PVC concrete-encased conduit.

36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.

37. RGS: See ERMC-S-G.

38. RMC: See ERMC.

39. RTRC: Reinforced thermosetting resin conduit.

40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.

41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.

42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.

43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.

44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:

1. AC: Armored cable.

2. CATV: Coaxial general-purpose cable.

3. CATVP: Coaxial plenum cable.

4. CATVR: Coaxial riser cable.

5. CI: Circuit integrity cable.

6. CL2: Class 2 cable.

7. CL2P: Class 2 plenum cable.

8. CL2R: Class 2 riser cable.

9. CL2X: Class 2 cable, limited use.

10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.
22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MC: Metal-clad cable.
30. MC-HL: Metal-clad cable, hazardous location.
31. MI: Mineral-insulated, metal-sheathed cable.
32. MTW: (machine tool wiring) Moisture-, heat-, and oil-resistant thermoplastic cable.
33. MV: Medium-voltage cable.
34. NM: Nonmetallic sheathed cable.
35. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.

36. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.

37. NPLF: Non-power-limited fire-alarm circuit cable.

38. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.

39. NPLFR: Non-power-limited fire-alarm circuit riser cable.

40. NUCC: Nonmetallic underground conduit with conductors.

41. OFC: Conductive optical fiber general-purpose cable.

42. OFCG: Conductive optical fiber general-purpose cable.

43. OFCP: Conductive optical fiber plenum cable.

44. OFCR: Conductive optical fiber riser cable.

45. OFN: Nonconductive optical fiber general-purpose cable.

46. OFNG: Nonconductive optical fiber general-purpose cable.

47. OFNP: Nonconductive optical fiber plenum cable.

48. OFNR: Nonconductive optical fiber riser cable.

49. P: Marine shipboard cable.

50. PLTC: Power-limited tray cable.

51. PLTC-ER: Power-limited tray cable, exposed run.

52. PV: Photovoltaic cable.

53. RHH: (high heat) Thermoset rubber, heat-resistant cable.

54. RHW: Thermoset rubber, moisture-resistant cable.

55. SA: Silicone rubber cable.

56. SE: Service-entrance cable.

57. SER: Service-entrance cable, round.

58. SEU: Service-entrance cable, flat.

59. SIS: Thermoset cable for switchboard and switchgear wiring.

60. TBS: Thermoplastic cable with outer braid.

61. TC: Tray cable.

62. TC-ER: Tray cable, exposed run.

63. TC-ER-HL: Tray cable, exposed run, hazardous location.

64. THW: Thermoplastic, heat- and moisture-resistant cable.

65. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.

66. THHW: Thermoplastic, heat- and moisture-resistant cable.

67. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.

68. TW: Thermoplastic, moisture-resistant cable.

69. UF: Underground feeder and branch-circuit cable.

70. USE: Underground service-entrance cable.

71. XHH: Cross-linked polyethylene, heat-resistant cable.

72. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Definitions:

1. 8-Position 8-Contact (8P8C) Modular Jack: An unkeyed jack with up to eight contacts commonly used to terminate twisted-pair and multiconductor Ethernet cable. Also called a "TIA-1096 miniature 8-position series jack" (8PSJ), or an "IEC 8877 8-pole jack."

    a. Be careful when suppliers use "RJ45" generically. Obsolete RJ45 jacks used for analog telephone cables have rejection keys. 8P8C jacks used for digital telephone cables and Ethernet cables do not have rejection keys.

2. Basic Impulse Insulation Level (BIL): Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.

3. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).

4. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.

5. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.

6. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire,

cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.

7. Designated Seismic System: A system component that requires design in accordance with Ch. 13 of ASCE/SEI 7 and for which the Component Importance Factor is greater than 1.0.

8. Direct Buried: Installed underground without encasement in concrete or other protective material.

9. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:

    a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.

    b. Concrete Box: A box intended for use in poured concrete.

    c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

    d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.

    e. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.

    f. Device Box: A box with provisions for mounting a wiring device directly to the box.

    g. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.

    h. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.

    i. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.

    j. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.

k. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.

l. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.

m. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.

n. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.

o. Raised-Floor Box: A floor box intended for use in raised floors.

p. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.

q. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.

r. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.

s. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.

t. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.

10. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that are designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety to human life.

11. Essential Electrical Systems: (healthcare facilities) Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system.

12. Fault Limited: Providing or being served by a source of electrical power that is limited to not more than 100 W when tested in accordance with UL 62368-1.

a. The term "fault limited" is intended to encompass most Class 1, 2, and 3 power-limited sources complying with Article 725 of NFPA 70; Class ES1 and ES2 electrical energy sources that are Class PS1 electrical power sources (e.g., USB); and Class ES3 electrical energy sources that are Class PS1 and PS2 electrical power sources (e.g., PoE). See UL 62368-1 for discussion of classes of electrical energy sources and classes of electrical power sources.

13. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.

14. Jacket: A continuous nonmetallic outer covering for conductors or cables.

15. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.

16. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.

17. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.

18. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.

19. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.

20. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.

21. Sheath: A continuous metallic covering for conductors or cables.

22. UL Category Control Number (CCN): An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.

23. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, which is supplied from a battery or other Class 2 or Class 3 power-limited source.

b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.

c. Extra-Low Voltage (ELV): Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).

d. Low Voltage (LV): Having electromotive force between any two conductors, or between a single conductor and ground, which is rated above 30 V but not exceeding 1000 V.

e. Medium Voltage (MV): Having electromotive force between any two conductors, or between a single conductor and ground, which is rated about 1 kV but not exceeding 69 kV.

f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, which is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.

24. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.

1.3 COORDINATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Construction Manager's and Owner's written permission.

3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:

a. Exercising generators.

b. Emergency lighting.

c. Fire-alarm systems.

B. Arrange to provide temporary electrical service or power in accordance with requirements specified in Division 01.

1.4 ACTION SUBMITTALS

A. Coordination Drawings for Ceiling Areas: Provide reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.

2. Structural members to which equipment and suspension systems will be attached.

3. Elevation, size, and route of plumbing piping.

4. Elevation, size, and route of ductwork.

5. Elevation, size, and route of conduit.

6. Elevation, size, and route of cable tray.

7. Elevation and size of wall-mounted and ceiling-mounted equipment.

8. Access panels.

9. Air inlets and outlets.

10. Control modules.

11. Luminaires.

12. Indicate clear dimensions for maintenance access in front of equipment.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Provide emergency operation, normal operation, and preventive maintenance manuals for each system, equipment, and device installed.:

2. Include the following information:

a. Manufacturer's operating specifications.

b. User's guides for software and hardware.

c. Schedule of maintenance material items recommended to be stored at Project site.

d. Detailed instructions covering operation under both normal and abnormal conditions.

e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.

f. List of load-current and overload-relay heaters with related motor nameplate data.

g. List of lamp types and photoelectric relays used on Project, with ANSI and manufacturers' codes.

h. Manufacturer's instructions for setting field-adjustable components.

i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL WORK

A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of Work specified in Division 26.

3.2 FIELD QUALITY CONTROL

A. Administrant for Low-Voltage Electrical Tests and Inspections:

1. Administer and perform tests and inspections with assistance of factory-authorized service representative.

3.3 CLEANING

A. Waste Management:

1. Electrical and electronics waste disposal per local, state, and federal requirements.

END OF SECTION

SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire.
2. Connectors and splices.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers:

1. The Okonite Company
2. General Cable
3. Southwire Company
4. Or approved equal

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Conductor Insulation:

1. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.

2. Type THHN and Type THWN-2: Comply with UL 83.

3. Type XHHW-2: Comply with UL 44.

F. Shield:

1. Type TC-ER: Cable designed for use with ASDs, with oversized crosslinked polyethylene insulation, dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires, and sunlight- and oil-resistant outer PVC jacket.

2.2 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Manufacturers:

1. 3M Electrical Products

2. ABB, Electrification Business

3. AFC Cable System, Atkore International

4. Gardner Bender

5. Hubbell Utility Solution, Hubbell Inc.

6. Ideal Industry, Inc.

7. ILSCO

8. O-Z Gedney, Emerson Electric Co.

9. Producto Electric Corp., PECO

10. Service Wire Co.

11. Shawflex, Shawcor Ltd.

12. TE Connectivity, Ltd.

13. Or approved equal.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper.

2. Type: Two hole with standard barrels.

3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

B. ASD Output Circuits: Type TC-ER cable with braided shield.

3.3 INSTALLATION, GENERAL

A. Conceal cables in finished walls, ceilings, and floors in raceway unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, which will not damage cables or raceway.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inch of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test feeder conductors for compliance with requirements.

2. Perform each of the following visual and electrical tests:

a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.

b. Test bolted connections for high resistance using one of the following:

1) A low-resistance ohmmeter.

2) Calibrated torque wrench.

3) Thermographic survey.

c. Inspect compression-applied connectors for correct cable match and indentation.

d. Inspect for correct identification.

e. Inspect cable jacket and condition.

f. Insulation-resistance test on each feeder conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.

g. Continuity test on each conductor and cable.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:

1. Procedures used.

2. Results that comply with requirements.

3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION

SECTION 260523 – CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Category 6 balanced twisted pair cable.
2. Balanced twisted pair cable hardware.
3. Control cable.
4. Control-circuit conductors.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inch or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.2 CATEGORY 6 BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz

B. Manufacturers:

1. 3M
2. Belden Inc.
3. General Cable
4. Genesis Cable Products, Honeywell
5. Hitachi Cable America Inc.
6. Or approved equal .

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100 ohm, No. 23 AWG solid copper.

E. Shielding/Screening: Shielded twisted pairs (FTP).

F. Cable Rating: Plenum.

G. Jacket: Yellow thermoplastic.

2.3 BALANCED TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

B. Manufacturers:

1. 3M
2. American Technology System Industries
3. Belden Inc.
4. Berk-Tek Leviton
5. Dynacom Corp.
6. General Cable

7. Genesis Cable Products
8. Hubbell Premise Wiring
9. KRONE Inc.
10. Panduit Corp.
11. Or approved equal.

C. General Requirements for Balanced Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables must be terminated with connecting hardware of same category or higher.

D. Source Limitations: Obtain balanced twisted pair cable hardware from same manufacturer as balanced twisted pair cable, from single source.

E. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

F. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

G. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:
   a. Universal T568A and T568B wiring labels.
   b. Labeling areas adjacent to conductors.
   c. Replaceable connectors.
   d. 24 or 48 ports.
2. Construction: 16-gauge steel and mountable on 19 inch equipment racks.
3. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

H. Patch Cords: Factory-made, four-pair cables in 36 inch lengths; terminated with an eight-position modular plug at each end.

1. Patch cords must have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords must have latch guards to protect against snagging.

I. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.

2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.

3. Marked to indicate transmission performance.

J. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.

2. Designed to snap-in to a patch panel or faceplate.

3. Standards:

a. Category 6, unshielded balanced twisted pair cable must comply with IEC 60603-7-4.

b. Category 6, shielded balanced twisted pair cable must comply with IEC 60603-7.5.

4. Marked to indicate transmission performance.

K. Faceplate:

1. Two port, vertical single-gang faceplates designed to mount to single-gang wall boxes.

2. Eight port, vertical double-gang faceplates designed to mount to double-gang wall boxes.

3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."

4. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."

5. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

L. Legend:

1. Machine printed, in the field, using adhesive-tape label.

2. Snap-in, clear-label covers and machine-printed paper inserts.

2.4 CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. Multi-pair, twisted, No. 16 AWG, stranded (19x 29) tinned-copper conductors.
2. PVC insulation.
3. Shielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. Multi-pair, twisted, No. 16 AWG, stranded (19x 29) tinned-copper conductors.
2. PVC insulation.
3. Shielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.5 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers:

1. Encore Wire Corp.
2. General Cable
3. Service Wire Co.
4. Southwire Co.
5. Or approved equal.

B. Class 1 Control Circuits: Stranded copper, Type TC, complying with UL 1277 in raceway.

C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

2.6 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes for cables must be no smaller than 4 inch square by 2-1/8 inch deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.

2. Flexible metal conduit must not be used.

B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.

2. Install cable trays to route cables if conduits cannot be located in these positions.

3. Secure conduits to backboard if entering the room from overhead.

4. Extend conduits 3 inch above finished floor.

5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96 inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.

2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."

3. Terminate all conductors; cable must not contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.

4. Cables may not be spliced and must be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.

5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.

6. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.

7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.

8. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.

9. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.

10. Ground wire must be copper, and grounding methods must comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.

2. Do not untwist balanced twisted pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.

2. Use insulated spade lugs for wire and cable connection to screw terminals.

3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment must be as follows:

a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inch.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment must be as follows:

    a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inch.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures must be as follows:

    a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.

    b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inch.

    c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inch.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inch.

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No. 14 AWG.

2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.

3. Class 3 low-energy, remote-control, alarm, and signal circuits; No. 12 AWG.

3.6 GROUNDING

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For control-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers must use label stocks, laminating adhesives, and inks complying with UL 969.

C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire must have a unique tag.

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

a. Test instruments must meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes grounding and bonding systems and equipment.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide product by one of the following:

1. Burndy; Part of Hubbell Electrical System.
2. Dossert; AFL Telecommunication LLC.
3. ERICO International Corporation.
4. Fushi Copperweld Inc.
5. Galvan Industries, Inc.; Electrical Products Division, LLC.
6. Harger Lightning and Grounding.
7. ILSCO.
8. O-Z/Gedney; A brand of the EGS Electrical Group.
9. Robbins Lightning, Inc.

10. Siemens Power Transmission & Distribution, Inc.

2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

C. Solid Conductors: ASTM B3.

D. Stranded Conductors: ASTM B8.

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.

2. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

3. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Mechanical-Type Bus-Bar Connectors: Cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

C. Compression-Type Bus-Bar Connectors: Copper or copper alloy, with two wire terminals.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

G. Conduit Hubs: Mechanical type, terminal with threaded hub.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

C. Isolated Grounding Conductors: Green-colored insulation with more than one continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Conductor Terminations and Connections:

1. Equipment Grounding Conductor Terminations: Bolted connectors.

2. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.

2. Lighting circuits.

3. Receptacle circuits.

4. Single-phase motor and appliance branch circuits.

5. Three-phase motor and appliance branch circuits.

6. Flexible raceway runs.

7. Armored and metal-clad cable runs.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

C. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

D. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.

2. Make connections with clean, bare metal at points of contact.

3. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.

4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

END OF SECTION

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Support systems.
2. Mounting, anchoring, and attachment components.
3. Installation of fabricated metal supports.
4. Installation of concrete bases.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" specifies concrete materials, reinforcement, and placement requirements referenced by this Section.
2. Section 055000 "Metal Fabrications" specifies site-fabricated metal supports referenced by this Section.
3. Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" specify cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal referenced by this Section.
4. Section 260010 “Supplemental Requirements for Electrical” specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
5. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration controls, seismic restraints, and wind restraints referenced by this Section.

1.2 DELEGATED DESIGN SERVICES

A. Delegated Design Professionals: Engage qualified structural professional engineer to design hangers and supports for electrical systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

C. Delegated Design Submittals: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 REGULATORY AGENCY APPROVALS

A. Delegated design submittals and shop drawings requiring approval by authorities having jurisdiction must be signed by qualified structural professional engineer responsible for their preparation.

1.6 QUALIFICATIONS

A. Structural Professional Engineer: Professional engineer possessing active qualifications with expertise in structural engineering, including design of seismic and wind controls, equipment hangers and supports, and concrete foundations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Prepare design calculations in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical."

2.2 SUPPORT SYSTEMS

A. Steel Slotted Support Systems:

1. Standard Features: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.

a. Referenced Standard: MFMA-4 factory-fabricated components for field assembly.

b. Material for Channel, Fittings, and Accessories: Galvanized steel.

c. Channel Width: Selected for applicable load criteria.

d. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

e. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

f. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Conduit and Cable Support Devices:

1. Standard Features: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Structural Steel for Fabricated Supports and Restraints:

1. Standard Features: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

2.3 MOUNTING, ANCHORING, AND ATTACHMENT COMPONENTS

A. Mechanical-Expansion Anchors:

1. Standard Features: Insert-wedge-type, zinc-coatedor stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

B. Concrete Inserts:

1. Standard Features: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

C. Clamps for Attachment to Steel Structural Elements:

1. Standard Features: MSS SP-58 units are suitable for attached structural element.

D. Through Bolts:

1. Standard Features: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325 (Grade A325M).

E. Toggle Bolts:

1. Standard Features: Stainless steel springhead type.

F. Hanger Rods:

1. Standard Features: Threaded steel.

PART 3 - EXECUTION

3.1 SELECTION OF HANGERS AND SUPPORTS

A. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as scheduled in NECA NEIS 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size must be 1/4 inch in diameter.

B. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.

2. Hot Work: NFPA 51B.

3. Installation of Steel Conduit: NECA NEIS 101

C. Special Installation Techniques:

1. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb.

2. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

a. To Wood: Fasten with lag screws or through bolts.

b. To New Concrete: Bolt to concrete inserts.

c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

d. To Existing Concrete: Expansion anchor fasteners.

e. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.

f. To Light Steel: Sheet metal screws.

g. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

3. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

D. Interfaces with Other Work:

1. Provide vibration and seismic controls with hangers and supports.

2. Touchup Finishes:

a. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for

shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1) Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

b. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3. Installation of Fabricated Metal Supports:

a. Provide site-fabricated metal supports.

b. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

c. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

4. Installation of Concrete Bases:

a. Provide concrete bases of dimensions indicated, but not less than 4 inch larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

b. Use 3000 psi, 28-day compressive-strength concrete.

c. Anchor equipment to concrete base as follows:

1) Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2) Install anchor bolts to elevations required for proper attachment to supported equipment.

3) Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION 260529

SECTION 260533 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type ERMC-S raceways, elbows, couplings, and nipples.
2. Type LFMC raceways.
3. Fittings for conduit, tubing, and cable.
4. Threaded metal joint compound.
5. Solvent cements.
6. Surface metal raceways and fittings.
7. Strut-type channel raceways and fittings.
8. Wireways and auxiliary gutters.
9. Metallic outlet boxes, device boxes, rings, and covers.
10. Nonmetallic outlet boxes, device boxes, rings, and covers.
11. Termination boxes.
12. Cabinets, cutout boxes, junction boxes, pull boxes, and miscellaneous enclosures.
13. Cover plates for device boxes.
14. Hoods for outlet boxes.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Wireways and auxiliary gutters.
2. Surface metal raceways.
3. Cabinets, cutout boxes, and miscellaneous enclosures.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details. Show that floor boxes are located to avoid interferences and are structurally allowable. Indicate floor thickness at location where boxes are embedded in concrete floors and underfloor clearances where boxes are installed in raised floors.

C. Samples: For wireways, nonmetallic wireways, surface raceways, and floor boxes for colors and textures specified, 12 inch long.

PART 2 - PRODUCTS

2.1 TYPE ERMC-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 6 and UL Category Control Number DYIX.

B. Manufacturers:

1. ABB

2. ANAMET Electrical, Inc.

3. Champion Fiberglass, Inc.

4. Excellerate

5. Robroy Industries

6. Or approved equal

C. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:

1. Exterior Coating: Zinc.

2. Options:

a. Interior Coating: Zinc.

b. Minimum Trade Size: 3/4 inch.

2.2 TYPE LFMC RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 360 and UL Category Control Number DXHR.

B. Steel Liquidtight Flexible Metal Conduit (LFMC-S):

1. Material: Steel.

2. Options:

a. Minimum Trade Size: 3/4 inch.

2.3 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

B. Fittings for Type ERMC, Type PVC, Raceways:

1. General Characteristics: UL 514B and UL Category Control Number DWTT.

2. Options:

a. Material: Die cast.

b. Coupling Method: Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable.

c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.

d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

C. Fittings for Type LFMC and Type LFNC Raceways:

1. General Characteristics: UL 514B and UL Category Control Number DXAS.

2.4 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 2419 and UL Category Control Number FOIZ.

2.5 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 514A and UL Category Control Number QCIT.

B. Metallic Outlet Boxes:

1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.

2. Options:

a. Material: Cast metal.

b. Cast-Metal Depth: Minimum 2.4 inch.

c. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing up to 50 lb and marked with maximum allowable weight].

C. Metallic Conduit Bodies:

1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

D. Metallic Device Boxes:

1. Description: Box with provisions for mounting wiring device directly to box.

2. Options:

a. Material: Sheet steel.

b. Sheet Metal Depth: minimum 3.5 inch.

E. Metallic Extension Rings:

1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.

2.6 CABINETS, CUTOUT BOXES, JUNCTION BOXES, PULL BOXES, AND MISCELLANEOUS ENCLOSURES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics:

a. Non-Environmental Characteristics: UL 50.

b. Environmental Characteristics: UL 50E.

B. Indoor Sheet Metal Cutout Boxes:

1. Description: Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.

2. Additional Characteristics: UL Category Control Number CYIV.

C. Indoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

2. Additional Characteristics: UL Category Control Number BGUZ.

D. Indoor Cast-Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

2. Additional Characteristics: UL Category Control Number BGUZ.

E. Outdoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

2. Additional Characteristics: UL Category Control Number BGUZ.

F. Outdoor Cast-Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

2. Additional Characteristics: UL Category Control Number BGUZ.

2.7 COVER PLATES FOR DEVICES BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics:

a. Reference Standards: UL 514D and UL Category Control Numbers QCIT and QCMZ.

b. Wallplate-Securing Screws: Metal with head color to match wallplate finish.

B. Metallic Cover Plates for Device Boxes:

1. Options:

a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.

b. Wallplate Material:

1) Galvanized steel: Unfinished areas.

2) Stainless steel: Finished areas.

PART 3 - EXECUTION

3.1 SELECTION OF RACEWAYS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of raceways. Consult Architect for resolution of conflicting requirements.

B. Outdoors:

1. Exposed and Subject to Physical Damage: ERMC.

2. Exposed and Not Subject to Physical Damage: ERMC.

3. Concealed Aboveground: ERMC.

C. Indoors:

1. Exposed and Subject to Physical Damage: ERMC. Subject to physical damage includes the following locations:

a. Locations less than 8 ft above finished floor.

b. Stub-ups to above suspended ceilings.

2. Exposed and Not Subject to Physical Damage: ERMC.

3. Concealed in Ceilings and Interior Walls and Partitions: ERMC.

4. Damp or Wet Locations: ERMC.

5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

D. Raceway Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERMC and IMC: Provide threaded type fittings unless otherwise indicated.

3.2 SELECTION OF BOXES AND ENCLOSURES

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:

1. Outdoors:

a. Type 3R unless otherwise indicated.

b. Locations Exposed to Hose down: Type 4.

c. Locations Subject to Potential Flooding: Type 6P.

d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.

e. Locations in-Ground or Exposed to Corrosive Agents: Type 4X.

f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.

2. Indoors:

a. Type 1 unless otherwise indicated.

b. Damp or Dusty Locations: Type 12.

c. Locations Exposed to Hose down: Type 4.

C. Exposed Boxes Installed Less Than 8 ft Above Floor:

1. Provide cast-metal boxes.

2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.3 INSTALLATION OF RACEWAYS

A. Installation Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for installation of raceways. Consult Architect for resolution of conflicting requirements.

2. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

3. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

4. Comply with NECA NEIS 101 for installation of steel raceways.

5. Install raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.

6. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4 inch and insulated throat metal bushings on 1-1/2 inch and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

7. Raceway Terminations at Locations Subject to Moisture or Vibration:

a. Provide insulating bushings to protect conductors, including conductors smaller than No. 4 AWG. Install insulated throat metal grounding bushings on service conduits.

B. General Requirements for Installation of Raceways:

1. Complete raceway installation before starting conductor installation.

2. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft above finished floor.

3. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within 12 inch of changes in direction.

4. Make bends in raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.

5. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

6. Support conduit within 12 inch of enclosures to which attached.

7. Install raceway sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings in accordance with NFPA 70.

8. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of raceways at the following points:

   a. Where an underground service raceway enters a building or structure.

   b. Conduit extending from interior to exterior of building.

   c. Where otherwise required by NFPA 70.

9. Do not install conduits within 2 inch of the bottom side of a metal deck roof.

10. Keep raceways at least 6 inch away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

11. Cut conduit perpendicular to the length. For conduits 2 inch and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.

12. Install pull wires in empty raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

C. Requirements for Installation of Specific Raceway Types:

1. Types ERMC and IMC:

   a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

2. Types FMC, LFMC, and LFNC:

   a. Comply with NEMA RV 3. Provide a maximum of 36 inch of flexible conduit for recessed and semi recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

D. Raceway Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.

1. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

3.4 INSTALLATION OF SURFACE RACEWAYS

A. Install surface raceway with a minimum 2 inch radius control at bend points.

B. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inch and with no less than two supports per straight raceway section. Support surface raceway in accordance with manufacturer's written instructions. Tape and glue are unacceptable support methods.

3.5 INSTALLATION OF BOXES AND ENCLOSURES

A. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.

B. Mount boxes at heights indicated on Drawings.

C. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.

D. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

E. Locate boxes so that cover or plate will not span different building finishes.

F. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.

G. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.

H. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.

I. Set metal floor boxes level and flush with finished floor surface.

J. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

K. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.

L. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.

M. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:

1. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.

2. Provide gaskets for wall plates and covers.

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING

A. Boxes: Remove construction dust and debris from device boxes, outlet boxes, and floor-mounted enclosures before installing wall plates, covers, and hoods.

END OF SECTION

SECTION 260533.13 - CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EMT duct raceways and elbows.
2. Type ENT duct raceways and fittings.
3. Type ERMC duct raceways, elbows, couplings, and nipples.
4. Type IMC duct raceways.
5. Type LFMC duct raceways.
6. Type LFNC duct raceways.
7. Type PVC duct raceways and fittings.
8. Fittings for conduit, tubing, and cable.
9. Joint compounds.
10. Solvent cements.

B. Related Requirements:

1. Section 133410 "Nonstructural Component and Cladding Requirements" specifies seismic hazard, wind hazard, other structural load design conditions applicable to the Work specified in this Section.
2. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
3. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conduit with conductors (Type NUCC).
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies conduit hangers and supports referenced by this Section.
5. Section 260543 "Underground Ducts and Raceways for Electrical Systems" specifies exterior duct banks, manholes, and underground utility construction.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.
3. EMT-S: Steel electrical metallic tubing.
4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. ERMC: Electrical rigid metal conduit.
7. ERMC-A: Aluminum electrical rigid metal conduit.
8. ERMC-S: Steel electrical rigid metal conduit.
9. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
10. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
11. ERMC-SS: Stainless steel electrical rigid metal conduit.
12. FMC: Flexible metal conduit.
13. FMC-A: Aluminum flexible metal conduit.
14. FMC-S: Steel flexible metal conduit.
15. FMT: Steel flexible metallic tubing.
16. FNMC: Flexible nonmetallic conduit. See "LFNC."
17. IMC: Steel electrical intermediate metal conduit.
18. LFMC: Liquidtight flexible metal conduit.
19. LFMC-A: Aluminum liquidtight flexible metal conduit.
20. LFMC-S: Steel liquidtight flexible metal conduit.
21. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
22. LFNC: Liquidtight flexible nonmetallic conduit.
23. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
24. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.

25. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.

26. PVC: Rigid PVC conduit.

27. PVC-40: Schedule 40 rigid PVC conduit.

28. PVC-80: Schedule 80 rigid PVC Conduit.

29. PVC-A: Type A rigid PVC concrete-encased conduit.

30. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.

31. RGS: See ERMC-S-G.

32. RMC: See ERMC.

33. RTRC: Reinforced thermosetting resin conduit.

34. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.

35. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.

36. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.

37. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.

38. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

B. Definitions:

1. Conduit: A structure containing one or more duct raceways.

2. Direct Buried: Installed underground without encasement in concrete or other protective material.

3. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.

4. Duct Raceway: A single enclosed raceway for conductors or cable.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

D. ERMC-S-PVC Installers: Installer possessing active qualifications and able to present unexpired certified Installer credentials issued by ERMC-S-PVC manufacturer prior to starting installation.

E. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have BICSI Technician (TECH) certification and documented training, and be experienced with testing communications equipment in accordance with BICSI testing standards.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 MANUFACTURERS AND PRODUCTS

A. Wheatland Tube.

B. Republic Conduit.

C. Cantex.

D. SEALTITE.

E. Crouse-Hinds by EATON.

F. ABB.

G. Thomas&Betts.

H. Atkore Allied Tube & Conduit.

I. Or equal.

2.3 TYPE EMT DUCT RACEWAYS AND ELBOWS

A. UL FJMX - Aluminum Electrical Metal Tubing (EMT-A) and Elbows:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FJMX; including UL 797A.

2. Standard Features:

a. Material: Aluminum.

b. Minimum Trade Size: trade size 3/4.

B. UL FJMX - Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FJMX; including UL 797.

2. Standard Features:

a. Material: Steel.

b. Exterior Coating: Zinc or Alternate corrosion-resistant coating.

c. Interior Coating: Zinc with organic top coating.

d. Minimum Trade Size: trade size 3/4.

2.4 TYPE ENT DUCT RACEWAYS AND FITTINGS

A. UL FKHU - Electrical Nonmetallic Tubing (ENT) and Fittings:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FKHU; including UL 1653.

2. Other Available Features Required by the Project:

a. Minimum Trade Size: trade size 3/4.

b. Fittings:

1) Mechanically Attached Fittings: UL 1653.

2) Solvent-Attached Fittings: UL 651.

2.5 TYPE ERMC DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. UL DYIX - Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DYIX; including UL 6.

2. Standard Features:

a. Exterior Coating: Zinc.

b. Interior Coating: Zinc with organic top coating.

c. Minimum Trade Size: trade size 3/4.

B. UL DYIX - PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN DYIX; including UL 6.

2. Standard Features:

a. Exterior Coating: PVC complying with NEMA RN 1.

b. Interior Coating: Zinc with organic top coating.

c. Minimum Trade Size: trade size 3/4.

3. Other Available Features Required by the Project:

a. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.

b. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

2.6 TYPE IMC DUCT RACEWAYS

A. UL DYBY - Steel Intermediate Metal Conduit (IMC):

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DYBY; including UL 1242.

2. Standard Features:

    a. Exterior Coating: Zinc.

    b. Interior Coating: Zinc with organic top coating.

    c. Minimum Trade Size: trade size 3/4.

2.7 TYPE LFMC DUCT RACEWAYS

A. UL DXHR - Steel Liquidtight Flexible Metal Conduit (LFMC-S):

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DXHR; including UL 360.

2. Standard Features:

    a. Material: Steel.

    b. Minimum Trade Size: trade size 3/4.

2.8 TYPE PVC DUCT RACEWAYS AND FITTINGS

A. UL DZYR - Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DZYR; including UL 651.

2. Standard Features:

    a. Dimensional Specifications: Schedule 40.

    b. Minimum Trade Size: trade size 3/4.

    c. Markings: For use with maximum 90 deg C wire.

B. UL DZYR - Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DZYR; including UL 651.

2. Standard Features:

    a. Dimensional Specifications: Type EB.

    b. Minimum Trade Size: trade size 2.

2.9 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. UL DWTT - Fittings for Type ERMC, Type IMC, Type PVC, Type HDPE, Type EPEC, and Type RTRC Duct Raceways:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DWTT; including UL 514B.

2. Standard Features:

    a. Material: Steel.

    b. Coupling Method: Compression coupling.

    c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

B. UL FKAV - Fittings for Type EMT Duct Raceways:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN FKAV; including UL 514B.

2. Standard Features:

    a. Material: Steel.

    b. Coupling Method: Compression coupling.

    c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

2.10 JOINT COMPOUNDS

A. UL FOIZ - Electrically Conductive Corrosion-Resistant Compound for Threaded Conduit:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN FOIZ; including UL Subject 2419.

2.11 SOLVENT CEMENTS

A. UL VBEW - Solvent Cements for Nonmetallic Duct Raceways and Fittings:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Solvent Cements: UL CCN VBEW; including UL 340.

    b. Solvent Cement Compatibility with PVC Conduit Fittings: UL CCN DWTT; including UL 514B. Follow solvent manufacturer's published instructions.

    c. Solvent Cement Compatibility with Rigid PVC Conduit: UL CCN DZYR; including UL 651. Follow solvent manufacturer's published instructions.

    d. Solvent Cement Compatibility with Rigid EPEC and HDPE Underground Conduit: UL CCN EAZX; including UL 651A. Follow solvent manufacturer's published instructions.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in the Contract Documents or manufacturer's published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.

B. Outdoors:

1. Exposed and Subject to Severe Physical Damage: ERMC.

2. Exposed and Subject to Physical Damage: ERMC.

3. Exposed and Not Subject to Physical Damage: ERMC.

4. Concealed Aboveground: ERMC.

5. Concrete Encased Not in Trench: PVC-40.

6. Concrete Encased in Trench: PVC-40 or PVC-EB.

7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

C. Indoors:

1. Hazardous Classified Locations: ERMC.

2. Exposed and Subject to Severe Physical Damage: ERMC.

3. Exposed and Subject to Physical Damage: ERMC.

4. Exposed and Not Subject to Physical Damage: ERMC.

5. Concealed in Ceilings and Interior Walls and Partitions: EMT.

6. Damp or Wet Locations: Corrosion-resistant EMT.

7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

D. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERMC and IMC: Provide threaded-type fittings unless otherwise indicated.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.

2. Electrical Safety: NFPA 70E.

3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.

4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.

5. Communications Work: BICSI N1.

6. Life Safety and Means of Egress Work: NFPA 101.

7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.

8. Work in Confined Spaces: NFPA 350.

9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.

10. Type EMT-A: Article 358 of NFPA 70 and NECA NEIS 102.

11. Type EMT-SS: Article 358 of NFPA 70 and NECA NEIS 101.

12. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.

13. Type ENT: Article 362 of NFPA 70 and NECA NEIS 102.

14. Type HDPE and Type EPEC: Article 353 of NFPA 70 and NECA NEIS 111.

15. Type ERMC-A: Article 344 of NFPA 70 and NECA NEIS 102.

16. Type ERMC-SS: Article 344 of NFPA 70 and NECA NEIS 101.

17. Type ERMC-S: Article 344 of NFPA 70 and NECA NEIS 101.

18. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.

19. Type FMC-A: Article 348 of NFPA 70 and NECA NEIS 102.

20. Type FMT: Article 360 of NFPA 70 and NECA NEIS 101.

21. Type IMC: Article 342 of NFPA 70 and NECA NEIS 101.

22. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.

23. Type LFNC: Article 342 of NFPA 70 and NECA NEIS 111.

24. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.

25. Type RTRC: Article 355 of NFPA 70 and NECA NEIS 111.

26. Expansion Fittings: NEMA FB 2.40.

27. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. General Requirements for Installation of Duct Raceways:

a. Complete duct raceway installation before starting conductor installation.

b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft above finished floor.

c. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within 12 inch of changes in direction.

d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.

e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

f. Support conduit within 12 inch of enclosures to which attached.

g. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.

h. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following points:

1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2) Where an underground service duct raceway enters a building or structure.

3) Conduit extending from interior to exterior of building.

4) Conduit extending into pressurized duct raceway and equipment.

5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.

6) Where otherwise required by NFPA 70.

i. Do not install duct raceways or electrical items on "explosion-relief" walls or rotating equipment.

j. Do not install conduits within 2 inch of the bottom side of a metal deck roof.

k. Keep duct raceways at least 6 inch away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.

l. Cut conduit perpendicular to the length. For conduits size 2 inch and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.

m. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.

n. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.

1) Termination fittings with shoulders do not require two locknuts.

o. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4 inch and insulated throat metal bushings on 1-1/2 inch and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

2. Types EMT-A, ERMC-A, and FMC-A: Do not install aluminum duct raceways or fittings in contact with concrete or earth.

3. Types ERMC and IMC:

   a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.

4. Type ERMC-S-PVC:

   a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.

   b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERMC-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERMC-S-PVC duct raceway.

   c. Coat field-cut threads on PVC-coated duct raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.

5. Types FMC, LFMC, and LFNC:

   a. Provide a maximum of 36 inch of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

6. Stub-ups to Above Recessed Ceilings:

   a. Provide EMT, IMC, or ERMC for duct raceways.

   b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

7. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:

   a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG. Install insulated throat metal grounding bushings on service conduits.

8. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.

   a. ERMC-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

   b. EMT: Provide setscrew fittings. Comply with NEMA FB 2.10.

c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

9. Expansion-Joint Fittings:

a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F and that have straight-run length that exceeds 25 ft. Install in runs of aboveground ERMC and EMT conduit that are located where environmental temperature change may exceed 100 deg F and that have straight-run length that exceeds 100 ft .

b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:

1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.

2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.

3) Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.

4) Attics: 135 deg F temperature change.

c. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.

d. Install expansion fittings at locations where conduits cross building or structure expansion joints.

e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

10. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.

11. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.

a. Provide warning signs.

D. Interfaces with Other Work:

1. Firestop penetrations of fire-rated floor and wall assemblies.

2. Provide conduit hangers and supports.

3. Coordinate installation of new products with existing conditions.

3.3 FIELD QUALITY CONTROL OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Administrant for Electrical Power Tests and Inspections:

1. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.

2. Administer and perform tests and inspections with assistance of factory-authorized service representative.

B. Administrant for Communications Tests and Inspections:

1. Owner will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.

2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.

3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.

4. Administer and perform tests and inspections with assistance of factory-authorized service representative.

C. Acceptance Testing Preparation:

1. Contractor to provide Acceptance Testing Form for approval.

D. Field tests and inspections must be witnessed by Architect, Owner, and authorities having jurisdiction.

E. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum 12 inch long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.

3. Conduit Placement:

a. Verify that center-line location and offsets are in accordance with the Drawings.

b. Verify that hangers and supports for conduits are attached to structure in accordance with the Drawings and/or as directed by qualified structural engineer.

c. Verify that nuts on bolts or hanger rods are secure.

d. Verify that space between raceways and cored holes are filled with non-shrinking grout or other approved material indicated on the Drawings and the Specifications.

e. Verify that expansion devices are installed at locations indicated on the Drawings and the Specifications.

f. Verify that ends are cut square to provide flush-butting surfaces when spliced and inside edges are free of burrs that could impede installation of cables.

g. Verify minimum separation of utilities, or that approved mechanical protection has been provided to surrounding conduit(s) where minimum separation cannot be achieved.

4. Document all changes on Record Drawings.

F. Nonconforming Work:

1. Conduit will be considered defective if it does not pass tests and inspections.

2. Remove and replace defective units and retest.

G. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

A. Verify that bentonite or other drilling fluids are contained and removed, and site is restored to its original or improved condition.

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533.13

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EPEC raceways and fittings.
2. Type ERMC-S-PVC raceways, elbows, couplings, and nipples.
3. Type PVC raceways and fittings.
4. Electrically conductive corrosion-resistant compounds for threaded conduit.
5. Solvent cements.
6. Duct accessories.
7. Handholes and boxes for exterior underground wiring.
8. Duct sealing.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260553 "Identification for Electrical Systems" specifies underground-line warning tape and concrete cable routing markers (warning planks).

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site or at the Owner’s desired location.

B. Preinstallation Coordination Meeting(s): For underground ducts and raceways. Conduct meeting(s) as videoconference or at Project site before underground ducts and/or raceways construction.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For concrete and steel used in precast concrete handholes, also include product certificates as required by ASTM C858.

B. Shop Drawings:

1. Electric Utility Duct Banks and Structures:

    a. Include plans, elevations, sections, and details, including attachments to other Work.

    b. Indicate locations of private property boundaries and utility easements.

    c. Include information required for approval by electric utility and for obtaining public space utility work permits.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

    a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.

    b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.

    c. Include cover design.

    d. Include grounding details.

    e. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and other accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates:

1. For concrete and steel used in precast concrete handholes, as required by ASTM C858.

B. Manufacturers' Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. Source Quality-Control Submittals:

1. Source quality-control reports.

PART 2 - PRODUCTS

2.1 TYPE EPEC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 651A and UL CCN EAZX.

B. Schedule 40 Electrical HDPE Underground Conduit (EPEC-40):

1. Dimensional Specifications: Schedule 40.

2. Options:

a. Minimum Trade Size: 1 inch.

2.2 TYPE ERMC-S-PVC RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 6 and UL CCN DYIX.

B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:

1. Exterior Coating: Zinc, PVC coated.

2. Options:

a. Interior Coating: Zinc with organic top coating.

b. Minimum Trade Size: 1 inch.

2.3 TYPE PVC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL 651 and UL CCN DZYR.

B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Dimensional Specifications: Schedule 40.

2. Options:

a. Minimum Trade Size: 1 inch.

2.4 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: UL Subject 2419 and UL CCN FOIZ.

2.5 SOLVENT CEMENTS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL CCN DWTT.

2.6 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics:

a. ASTM C858 for design and manufacturing processes.

b. SCTE 77.

B. Source Quality Control:

1. Precast Concrete Utility Structures: Test and inspect in accordance with ASTM C1037.

2. Polymer Concrete and Nonconcrete Handhole and Pull-Box Prototypes: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests must be for specified tier ratings of products supplied. Testing machine pressure gages must have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

a. Strength tests of complete boxes and covers must be by independent testing agency or manufacturer. Qualified registered professional engineer must certify tests by manufacturer.

C. Precast Concrete Handholes and Boxes :

1. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover must form top of enclosure and must have load rating consistent with that of handhole or box.

2. Configuration: Units must be designed for flush burial and have open bottom unless otherwise indicated.

3. Frame and Cover:

   a. Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

   b. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.

   c. Cover Legend: Molded lettering, **"ELECTRIC"**.

4. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

   a. Extension must provide increased depth as required.

   b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

5. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at installation location with ground-water level at grade.

6. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus additional 12 inch vertically and horizontally to accommodate alignment variations.

7. Handholes 12 inch wide by 24 inch long and larger must have inserts for cable racks and pulling-in irons installed before concrete is poured.

D. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover:

1. Description: Molded of sand, concrete, and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or combination.

2. Configuration: Units must be designed for flush burial and have open bottom unless otherwise indicated.

3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and installed location.

   a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.

   b. Cover Legend: Molded lettering, **"ELECTRIC"**

4. Conduit Entrance Provisions: Conduit-terminating fittings must mate with entering ducts for secure, fixed installation in enclosure wall.

5. Handholes 12 inch wide by 24 inch long and larger must have factory-installed inserts for cable racks and pulling-in irons.

2.8 DUCT SEALING

A. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Compound must be capable

of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals. Duct sealing compound must be removable without damaging ducts or cables.

B. Inflatable Duct-Sealing System: Wraparound inflatable bladder that seals ducts that are empty or containing conductors against air and water infiltration. System is suitable for use in steel, plastic, or concrete ducts and penetrations.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in field. Notify Engineer if there is conflict between areas of excavation and existing structures.

B. Coordinate elevations of duct and duct-bank entrances into handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Engineer.

3.2 SELECTION OF UNDERGROUND DUCTS

A. Duct for Electrical Feeders: PVC-40, concrete encased unless otherwise indicated.

B. Duct for Electrical Branch Circuits: PVC-40, direct buried unless otherwise indicated.

C. Underground Ducts Crossing Walks: PVC-40.

D. Underground Ducts Crossing Roadways: PVC-40, encased in reinforced concrete.

E. Stub-ups: Concrete encased, ERMC-S-PVC.

3.3 SELECTION OF UNDERGROUND ENCLOSURES

A. Handholes and Boxes:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-20 structural load rating.

2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.

3. Units in Sidewalk and Similar Applications with Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.

4. Cover design load must not exceed load rating of handhole or box.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Restore area after construction vehicle traffic in immediate area is complete.

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

E. Cut and patch existing pavement in path of underground duct, duct bank, and underground structures in accordance with Section 321216 “Asphalt Paving” and Section 321313 “Concrete Paving.”

3.5 INSTALLATION OF DUCTS AND DUCT BANKS

A. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.

2. Consult Engineer for resolution of conflicting requirements.

3. Direct-Buried Duct

3.6 INSTALLATION OF CONCRETE HANDHOLES, AND BOXES

A. Reference Standards:

1. Precast Concrete Handholes: Comply with ASTM C891 unless otherwise indicated.

2. Consult Engineer for resolution of conflicting requirements.

B. Special Techniques:

1. Precast Concrete Handholes:

a. Install units level and plumb and with orientation and depth coordinated with connecting duct to minimize bends and deflections required for proper entrances.

b. Unless otherwise indicated, support units on level bed of crushed stone or gravel graded from 1 inch sieve to No. 4 (sieve and compacted to same density as adjacent undisturbed earth).

c. Field-cut openings for conduits in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be

cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

2. Elevations:

a. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

b. .

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Reference Standards:

1. Consult Engineer for resolution of conflicting requirements.

B. Special Techniques:

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.

2. Unless otherwise indicated, support units on level bed of crushed stone or gravel, graded from 1/2 inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

3. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

4. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

5. Field cut openings for duct in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

6. Ground handholes and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.

2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum 12 inch long

mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.

3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Nonconforming Work:

1. Underground ducts, raceways, and structures will be considered defective if they do not pass tests and inspections.

2. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Assemble and submit test and inspection reports.

END OF SECTION 260543

SECTION 260544 – SLEEVES & SLEEVE SEALS FOR ELECTRICAL RACEWAYS & CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve seal systems.
4. Grout.
5. Pourable sealants.
6. Foam sealants.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Wall Sleeves, Steel:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, LLC.
   b. CCI Piping Systems.
   c. Flexicraft Industries.
   d. GPT; an EnPro Industries Co.
   e. Or approved equal
2. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

B. Pipe Sleeves, PVC:

1. Manufacturers: Subject to compliance with requirement, provide products by one the following:

a. CCI Piping Systems.

b. GPT; an EnPro Industries Co.

c. Metraflex Co.

d. Or approved equal

2. Description: ASTM D1785, Schedule 40.

C. Sheet Metal Sleeves, Galvanized Steel, Round:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Benefast.

b. Or approved equal.

2. Description: Galvanized-steel sheet; thickness not less than 0.0239 inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

A. Sheet Metal Sleeves, Galvanized Steel, Rectangular:

1. Manufacturers:

a. Abesco Fire, LLC.

b. Wiremold; Legrand North America, LLC.

c. Or approved equal.

2. Description:

a. Material: Galvanized sheet steel.

b. Minimum Metal Thickness:

1) For sleeve cross-section rectangle perimeter less than 50 inch and with no side larger than 16 inch, thickness must be 0.052 inch.

2) For sleeve cross-section rectangle perimeter not less than 50 inch or with one or more sides larger than 16 inch, thickness must be 0.138 inch.

2.3 GROUT

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. W.R. Meadows, Inc.

2. Or approved equal.

B. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

2. Design Mix: 5000 psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.4 POURABLE SEALANTS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Specified Technologies, Inc.; SpecSeal SIL 300 S/L (self-leveling) Silicone Firestop Sealant or comparable product by one of the following:

1. Carlisle SynTec Inc.

2. GAF.

3. Johns Manville; a Berkshire Hathaway Co.

4. Or approved equal.

B. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.5 FOAM SEALANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Dow Chemical Co.

2. Innovative Chemical Products.

3. Or approved equal.

B. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.

b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable, unless sleeve seal system is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inch above finished floor level. Install sleeves during erection of floors.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for wall assemblies.

C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

E. Underground, Exterior-Wall and Floor Penetrations:

1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve seal system. Install sleeve during construction of floor or wall.

2. Install steel pipe sleeves. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE SEAL SYSTEMS

A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION

SECTION 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vibration controls.

2. Seismic controls.

B. Related Requirements:

1. Section 133410 "Nonstructural Component and Cladding Requirements" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.

2. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

3. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.

1.2 DELEGATED DESIGN SERVICES

A. Delegated Design Professionals: Engage qualified structural professional engineer to design seismic and wind controls.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Prepare and submit catalog cuts, and performance data illustrating size, physical appearance, and other characteristics of product.

a. Include rated load capacity for each seismic-restraint device.

b. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic- and wind-restraint component used.

c. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an agency acceptable to authorities having jurisdiction.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

3. Show coordination of seismic and wind bracing for components with other systems and equipment in the vicinity, including other supports and seismic restraints.

C. Delegated Design Submittals:

1. For each seismic-restraint device, including restraint - rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:

a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.

b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic criteria. Include certification that device is approved by qualified testing laboratory for seismic reinforcement use.

c. Seismic Design Calculations: Submit input data and loading calculations.

2. Seismic-Restraint Detail Drawings:

a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

3. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

D. Field quality-control reports.

1.4 REGULATORY AGENCY APPROVALS

A. Delegated design submittals and shop drawings requiring approval by authorities having jurisdiction must be signed by qualified structural professional engineer responsible for their preparation.

1.5 QUALIFICATIONS

A. Structural Professional Engineer: Professional engineer possessing active qualifications with expertise in structural engineering, including design of seismic and wind controls, equipment hangers and supports, and concrete foundations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Prepare design calculations in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical" and Section 133410 "Nonstructural Component and Cladding Requirements."

B. Seismic Restraint Device Ratings: Devices must be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices must be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an agency acceptable to authorities having jurisdiction.

C. Consequential Damage: Provide additional seismic restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.

D. Fire/Smoke Resistance: Seismic- and wind-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by qualified testing laboratory in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:

1. Load ratings, features, and applications of reinforcement components must be based on testing standards of qualified testing laboratory.

2.2 VIBRATION CONTROLS

A. Elastomeric Isolation Pads:

1. Standard Features:

a. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.

b. Size: Factory or field cut to match requirements of supported equipment.

c. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.

d. Surface Pattern: Smooth, ribbed, or waffle pattern.

2.3 SEISMIC CONTROLS

A. Restraints - Rigid Type:

1. Standard Features: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and

to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

B. Restraints - Cable Type:

1. Standard Features:

a. Seismic- and Wind-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.

b. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. Cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

C. Restraint Accessories:

1. Standard Features:

a. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.

b. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

c. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

d. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

e. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

D. Mechanical Anchor Bolts:

1. Standard Features:

a. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

b. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.

c. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

E. Adhesive Anchor Bolts:

1. Standard Features

a. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

b. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.

c. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

F. Concrete Inserts:

1. Standard Features:

a. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC446 testing.

b. Comply with MSS SP-58.

PART 3 - EXECUTION

3.1 SELECTION OF VIBRATION AND SEISMIC CONTROLS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static, wind, and seismic loads within specified loading limits.

3.2 INSTALLATION OF SEISMIC CONTROLS

A. Provide seismic control devices for systems and equipment the Specifications indicate they must be installed on specific equipment and systems, and where required by applicable codes.

1. Install equipment and devices to withstand the effects of earthquake motions.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Installation of seismic restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.

D. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in the structural element to which anchor will be fastened.

4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

J. Accommodation of Differential Seismic Motion: Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.3 FIELD QUALITY CONTROL

A. Special Structural Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.

3. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.

4. Test to 90 percent of rated proof load of device.

B. Nonconforming Work:

1. Seismic controls will be considered defective if they do not pass tests and inspections.

2. Remove and replace malfunctioning units and retest as specified above.

C. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

END OF SECTION 260548

SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Bands and tubes.
3. Tapes and stencils.
4. Tags.
5. Signs.
6. Cable ties.
7. Miscellaneous identification products.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.

5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

B. Comply with NFPA 70E and Section 260573 "Power System Studies" requirements for arc-flash warning labels.

C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, must comply with UL 969.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 1000 V or Less:

1. Black letters on orange field.

2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.

1. Color must be factory applied or field applied for sizes larger than 8 AWG if authorities having jurisdiction permit.

2. Colors for 208Y/120 V Circuits:

a. Phase A: Black.

b. Phase B: Red.

c. Phase C: Blue.

3. Colors for 480Y/277 V Circuits:

a. Phase A: Brown.

b. Phase B: Orange.

c. Phase C: Yellow.

4. Color for Neutral: White or gray.

5. Color for Equipment Grounds: Green.

6. Colors for Isolated Grounds: Green with two or more yellow stripes.

C. Warning Label Colors:

1. Identify system voltage with black letters on orange background.

D. Warning labels and signs must include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

E. Equipment Identification Labels:

1. Black letters on white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Brady Corporation; B-437 or comparable product by one of the following:

a. Grafoplast Wire Markers.

b. HellermannTyton.

c. LEM Products, Inc.

d. Panduit Corp.

e. Seton Identification Products; a Brady Corporation Company.

f. TE Connectivity.

g. Or approved equal.

B. Self-Adhesive Wraparound Labels: Preprinted, 3 mil thick, polyester flexible label with acrylic pressure-sensitive adhesive.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Brady Corporation; B-427 or comparable product by one of the following:

a. Brother International Corporation.

b. Dymo; a division of Newell Brands.

c. Emedco.

d. HellermannTyton.

e. Ideal Industries, Inc.

f. Panduit Corp.

g. Seton Identification Products; a Brady Corporation Company.

h. Or approved equal.

2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over legend. Labels sized such that clear shield overlaps entire printed legend.

3. Marker for Labels:

a. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

C. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3 mil thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Brady Corporation; B-439 or comparable product by one of the following:

a. Brother International Corporation.

b. Dymo, a division of Newell Brands.

c. Emedco.

d. HellermannTyton.

e. LEM Products, Inc.

f. Panduit Corp.

g. Seton Identification Products; a Brady Corporation Company.

h. Or approved equal.

2. Minimum Nominal Size:

a. 1-1/2 by 6 inch for raceway and conductors.

b. 3-1/2 by 5 inch for equipment.

c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of 200 deg F . Comply with UL 224.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Brady Corporation; B-342 or comparable product by one of the following:

a. Brother International Corp.

b. Dymo, a division of Newell Brands.

c. Hellermann Tyton.

d. Panduit Corp.

e. Sumimoto Electric.

f. TE Connectivity.

g. Or approved equal.

2.5 TAPES AND STENCILS

A. Floor Marking Tape: 2 inch wide, 5 mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Brady Corporation; B-514 and B-634 or comparable product by one of the following:

a. Carlton Industries, LP.

b. Seton Identification Products; a Brady Corporation Company.

c. Or approved equal

2.6 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch , with stamped legend, punched for use with self-locking cable tie fastener.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Brady Corporation; catalog item 23213 or comparable product by one of the following:

a. Carlton Industries, LP.

b. Emedco.

c. Marking Services, Inc.

d. Seton Identification Products; a Brady Corporation Company.

e. Or approved equal.

2.7 SIGNS

A. Baked-Enamel Signs:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Brady Corporation; B-555 or comparable product by one of the following:

a. Carlton Industries, LP.

b. Champion America.

c. Emedco.

d. Marking Services, Inc.

e. Or approved equal.

2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.

3. 1/4 inch grommets in corners for mounting.

4. Nominal Size: 7 by 10 inch.

B. Laminated Acrylic or Melamine Plastic Signs:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Brady Corporation; Electromark 2-Layer Engraved Acrylic Nameplate or comparable product by one of the following:

a. Carlton Industries, LP.

b. Emedco.

c. Marking Services, Inc.

d. Or approved equal.

2. Engraved legend.

3. Thickness:

a. For signs up to 20 sq. inch , minimum 1/16 inch thick.

b. For signs larger than 20 sq. inch , 1/8 inch thick.

c. Punched or drilled for mechanical fasteners with 1/4 inch grommets in corners for mounting.

d. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the followings:

1. HellermannTyton.

2. Ideal Industries, Inc.

3. Marking Services, Inc.

4. Panduit Corp.

5. Or approved equal.

B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch .

2. Tensile Strength at 73 deg F in accordance with ASTM D638: 12,000 psi .

3. Temperature Range: Minus 40 to plus 185 deg F.

4. Color: Black, except where used for color-coding.

C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F in accordance with ASTM D638: 12,000 psi .
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F in accordance with ASTM D638: 7000 psi .
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 1000 V: Identification must completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

I. Emergency Operating Instruction Signs: Install instruction signs with white legend on red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.

J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.

K. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "EMERGENCY POWER."

2. "POWER."

L. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.

2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.

M. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.

N. Self-Adhesive Labels:

1. Install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.

2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on 1-1/2 inch high label; where two lines of text are required, use labels 2 inch high.

O. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.

P. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.

Q. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.

R. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

S. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.

T. Metal Tags:

1. Place in location with high visibility and accessibility.

2. Secure using UV-stabilized cable ties.

U. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on minimum 1-1/2 inch high sign; where two lines of text are required, use signs minimum 2 inch high.

V. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on 1-1/2 inch high sign; where two lines of text are required, use labels 2 inch high.

W. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.

2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Accessible Fittings for Raceways and Cables within Buildings: Identify cover of junction and pull box of the following systems with self-adhesive labels containing wiring system legend and system voltage. System legends must be as follows:

1. "EMERGENCY POWER."

2. "POWER."

D. Power-Circuit Conductor Identification, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.

E. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with conductor or cable designation, origin, and destination.

F. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with conductor designation.

G. Conductors to Be Extended in Future: Attach write-on tags to conductors and list source.

H. Auxiliary Electrical Systems Conductor Identification: Marker tape that is uniform and consistent with system used by manufacturer for factory-installed connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

I. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

J. Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.

K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.

1. Apply to exterior of door, cover, or other access.

2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

a. Power-transfer switches.

b. Controls with external control power connections.

L. Operating Instruction Signs: Self-adhesive labels.

M. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.

N. Equipment Identification Labels:

1. Indoor Equipment: Baked-enamel signs.

2. Outdoor Equipment: Laminated acrylic or melamine sign.

3. Equipment to Be Labeled:

   a. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of engraved, laminated acrylic or melamine label.

   b. Enclosures and electrical cabinets.

   c. Access doors and panels for concealed electrical items.

   d. Switchboards.

   e. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.

   f. Emergency system boxes and enclosures.

   g. Enclosed switches.

   h. Enclosed controllers.

   i. Variable-speed controllers.

   j. Push-button stations.

   k. Power-transfer equipment.

   l. Contactors.

   m. Remote-controlled switches, dimmer modules, and control devices.

   n. Power-generating units.

   o. Monitoring and control equipment.

END OF SECTION

SECTION 260573 - POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Short-circuit study.

2. Overcurrent protective device coordination study.

3. Arc-flash hazard study.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For power system analysis software to be used for studies.

1. Product Certificates: For power system study software applications, include certificate stating compliance with specified requirements, signed by software manufacturer.

B. Power System Study Reports:

1. Submit reports after approval of system protective devices submittals. Submittals must be in digital form.

2. Submit short-circuit study input data, including completed computer-program input data sheets.

3. Submit coordination study input data, including completed computer-program input data sheets.

4. Submit arc-flash study input data, including completed computer-program input data sheets.

5. Submit revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.3 QUALITY ASSURANCE

A. Submittals for power system studies must be signed and sealed by qualified electrical professional engineer responsible for their preparation.

B. Studies must be performed using commercially developed and distributed software designed specifically for power system analysis.

C. Software algorithms must comply with requirements of standards and guides specified in this Section.

D. Manual calculations are unacceptable.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

A. Standard Features:

1. Power System Analysis:

a. Power-systems-analysis software applications must have analytical capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 3002 series standards.

b. Computer software application must be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program must report device settings and ratings of overcurrent protective devices and must demonstrate selective coordination by computer-generated, time-current coordination plots.

c. Computer software application must be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.

2. Analysis Standards:

a. Short-Circuit Current Analysis: In accordance with IEEE 3002.3.

b. Device Coordination Analysis: In accordance with IEEE 3004.3 and IEEE 3004.5.

c. Arc-Flash Hazard Analysis: In accordance with IEEE 1584.

3. Capable of printing arc-flash hazard warnings for equipment on weather- and UV-resistant, pressure-sensitive adhesive labels complying with NFPA 70E.

a. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard study:

1) Equipment designation.

2) Nominal voltage.

3) Protection boundaries.

a) Arc-flash boundary.

b) Restricted approach boundary.

c) Limited approach boundary.

4) Arc-flash PPE category.

5) Required minimum arc rating of PPE in Cal/cm squared.

6) Available incident energy.

7) Working distance.

8) Engineering report number, revision number, and issue date.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Collect and analyze data for power system studies.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call discrepancies to Engineer's attention.

2. For equipment included as Work on the Project, use characteristics submitted under provisions of action submittals and information submittals for the Project.

3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers in accordance with NFPA 70E.

4. Gather and tabulate required input data to support power system studies. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 3002 series standards as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:

a. Product data for the Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

b. Electrical power utility impedance at service.

c. Power sources and ties.

d. Short-circuit current at each system bus (three phase and line to ground).

e. Full-load current of loads.

f. Voltage level at each bus.

g. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.

h. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.

i. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.

j. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.

k. Maximum demands from service meters.

l. Motor horsepower and NEMA MG 1 code letter designation.

m. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).

n. Derating factors.

3.2 PREPARATION

A. Preparation of Data for Short-Circuit Study:

1. Verify completeness of data supplied on one-line diagram. Call discrepancies to Engineer's attention.

2. For equipment included as Work on the Project, use characteristics submitted under provisions of action submittals and information submittals for the Project.

3. Prepare one-line diagram of modeled power system, showing the following:

a. Protective device designations and ampere ratings.

b. Conductor types, sizes, and lengths.

c. Transformer kVA and voltage ratings.

d. Motor and generator designations and kVA ratings.

e. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.

f. Derating factors and environmental conditions.

g. Revisions to electrical equipment required by study.

B. Preparation of Data for Overcurrent Protective Device Coordination Study:

1. Prepare data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, indicating the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.

    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

    d. Generator thermal-damage curve.

    e. Ratings, types, and settings of utility company's overcurrent protective devices.

    f. Special overcurrent protective device settings or types stipulated by utility company.

    g. Time-current-characteristic curves of devices indicated to be coordinated.

    h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

    j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.

    k. Identify series-rated interrupting devices for condition where available fault current is greater than interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

2. Examine the Project's overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.

3. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

C. Preparation of Data for Arc-Flash Hazard Study:

1. Assemble data from short-circuit study and overcurrent protective device coordination study.

2. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.3 SHORT-CIRCUIT STUDY

A. Base study on device characteristics supplied by device manufacturer.

B. Begin short-circuit current analysis at service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 5 kA or less.

C. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for the Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

D. Include AC fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase AC systems. Also account for fault-current DC decrement to address asymmetrical requirements of interrupting equipment.

E. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

F. Include in report identification of protective device applied outside its capacity.

3.4 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

A. Base study on device characteristics supplied by device manufacturer. When analysis of full range of device is impractical, limiting scope of analysis from 10 to 100 percent of device range is acceptable.

B. Begin analysis at service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 5 kA or less.

C. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for the Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

D. Transformer Primary Overcurrent Protective Devices:

1. Device must not operate in response to the following:

a. Inrush current when first energized.

b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

c. Permissible transformer overloads in accordance with IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings must protect transformers in accordance with IEEE C57.12.00, for fault currents.

E. Motor Protection:

1. Select protection for low-voltage motors in accordance with IEEE 3004.8 and NFPA 70.

2. Select protection for motors served at voltages more than 600 V in accordance with IEEE 620.

F. Conductor Protection: Protect cables against damage from fault currents in accordance with ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 3004.7. Demonstrate that equipment withstands maximum short-circuit current for time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

G. Generator Protection: Select protection in accordance with manufacturer's published instructions and IEEE C37.102.

H. Include AC fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase AC systems. Also account for fault-current DC decrement, to address asymmetrical requirements of interrupting equipment.

I. Include coordination of ground-fault protection devices.

J. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

K. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.

2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.

3. Include in report identification of protective device applied outside its capacity.

3.5 ARC-FLASH HAZARD STUDY

A. Comply with NFPA 70E, including Annex D, for arc-flash hazard study.

B. Preparatory Studies: Obtain short-circuit study and overcurrent protective device coordination study results prior to starting arc-flash hazard study.

C. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation must assume maximum contribution from utility and must assume motors to be operating under full-load conditions.

2. Calculate arc-flash energy at 85 percent of maximum short-circuit current in accordance with IEEE 1584 recommendations.

3. Calculate arc-flash energy at 38 percent of maximum short-circuit current in accordance with NFPA 70E recommendations.

4. Calculate arc-flash energy with utility contribution at minimum and assume no motor contribution.

D. Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except nominal arc-flash hazard warning data may be provided for equipment fed from transformers rated below 240 V(ac), 2000 A, instead of documenting precise calculations.

F. Calculate limited, restricted, and prohibited approach boundaries for each location.

G. Incident energy calculations must consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations must account for changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators must be decremented as follows:

1. Fault contribution from induction motors must not be considered beyond three to five cycles.

2. Fault contribution from synchronous motors and generators must be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 to 3 p.u. after 10 cycles).

H. Arc-flash energy must be reported for maximum of line or load side of circuit breaker. However, arc-flash computation must be performed and reported for both line and load side of circuit breaker as follows:

1. When circuit breaker is in separate enclosure.

2. When line terminals of circuit breaker are separate from work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.6 POWER SYSTEM STUDY REPORTS

A. Preparation of Power System Study Reports: Prepare and submit the following:

1. Short-Circuit Study Report Contents:

a. Executive summary of study findings.

b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

c. One-line diagram of modeled power system, showing the following:

1) Protective device designations and ampere ratings.

2) Conductor types, sizes, and lengths.

3) Transformer kVA and voltage ratings.

4) Motor and generator designations and kVA ratings.

5) Switchgear, switchboard, motor-control center, and panelboard designations and ratings.

6) Derating factors and environmental conditions.

7) Revisions to electrical equipment required by study.

d. Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.

e. Short-Circuit Study Input Data:

1) One-line diagram of system being studied.

2) Power sources available.

3) Manufacturer, model, and interrupting rating of protective devices.

4) Conductors.

5) Transformer data.

f. Protective Device Evaluation:

1) Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.

2) Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.

3) For 600 V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

4) For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.

5) Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

g. Short-Circuit Study Output Reports:

1) Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.

b) Calculated fault-current magnitude and angle.

c) Fault-point X/R ratio.

d) Equivalent impedance.

2) Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.

b) Calculated symmetrical fault-current magnitude and angle.

c) Fault-point X/R ratio.

d) Calculated asymmetrical fault currents based on fault-point X/R ratio; based on calculated symmetrical value multiplied by 1.6; and based on calculated symmetrical value multiplied by 2.7.

3) Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.

b) Calculated symmetrical fault-current magnitude and angle.

c) Fault-point X/R ratio.

d) No AC Decrement (NACD) ratio.

e) Equivalent impedance.

f) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.

g) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

2. Overcurrent Protection Device Coordination Study Report Contents:

a. Executive summary of study findings.

b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

c. One-line diagram of modeled power system, showing the following:

1) Protective device designations and ampere ratings.

2) Conductor types, sizes, and lengths.

3) Transformer kVA and voltage ratings.

4) Motor and generator designations and kVA ratings.

5) Switchgear, switchboard, motor-control center, and panelboard designations.

6) Revisions to electrical equipment required by study.

d. Report recommended settings of protective devices, ready to be applied in field. Use manufacturer's data sheets for recording recommended setting of overcurrent protective devices when available.

1) Phase and Ground Relays:

a) Device tag.

b) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.

c) Recommendations on improved relaying systems, if applicable.

2) Circuit Breakers:

a) Adjustable pickups and time delays (long time, short time, and ground).

b) Adjustable time-current characteristic.

c) Adjustable instantaneous pickup.

d) Recommendations on improved trip systems, if applicable.

3) Fuses: Show current rating, voltage, and class.

e. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for switching schemes and for emergency periods where power source is local generation. Show the following information:

1) Device tag and title, one-line diagram with legend identifying portion of system covered.

2) Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

3) Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

4) Plot the following listed characteristic curves, as applicable:

a) Power utility's overcurrent protective device.

b) Medium-voltage equipment overcurrent relays.

c) Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.

d) Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.

e) Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.

f) Cables and conductors damage curves.

g) Ground-fault protective devices.

h) Motor-starting characteristics and motor damage points.

i) Generator short-circuit decrement curve and generator damage point.

j) Largest feeder circuit breaker in each motor-control center and panelboard.

5) Maintain selectivity for tripping currents caused by overloads.

6) Provide adequate time margins between device characteristics such that selective operation is achieved.

7) Comments and recommendations for system improvements.

3. Arc-Flash Hazard Study Report Contents:

a. Executive summary of study findings.

b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

c. One-line diagram, showing the following:

1) Protective device designations and ampere ratings.

2) Conductor types, sizes, and lengths.

3) Transformer kVA and voltage ratings, including derating factors and environmental conditions.

4) Motor and generator designations and kVA ratings.

5) Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

d. Short-circuit study output data.

e. Overcurrent protective device coordination study report contents.

f. Arc-Flash Study Output Reports:

1) Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in report:

a) Voltage.

b) Calculated symmetrical fault-current magnitude and angle.

c) Fault-point X/R ratio.

d) No AC Decrement (NACD) ratio.

e) Equivalent impedance.

f) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.

g) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

g. Incident Energy and Flash Protection Boundary Calculations:

1) Arcing fault magnitude.

2) Protective device clearing time.

3) Duration of arc.

4) Arc-flash boundary.

5) Restricted approach boundary.

6) Limited approach boundary.

7) Working distance.

8) Incident energy.

9) Hazard risk category.

10) Recommendations for arc-flash energy reduction.

h. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

3.7 FIELD ADJUSTMENT FOR DEVICE COORDINATION

A. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for adjustable overcurrent protective devices.

3.8 WARNING LABELING OF ARC-FLASH HAZARDS

A. Apply one arc-flash label on front cover of each section of equipment for each equipment included in study, including each piece of equipment listed below:

1. Switchboards.

2. Panelboards.

3. Low voltage transformers.

4. Safety switches.

5. Control panels.

B. Base arc-flash label data on highest values calculated at each location.

C. Machine print warning labels with no handwritten or field-applied markings.

D. Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.

E. Indicate on record Drawings location of equipment where personnel could be exposed to arc-flash hazard during their work.

1. Indicate arc-flash energy.

2. Indicate protection level required.

END OF SECTION 260573

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Outdoor photoelectric switches.

2. Outdoor motion sensors.

B. Related Requirements:

1. Section 133410 "Nonstructural Component and Cladding Requirements" specifies seismic hazard, wind hazard, other structural design conditions applicable to the Work specified in this Section.

2. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.

1.2 ACTION SUBMITTALS

A. Product data.

B. Shop Drawings: Prepare and submit the following:

1. Installation details for the following:

a. Occupancy sensors.

b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.

3. Diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Field Reports:

1. Manufacturer's field reports for field quality-control support.

2. Field reports for software and firmware upgrades.

1.4 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multiteam projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

D. Lighting Testing and Inspecting Agency: Entity possessing active qualifications with documented training and experience with testing and inspecting lighting installations in accordance with applicable IES standards.

1.6 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that installed lighting control devices perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that lighting control devices perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control software.

b. Faulty operation of lighting control devices.

2. Initial Extended-Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.

3. Follow-On Extended-Warranty Period: Eight years from date of Substantial Completion; full coverage for materials only, free on board origin, freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements:

1. Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Must comply with CCR Title 24.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. UL WJFX - Solid-State Outdoor Photoelectric Switch, Flexible Mounting:

1. nLIGHT, Acuity Brands Lighting.

2. or equal.

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Plug-in, Locking-Type Photocontrols: UL CCN WJFX, including UL 773.

4. Standard Features:

a. Solid state, with SPST dry contacts rated for 1000 W incandescent or 1800 VA inductive, to operate connected relay, contactor coils, or microprocessor input; and compatible with drivers and LED lamps.

b. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

c. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.

d. Time Delay: Fifteen-second minimum, to prevent false operation.

e. Surge Protection: Metal-oxide varistor.

f. Mounting: Twist lock complies with ANSI C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure from same source and manufacturer as switch.

g. Failure Mode: Luminaire stays ON.

B. UL WJFX - Solid-State Outdoor Photoelectric Switch, Luminaire-Mounted:

1. nLIGTH, Acuity Brands Lighting.

2. or equal.

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Plug-in, Locking-Type Photocontrols: UL CCN WJFX, including UL 773.

4. Standard Features:

    a. Solid state, with SPST dry contacts rated for 1000 W incandescent or 1800 VA inductive, to operate connected load, and compatible with CFL and LED lamps.

    b. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.

    c. Time Delay: Thirty-second minimum, to prevent false operation.

    d. Lightning Arrester: Air-gap type.

    e. Mounting: Twist lock complying with ANSI C136.10, with base from same source and manufacturer as switch.

    f. Failure Mode: Luminaire stays ON.

C. UL WJFX - Solid-State, Low-Voltage, Outdoor Photoelectric Switch:

1. nLIGHT, Acuity Brands Lighting.

2. or equal.

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Plug-in, Locking-Type Photocontrols: UL CCN WJFX, including UL 773.

4. Standard Features:

    a. Solid state; one set of N.O. dry contacts rated for 24 V(dc) at 1 A , to operate connected load, and compatible with luminaire power pack.

    b. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.

    c. Time Delay: Thirty-second minimum, to prevent false operation.

    d. Mounting: 1/2 inch threaded male conduit.

    e. Failure Mode: Luminaire stays ON.

f. Power Pack: same source and manufacturer as switch.

1) Dry contacts rated for 20 A driver or LED load at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.

a) LED status lights to indicate load status.

b) Plenum rated.

2.3 OUTDOOR MOTION SENSORS

A. Solid-State Outdoor Motion Sensor:

1. Wattstopper, FSP-212/FSP-212U

2. Or equal.

3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:

a. Plug-in, Locking-Type Photocontrols: UL CCN WJFX, including UL 773.

b. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.

c. Intrusion Detection Units: UL CCN ANSR, including UL 639.

4. Standard Features:

a. PIR type, weatherproof. Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch.

b. Switch Rating:

1) Luminaire-Mounted Sensor: 1000 W incandescent, 500 VA fluorescent/LED.

2) Separately Mounted Sensor: Dry contacts rated for 20 A driver or LED load at 120 V(ac. Sensor has 24 V(dc), 150 mA, Class 2 power source.

3) Switch Type: Single pole, manual "on," automatic "off."

c. Voltage: 120 V or Dual voltage, 120/277 V type.

d. Detector Coverage:

1) Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft.

2) Long Range: 180-degree field of view and 110 ft detection range.

e. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

1) Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.

f. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.

g. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as "raintight" in accordance with UL 773A.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 INSTALLATION OF LIGHTING CONTROL DEVICES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.

2. Electrical Maintenance: NFPA 70B.

3. Electrical Safety: NFPA 70E.

4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.

5. Communications Work: BICSI N1.

6. Life Safety and Means of Egress Work: NFPA 101.

7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.

8. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

2. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3. Installation of Wiring:

a. Conduit: Minimum conduit size is 1/2 inch.

b. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's published instructions.

c. Size conductors in accordance with lighting control device manufacturer's published instructions unless otherwise indicated.

d. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

D. Interfaces with Other Work:

1. Identification: Provide labels for lighting control devices and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.

b. Label each enclosure with engraved metal or laminated-plastic nameplate.

c. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

3.3 FIELD QUALITY CONTROL

A. Administrant for Electrical Power Tests and Inspections:

1. Administer and perform tests and inspections with assistance of factory-authorized service representative.

B. Administrant for Lighting Tests and Inspections:

1. Administer and perform tests and inspections with assistance of factory-authorized service representative.

C. Tests and Inspections:

1. Operational Test: After installing sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Nonconforming Work:

1. Lighting control devices will be considered defective if they do not pass tests and inspections.

2. Remove and replace defective units and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLOSEOUT ACTIVITIES

A. Demonstration:

1. Demonstrate to Owner's maintenance and clerical personnel and building occupants how to operate the following systems and equipment:

a. Lighting control devices.

END OF SECTION 260923

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

3. Include diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

1. Transformer working clearances, anchoring, torque values, and insulation-resistance testing.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.

2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

2.2 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.

C. Coils: Continuous windings except for taps.

1. Coil Material: Copper.

2. Internal Coil Connections: Brazed or pressure type.

D. Enclosure: Ventilated.

1. Core and coil must be encapsulated within resin compound to seal out moisture and air.

2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.

3. Wiring Compartment: Sized for conduit entry and wiring installation.

4. Environmental Protection:

a. Indoor: UL 50E, Type 2.

b. Outdoor: UL 50E, Type 3R.

E. Taps for Transformers 3 kVA and Smaller: None.

F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

H. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.

I. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.

2.3 IDENTIFICATION

A. Nameplates:

1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at location of transformer.

E. Environment: Enclosures must be rated for environment in which they are located.

3.2 INSTALLATION

A. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions, seismic requirements applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Secure transformer to concrete base in accordance with manufacturer's published instructions.

C. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.

D. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection.

1) Inspect physical and mechanical condition.

2) Inspect anchorage, alignment, and grounding.

3) Verify that resilient mounts are free and that shipping brackets have been removed.

4) Verify that unit is clean.

5) Perform specific inspections and mechanical tests recommended by manufacturer.

6) Verify that as-left tap connections are as specified.

7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

1) Measure resistance at windings, taps, and bolted connections.

2) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

B. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.

C. Nonconforming Work:

1. Transformer will be considered defective if it does not pass tests and inspections.

2. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Assemble and submit test and inspection reports.

3.5 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Switchboards.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Accessory components and features.

B. Related Requirements

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Switchboards.
2. Overcurrent protective devices.
3. Surge protection devices.
4. Accessories.
5. Other components.
6. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than UL 50E, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.

5. Detail utility company's metering provisions with indication of approval by utility company.

6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

7. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field Quality-Control Reports:

a. Test procedures used.

b. Test results that comply with requirements.

c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Handling, storing, and providing temporary heat.

2. Mounting accessories and anchoring devices.

3. Testing and adjusting overcurrent protective devices.

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.5 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed switchboard perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that switchboard performs in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Comply with NEMA PB 2.

C. Comply with NFPA 70.

D. Comply with UL 891.

E. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Fixed**,** individually mounted.

2. Branch Devices: Panel mounted.

3. Sections front and rear aligned.

F. Outdoor Enclosures: Type 3R.

1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.

G. Service Entrance Rating: Switchboards intended for use as service entrance equipment may contain from one to six service disconnecting means with overcurrent protection, neutral bus with disconnecting link, grounding electrode conductor terminal, and main bonding jumper.

H. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

I. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

J. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

K. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from front of switchboard.

2. Ground Bus: Minimum-size required by UL 891**,** hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.

3. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

4. Disconnect Links:

a. Isolate neutral bus from incoming neutral conductors.

b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

L. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 SURGE PROTECTION DEVICES

A. SPDs: Listed and labeled in accordance with UL 1449, Type 2.

B. Features and Accessories:

1. Internal thermal protection that disconnects SPD before damaging internal suppressor components.

2. Indicator light display for protection status.

3. Form-C contacts rated at 5 A and 250 V(ac), one normally open and one normally closed, for remote monitoring of protection status.

4. Surge counter.

C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase may not be less than 300 kA. Peak surge current rating must be arithmetic sum of ratings of individual MOVs in each mode.

D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits may not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.

2. Line to Ground: 1200 V for 480Y/277 V, 1200 V for 208Y/120 V.

3. Line to Line: 2000 V for 480Y/277 V, 1000 V for 208Y/120 V.

E. SCCR: Equal or exceed 200 kA.

F. Nominal Rating: 20 kA.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.

    b. Long- and short-time pickup levels.

    c. Long- and short-time adjustments.

    d. Ground-fault pickup level, time delay, and I squared t (I^2t) response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.

6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).

7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30 mA trip).

8. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.

    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.

    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

    e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

    f. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

h. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.

2.4 ACCESSORY COMPONENTS AND FEATURES

A. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548 "Vibration and Seismic Controls for Electrical Systems" or manufacturer's instructions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Switchboards and Accessories: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 2.1.

2. Consult Engineer for resolution of conflicting requirements.

C. Special Techniques:

1. Equipment Mounting: Install switchboards on concrete base, 4 inch nominal thickness. Comply with requirements for concrete base specified in Section 260529 "Hangers and Supports for Electrical Systems."

a. Install conduits entering underneath switchboard, entering under vertical section where conductors will terminate. Install with couplings flush with concrete base. Extend 2 inch above concrete base after switchboard is anchored in place.

b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around full perimeter of concrete base.

c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, published instructions, and directions furnished with items to be embedded.

e. Install anchor bolts to elevations required for proper attachment to switchboards.

f. Anchor switchboard to building structure at top of switchboard if required or recommended by manufacturer.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

3. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

4. Install filler plates in unused spaces of panel-mounted sections.

5. Install overcurrent protective devices, surge protection devices, and instrumentation.

a. Set field-adjustable switches and circuit-breaker trip ranges.

3.2 CONNECTIONS

A. Bond conduits entering underneath switchboard to equipment ground bus with bonding conductor sized in accordance with NFPA 70.

B. Support and secure conductors within switchboard in accordance with NFPA 70.

C. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Service Equipment Label: Labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Acceptance Testing:

a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within switchboard,

and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.

b. Test continuity of each circuit.

2. Test ground-fault protection of equipment for service equipment in accordance with NFPA 70.

3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

5. Perform the following infrared scan tests and inspections, and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.

c. Instruments and Equipment:

1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

B. Nonconforming Work:

1. Switchboard will be considered defective if it does not pass tests and inspections.

2. Remove and replace defective units and retest.

C. Collect, assemble, and submit test and inspection reports, including certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262413

SECTION 262416 – PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. HID: High-intensity discharge.

E. MCCB: Molded-case circuit breaker.

F. SPD: Surge protective device.

G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.

2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.

2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.

3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.

4. Detail bus configuration, current, and voltage ratings.

5. Short-circuit current rating of panelboards and overcurrent protective devices.

6. Include evidence of NRTL listing for series rating of installed devices.

7. Include evidence of NRTL listing for SPD as installed in panelboard.

8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

9. Include wiring diagrams for power, signal, and control wiring.

10. Key interlock scheme drawing and sequence of operations.

11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Panelboard Schedules: For installation in panelboards.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.

2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.

3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.

b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without Construction Manager's and Owner's written permission.

3. Comply with NFPA 70E.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Enclosures: Flush-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

b. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2. Height: 84 inch maximum.

3. Front: Secured to box with concealed trim clamps. For flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.

4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.

5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.

7. Finishes:

a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

b. Back Boxes: Same finish as panels and trim.

c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

F. Incoming Mains:

1. Location: Convertible between top and bottom.

2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

G. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

a. Plating shall run entire length of bus.

b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.

3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.

5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.

7. Split Bus: Vertical buses divided into individual vertical sections.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Terminations shall allow use of 75 deg C rated conductors without derating.

3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.

4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.

5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.

6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.

9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

I. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.

1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.

2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.

2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide lighting and appliance branch-circuit panelboards by Mersen USA or comparable product by one of the following:

1. ABB.

2. Eaton.

3. Schneider Electric USA (Square D).

4. Or approved equal.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

G. Column-Type Panelboards: Single row of overcurrent devices with narrow gutter extension .

1. Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide disconnecting and overcurrent protective devices by Mersen USA or comparable product by one of the following:

1. ABB.

2. Eaton.

3. Schneider Electric USA (Square D).

4. Or approved equal.

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

a. Inverse time-current element for low-level overloads.

b. Instantaneous magnetic trip element for short circuits.

c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic Trip Circuit Breakers:

a. RMS sensing.

b. Field-replaceable rating plug or electronic trip.

c. Digital display of settings, trip targets, and indicated metering displays.

d. Multi-button keypad to access programmable functions and monitored data.

e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.

f. Integral test jack for connection to portable test set or laptop computer.

g. Field-Adjustable Settings:

1) Instantaneous trip.

2) Long- and short-time pickup levels.

3) Long and short time adjustments.

4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).

6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).

7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.

8. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.

b. Breaker handle indicates tripped status.

c. UL listed for reverse connection without restrictive line or load ratings.

d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

e. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

f. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.

g. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

i. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.5 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:

1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Mount top of trim 90 inch above finished floor unless otherwise indicated.

G. Mount panelboard cabinet plumb and rigid without distortion of box.

H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Mount surface-mounted panelboards to steel slotted supports 1-1/4 inch in depth. Orient steel slotted supports vertically.

J. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

L. Install filler plates in unused spaces.

M. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

N. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.

2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.

4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 262726 – WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General-use switches.
2. General-grade duplex straight-blade receptacles.
3. Receptacles with arc-fault and ground-fault protective devices.
4. Connectors, cords, and plugs.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Momentary-contact switches.
2. Duplex straight-blade receptacles.
3. Receptacles with GFCI device.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Duplex straight-blade receptacles.
2. Receptacles with GFCI device.

B. Sample warranties.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that packaged with protective covering for storage and identified with labels describing contents.

1. Ten percent of each type but no fewer than two of each type.

B. Special Tools:

1. Proprietary equipment and software required to maintain, repair, adjust, or implement future changes to controlled receptacles.

2. Proprietary equipment required to maintain, repair, adjust, or implement future changes to cord connectors.

1.5 WARRANTY FOR DEVICES

A. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 GENERAL-USE SWITCHES

A. Switch:

1. Hubbell 1221 to 1224; General Electric 5951-1 to 5954-1, or approved equal.

2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

a. Reference Standards: UL CCN WMUZ and UL 20.

4. Options:

a. Device Color: Brown of ivory to match device plates with phenolic plastic device plates.

b. Configuration:

1) General-duty, 120-277 V, 20 A, single pole and three way.

5. Accessories:

a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.2 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Duplex Straight-Blade Receptacle:

1. Hubbell 5362, General Electric 4108-1, or approved equal.
2. Hubbell 5235, General Electric 4188, or approved equal.
3. Regulatory Requirements:
    a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
4. General Characteristics:
    a. Reference Standards: UL CCN RTRT and UL 498.
5. Options:
    a. Device Color: Brown or Ivory to match device plates with phenolic plastic device plates.
    b. Configuration:
        1) General-duty, NEMA 5-20R.
        2) General-duty, NEMA 6-20R.
6. Accessories:
    a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.3 RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device

1. Hubbell
2. General Electric
3. Or approved equal
4. Regulatory Requirements:
    a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
5. General Characteristics:
    a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
6. Options:

a. Device Color: Brown or ivory to match device plates with phenolic plasting device plates.

b. Configuration: Heavy-duty, NEMA 5-20R.

7. Accessories:

a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receptacles:

1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.2 INSTALLATION OF SWITCHES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.

2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.

3. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."

a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

3.3 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.

2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.

3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.

4. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."

a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

3.4 FIELD QUALITY CONTROL OF SWITCHES

A. Field tests and inspections must be witnessed by Construction Manager and Owner or Owner’s Representative.

B. Tests and Inspections:

1. Perform tests and inspections in accordance with manufacturers' instructions.

C. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.

2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

3.5 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

A. Field tests and inspections must be witnessed by Construction Manager and Owner or Owner’s Representative.

B. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.

2. Verify polarity of hot and neutral pins.

3. Measure line voltage.

4. Measure percent voltage drop.

5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.

C. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.

2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

3.6 SYSTEM STARTUP FOR SWITCHES

A. Perform startup service.

1. Complete installation and startup checks for momentary switches in accordance with manufacturer's instructions.

3.7 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.

2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

B. Connectors, Cords, and Plugs:

1. After installation, protect connectors, cords, and plugs from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Non-fusible switches.
3. Enclosures.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Enclosure types and details for types other than UL 50E, Type 1.
3. Current and voltage ratings.
4. Short-circuit current ratings (interrupting and withstand, as appropriate).
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Warranty documentation.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 FUSIBLE SWITCHES

A. Type HD, Heavy Duty:

1. Single throw.

2. Three pole.

3. 240 or 600 V(ac) as required.

4. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.

5. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.

4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

5. Service-Rated Switches: Labeled for use as service equipment.

2.3 NON-FUSIBLE SWITCHES

A. Type GD, General Duty, Three Pole, Single Throw, 240 V(ac), 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

B. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.

B. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts.

C. Operating Mechanism: Circuit-breaker operating handle must be externally operable with operating mechanism being integral part of box, not cover. Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.

PART 3 - EXECUTION

3.1 SELECTION OF ENCLOSURES

A. Indoor, Dry and Clean Locations: UL 50E, Type 1.

B. Outdoor Locations: UL 50E, Type 4X.

C. Other Wet or Damp, Indoor Locations: UL 50E, Type 4.

D. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.

3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

2. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

3. Install fuses in fusible devices.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect anchorage, alignment, grounding, and clearances.

c. Verify that unit is clean.

d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.

e. Verify that fuse sizes and types match the Specifications and Drawings.

f. Verify that each fuse has adequate mechanical support and contact integrity.

g. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify correct phase barrier installation.

i. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

B. Nonconforming Work:

1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

2. Remove and replace defective units and retest.

C. Collect, assemble, and submit test and inspection reports.

1. Test procedures used.

2. Include identification of each enclosed switch and circuit breaker tested and describe test results.

3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

SECTION 263213.13 – DIESEL-ENGINE-DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Diesel engine.
2. Diesel fuel-oil system.
3. Control and monitoring.
4. Generator overcurrent and fault protection.
5. Generator, exciter, and voltage regulator.
6. Outdoor engine generator enclosure.
7. Vibration isolation devices.

B. Related Requirements:

1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.2 DEFINITIONS

A. EPS: Emergency power supply.

B. EPSS: Emergency power supply system.

C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.
4. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.

5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.

6. Include airflow requirements for cooling and combustion air in cubic feet per minute at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F. Provide Drawings indicating requirements and limitations for location of air intake and exhausts.

7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Identify fluid drain ports and clearance requirements for proper fluid drain.

4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.

6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for engine generators and functional relationship between all electrical components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified summary of prototype-unit test report.

2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.

4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.

5. Report of sound generation.

6. Report of exhaust emissions showing compliance with applicable regulations.

C. Field quality-control reports.

D. Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.

1. Include the following:

a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

b. Operating instructions laminated and mounted adjacent to generator location.

c. Training plan.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.

2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.

3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

4. Tools: Each tool listed by part number in operations and maintenance manual.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Caterpillar Inc.

B. Cummins Power Generation

C. Kohler Power Systems

D. Or approved equal

E. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. NFPA Compliance:

1. Comply with NFPA 37.

2. Comply with NFPA 70.

3. Comply with NFPA 110 requirements for Level 2 EPSS.

B. UL Compliance: Comply with UL 2200.

C. Engine Exhaust Emissions: Comply with EPA Tier 3 requirements and applicable state and local government requirements.

D. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

E. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 25 to 104 deg F.

2. Altitude: 2,700 feet above sea level.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Power Rating: Standby.

D. EPSS Class: Engine generator shall be classified as a Class 8 according to NFPA 110.

E. Service Load: As indicated on drawings.

F. Power Factor: 0.8 lagging.

G. Frequency: 60 Hz.

H. Voltage: 480-V ac.

I. Phase: Three-phase, four wire, wye.

J. Induction Method: Turbocharged.

K. Governor: Adjustable isochronous, with speed sensing.

L. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

M. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.

2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

N. Engine Generator Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.

3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.

4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.

5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.

7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

8. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

10. Start Time:

    a. Comply with NFPA 110, Type 10 system requirements.

2.4 DIESEL ENGINE

A. Rated Engine Speed: 1800 rpm.

B. Lubrication System: Engine or skid-mounted.

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.

2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.

3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

C. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499.

D. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.

    a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.

    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

E. Muffler/Silencer:

1. Commercial type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

a. Minimum sound attenuation of 12 dB at 500 Hz.

b. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 90 dBA or less.

F. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

G. Starting System: 24-V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.

2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.

3. Cranking Cycle: As required by NFPA 110 for system level specified.

4. Battery: Nickel cadmium, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.

5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

6. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for nickel-cadmium batteries. Unit shall comply with UL 1236 and include the following features:

a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 to 140 deg F to prevent overcharging at high temperatures and undercharging at low temperatures.

c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.

e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.5 DIESEL FUEL-OIL SYSTEM

A. Comply with NFPA 37.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel. Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:

1. Tank level indicator.

2. Fuel-Tank Capacity: Minimum 133 percent of total fuel required for planned operation plus fuel for periodic maintenance operations between fuel refills.

3. Leak detection in interstitial space.

4. Vandal-resistant fill cap.

5. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.6 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Provide minimum run time control set for 15 minutes with override only by operation of a remote emergency-stop switch.

C. Comply with UL 508A.

D. Configuration:

1. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.

E. Control and Monitoring Panel:

1. Digital engine generator controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.

2. Instruments: Located on the control and monitoring panel and viewable during operation.

a. Engine lubricating-oil pressure gage.

b. Engine-coolant temperature gage.

c. DC voltmeter (alternator battery charging).

d. Running-time meter.

e. AC voltmeter.

f. AC ammeter.

g. AC frequency meter.

h. Generator-voltage adjusting rheostat.

3. Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:

a. Cranking control equipment.

b. Run-Off-Auto switch.

c. Control switch not in automatic position alarm.

d. Overcrank alarm.

e. Overcrank shutdown device.

f. Low-water temperature alarm.

g. High engine temperature pre-alarm.

h. High engine temperature.

i. High engine temperature shutdown device.

j. Overspeed alarm.

k. Overspeed shutdown device.

l. Low fuel main tank.

1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for duration required in "Fuel Tank Capacity" Subparagraph in "Diesel Fuel-Oil System" Article.

m. Coolant low-level alarm.

n. Coolant high-temperature alarm.

o. Coolant low-temperature alarm.

p. EPS load indicator.

q. Battery high-voltage alarm.

r. Low cranking voltage alarm.

s. Battery-charger malfunction alarm.

t. Battery low-voltage alarm.

u. Lamp test.

v. Contacts for local and remote common alarm.

w. Hours of operation.

x. Engine generator metering, including voltage, current, hertz, kilowatt, kilovolt ampere, and power factor.

F. Connection to Datalink:

1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.

2. Provide connections for datalink transmission of indications to remote data terminals via Ethernet

G. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.

H. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

I. Remote Emergency-Stop Switch: Wall mounted unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.

1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Overcurrent Protective Device:

1. Molded-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:

a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.

b. Trip Settings: Selected to coordinate with generator thermal damage curve.

c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.

d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide 12-lead alternator.

E. Range: Provide broad range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Drip proof.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.

2. Maintain voltage within 15 percent on one step, full load.

3. Provide anti-hunt provision to stabilize voltage.

4. Maintain frequency within 10 percent and stabilize at rated frequency within 5 seconds.

2.9 OUTDOOR ENGINE GENERATOR ENCLOSURE

A. Description:

1. Vandal-resistant, sound-attenuating, weatherproof steel housing; wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

a. Sound Attenuation Level: II.

B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 100 mph.

C. Hinged Doors: With padlocking provisions.

D. Lighting: Provide weather-resistant LED lighting with 30 fc average maintained.

E. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.

F. Muffler Location: Within enclosure.

G. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.

1. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

H. Interior Lights with Switch: Factory-wired, vapor-proof luminaires within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.

I. Convenience Outlets: Factory-wired, GFCI. Arrange for external electrical connection.

2.10 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Standard neoprene separated by steel shims.

2. Shore A Scale Durometer Rating: As recommended by Manufacturer.

3. Number of Layers: As recommended by Manufacturer.

4. Minimum Deflection: 1 inch.

B. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.11 FINISHES

A. Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with IEEE 115.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than six working days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Construction Manager and Owner's written permission.

3.3 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions.

C. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

3.5 IDENTIFICATION

A. Identify system components according to Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Testing Agency:

1. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.

a. Visual and Mechanical Inspection:

1) Compare equipment nameplate data with Drawings and the Specifications.

2) Inspect physical and mechanical condition.

3) Inspect anchorage, alignment, and grounding.

4) Verify that the unit is clean.

b. Electrical and Mechanical Tests:

1) Perform insulation-resistance tests according to IEEE 43.

a) Machines Larger Than 150 kW: Test duration shall be 10 minutes. Calculate polarization index.

2) Test protective relay devices.

3) Verify phase rotation, phasing, and synchronized operation as required by the application.

4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.

5) Perform vibration test for each main bearing cap.

6) Verify correct functioning of the governor and regulator.

2. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.

b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.

c. Verify acceptance of charge for each element of the battery after discharge.

d. Verify that measurements are within manufacturer's specifications.

3. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

4. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.

5. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.

6. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION

SECTION 263600 – TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Contactor-type automatic transfer switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.

2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.

2. Include material lists for each switch specified.

3. Single-Line Diagram: Show connections between transfer switch, power sources, and load.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. Include the following:

a. Features and operating sequences, both automatic and manual.

b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.5 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify Owner no fewer than six days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Owner's written permission.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 110.

D. Comply with UL 1008 unless requirements of these Specifications are stricter.

E. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.

F. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

2. Short-time withstand capability for 30 cycles.

G. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

I. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

J. Neutral Terminal: Solid and fully rated unless otherwise indicated.

K. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

L. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.

3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

4. Accessible via rear and/or front access.

M. Enclosures: General-purpose NEMA 250, Type 3R, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Caterpillar, Inc.

B. Cummins Power Generation

C. Kohler Power Systems

D. ASCO Power Technologies

E. Or approved equal

F. Comply with Level 1 equipment according to NFPA 110.

G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double throw; mechanically held in both directions.

2. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.

3. Conductor Connectors: Suitable for use with conductor material and sizes.

4. Material: Hard-drawn copper, 98 percent conductivity.

5. Main and Neutral Lugs: Mechanical type.

6. Ground Lugs and Bus-Configured Terminators: Mechanical type.

7. Connectors shall be marked for conductor size and type according to UL 1008.

H. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.

1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.

2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

3. Fully automatic break-before-make operation with center off position.

I. Electric Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

J. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.

2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

5. Test Switch: Simulate normal-source failure.

6. Switch-Position Pilot Lights: Indicate source to which load is connected.

7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

11. Engine Shutdown Contacts:

    a. Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.

    b. Push-button programming control with digital display of settings.

    c. Integral battery operation of time switch when normal control power is unavailable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

3. Provide workspace and clearances required by NFPA 70.

B. Identify components according to Section 260553 "Identification for Electrical Systems."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

D. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring Method: Install cables in raceways except within electrical enclosures.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Administrant for Tests and Inspections:

1. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. After installing equipment, test for compliance with requirements according to NETA ATS.

2. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with Drawings and Specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding, and required clearances.

d. Verify that the unit is clean.

e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

f. Verify that manual transfer warnings are attached and visible.

g. Verify tightness of all control connections.

h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:

1) Use of low-resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

i. Perform manual transfer operation.

j. Verify positive mechanical interlocking between normal and alternate sources.

k. Perform visual and mechanical inspection of surge arresters.

l. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.

3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:

a. Perform insulation-resistance tests on all control wiring with respect to ground.

b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.

c. Verify settings and operation of control devices.

d. Calibrate and set all relays and timers.

e. Verify phase rotation, phasing, and synchronized operation.

f. Perform automatic transfer tests.

g. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.

2) Engine start sequence.

3) Time delay on transfer.

4) Alternative source voltage-sensing and frequency-sensing relays.

5) Automatic transfer operation.

6) Interlocks and limit switch function.

7) Time delay and retransfer on normal power restoration.

8) Engine cool-down and shutdown feature.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.

b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.

c. Verify that manual transfer warnings are properly placed.

d. Perform manual transfer operation.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.

b. Simulate loss of phase-to-ground voltage for each phase of normal source.

c. Verify time-delay settings.

d. Verify pickup and dropout voltages by data readout or inspection of control settings.

e. Perform contact-resistance test across main contacts and correct values exceeding 500 micro-ohms and values for one pole deviating by more than 50 percent from other poles.

f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Transfer switches will be considered defective if they do not pass tests and inspections.

F. Remove and replace malfunctioning units and retest as specified above.

G. Prepare test and inspection reports.

H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

C. Coordinate this training with that for generator equipment.

END OF SECTION

SECTION 265000 - LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Luminaires.

2. Luminaire fittings.

B. Related Requirements:

1. Section 133410 "Nonstructural Component and Cladding Requirements" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.

2. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Luminaires: Include the following additional information:

a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

b. Product Certificates: Include product certificates stating compliance with standards listed below, signed by manufacturer or fabricator.

1) Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with current accreditation under National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

c. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on the Drawings.

d. Include battery and charger data for emergency lighting units.

e. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.

f. Include photometric data and adjustment factors obtained from qualified laboratory tests.

g. Include manufacturer's sample warranty language.

2. Luminaire Fittings: Include the following additional information:

a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

b. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on the Drawings.

c. Include manufacturer's sample warranty language.

1.3 CLOSEOUT SUBMITTALS

A. Warranty documentation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 LUMINAIRES

A. Surface-Mounted Luminaire:

1. Listing Criteria:

a. LED Luminaires: UL CCN IFAM; including UL 1598.

2. Other Available Features Required by the Project:

a. Mounting Hardware: Ceiling-mounted

B. Recessed Luminaire:

1. Listing Criteria:

a. LED Luminaires: UL CCN IFAO; including UL 1598

b. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

2. Standard Features:

a. Ceiling Compatibility: NEMA LE 4.

b. Openings: Doors, frames, and access panels must operate smoothly, not leak light under operating conditions, and permit relamping without use of tools or parts falling from enclosure.

3. Other Available Features Required by the Project:

    a. Mounting Hardware: Ceiling-mounted; include universal mounting bracket and integral junction box with conduit fittings.

    b. Dimmable from 100 percent to zero percent of maximum light output.

4. Installation Markings:

    a. Relamping Labels: Include recommended lamp type, diameter, shape, size, wattage, and coating on factory-applied label that is visible when luminaire is open for relamping.

    b. LED Luminaires (UL CCN IFAO):

        1) "SUITABLE FOR SUSPENDED CEILING."

5. Seismic and Wind Performance: Installed product must perform in accordance with Section 133410 "Nonstructural Component and Cladding Requirements" and the following:

    a. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events.

    b. Component Importance Factor (I_p): 1.0.

    c. Component Amplification Factor (a_p): 1.0.

    d. Component Response Modification Factor (R_p): 1.5.

    e. Component Overstrength Factor (Ω_o): 1.5.

C. UL FTBR or FTBV - Emergency Lighting and Power Equipment:

1. Lithonia Lighting

2. Or equal.

3. Listing Criteria:

    a. Emergency Lighting and Power: UL CCN FTBR or UL CCN FTBV; including UL 924, NFPA 101, and ICC IBC.

    b. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

4. Standard Features:

    a. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

b. Status and Test Indication: Visible and accessible without opening luminaire or entering ceiling space.

1) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2) Test Push-Button: Push-to-test button in unit housing simulates loss of normal power and demonstrates unit operability.

c. Nominal Operating Voltage: 120 V(ac).

d. Mounting: Ceiling and Wall with universal junction box adaptor.

e. Enclosure: UV stable thermoplastic housing rated for damp and wet locations.

f. Flame Rating: UL 94 5VA.

g. Light Source: One or Two LED head(s).

h. Internal-Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast or driver.

1) Emergency Connection: Operate one lamp(s) continuously at an output of 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast or driver.

2) Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

3) Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.

a) Push-Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

b) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4) Battery Type: Ni-Cd or Li-ion.

5) Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

6) Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

7) Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

i. External-Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.

1) Emergency Connection: Operate one LED lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast or driver.

2) Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

3) Battery Type: Ni-Cd or Li-ion.

4) Charger: Fully automatic, solid-state, constant-current type.

5) Housing: Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly must be located no less than half of distance recommended by ballast or driver or emergency power unit manufacturer, whichever is less.

6) Test Push-Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

7) LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

8) Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

9) Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

5. Installation Markings:

a. Relamping Labels: Include recommended lamp type, diameter, shape, size, wattage, and coating on factory-applied label that is visible when luminaire is open for relamping.

b. All Luminaires (UL CCN HYXT):

1) For restroom lamp: "SUITABLE FOR DAMP LOCATIONS."

2) For exterior lamp: "SUITABLE FOR WET LOCATIONS."

3) Marked to identify voltage supply or type of branch circuit or both.

c. Emergency Lighting and Power Equipment (UL CCN FTBR):

D. UL FWBO - Exit Fixture:

1. Lithonia Lighting

2. Or equal.

3. Listing Criteria:

a. Exit Fixtures: UL CCN FWBO; including UL 924, NFPA 101, and ICC IBC.

b. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

4. Standard Features:

a. Nominal Operating Voltage: 120 V(ac).

b. Light Source: LED; 50,000 hours minimum rated life.

c. Legend Color: Red.

d. Internal emergency power unit.

e. Battery Type: Ni-Cd or Li-ion.

f. Master/Remote Sign Configurations:

1) Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply battery for power connection to remote unit.

2) Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

5. Installation Markings:

a. All Luminaires (UL CCN HYXT):

1) Marked to identify voltage supply or type of branch circuit or both.

b. Exit Fixtures (UL CCN FWBO):

2.3 LUMINAIRE FITTINGS

A. Luminaire Support Accessories:

1. Standard Features:

a. Sized and rated for luminaire weight.

b. Capable of maintaining luminaire position after cleaning and relamping.

c. Capable of supporting luminaire without causing deflection of ceiling or wall.

d. Capable of supporting horizontal force equal to 100 percent of luminaire weight and vertical force equal to 400 percent of luminaire weight.

PART 3 - EXECUTION

3.1 INSTALLATION OF LIGHTING

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.

2. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.

3. Installation of Indoor Lighting Systems: NECA NEIS 500.

4. Installation of Exterior Lighting Systems: NECA NEIS 501.

C. Special Installation Techniques:

1. Install luminaires level, plumb, and square with finished floor or grade unless otherwise indicated.

2. Install luminaires at height and aiming angle as indicated on the Drawings.
3. Coordinate layout and installation of luminaires with other construction.
4. Flush-Mounted Luminaire Support:

a. Secured to outlet box.

b. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.

c. Trim ring flush with finished surface.

5. Wall-Mounted Luminaire Support: Attached to a minimum 1/8 inch backing plate attached to wall structural members.

a. Do not attach luminaires directly to gypsum board.

6. Ceiling-Grid-Mounted Luminaire Support:

a. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each luminaire. Locate not more than 6 inch from luminaire corners.

b. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for application.

c. Luminaires of Sizes Smaller than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with no fewer than two 3/4 inch metal channels spanning and secured to ceiling tees.

d. Seismic Restraint: Install at least one independent support rod or wire from structure to tab on luminaire. Wire or rod must have breaking strength for luminaire weight with safety factor of 3.0.

7. Install wiring connections for luminaires.

8. Identification: Provide labels for luminaires and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.

D. Protection: After installation, protect lighting equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.2 FIELD QUALITY CONTROL OF LIGHTING

A. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

3. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

4. Verify operation of photoelectric controls.

B. Nonconforming Work:

1. Luminaire will be considered defective if it does not pass tests and inspections.

2. Remove and replace defective units and retest.

C. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

END OF SECTION 265000

SECTION 271323 – COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Communications network fiber optic cabling.

B. Connectors, hardware and accessories.

1.2 WORK INCLUDED

A. The intent of these specifications is to describe the requirements of hardware, installation, testing and implementing the fiber optic network.

B. The Fiber Optic Cable System Installer, referred to hereafter as the Fiber Optic Installer, shall install all cable and related equipment, and provide all labor and materials necessary for complete and operating networks in accordance with the Contract Drawings and these specifications. The installation work shall include, but is not necessarily limited to, the following:

1. Provide a comprehensive fiber optic OTDR testing plan and conduct tests as necessary to validate correct installation.

1.3 RELATED SECTIONS

A. Section 260533—Raceway and Boxes for Electrical Systems

B. Section 260553—Identification for Electrical Systems

1.4 REFERENCES

A. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA):

1. 568A Commercial Building Telecommunications Cabling Stranded

2. 569A Commercial Building Standard for Telecommunications Pathways & Spaces

3. 598A Optical Fiber Color Coding

4. 607 Grounding and Bonding Standard

5. TSB-72 Centralized Optical Fiber Cabling Guidelines

6. EIA for Fiber Optic Testing Procedures (FOTP)

a. FOTP-1 Cable Flexing for Fiber Optic Connectors

b.	FOTP-2	Impact Test Measurements for Fiber Optic Devices
c.	FOTP-3	Temperature Cycling of Fiber Optic Connectors (Thermal Shock)
d.	FOTP-5	Humidity Test Procedures for Fiber Optic Connecting Devices
e.	FOTP-6	Cable Retention Test Procedure for Fiber Optic Interconnection Devices
f.	FOTP-11	Vibration Test Procedure for Fiber Optic Connecting Devices
g.	FOTP-14	Fiber Optic Shock Test
h.	FOTP-25	Impact Testing of Fiber Optic Cable and Cable Assemblies
i.	FOTP-30	Frequency Domain Measurement of Multimode Optical Fiber Information Transmission Capacity
j.	FOTP-35	Interconnection Device Insertion Loss Test
k.	FOTP-36	Twist Test for Fiber Optic Cable Assemblies
l.	FOTP-41	Compressive Loading Resistance of Fiber Optic Cable
m.	FOTP-46	Spectral Attenuation Measurements for Long-Length, Graded-Index Optical Fibers
n.	FOTP-50	Light Launch Conditions for Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements

B. National Fire Protection Association (NFPA):

1. National Electrical Code (NEC)

C. Institute of Electronic and Electrical Engineers (IEEE):

1. 802.3 CSMA/CD Access Method and Physical Layer

1.5 SUBMITTALS

A. Provide following submittals consistent with Division 01, Shop Drawings, Product Data, and Samples.

B. Include a copy of this specification section; pertinent Contract Drawings; other relevant specification sections as noted above; and all addendum updates with each specification

paragraph and Contract Drawing clearly check-marked to indicate compliance with specification and drawing requirements or marked to indicate requested deviations/substitutions from the specification requirements.

C. Shop Drawings: Provide drawings indicating the locations of all pullboxes with station numbers.

D. Product Data:

1. Catalog data on conduit system, pullboxes, conduit fittings, conduit plugs, pull rope, identification tape, and warning signs

2. Catalog data on all testing devices proposed for use plus certifications of accuracy, calibration, and traceability to standards of the National Institute for Standards and Testing

3. Wire and cable descriptive product information

E. Cable pulling calculations for all conduit runs. Indicate on the submittal any additional pullboxes that are required, including station number and a written description of the location.

F. A cable pulling and splicing work plan shall be submitted a minimum of 45 days prior to the planned initiation of cable pulling. The work plan must be approved by the Engineer a minimum of 15 days prior to pulling cable. Work plan shall include the following:

1. Pull tension calculations

2. Calculated amount of lubrication required

3. Detailed description of pull operation methods for all conduit runs

4. Tools and equipment to be used for cable installation and testing

5. Physical location of equipment setup and type

6. Safety and manual assist cable pulling operations

7. Detailed schedule for pulling and testing cables

G. Quality Assurance Submittals:

1. Test Report showing compliance with this Section

2. Manufacturer certification that cable is suitable for installation in conduit underground.

1.6 RECORD DRAWINGS

A. In compliance with Division 01, Record Drawings, the Fiber Optic Installer shall, upon completion, submit Record Drawings showing the following:

1. Horizontal alignment of fiber optic conduit

2. Vertical alignment of fiber optic conduit

3. Location of all pullboxes using Station Number, and the exact Northing and Easting of each pullbox using the GIS coordinate system.

1.7 SPARE PARTS

A. Provide four of each type of patch cable used.

1.8 QUALITY ASSURANCE

A. The fiber optic cable installer shall be factory certified to install fiber optic cable.

B. Cabled optical fibers shall be 100% attenuation tested at the factory. The attenuation of each fiber shall be provided with each cable reel. The attenuation shall be measured at 62.5/125 nm for multi-mode fibers. The manufacturer will store these values for a minimum of 5 years. These values shall be made available upon request.

C. The cable manufacturer shall be ISO 9001 certified.

D. Fiber Optic Installer shall provide verification of current manufacturer certification for the installer of network equipment and cabling to be installed under this contract.

E. Fiber Optic Installer shall have successfully completed a minimum of five (5) operational systems of similar scope and complexity. Information provided shall include the following:

1. Location of previously installed systems

2. Area of coverage (voice, data and fiber optic cable types and number of terminations)

3. Design, building engineer, and telephone number at each installed location

F. Fiber Optic Installer shall provide verification of a current Contractor's license from the Contractor's Licensing Board.

PART 2 - PRODUCTS

2.1 CONDUIT:

A. Conduit shall be as indicated on the contract drawings. Fittings shall be appropriate for underground installation

B. Conduit Duct Plugs shall be Jackmoon Simplex Duct Plugs or equal, with bushing sleeves.

C. Pull Rope shall be Low friction, polyethylene jacketed polypropylene rope with 1800 psi tensile strength, Vikamatic “Fiber Glide” or equal.

2.2 FIBER OPTIC CABLE:

A. Cable Type: All dielectric indoor plant stranded loose-tube, gel-free fiber optic cable, OM2.

B. Number of Fibers: 12 fibers or as indicated on the Contract Drawings.

C. All fiber optic cable, including both indoor and outdoor, shall have a black outer jacket.

D. Manufacturers:

1. Corning

2. Belden

3. Approved Equal

E. Buffer Tubes:

1. Optical fibers shall be grouped inside a loose buffer tube. Tubes shall be color-coded and arranged symmetrically around the central member.

2. The fibers shall not adhere to the inside walls of the loose buffer tube. Buffer tubes shall be kink resistant within the specified minimum bend radius.

3. Buffer tubes shall be stranded around a central member using the reverse oscillation, or “S-Z”, stranding process.

F. Each fiber shall be numbered and color-coded. The colors of the individual fibers shall be stable across the indicated storage and operating temperature range and not be subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

G. Cable Core:

1. Filler may be included in the cable core composition to lend symmetry to the cable cross section where needed.

2. A central anti-buckling member shall be included in the cable. The anti-buckling member shall be composed of a glass reinforced plastic rod.

3. The cable core shall contain a water-blocking material. The water blocking material shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter and shall be readily removable with conventional nontoxic solvents.

4. Tensile strength shall be provided by a combination of high tensile strength dielectric yarns. The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.

H. The all-dielectric cable shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.4-mm. Jacketing material shall be applied directly over the tensile strength members and water blocking material. The jacket or sheath shall be free of holes, splits, and blisters. The cable jacket shall contain no metallic elements and shall be of a consistent thickness.

I. The cable shall contain at least one ripcord under the sheath for easy sheath removal.

J. Fan-Out Termination for Loose Tube Cables:

1. Individual fibers within the loose tube cable require handling protection inside the termination cabinets. Fan-out kits shall be installed in the patch panel enclosures to transition the loose tube fibers to ruggedized tight-buffered fiber pigtail cables. Fan-out tubes or furcation kits shall not be used. Optical fusion splices shall connect the loose tube fibers to the tight-buffered pigtail cables. The optical splice

2. Loss shall comply with the specifications for optical splices. Splice protection sleeves shall protect all splices. A wall-mountable splice center shall house the splices and serve to fully protect excess lengths of loose tube fibers from exposure.

3. The tight-buffered pigtails shall be terminated with LC connectors.

K. Fan-Out Pigtail Cable Specifications:

1. Multi-mode fiber (OM2) shall be used in the pigtails.

2.3 FIBER OPTIC TERMINATION PATCH PANELS:

A. Where indicated, the fiber optic cable shall terminate inside a communications cabinet on a termination patch panel. Fiber sub-cables within the cable shall be terminated with fusion-spliced field installable connectors. The patch panel shall have a fiber capacity equal to the total number of fibers (connected and spare) for all cables to be connected.

B. The termination patch panel shall be equipped with a suitable means for routing and securing of cables and shall provide a suitable means of protection for the mounted fiber connectors, to prevent damage to fibers and connectors during all regular operation and maintenance functions. Cables shall be provided with strain relief. Bend diameters on cable fibers and jumpers shall be greater than 4-inch for optical and mechanical integrity of the optical fibers.

2.4 OPTICAL CONNECTORS

A. Connectors shall be field-installable and must be matched to the cable used. The connectors shall provide tight fitting termination to the cladding and buffer coating. Epoxy-based or hot melt adhesives shall be used to bond the fiber and buffer to the connector ferrule and body prior to polishing the end face. No dry-termination, mechanical or quick crimp connectors are allowed.

B. After termination with connectors, the fiber ends shall be visually inspected at a magnification of not less than 100 power to check for cracks or pits in the end face of the fiber. If irregularities cannot be removed by further polishing, the entire process shall be redone by cutting off and disposing of the connector body.

C. Connectors shall have a maximum allowable connection loss of 0.3 dB per mated pair, as measured per EIA-455-34. No index-matching gel is to be used; only dry interfaces will be accepted:

1. Multi-mode connectors shall be capable of field installation on 62.5/125 micron fibers with 900 micron buffers (OD).

D. Each connector shall be of the industry standard LC type compatible, designed for multi-mode tolerances, and shall meet or exceed the applicable provisions of TIA/EIA-604-10, TIA/EIA-568-B.3, and shall be capable of 100 repeated matings with a maximum loss increase of 0.1 dB.

2.5 SPLICE CLOSURES:

A. Splices not allowed.

PART 3 - EXECUTION

3.1 CONDUIT INSTALLATION

A. General:

1. Conduit shall be cleaned and tested prior to installation of cables.

2. Fiber Optic Installer shall install pull rope in the conduit.

3. Conduits entering pullboxes shall be sealed with duct plugs.

4. The conduit shall gradually and smoothly slope up to the elevation of the pullbox entrance. Use of manufactured bends shall be limited to an absolute minimum. Factory bends, if required, shall be no more than 222 degrees.

5. A trace wire shall be installed along the entire fiber optic cable route for use in active cable location. The trace wire shall be a #12 AWG bare-copper solid strand. No insulation or other coating material shall be on the trace wire. The trace wire shall have a termination at each pullbox for connection to testing equipment.

6. Identification Tape: A 6-inch wide magnetically detectable warning tape with orange protective polyethylene jacket resistant to alkalis, acids, and other destructive elements shall be installed along the entire length of the conduit route. The polyethylene tape shall be continuously imprinted “CAUTION-FIBER OPTIC CABLE”. The warning tape shall be Teletrace by Vikamatic, or equal.

B. Conduit Installation in Common Trench:

1. Conduits shall not be installed in any common trench with pipelines

2. Fiber Optic Installer shall install marker signs along conduit trace as indicated.

3.2 FIBER OPTIC CABLE INSTALLATION

A. General:

1. The Fiber Optic Installer shall determine a suitable cable installation method to meet all cable installation requirements in all conduit segments. Work shall be carried out in accordance with and consistent with the highest standards of quality and craftsmanship in the communication industry with regard to the electrical and mechanical integrity of the connections; the finished appearance of the installation; and the accuracy and completeness of documentation.

2. The Fiber Optic Installer shall make a physical survey of the Site for the purpose of establishing the exact cable routing and cutting lengths prior to the commencement of any work or committing any materials.

3. The cable shall be carefully inspected for jacket defects as it is removed from the reel. If defects are noticed, the pulling operation shall be terminated immediately, and the Engineer notified.

4. Fiber optic cables shall be installed in continuous lengths without intermediate splices throughout the project. Cable installation personnel shall be familiar with the manufacturer's recommended procedures including at least the following:

a. Pulling using direct attachment to internal strength members.

b. Cable tensile limitations and tension monitoring procedures.

c. Cable bending radius limitations.

d. Cable twisting limitations.

B. Cable Protection During Installation:

1. Fiber optic cable shall be pulled in conduit unless indicated otherwise. Care shall be exercised to reduce the possibility of damage to the outer jacket of the fiber optic cable. The requirements herein shall be followed at a minimum, but the Fiber Optic Installer shall be responsible for additional measures if necessary to protect the cable. Damage shall be repaired by the Fiber Optic Installer as part of the work.

2. The Fiber Optic Installer shall comply with the cable manufacturer's recommended installation procedures at all times. Cable installation procedures shall conform to Belcore guidelines.

3. A cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it off the reel and into the duct. The cable shall be carefully inspected for jacket defects as it is removed from the reel. If defects are noticed, the pulling operation shall be terminated immediately, and the Engineer notified.

4. Precautions shall be taken during installation to prevent the cable from being kinked, crushed or twisted. A pulling eye shall be attached to the cable end to pull the cable through the duct and conduit system. As the cable is pulled off the reel and into the cable feeder guide, it shall be lubricated.

5. Crushed or kinked cable shall be replaced with new cable.

6. Dynamometers or break away pulling swings shall be used to ensure the pulling line tension does not exceed the installation tension values specified by the cable manufacturer. The mechanical stress placed upon the cable during installation shall not be such that the cable is twisted and stretched. Maximum allowable cable strain during installation shall be less than 0.75 percent.

C. Lubrication: As the cable is pulled into the conduit system, it shall be coated with a water-based lubricant approved by the cable manufacturer. Lubricant shall be applied at a rate to provide a continuous 10-mil coating or as recommended by the manufacturer. Lubricant shall be Polywater F7 manufactured by American Polywater or accepted equal.

D. To accommodate long continuous installation lengths, bi-directional “center pull” techniques for pulling of the fiber optic cable are acceptable.

E. When power equipment is used to install fiber optic cables, the pulling speed shall not exceed 30 meters per minute. The pulling tension, bending radius, and twist limitation for fiber optic cable shall not be exceeded under any circumstances.

F. Large diameter wheels, pulling sheaves, and cable guides shall be used to maintain the appropriate bending radius. Tension monitoring shall be accomplished using commercial dynamometers or load cell instruments.

G. The pulling eye/sheath termination hardware on the fiber optic cables shall not be pulled over any sheave blocks.

H. Pulls shall be documented by a graph which is annotated with the following information:

1. Reel number

2. Station from and station to

3. Date and time

4. Explanations of abnormalities in readings or interruptions

5. Sign-off by Fiber Optic Installer and Engineer.

I. Under no conditions shall the cable be left exposed or unattended.

J. Repairs: Repair of cable jacket will not be permitted. Jacket damage shall require removal and re-installation of new cable at the Fiber Optic Installer's expense.

K. Installation at Pullboxes:

1. Pulling of the cable shall be hand assisted at each handhole or pullbox. The cable shall not be crushed, kinked, or forced around a sharp corner. Sufficient slack shall be left at each end of the cable to allow proper cable termination.

2. The cable shall be looped in all pullboxes as indicated to provide approximately 15-feet of extra cable in the pullbox. At termination points such as at cabinets or computers, a 15-foot loop shall also be provided wherever space permits. The fiber optic cable shall be coiled and secured with cable ties in the pullbox. The Fiber Optic Installer shall not compromise the minimum bending radius of the fiber optic cable when preparing this stored cable slack.

3. Imprinted plastic-coated cloth identification/warning tags shall be securely attached to the cables in at least two locations in each handhole. Tags shall be by Brady or Thomas & Betts.

4. When cables at each pullbox are securely racked, unused conduits and voids around conduit containing cables shall be sealed.

5. Cable Marking: At each pullbox and at each cabinet, the cable shall be visibly marked with yellow warning tape as follows:

a. “CAUTION - FIBER OPTIC CABLE”

L. Splicing:

1. Splicing of fiber optic cable will not be permitted except in emergency conditions or if indicated otherwise. Cable runs and looping of the cable shall be provided in one continuous length. If the Engineer authorizes splicing, splicing shall be by trained, authorized persons only. Any allowed splicing of fiber optic cable shall be by fusion splice only; no mechanical splices are permitted.

2. Fusion splicing equipment shall be in good working order, properly calibrated, and meeting all industry standards and safety regulations. Cable preparation, closure installation and splicing shall be accomplished in accordance with accepted and approved industry standards.

3. Splices shall be made in pullboxes and using re-enterable splice closures.

4. The average splice loss shall be 0.1 dB or less per splice. The average splice loss is defined as the summation of the loss as measured in both directions using an optical time domain reflectometer (OTDR) through the fusion splice, divided by two. No individual splice loss measured in a single direction shall exceed 0.15 dB.

5. Upon completion of a splicing operation, waste material shall be deposited in suitable containers, removed from the Site, and disposed of in an environmentally acceptable manner.

3.3 PULLBOXES

A. Field Location of Pullboxes:

1. The Contract Drawings indicate the location of pullboxes, conduit runs, and other items. Exact locations shall be determined by the Fiber Optic Installer based on physical size and arrangement of equipment, finished elevations, calculated cable pulling tensions, field obstructions, and the criteria below. Locations on the Contract Drawings should be followed as closely as possible; however, pullboxes shall be located according to the following criteria:

a. At no point shall the cable pulling tension exceed 600 pounds. If cable pulling tension is calculated to exceed 600 pounds, additional pullboxes shall be provided at no extra cost to the Owner.

b. The maximum distance between any two pullboxes shall not exceed 750 feet.

c. Within the 750-feet distance, the Fiber Optic Installer shall install pullboxes at locations wherever the cumulative change of direction of the conduit exceeds 180 degrees.

d. The minimum bending radius for conduit shall be 3-feet.

e. A pullbox shall be installed on one side of a tunneled crossing. However, for any crossing, which requires more than 180 degrees of conduit bends to account for elevation differences or route adjustments, a pullbox shall be provided on both sides of the crossing.

f. Pullboxes shall be installed a minimum of 12-inch away from all structures.

B. Construction:

1. The Fiber Optic Installer shall install the pullbox covers so that the top of the cover is flush with the restored pavement. Pullboxes installed in soil areas shall be installed so that the top of the cover is at least one-inch but not more than 4-inch above the final grade level of the restored surface to prevent accumulation of dirt, silt, and debris on the top of the hand hole cover. Pullboxes installed in areas not subject to flooding or standing water shall have a minimum of five 5-inch drainage holes in the bottom of the box.

2. Fiber Optic Installer shall perform conduit integrity tests for each section between pullboxes after backfilling and compaction using the test and procedures described in this Section. These tests shall be performed prior to installation of the pull rope.

3. Pullbox conduit entries shall be sealed with duct plugs to prevent the intrusion of water and debris into the pullboxes.

4. Pullboxes shall be installed on a compacted level foundation consisting of 4-inch of granular material

5. Compaction around pullboxes and associated details shall be performed.

6. Upon final acceptance of the conduit system, all pullboxes shall be free of debris and water, and be ready for installation.

3.4 MODIFICATIONS

A. All dimensions and exact locations of underground substructures shall be field verified. Minor changes in locations of pullboxes, which result in no additional costs for material or labor, shall be made at no additional cost to the Owner. However, the Fiber Optic Installer shall prepare proposals consisting of detailed material lists, cost estimates, and schedules for rerouting the conduit around existing unforeseen underground utilities and structures, which result in additional cost, to be considered in accordance with the provisions of the General Conditions.

B. The Fiber Optic Installer shall consider the following when preparing proposals:

1. Manufactured bends shall be minimized

2. Required bends shall be less than 222 degrees

3.5 CONDUIT SYSTEM CLEANING AND TESTING

A. Following the backfill placement and compaction, all conduits shall be cleared of loose material by brush and compressed air.

B. Conduit shall be tested for leakage by air testing at 5 psi, maintaining the pressure for one hour without showing any leakage.

C. Following the leakage test, a test mandrel 1/4 inch smaller than the inside diameter shall be passed through all conduits to detect alignment and deformation problems. Mandrel shall be passed in both directions.

D. Cleaning and testing of the conduit shall be performed by the Fiber Optic Installer and witnessed by the Engineer. The cleaning and testing operation shall be conducted for each conduit section between adjacent pullboxes, a section at a time, for the entire route. The results of tests shall be documented by the Fiber Optic Installer and signed by the Engineer and the Fiber Optic Installer.

E. The Fiber Optic Installer shall provide a five-day advance notice of the schedule and location of test to the Engineer.

F. The Fiber Optic Installer shall remove and replace conduit which fails either test, and shall repeat the test.

3.6 FIBER OPTIC CABLE TESTING

A. General: The Fiber Optic Installer shall perform pre-installation and post-installation FOC tests. The Engineer shall be notified a minimum of 10 days in advance so that these tests are witnessed. All test equipment shall be traceable to LIST standards.

B. Test Equipment: The Fiber Optic Installer shall use the following to perform pre-installation and post-installation FOC tests:

1. Optical Time Domain Reflectometer (OTDR): The OTDR shall be laser precision, ALT Inc. MODEL 5200 LRFL, or equal.

C. Pre-Installation Tests:

1. The purpose of these tests is to perform acceptance tests on the cable prior to installation to verify that the cable conforms to the manufacturer's specifications, and is free of defects, breaks and damages by transportation and manufacturing processes.

2. Prior to removal of each cable from the delivery reel, all optical fibers within the cables shall be tested by the Fiber Optic Installer using an OTDR. The OTDR tests shall consist of end-to-end length and fiber attenuation (dB/km) measurements to ensure proper performance of the fiber optic cable. The tests shall be performed from both ends of each fiber to ensure complete fiber continuity within the cable structure.

3. Pre-installation, “on-reel” test results shall be compared with the manufacturer's test report delivered with the cable. Gross dissimilarities shall be noted and remedied between the Fiber Optic Installer and manufacturer. In all cases, all fibers must meet the optical attenuation specifications prior to cable installation.

4. The Fiber Optic Installer shall perform tests on all reels of cable. The Engineer shall be notified a minimum of 15 days prior to any test.

5. The Fiber Optic Installer shall document each test and submit the report for review.
6. Cable shall not be installed until the Engineer has reviewed the test report.

7. Maximum allowable attenuation is 0.5 dB/km at 1310 and 1550 nm. The Fiber Optic Installer shall replace any cable in which any fiber does not meet this requirement.

D. Post-Installation Tests: After fiber optic cable has been installed the following tests shall be performed:

1. A recording OTDR shall be used to test for end-to-end continuity and attenuation of each optical fiber. The OTDR shall be equipped with a 1310 nm and 1550 nm light source for the single mode fiber (SMF), and an 850 nm and 1300 nm light source for multi-mode fibers. The OTDR shall have an X-Y plotter to provide a hard copy record of each trace of each fiber. The OTDR shall be equipped with sufficient internal masking to allow the entire cable section to be tested. This may be achieved by using an optical fiber pigtail of 30 feet or more to display the required cable section.

2. The maximum permissible end-to-end loss shall be 0.5 dB/km. The Fiber Optic Installer shall replace any cable in which any fiber does not meet this requirement.

3. The OTDR shall be calibrated for the correct index of refraction to provide proper length measurement for the known length of reference fiber.

4. A transmission test shall be performed with the use of a 1310 and 1550 nm stabilized light sources and 1310 nm/1550 nm power meters for SMF. This test shall be conducted in both directions on each fiber of each cable.

5. Hard and electronic copy of test documentation shall be submitted to the Engineer. The documentation shall include the trace plot, index, dB/km loss, cable length, date and time of test, wavelength, pulse width, the test site, cable ID, fiber number and type, and operator's initials. The Fiber Optic Installer shall compare the pre-installation test results to the post-installation results. If a deviation of greater than one (1.0) dB occurs, the Engineer shall be notified in writing by the Fiber Optic Installer, and the cable shall be removed and replaced at no additional cost.

6. Upon completion of the previous tests, all FOC coils shall be secured with ends capped to prevent intrusion of dirt and water.

E. Required OTDR Trace Information:

1. All traces shall display the entire length of cable under test, highlighting any localized loss discontinuities (installation-induced losses and/or connector losses). The trace shall display fiber length (in kilofeet), fiber loss (dB), and average fiber attenuation (in dB/km) as measured between two markers placed as near to the opposite ends of the fiber under test as is possible while still allowing an accurate reading. Care shall be taken to ensure that the markers are placed in the linear region of the trace: away from the front-end response and far-end Fresnel reflection spike. Time averaging shall be used to improve the display signal to noise ratio. The pulse width of the OTDR shall be set to a sufficient width to provide adequate injected power to measure the entire length of the fiber under test.

2. If connectors exist in the cable under test, then two traces shall be recorded. One trace shall record the fiber loss (dB) and average attenuation (dB/km) of the entire cable segment under test, including connectors. The second trace shall display a magnified view of the connector regions, revealing the connector losses (dB). All connector losses shall be measured using the 5-point splice loss measurement technique.

3. The OTDR trace shall also include the following information:

a. The date and time of the test

b. The cable ID number

c. The cable segment ID number

d. The fiber color or sub-cable number

e. Launch point connector number

f. The optical wavelength used for the test

g. The refractive index setting of the OTDR

h. The pulse width setting of the OTDR

i. The averaging interval of the test

3.7 SYSTEM ACCEPTANCE

A. After all network equipment, cables, and all other necessary devices are installed and tested and accepted by the Engineer, the Fiber Optic Installer shall conduct tests to verify that all the networks perform as a system as intended according to this specification. The Fiber Optic Installer shall demonstrate that the network is able to transmit/receive data and signals at the various user locations at the Treatment Plant at the speed and quality as stipulated in this

specification. The Fiber Optic Installer shall repair, adjust, and replace, at his cost, any deficiency in material, equipment, and installation before the system will be accepted by the Engineer.

3.8 WARRANTY

A. The Fiber Optic Installer shall furnish an unconditional warranty on fiber optic cable for a minimum period of two years following system acceptance

END OF SECTION 271323

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Category 6 twisted pair cable.

2. Twisted pair cable hardware.

3. Cable management system.

1.2 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.

2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.

3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules:

a. Electronic copy of labeling schedules, in software and format selected by Owner.

2. Cabling administration Drawings and printouts.

3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment.

C. Twisted pair cable testing plan.

D. Samples: For telecommunications jacks and plugs, in specified finish, one for each type and configuration and cover plates for color selection and evaluation of technical features.

E. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer**,** installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: On USB media.

3. Device address list.

4. Printout of software application and graphic screens.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.7 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated:

a. Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway.

b. Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2. Communications, Non-Plenum Rated:

a. Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.

2. Smoke-Developed Index: 50 or less.

2.3 CATEGORY 6 TWISTED PAIR CABLE

A. Description: Four-pair, balanced twisted pair cable, with internal spline**,** certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz

B. Belden

C. CommScope

D. Hitachi

E. CORDATA Labs

F. Mohawk

G. or equal

H. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

I. Conductors: 100-ohm, 23 AWG solid copper.

J. Shielding/Screening: Shielded twisted pairs (FTP).

K. Cable Rating: Plenum.

L. Jacket: Blue thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6.

2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.

3. Cables shall be terminated with connecting hardware of same category or higher.

C. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.

D. Connecting Blocks:

1. 110-style IDC for Category 6.

2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

3. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.

b. Labeling areas adjacent to conductors.

c. Replaceable connectors.

d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.

3. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

F. Patch Cords: Factory-made, four-pair cables in 6-ft lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.

G. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.

2. Standard: Comply with TIA-568-C.2.

3. Marked to indicate transmission performance.

H. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.

2. Designed to snap-in to a patch panel or cover plate.

3. Standard: Comply with TIA-568-C.2.

4. Marked to indicate transmission performance.

I. Cover Plate:

1. Two port, vertical single gang cover plates designed to mount to single gang wall boxes.
2. Plastic Cover Plate: High-impact plastic.

3. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

J. Legend:

1. Machine printed, in the field, using adhesive-tape label.

2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 CABLE MANAGEMENT SYSTEM

A. Description: Computer-based cable management system, with integrated database and graphic capabilities.

B. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.

C. Information shall be presented in database view, schematic plans, or technical drawings.

1. AutoCAD drawing software shall be used as drawing and schematic plans software.

D. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.

2. Direct download circuit labeling into labeling printer.

PART 3 - EXECUTION

3.1 INSTALLATION OF TWISTED PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. Routing: Install cables in raceways, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

D. General Requirements for Cabling:

1. Comply with TIA-568-C.1.

2. Comply with BICSI's Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.

3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.

5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inch and not more than 6 inch from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.

8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.

9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.

10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

11. In the communications equipment room, install a 10-foot-long service loop on each end of cable.

12. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.

3.2 FIRESTOPPING

A. Comply with TIA-569-D, Annex A, "Firestopping."

B. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.3 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

C. Comply with TIA-607-B and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration, including optional identification requirements of this standard.

C. Equipment grounding conductors.

D. Cable and Wire Identification:

1. Label each cable within 4 inch of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.

3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.

4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.

    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

E. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.5 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Contractor shall submit Acceptance Testing Form for approval.

B. Field tests and inspections must be witnessed by Owner.

C. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

E. Nonconforming Work:

1. End-to-end cabling will be considered defective if it does not pass tests and inspections.

2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.6 MAINTENANCE

A. Software Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software service agreement includes software support for two years.

2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.

    a. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 271513

SECTION 311000 - SITE CLEARING

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Stripping and stockpiling rock.
6. Removing above- and below-grade site improvements.
7. Disconnecting, capping or sealing, and removing site utilities.
8. Temporary erosion and sedimentation control.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction as indicated on Drawings and in accordance to applying specifications.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.6 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

B. Topsoil stripping and stockpiling program.

C. Rock stockpiling program.

D. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

E. Burning: Documentation of compliance with burning requirements and permitting of authorities having jurisdiction. Identify location(s) and conditions under which burning will be performed.

1.7 QUALITY ASSURANCE

A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

B. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.8 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Engineer.

C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises, per coordination with the Owner.

D. Utility Locator Service: Notify local utility locator service for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

F. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."

G. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with **MPI #23.**

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed**.**

1. Arrange with utility companies to shut off indicated utilities.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer's written permission.

E. Excavate for and remove underground utilities indicated to be removed.

F. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots larger than **2 inches (50 mm)** in diameter, obstructions, and debris to a depth of **18 inches (450 mm)** below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of **6 inches (150 mm)** in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to **72 inches (1800 mm)**.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.6 STOCKPILING ROCK

A. Remove from construction area naturally formed rocks that measure more than **1 foot (300 mm)** across in least dimension. Do not include excavated or crushed rock.

1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile rock where indicated and approved by Owner without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.

1. Limit height of rock stockpiles to **36 inches (900 mm)**.
2. Do not stockpile rock within protection zones.
3. Dispose of surplus rock. Surplus rock is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus rock to allow later use by the Owner.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Burning tree, shrub, and other vegetation waste is permitted according to burning requirements and permitting of authorities having jurisdiction. Control such burning to produce the least smoke or air pollutants and minimum annoyance to surrounding properties. Burning of other waste and debris is prohibited.

C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs, walks, pavements, turf, grasses, and plants.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete walks and pavements.
6. Subbase course for asphalt paving.
7. Subsurface drainage backfill for walls and trenches.
8. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Requirements:

1. Section 311000 "Site Clearing" for site stripping, grubbing, stripping topsoil, and removal of above- and below-grade improvements and utilities.
2. Section 316329 "Drilled Concrete Piers and Shafts" for excavation of shafts and disposal of surplus excavated material.

1.2 UNIT PRICES

A. Work of this Section is affected by unit prices for earth moving specified in Section 012200 "Unit Prices."

B. Quantity allowances for earth moving are included in Section 012100 "Allowances."

C. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials.

1. **24 inches (600 mm)** outside of concrete forms other than at footings.
2. **12 inches (300 mm)** outside of concrete forms at footings.
3. **6 inches (150 mm)** outside of minimum required dimensions of concrete cast against grade.
4. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
5. **6 inches (150 mm)** beneath bottom of concrete slabs-on-grade.
6. **6 inches (150 mm)** beneath pipe in trenches, and the greater of **24 inches (600 mm)** wider than pipe or **42 inches (1065 mm)** wide.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavation more than **10 feet (3 m)** in width and more than **30 feet (9 m)** in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, will be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock:

1. Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed **1 cu. yd. (0.76 cu. m)** for bulk excavation or **3/4 cu. yd. (0.57 cu. m)** for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

a. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- (1065-mm-) maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp (103-kW) flywheel power with bucket-curling force of not less than 28,700 lbf (128 kN) and stick-crowd force of not less than 18,400 lbf (82 kN) with extra-long reach boom.
b. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp (172-kW) flywheel power and developing a minimum of 47,992-lbf (213.3-kN) breakout force with a general-purpose bare bucket.

2. Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material **3/4 cu. yd. (0.57 cu. m)** or more in volume that exceed a standard penetration resistance of **100 blows/2 inches (97 blows/50 mm)** when tested by a geotechnical testing agency, according to ASTM D1586.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other fabricated stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct preexcavation conference at Project site.

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:

a. Personnel and equipment needed to make progress and avoid delays.
b. Coordination of Work with utility locator service.
c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
d. Extent of trenching by hand or with air spade.
e. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Controlled low-strength material, including design mixture.
3. Geofoam.
4. Warning tapes.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: 12 by 12 inches (300 by 300 mm).
2. Warning Tape: 12 inches (300 mm) long; of each color.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D2487.
2. Laboratory compaction curve according to ASTM D698 and ASTM D1557.

C. Blasting plan approved by authorities having jurisdiction.

D. Seismic survey report from seismic survey agency.

E. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.7 QUALITY ASSURANCE

A. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:

1. Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
2. Seismographic monitoring during blasting operations.

B. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:

1. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
2. Seismographic monitoring during blasting operations.

C. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

1.8 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Utility Locator Service: Notify local utility locator service for area where Project is located before beginning earth-moving operations.

D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 015000 "Temporary Facilities and Controls" and Section 311000 "Site Clearing" are in place.

E. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487 or a combination of these groups; free of rock or gravel larger than **3 inches (75 mm)** in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

1. Liquid Limit: Per local regulation.
2. Plasticity Index: Per local regulation.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 3/4-inch sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a 3/4-inch sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 3/4-inch sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

H. Drainage Course: Narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and zero to 5 percent passing a No. 8 (2.36-mm) sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and zero to 5 percent passing a No. 4 (4.75-mm) sieve.

J. Sand: ASTM C33/C33M; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability:

   a. Class 2; AASHTO M 288.
   b. As follows:

      1) Grab Tensile Strength: 157 lbf (700 N); ASTM D4632.
      2) Sewn Seam Strength: 142 lbf (630 N); ASTM D4632.
      3) Tear Strength: 56 lbf (250 N); ASTM D4533.
      4) Puncture Strength: 56 lbf (250 N); ASTM D4833.

   c. Apparent Opening Size: **No. 40 (0.425-mm)** sieve, maximum; ASTM D4751.
   d. Permittivity: **0.5** per second, minimum; ASTM D4491.
   e. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability:

a. Class 2; AASHTO M 288.
b. As follows:

1) Grab Tensile Strength: 247 lbf (1100 N); ASTM D4632.
2) Sewn Seam Strength: 222 lbf (990 N); ASTM D4632.
3) Tear Strength: 90 lbf (400 N); ASTM D4533.
4) Puncture Strength: 90 lbf (400 N); ASTM D4833.

c. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D4751.
d. Permittivity: 0.02 per second, minimum; ASTM D4491.
e. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting, flowable concrete material produced from the following:

1. Portland Cement: ASTM C150/C150M, Type I.
2. Fly Ash: ASTM C618, Class C or F.
3. Normal-Weight Aggregate: ASTM C33/C33M, **3/4-inch (19-mm)** nominal maximum aggregate size.
4. Foaming Agent: ASTM C869/C869M.
5. Water: ASTM C94/C94M.
6. Air-Entraining Admixture: ASTM C260/C260M.

B. Produce cellular, low-density, controlled low-strength material with the following physical properties:

1. As-Cast Unit Weight: **30 to 36 lb/cu. ft. (480 to 576 kg/cu. m)** at point of placement, when tested according to ASTM C138/C138M.
2. Compressive Strength: **80 psi (550 kPa)**, when tested according to ASTM C495/C495M.

C. Produce conventional-weight, controlled low-strength material with **80-psi (550-kPa)** compressive strength when tested according to ASTM C495/C495M.

2.4 GEOFOAM

A. Extruded-Polystyrene Board Insulation: ASTM C578, **Type IV, 1.55-lb/cu. ft. (25-kg/cu. m)** density, 25-psi (173-kPa) compressive strength.

B. Molded-Polystyrene Board Insulation: ASTM C578, Type I, 0.90-lb/cu. ft. (15-kg/cu. m) density, 10-psi (69-kPa) compressive strength.

1. Manufacture molded polystyrene with an inorganic mineral registered with the EPA and suitable for application as a termite deterrent.

C. Rigid Cellular Polystyrene Geofoam: ASTM D6817, Type EPS 19, 1.15-lb/cu. ft. (18.4-kg/cu. m) density, 5.8-psi (40-kPa) compressive strength at 1 percent deformation; 16-psi (110-kPa) compressive strength at 10 percent deformation.

D. Connectors: Geofoam manufacturer's multibarbed, galvanized-steel sheet connectors .

2.5 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

3.3 EXPLOSIVES

A. Explosives:

1. Do not use explosives.

B. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. **24 inches (600 mm)** outside of concrete forms other than at footings.
b. **12 inches (300 mm)** outside of concrete forms at footings.
c. **6 inches (150 mm)** outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. **6 inches (150 mm)** beneath bottom of concrete slabs-on-grade.
f. **6 inches (150 mm)** beneath pipe in trenches and the greater of **24 inches (600 mm)** wider than pipe or **42 inches (1065 mm)** wide.

C. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

    a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. **24 inches (600 mm)** outside of concrete forms other than at footings.
    b. **12 inches (300 mm)** outside of concrete forms at footings.
    c. **6 inches (150 mm)** outside of minimum required dimensions of concrete cast against grade.
    d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    e. **6 inches (150 mm)** beneath bottom of concrete slabs-on-grade.
    f. **6 inches (150 mm)** beneath pipe in trenches and the greater of **24 inches (600 mm)** wider than pipe or **42 inches (1065 mm)** wide.

3.4 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations 6 to 12 inches (150 to 300 mm) above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: **12 inches (300 mm) each side of pipe or conduit**.

C. Trench Bottoms:

1. Excavate trenches 4 inches (100 mm) deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

a. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.7 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes) to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).

2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within **18 inches (450 mm)** of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

D. Trenches under Roadways: Provide **4-inch- (100-mm-)** thick, concrete-base slab support for piping or conduit less than **30 inches (750 mm)** below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of **4 inches (100 mm)** of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of subbase material in any dimension, to a height of 12 inches (300 mm) over the pipe or conduit.

    a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

G. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

H. Warning Tape: Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.12 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 GEOFOAM FILL

A. Place a leveling course of sand, **2 inches (50 mm)** thick, over subgrade. Finish leveling course to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

1. Place leveling course on subgrades free of mud, frost, snow, or ice.

B. Install geofoam blocks in layers with abutting edges and ends and with the long dimension of each block at right angles to blocks in each subsequent layer. Offset joints of blocks in successive layers.

C. Install geofoam connectors at each layer of geofoam to resist horizontal displacement according to geofoam manufacturer's written instructions.

D. Cover geofoam with separation geotextile before placing overlying soil materials.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than **8 inches (200 mm)** in loose depth for material compacted by heavy compaction equipment and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to **ASTM D698**:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at **95** percent.
2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at **85** percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at **85** percent.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus **1 inch (25 mm).**
2. Walks: Plus or minus **1 inch (25 mm)**.
3. Pavements: Plus or minus **1/2 inch (13 mm).**

C. Grading inside Building Lines: Finish subgrade to a tolerance of **1/2 inch (13 mm)** when tested with a 10-foot (3-m) straightedge.

3.17 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch (150-mm) course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches (300 mm) of filter material, placed in compacted layers 6 inches (150 mm) thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).

1. Compact each filter material layer with a minimum of two passes of a plate-type vibratory compactor.

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches (300 mm) of final subgrade, in compacted layers 6 inches (150 mm) thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).

1. Compact each filter material layer with a minimum of two passes of a plate-type vibratory compactor.
2. Place and compact impervious fill over drainage backfill in 6-inch- (150-mm-) thick compacted layers to final subgrade.

3.18 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.

2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course to required crown elevations and cross-slope grades.
4. Place subbase course 6 inches (150 mm) or less in compacted thickness in a single layer.
5. Place subbase course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
6. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to **ASTM D698**.

C. Pavement Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase layer to not less than 95 percent of maximum dry unit weight according to **ASTM D698**.

3.19 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches (150 mm) or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.20 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material classification and maximum lift thickness comply with requirements.
3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.
4. <**Insert special inspections**>.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every **2000 sq. ft. (186 sq. m)** or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every **100 feet (30 m)** or less of wall length but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every **150 feet (46 m)** or less of trench length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.21 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 316329 - DRILLED CONCRETE PIERS AND SHAFTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dry-installed drilled piers.
2. Slurry displacement-installed drilled piers.
3. Dry-installed or slurry displacement-installed drilled piers at Contractor's choice.

1.2 UNIT PRICES

A. Drilled Piers: Actual net volume of drilled piers in place and approved. Actual length, shaft diameter, and bell diameter if applicable, may vary, to coincide with elevations where satisfactory bearing strata are encountered. These dimensions may also vary with actual bearing value of bearing strata determined by an independent testing and inspecting agency. Adjustments are made on net variation of total quantities, based on design dimensions for shafts and bells.

1. Base bids on indicated number of drilled piers and, for each pier, the design length from top elevation to bottom of shaft, extended through the bell, if applicable, and the diameter of shaft and bell.
2. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, testing and inspecting, and other items for complete drilled-pier installation.

B. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed outside dimensions of drilled piers cast against rock. Unit prices for rock excavation include replacement with approved materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **Project site** or via teleconference at owner’s request.

1. Review methods and procedures related to drilled piers including, but not limited to, the following:

a. Review geotechnical report.
b. Discuss existing utilities and subsurface conditions.
c. Review coordination with temporary controls and protections.
d. Review measurement and payment of unit prices.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture. Submit alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Shop Drawings: For concrete reinforcement, detailing fabricating, bending, supporting, and placing.

D. Pile Installation Plan: Provide sufficient detail for the Engineer to grasp the means, methods, and materials that the contractor plans to use to successfully complete CIDH pile installation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, land surveyor, professional engineer, and testing agency.

B. Material Certificates: From manufacturer, for the following:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.

C. Material Test Reports: For each material below, by a qualified testing agency:

1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Record drawings.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in drilled-pier work.

B. Testing Agency Qualifications: Qualified according to ASTM C1077, ASTM D3740, and ASTM E329 for testing indicated.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.8 FIELD CONDITIONS

A. Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.

1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.

B. Interruption of Existing Utilities: Do not interrupt any utility to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify owner no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Owner's written permission.

C. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for drilled piers.
2. The geotechnical report is included elsewhere in the Project Manual.

D. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

1. Record and maintain information pertinent to each drilled pier and indicate on record Drawings. Cooperate with Owner's testing and inspecting agency to provide data for required reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Drilled-Pier Standards: Comply with ACI 336.1 except as modified in this Section. Construction of CIDH piles shall also be in conformance with the 2023 Caltrans Standard Specifications from the State of California State Transportation Agency Department of Transportation. This includes the following sections: Section 49 – Piling, Section 52 – Reinforcement and Section 90 – Concrete.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60 , deformed.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C150/C150M, **Type V**. Supplement with the following:

a. Fly Ash: ASTM C618, Class F.
b. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

2. Blended Hydraulic Cement: ASTM C595/C595M, Type IL (HS) cement.

B. Normal-Weight Aggregate: ASTM C33/C33M, graded, 3/4-inch nominal maximum coarse-aggregate size. Provide aggregate from a single source

1. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C94/C94M and potable.

D. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
3. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
4. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

2.4 STEEL CASINGS

A. Steel Pipe Casings: ASTM A283/A283M, Grade C, or ASTM A36/A36M, carbon-steel plate, with joints full-penetration welded according to AWS D1.1/D1.1M.

B. Corrugated-Steel Pipe Casings: ASTM A929/A929M, steel sheet, zinc coated.

C. Liners: Comply with ACI 336.1.

2.5 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

D. Proportion normal-weight concrete mixture as follows:

1. Compressive Strength (28 Days): 4500 psi .
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Minimum Slump: Capable of maintaining the following slump until completion of placement:

    a. 4 inches for dry, uncased, or permanent-cased drilling method.
    b. 6 inches for temporary-casing drilling method.

4. Air Content: Do not air entrain concrete.

2.6 REINFORCEMENT FABRICATION

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.

3.2 EXCAVATION

A. Classified Excavation: Excavation is classified as standard excavation, special excavation, and obstruction removal and includes excavation to bearing elevations as follows:

1. Standard excavation includes excavation accomplished with conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work.
2. Special excavation includes excavation that requires special equipment or procedures where drilled-pier excavation equipment used in standard excavation, operating at maximum power, torque, and downthrust, cannot advance the shaft.

    a. Special excavation requires use of special rock augers, core barrels, air tools, blasting, or other methods of hand excavation.
    b. Earth seams, rock fragments, and voids included in rock excavation area are considered rock for full volume of shaft from initial contact with rock.

3. Obstructions: Payment for removing unanticipated boulders, concrete, masonry, or other subsurface obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work is according to Contract provisions for changes in the Work.

B. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.

C. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation.

1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
2. Remove water from excavated shafts before concreting.

D. Notify and allow testing and inspecting agency to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Engineer.

1. Do not excavate shafts deeper than elevations indicated unless approved by Engineer.
2. Payment for additional authorized excavation is according to Contract provisions for changes in the Work.

E. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.

1. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete.

F. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.

1. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit corrective construction proposals to Engineer for review before proceeding.

3.3 PERMANENT STEEL CASING INSTALLATION

A. Install permanent steel casings of minimum wall thickness indicated and of diameter not less than diameter of drilled pier.

1. Install casings as excavation proceeds, to maintain sidewall stability.
2. Connect casing sections by continuous penetration welds to form watertight, continuous casing.
3. Remove and replace or repair casings that have been damaged during installation and that could impair strength or efficiency of drilled pier.

3.4 STEEL REINFORCEMENT INSTALLATION

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover over reinforcement.

E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.

F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.5 CONCRETE PLACEMENT

A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by a qualified Special Inspector.

1. Construct a construction joint if concrete placement is delayed more than one hour. Level top surface of concrete and insert joint dowel bars. Before placing remainder of concrete, clean surface laitance, roughen, and slush concrete with commercial bonding agent or with sand-cement grout mixed at ratio of 1:1.

B. Slurry Displacement Method: Place concrete in slurry-filled shafts by tremie methods or pumping. Control placement operations to ensure that tremie or pump pipe is embedded no less than 60 inches into concrete and that flow of concrete is continuous from bottom to top of drilled pier.

C. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch head of concrete above bottom of casing.

1. Vibrate top 60 inches of concrete after withdrawal of temporary casing.

D. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.

E. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.

1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.

F. If hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no more than 90 deg F.

1. Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of seven days.

3.6 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Drilled piers.
2. Excavation.
3. Concrete.
4. Steel reinforcement welding.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Drilled-Pier Tests and Inspections: For each drilled pier, before concrete placement.

1. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths and bearing capacities are determined by testing and inspecting agency. Final evaluations and approval of data are determined by Architect.

a. Bearing Stratum Tests: Testing agency takes undisturbed hardpan core samples from drilled-pier bottoms; tests each sample for compression, moisture content, and density; and reports results and evaluations.

D. Concrete Tests and Inspections: ASTM C172/C172M except modified for slump to comply with ASTM C94/C94M.

1. Slump: ASTM C143/C143M; one test at point of placement for each compressive-strength test but no fewer than one test for each concrete load.
2. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and 80 deg F and above, and one test for each set of compressive-strength specimens.
3. Compression Test Specimens: ASTM C31/C31M; one set of four standard cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.
4. Compressive-Strength Tests: ASTM C39/C39M; one set for each drilled pier but not more than one set for each truck load. Test one specimen at seven days, test two specimens at 28 days, and retain one specimen in reserve for later testing if required.
5. If frequency of testing provides fewer than five strength tests for a given class of concrete, conduct tests from at least five randomly selected batches or from each batch if fewer than five are used.
6. If strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor is to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
7. Strength of each concrete mixture is satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength

and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

8. Report test results in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. List Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests in reports of compressive-strength tests.
9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but not be used as sole basis for approval or rejection of concrete.
10. Additional Tests: Testing and inspecting agency to make additional tests of concrete if test results indicate that slump, compressive strengths, or other requirements have not been met, as directed by Architect.

11. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

E. An excavation, concrete, or a drilled pier will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports for each drilled pier as follows:

1. Actual top and bottom elevations.
2. Actual drilled-pier diameter at top, bottom, and bell.
3. Top of rock elevation.
4. Description of soil materials.
5. Description, location, and dimensions of obstructions.
6. Final top centerline location and deviations from requirements.
7. Variation of shaft from plumb.
8. Shaft excavating method.
9. Levelness of bottom and adequacy of cleanout.
10. Properties of slurry and slurry test results at time of slurry placement and at time of concrete placement.
11. Ground-water conditions and water-infiltration rate, depth, and pumping.
12. Description, purpose, length, wall thickness, diameter, tip, and top and bottom elevations of temporary or permanent casings. Include anchorage and sealing methods used and condition and weather tightness of splices if any.
13. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
14. Date and time of starting and completing excavation.
15. Inspection report.
16. Condition of reinforcing steel and splices.
17. Position of reinforcing steel.
18. Concrete placing method, including elevation of consolidation and delays.
19. Elevation of concrete during removal of casings.
20. Locations of construction joints.
21. Concrete volume.
22. Concrete testing results.

23. Remarks, unusual conditions encountered, and deviations from requirement

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 316329

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt overlay.
3. Cold milling of existing asphalt pavement.
4. Hot-mix asphalt patching.
5. Asphalt curbs.
6. Asphalt traffic-calming devices.
7. Asphalt surface treatments.

B. Related Requirements:

1. Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition “for demolition and removal of existing asphalt pavement.
2. Section 312000 "Earth Moving" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
3. Section 321313 "Concrete Paving" for concrete pavement and for separate concrete curbs, gutters, and driveway aprons.
4. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.

1.3 UNIT PRICES

A. Work of this Section is affected by specified unit prices.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.

b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.5 ACTION SUBMITTALS

A. Product Data: Include technical data and tested physical and performance properties.

1. Herbicide.
2. Paving geotextile.
3. Joint sealant.

B. Hot-Mix Asphalt Designs:

1. Certification, by authorities having jurisdiction, of approval of each hot-mix asphalt design proposed for the Work.
2. For each hot-mix asphalt design proposed for the Work.

C. Samples for Verification: For the following product, in manufacturer's standard sizes unless otherwise indicated:

1. Paving Geotextile: 12 by 12 inches (300 by 300 mm) minimum.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For paving-mix manufacturer and testing agency.

B. Material Certificates: Mixes containing recycled materials will perform equal to mixes produced from all new materials.

1. Aggregates.
2. Asphalt binder.
3. Asphalt cement.
4. Cutback prime coat.
5. Emulsified asphalt prime coat.
6. Tack coat.
7. Fog seal.
8. Undersealing asphalt.

C. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.

B. Testing Agency Qualifications: Qualified in accordance with ASTM D3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of California DOT for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
2. Tack Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
3. Slurry Coat: Comply with weather limitations in ASTM D3910.
4. Asphalt Base Course and Binder Course: Minimum surface temperature of 40 deg F (4.4 deg C) and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.6 deg C) at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D692/D692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: **ASTM D1073**, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: **ASTM D242/D242M**, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: ASTM D6373 or AASHTO M 320

B. Asphalt Cement: ASTM D3381/D3381M for viscosity-graded material, ASTM D946/D946M for penetration-graded material.

C. Cutback Prime Coat: ASTM D2027/D2027M, medium-curing cutback asphalt, MC-30 or MC-70.

D. Emulsified Asphalt Prime Coat: ASTM D977 or AASHTO M 140 emulsified asphalt, or ASTM D2397/D2397M or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

E. Tack Coat: ASTM D977 or AASHTO M 140 emulsified asphalt, or ASTM D2397/D2397M or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

F. Fog Seal: ASTM D977 or AASHTO M 140 emulsified asphalt, or ASTM D2397/D2397M or AASHTO M 208 cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.

G. Water: Potable.

H. Undersealing Asphalt: ASTM D3141/D3141M; pumping consistency.

2.3 AUXILIARY MATERIALS

A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled materials from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.

B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

C. Sand: **ASTM D1073** or **AASHTO M 29**, Grade No. 2 or No. 3.

D. Paving Geotextile: AASHTO M 288 paving fabric; nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.

E. Joint Sealant: ASTM D6690, **Type I**, hot-applied, single-component, polymer-modified bituminous sealant.

2.4 MIXES

A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

B. Emulsified-Asphalt Slurry: ASTM D3910, **Type 2**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protection: Provide protective materials, procedures, and worker training to prevent asphalt materials from spilling, coating, or building up on curbs, driveway aprons, manholes, and other surfaces adjacent to the Work.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.

3.3 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of **1-1/2 inches (38 mm)**
2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, driveway aprons, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Patch surface depressions deeper than 1 inch (25 mm) after milling, before wearing course is laid.
7. Handle milled asphalt material in accordance with approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."
8. Keep milled pavement surface free of loose material and dust.
9. Do not allow milled materials to accumulate on-site.

3.4 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Undersealing: Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Single-Course Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

E. Placing Two-Course Patch Material: Partially fill excavated pavements with hot-mix asphalt base course mix and, while still hot, compact. Cover asphalt base course with compacted layer of hot-mix asphalt surface course, finished flush with adjacent surfaces.

3.5 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch (25 mm) in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches (75 mm) thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of **1/4 inch (6 mm)**

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.

3.6 SURFACE PREPARATION

A. Ensure that prepared subgrade has been proof-rolled and is ready to receive paving. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces.

B. Herbicide Treatment: Apply herbicide in accordance with manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Cutback Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. (0.7 to 2.3 L/sq. m). Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

D. Emulsified Asphalt Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.10 to 0.30 gal./sq. yd. per inch depth (0.5 to 1.40 L/sq. m per 25 mm depth). Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.7 INSTALLATION OF PAVING GEOTEXTILE

A. Apply tack coat, asphalt binder, or asphalt cement uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd. (0.8 to 1.2 L/sq. m).

B. Place paving geotextile promptly in accordance with manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches (100 mm) and transverse joints 6 inches (150 mm).

C. Protect paving geotextile from traffic and other damage, and place hot-mix asphalt overlay the same day.

3.8 HOT-MIX ASPHALT PLACEMENT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course and binder course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at a minimum temperature of 250 deg F (121 deg C).
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches (25 to 38 mm) from strip to strip to ensure proper compaction of mix along longitudinal joints.
2. Complete a section of asphalt base course and binder course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.9 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
3. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method in accordance with AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.10 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density, Marshall Test Method: 96 percent of reference laboratory density in accordance with **ASTM D6927 or AASHTO T 245**, but not less than 94 percent or greater than 100 percent.
2. Average Density, Rice Test Method: 92 percent of reference maximum theoretical density in accordance with ASTM D2041/D2041M, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.11 ASPHALT CURBS

A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread hot-mix asphalt at a minimum temperature of 250 deg F (121 deg C).

1. Hot-Mix Asphalt: Same as pavement surface-course mix.

B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.12 ASPHALT TRAFFIC-CALMING DEVICES

A. Construct hot-mix asphalt speed compacted pavement surfaces. Apply a tack coat unless pavement surface is still tacky and free from dust. Spread hot-mix asphalt at a minimum temperature of 250 deg F (121 deg C).

1. Tack Coat Application: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
2. Hot-Mix Asphalt: Same as pavement surface-course mix.
3. Before installation, mill pavement that will be in contact with bottom of traffic-calming device. Mill to a depth of 1 inch (25 mm) from top of pavement to a clean, rough profile.

B. Place and compact hot-mix asphalt to cross section indicated, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.13 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch (13 mm).
2. Surface Course: Plus 1/4 inch (6 mm), no minus.

B. Pavement Surface Smoothness: Compact each course to produce surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:

1. Base Course: **1/4 inch (6 mm)**.
2. Surface Course: **1/8 inch (3 mm)**.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).

C. Asphalt Traffic-Calming Devices: Compact and form asphalt to the shapes indicated and within a tolerance of plus or minus 1/8 inch (3 mm) of height indicated above pavement surface.

3.14 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. (0.45 to 0.7 L/sq. m) to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.

B. Slurry Seals: Apply slurry coat in a uniform thickness in accordance with ASTM D3910 and allow to cure.

1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined in accordance with ASTM D3549/D3549M.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. Asphalt Traffic-Calming Devices: Finished height of traffic-calming devices above pavement will be measured for compliance with tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement in accordance with **ASTM D979/D979M** or **AASHTO T 168**.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared in accordance with ASTM D2041/D2041M, and compacted in accordance with job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples in accordance with ASTM D1188 or ASTM D2726/D2726M.

    a. One core sample will be taken for every 1000 sq. yd. (836 sq. m) or less of installed pavement, with no fewer than three cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method in accordance with ASTM D2950/D2950M and coordinated with ASTM D1188 or ASTM D2726/D2726M.

F. Replace and compact hot-mix asphalt where core tests were taken.

G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.16 WASTE HANDLING

A. General: Handle asphalt-paving waste in accordance with approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes concrete paving including the following:

1. Driveways.
2. Roadways.
3. Parking lots.
4. Curbs and gutters.
5. Walks.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
2. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.
3. Section 321713 "Parking Bumpers."
4. Section 321716 "Manufactured Traffic-Calming Devices."
5. Section 321723 "Pavement Markings."
6. Section 321726 "Tactile Warning Surfacing" for detectable warning materials.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project Site.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

a. Concrete mixture design.
b. Quality control of concrete materials and concrete paving construction practices.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.

c. Ready-mix concrete manufacturer.
d. Concrete paving Subcontractor.
e. Manufacturer's representative of stamped concrete paving system used for stamped detectable warnings.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.

C. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:

1. Exposed Aggregate: **10-lb (4.5-kg)** Sample of each mix.

D. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified installer, manufacturer, and testing agency.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Stamped Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests must be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Engineer and not less than **96 inches (2400 mm) by 96 inches (2400 mm)**.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.8 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete..
3. Fog-spray forms**,** and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet (30.5 m) or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from steel wire into flat sheets.

B. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

C. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel.

D. Reinforcing Bars: ASTM A615/A615M, Grade 60 (Grade 420); deformed.

E. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A615/A615M, Grade 60 (Grade 420) deformed bars.

F. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, Grade 60 (Grade 420) deformed bars.

G. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, Grade 60 (Grade 420) deformed bars; assembled with clips.

H. Plain-Steel Wire: ASTM A1064/A1064M, galvanized.

I. Deformed-Steel Wire: ASTM A1064/A1064M.

J. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A; coated, deformed.

K. Joint Dowel Bars: ASTM A615/A615M, Grade 60 (Grade 420) plain-steel bars. Cut bars true to length with ends square and free of burrs.

L. Epoxy-Coated, Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, Grade 60 (Grade 420) plain-steel bars.

M. Tie Bars: ASTM A615/A615M, Grade 60 (Grade 420); deformed.

N. Hook Bolts: ASTM A307, Grade A (ASTM F568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

O. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

P. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

Q. Zinc Repair Material: ASTM A780/A780M.

2.4 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C150/C150M, gray portland cement Type I.
2. Fly Ash: ASTM C618.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C595/C595M, Type IS, portland blast-furnace slag cement.

B. Normal-Weight Aggregates: ASTM C33/C33M, Class per application, uniformly graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: **1-1/2 inches (38 mm)** nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:

1. Aggregate Sizes: **3/4 to 1 inch (19 to 25 mm)** nominal.
2. Aggregate Source, Shape, and Color:

D. Air-Entraining Admixture: ASTM C260/C260M.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

F. Water: Potable and complying with ASTM C94/C94M.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 2, Class B, dissipating.

2.6 RELATED MATERIALS

A. Joint Fillers: D1752, cork or self-expanding cork or ASTM D8139, semirigid, closed-cell polypropylene foam in preformed strips.

B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less

than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

C. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types I and II, nonload bearing for bonding hardened or freshly mixed concrete to hardened concrete.

E. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch (3 to 6 mm).

F. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
1. Color: As indicated by manufacturer's designation.

G. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch (9.5-mm) sieve and 85 percent retained on a No. 8 (2.36-mm) sieve.

2.7 STAMPED DETECTABLE WARNING MATERIALS

A. Detectable Warning Stamp: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.
1. Size of Stamp: One piece, matching detectable warning area shown on Drawings.

B. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation designed to facilitate release of stamp mats.

2.8 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content, 1-1/2-inch (38-mm) Nominal Maximum Aggregate Size: 5-1/2 percent plus or minus 1-1/2 percent.
2. Air Content, 1-inch (25-mm) Nominal Maximum Aggregate Size: 6 percent plus or minus 1-1/2 percent.
3. Air Content, 3/4-inch (19-mm) Nominal Maximum Aggregate Size: 6 percent plus or minus 1-1/2 percent.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use high-range, water-reducing and retarding admixture] [plasticizing and retarding admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than **1.0 lb/cu. yd. (0.60 kg/cu. m)**.

G. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

H. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days): **4500 psi (31 MPa)**.
2. Maximum W/C Ratio at Point of Placement: 0.45.
3. Slump Limit: **4 inches (100 mm)**, plus or minus 1 inch (25 mm).

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).

3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction**.** Limit vehicle speed to 3 mph (5 km/h).
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of **1/2 inch (13 mm)** according to requirements in Section 312000 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 INSTALLATION OF STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963/D3963M.

G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of **15 feet max,** unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows**:**

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a **1/4-inch (6-mm)** radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

   a. Tolerance: Ensure that grooved joints are within **3 inches (75 mm)** either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

   a. Tolerance: Ensure that sawed joints are within **3 inches (75 mm)** either way from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a **1/4-inch (6-mm)** radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation**,** and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface, before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies[**, reinforcement,**] or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 SPECIAL FINISHES

A. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:

1. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.

2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.

B. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of 1/16 inch (1.6 mm).

1. Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.

C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions and as follows:

1. Uniformly spread **25 lb/100 sq. ft. (12 kg/10 sq. m)** of dampened, slip-resistive aggregate over paving surface in two applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
2. Uniformly distribute approximately two-thirds of slip-resistive aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
3. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
4. After curing, lightly work surface with a steel-wire brush or abrasive stone and water to expose nonslip aggregate.

D. Rock-Salt Finish: After initial floating, troweling, or brooming, uniformly spread rock salt over paving surface at the rate of 5 lb/100 sq. ft. (0.2 kg/10 sq. m).

1. Embed rock salt into plastic concrete with roller or float.
2. Cover paving surface with 1-mil- (0.025-mm-) thick polyethylene sheet and remove sheet when concrete has hardened and seven-day curing period has elapsed.
3. After seven-day curing period, saturate concrete with water and broom-sweep surface to dissolve remaining rock salt, thereby leaving pits and holes.

E. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surface according to manufacturer's written instructions and as follows:

1. Uniformly spread dry-shake hardener at a rate of **100 lb/100 sq. ft. (49 kg/10 sq. m)** unless greater amount is recommended by manufacturer to match paving color required.
2. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
3. After final power floating, apply a hand-troweled finish followed by a broom finish.
4. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

3.9 INSTALLATION OF DETECTABLE WARNINGS

A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Section 321726 "Tactile Warning Surfacing."

1. Tolerance for Opening Size: Plus 1/4 inch (6 mm), no minus.

B. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 321726 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding concrete paving. Embed tiles in fresh concrete to comply with Section 321726 "Tactile Warning Surfacing" immediately after screeding concrete surface.

C. Stamped Detectable Warnings: Install stamped detectable warnings as part of a continuous concrete paving placement and according to stamp-mat manufacturer's written instructions.

1. Before using stamp mats, verify that the vent holes are unobstructed.
2. Apply liquid release agent to the concrete surface and the stamp mat.
3. Stamping: After application and final floating of pigmented mineral dry-shake hardener, accurately align and place stamp mats in sequence. Uniformly load, gently vibrate, and press mats into concrete to produce imprint pattern on concrete surface. Load and tamp mats directly perpendicular to the stamp-mat surface to prevent distortion in shape of domes. Press and tamp until mortar begins to come through all of the vent holes. Gently remove stamp mats.
4. Trimming: After 24 hours, cut off the tips of mortar formed by the vent holes.
5. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

3.10 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture retaining-cover curing, curing compound or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.11 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 (ACI 117M) and as follows:

1. Elevation: 3/4 inch (19 mm).
2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
3. Surface: Gap below 10-feet- (3-m-) long; unleveled straightedge not to exceed 1/2 inch (13 mm).
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches (13 mm per 300 mm) of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).
6. Vertical Alignment of Dowels: 1/4 inch (6 mm).
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.
8. Joint Spacing: 3 inches (75 mm).
9. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
10. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M will be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each **100 cu. yd. (76 cu. m)** or fraction thereof of each concrete mixture placed each day.

a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.

a. A compressive-strength test to be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

D. Test results to be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests to contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency will make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.13 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Engineer.

B. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.
2. Hot-applied joint sealants.
3. Cold-applied, fuel-resistant joint sealants.
4. Hot-applied, fuel-resistant joint sealants.
5. Joint-sealant backer materials.
6. Primers.

B. Related Requirements:

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Concrete pavement joint sealants.
2. Joint-sealant backer materials.

B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of joint sealant.

C. Samples for Verification: Actual sample of finished products for each kind and color of joint sealant required.

1. Size: Joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Paving-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For installer and testing agency.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Testing: Performed by a qualified testing agency.

1.7 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer**.**
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint sealants from single manufacturer**.**

2.2 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backer materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.3 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D5893/D5893M, Type NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D5893/D5893M, Type SL.

C. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade NS, Class 25, for Use T.

D. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.

E. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 25, for Use T.

2.4 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant, Type I: ASTM D6690.

B. Hot-Applied, Single-Component Joint Sealant, Type I or Type II: ASTM D6690.

C. Hot-Applied, Single-Component Joint Sealant, Type I, II, or III: ASTM D6690.

D. Hot-Applied, Single-Component Joint Sealant, Type IV: ASTM D6690.

2.5 COLD-APPLIED, FUEL-RESISTANT JOINT SEALANTS

A. Fuel-Resistant, Single-Component, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.

B. Fuel-Resistant, Multicomponent, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 12-1/2 or 25, for Use T.

2.6 HOT-APPLIED, FUEL-RESISTANT JOINT SEALANTS

A. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants, Type I or Type II: ASTM D7116.

B. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants, Type III: ASTM D7116.

2.7 JOINT-SEALANT BACKER MATERIALS

A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.8 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backers to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backer materials.

2. Do not stretch, twist, puncture, or tear joint-sealant backer materials.
3. Remove absorbent joint-sealant backer materials that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backer material installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants in accordance with the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.5 PAVING-JOINT-SEALANT SCHEDULE

A. Joints within concrete paving:

1. Joint Location:

a. Expansion and isolation joints in concrete paving.
b. Contraction joints in concrete paving.
c. Other joints as indicated.

2. Joint Sealant: Single-component, nonsag, silicone joint sealant.
3. Joint-Sealant Color: Manufacturer’s standard.

B. Joints within concrete paving and between concrete and asphalt paving:

1. Joint Location:

    a. Joints between concrete and asphalt paving.
    b. Joints between concrete curbs and asphalt paving.
    c. Other joints as indicated.

2. Joint Sealant: Hot-applied, single-component joint sealant.
3. Joint-Sealant Color: Manufacturer’s standard.

C. Fuel-resistant joints within concrete paving**:**

1. Joint Location:

    a. Expansion and isolation joints in concrete paving.
    b. Contraction joints in concrete paving.
    c. Other joints as indicated.

2. Joint Sealant: Fuel-resistant, single-component, pourable, modified-urethane, elastomeric joint sealant.
3. Joint-Sealant Color: Manufacturer’s standard.

END OF SECTION 321373

SECTION 321713 - PARKING BUMPERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Precast concrete wheel stops.
2. Resilient wheel stops.
3. Resilient-shell, concrete-filled wheel stops.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Precast concrete wheel stops.
2. Resilient wheel stops.
3. Resilient-shell, concrete-filled wheel stops

B. Sustainable Design Submittals:

C. Samples for Initial Selection: For each type of exposed finish requiring color selection.

D. Samples for Verification: For wheel stops, **6 inches (150 mm) long** showing color and cross section; with mounting hardware.

PART 2 - PRODUCTS

2.1 PARKING BUMPERS

A. Precast Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete; **4000-psi (27.6-MPa)** minimum compressive strength; manufacturer's standard height and width. Provide chamfered corners**,** and a minimum of two factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.
1. Source Limitations: Obtain wheel stops from single source from single manufacturer.
2. Surface Appearance: Smooth, free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.
3. Surface Sealer: Manufacturer's standard salt-resistant, clear **sealer** applied at precasting location.

4. Mounting Hardware: Hardware as standard with wheel-stop manufacturer.

B. Resilient Wheel Stops: Solid, integrally colored rubber or plastic; UV stabilized; **manufacturer's standard height and width**. Provide chamfered corners and a minimum of two factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.
1. Source Limitations: Obtain wheel stops from single source from single manufacturer.
2. Color: Per Manufacturer
3. Embedded Markings: Molded-in, reflective markings, permanently inset in exposed surface.
4. Mounting Hardware: **Hardware as standard with wheel-stop manufacturer**.
5. Adhesive: Polyurethane or epoxy, as recommended in writing by wheel-stop manufacturer for adhesion to substrate.

C. Resilient-Shell, Concrete-Filled Wheel Stops: Integrally colored HDPE polymer; UV-stabilized resilient shell; filled with precast, steel-reinforced concrete; **4000-psi (27.6-MPa)** minimum compressive strength; manufacturer's standard height and width. Provide chamfered corners and a minimum of two factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.
1. Source Limitations: Obtain wheel stops from single source from single manufacturer.

2. Color: Per Manufacturer
3. Surface Appearance: Smooth and uniform, with straight and sharp corners.
4. Mounting Hardware: Galvanized-steel spike or dowel, 1/2-inch (13-mm) minimum diameter, 14-inch (350-mm) minimum length.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation in accordance with manufacturer's written instructions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wheel stops in accordance with manufacturer's written instructions unless otherwise indicated.

B. Install wheel stops in bed of adhesive before anchoring to substrate.

C. Securely anchor wheel stops to substrate with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheel stop.

END OF SECTION 321713

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SECTION 321726 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cast-in-place detectable warning tiles.
2. Surface-applied detectable warning tiles.
3. Detectable warning mats.
4. Cast-in-place detectable warning metal tiles.
5. Surface-applied detectable warning metal tiles.
6. Detectable warning unit pavers.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for concrete walkways serving as substrates for tactile warning surfacing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Samples for Initial Selection: For each type of exposed finish requiring color selection.

D. Samples for Verification: For each type of tactile warning surface, in manufacturer's standard sizes unless otherwise indicated, showing edge condition, truncated-dome pattern, texture, color, and cross section; with fasteners and anchors.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For tactile warning surfacing, to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.7 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Adhesive Application:

1. Apply adhesive only when ambient temperature is above 50 deg F (10 deg C) and when temperature has not been below 35 deg F (2 deg C) for 12 hours immediately before application. Do not apply when substrate is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks, and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and higher.

a. When ambient temperature exceeds 100 deg F (38 deg C), or when wind velocity exceeds 8 mph (13 km/h) and ambient temperature exceeds 90 deg F (32 deg C), set unit pavers within 1 minute of spreading setting-bed mortar.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of tactile warning surfaces that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering and wear.
b. Separation or delamination of materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for tactile warning surfaces.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

B. Source Limitations: Obtain each type of tactile warning surfacing, joint material, setting material, anchor, and fastener from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:

1. Furnish Type 304 stainless-steel fasteners for exterior use.
2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

B. Adhesive: As recommended by manufacturer for adhering tactile warning surfacing unit to pavement.

C. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions. Verify that installation of tactile warning surfacing will comply with accessibility requirements upon completion.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

3.3 INSTALLATION OF DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 321313 "Concrete Paving." Mix, place, and finish concrete to conditions complying with detectable warning tile manufacturer's written requirements for satisfactory embedment of tile.
2. Set each detectable warning tile accurately and firmly in place and completely seat tile back and embedments in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus 1/8 inch (3 mm) from flush.
4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
5. Clean tiles using methods recommended in writing by manufacturer.

B. Removable Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 321313 "Concrete Paving." Mix, place, and finish concrete to conditions complying with detectable warning tile manufacturer's written requirements for satisfactory embedment of removable tile.
2. Set each detectable warning tile accurately and firmly in place with embedding anchors and fasteners attached, and firmly seat tile back in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus 1/8 inch (3 mm) from flush.
4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
5. Clean tiles using methods recommended in writing by manufacturer.

C. Surface-Applied Detectable Warning Tiles:

1. Lay out detectable warning tiles as indicated and mark concrete pavement.
2. Prepare existing paving surface by grinding and cleaning as recommended by manufacturer.

    a. Cut perimeter kerf in existing concrete pavement to receive metal tile flange.

3. Apply adhesive to back of tiles in amounts and pattern recommended by manufacturer, and set tiles in place. Firmly seat tiles in adhesive bed, eliminating air pockets and establishing full adhesion to pavement. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.

4. Install anchor devices through face of tiles and into pavement using anchors located as recommended by manufacturer. Set heads of anchors flush with top surface of mat.
5. Mask perimeter of tiles and adjacent concrete, and apply sealant in continuous bead around perimeter of tile installation.
6. Remove masking, adhesive, excess sealant, and soil from exposed surfaces of detectable warning tiles and surrounding concrete pavement using cleaning agents recommended in writing by manufacturer.
7. Protect installed tiles from traffic until adhesive has set.

3.4 INSTALLATION OF DETECTABLE WARNING MATS

A. Lay out detectable warning mats as indicated and mark concrete pavement at edges of mats.

B. Prepare existing paving surface by grinding and cleaning as recommended by manufacturer.

C. Apply adhesive to back of mat in amounts and pattern recommended by manufacturer, and set mat in place. Firmly seat mat in adhesive bed, eliminating air pockets and establishing full adhesion to pavement. If necessary, temporarily apply weight to mat to ensure full contact with adhesive.

D. Install anchor devices through face of mat and into pavement using anchors located as recommended by manufacturer. Set heads of anchors flush with mat surface.

E. Mask mat perimeter and adjacent concrete, and apply sealant in continuous bead around perimeter of mat.

F. Remove masking, adhesive, excess sealant, and soil from exposed surfaces of detectable warning mat and surrounding concrete pavement using cleaning agents recommended in writing by manufacturer.

G. Protect installed mat from traffic until adhesive has set.

3.5 INSTALLATION OF DETECTABLE WARNING UNIT PAVERS

A. Unit Paver Installation, General:

1. Setting-Bed and Unit Paver Installation: Comply with installation requirements in Section 321400 "Unit Paving."
2. Mix unit pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
3. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.
4. Tolerances: Do not exceed 1/4 inch in 10 feet (6 mm in 3 m) from level, or indicated slope, for finished surface of paving.

B. Aggregate Setting-Bed Applications:

1. Place aggregate base, compact by tamping with plate vibrator, and screed to depth indicated.

2. Place leveling course and screed to a thickness of 1 to 1-1/2 inches (25 to 38 mm), taking care that moisture content remains constant and density is loose and uniform until unit pavers are set and compacted.
3. Treat leveling course with herbicide to inhibit growth of grass and weeds.
4. Set unit pavers with a minimum joint width of 1/16 inch (1.5 mm) and a maximum of 1/8 inch (3 mm), being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines.
5. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf (16- to 22-kN) compaction force at 80 to 90 Hz.
6. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

C. Mortar Setting-Bed Applications:

1. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
2. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch (1.6-mm) thickness for bond coat.
3. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
4. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
5. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch- (1.5-mm-) thick bond coat to mortar bed or to back of each paver with a flat trowel.
6. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
7. Spaced Joint Widths: Provide **3/8-inch (10-mm)** nominal joint width with variations not exceeding plus or minus **1/16 inch (1.5 mm)**.
8. Grouted Joints: Grout paver joints complying with ANSI A108.10. Grout joints as soon as possible after initial set of setting bed.

    a. Force grout into joints, taking care not to smear grout on adjoining surfaces.
    b. Tool exposed joints slightly concave when thumbprint hard.
    c. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

9. Remove excess grout from exposed paver surfaces; wash and scrub clean.
10. Protect installation from traffic until grout has set.

3.6 CLEANING AND PROTECTION

A. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless

otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.

B. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION 321726

SECTION 321726 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cast-in-place detectable warning tiles.
2. Surface-applied detectable warning tiles.
3. Detectable warning mats.
4. Cast-in-place detectable warning metal tiles.
5. Surface-applied detectable warning metal tiles.
6. Detectable warning unit pavers.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for concrete walkways serving as substrates for tactile warning surfacing.
2. Section 321400 "Unit Paving" for unit paving installations incorporating detectable warning unit pavers specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Samples for Initial Selection: For each type of exposed finish requiring color selection.

D. Samples for Verification: For each type of tactile warning surface, in manufacturer's standard sizes unless otherwise indicated, showing edge condition, truncated-dome pattern, texture, color, and cross section; with fasteners and anchors.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For tactile warning surfacing, to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1.7 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Adhesive Application:

1. Apply adhesive only when ambient temperature is above 50 deg F (10 deg C) and when temperature has not been below 35 deg F (2 deg C) for 12 hours immediately before application. Do not apply when substrate is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks, and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and higher.

a. When ambient temperature exceeds 100 deg F (38 deg C), or when wind velocity exceeds 8 mph (13 km/h) and ambient temperature exceeds 90 deg F (32 deg C), set unit pavers within 1 minute of spreading setting-bed mortar.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of tactile warning surfaces that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering and wear.
b. Separation or delamination of materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for tactile warning surfaces.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

B. Source Limitations: Obtain each type of tactile warning surfacing, joint material, setting material, anchor, and fastener from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles: Accessible truncated-dome detectable warning tiles for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.
1. Material: Cast-fiber-reinforced polymer concrete tile.
2. Color: Safety yellow.
3. Shapes and Sizes:

a. Rectangular panel, **36 by 48 inches (914 by 1219 mm).**
b. Radius panel, nominal 24 inches (610 mm) deep by **6-foot (1829-mm)** outside radius.

4. Dome Spacing and Configuration: Manufacturer's standard compliant spacing in manufacturer's standard pattern.
5. Mounting:

a. Replaceable detectable warning tile wet-set into freshly poured concrete and surface-fastened to permanently embedded anchors.

B. Surface-Applied Detectable Warning Tiles: Accessible truncated-dome detectable warning concrete tiles configured for surface application on existing concrete walkway surfaces, with slip-resistant surface treatment on domes, field of tile, and beveled outside edges.
1. Material: Cast-fiber-reinforced polymer concrete tile.
2. Color: Safety yellow.
3. Shapes and Sizes:

a. Rectangular panel, **36 by 48 inches (914 by 1219 mm).**
b. Radius panel, nominal 24 inches (610 mm) deep by **6-foot (1829-mm)** outside radius.

4. Dome Spacing and Configuration: Manufacturer's standard compliant spacing in manufacturer's standard pattern.

5. Mounting: Adhered to existing concrete walkway.

C. Cast-in-Place Detectable Warning Metal Tiles: Accessible truncated-dome detectable warning metal tiles configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.
   1. Material:
      a. Stainless-Steel Plate and Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.
         1) Finish and Color:
            a) Manufacturer's standard powder coat, safety yellow.
            b) Mill finish.
      b. Cast Iron: Gray iron, ASTM A 48/A 48M, CL 35.
   2. Shapes and Sizes:
      a. Rectangular panel, **36 by 48 inches (914 by 1219 mm).**
      b. Radius panel, nominal 24 inches (610 mm) deep by **6-foot (1829-mm)** outside radius.
   3. Dome Spacing and Configuration: Manufacturer's standard compliant spacing in manufacturer's standard pattern.
   4. Mounting:
      a. Replaceable embedded detectable warning tile fastened to permanently installed anchors.

D. Surface-Applied Detectable Warning Metal Tiles: Accessible truncated-dome detectable warning metal tiles or plates configured for fastening to surface of existing concrete walkway surfaces, with slip-resistant surface treatment on domes, field of tile, and beveled outside edges.
   1. Material: Stainless-Steel Plate and Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.
   2. Finish and Color:
      a. Manufacturer's standard powder coat, safety yellow.
      b. Mill finish.
   3. Shapes and Sizes:
      a. Rectangular panel, **36 by 48 inches (914 by 1219 mm).**
      b. Radius panel, nominal 24 inches (610 mm) deep by **6-foot (1829-mm)** outside radius.
   4. Dome Spacing and Configuration: Manufacturer's standard compliant spacing in manufacturer's standard pattern.
   5. Mounting:

a. Replaceable surface-applied detectable warning tile fastened with permanently installed anchors to existing concrete walkway.
b. Permanently fixed detectable warning tile adhered to existing concrete walkway.

2.3 DETECTABLE WARNING MATS

A. Surface-Applied Detectable Warning Mats: Accessible truncated-dome detectable warning resilient mats, UV resistant, manufactured for adhering to existing concrete walkway surfaces, with slip-resistant surface treatment on domes, field of mat, and beveled outside edges.
1. Material: Modified rubber compound, UV resistant.
2. Color: As indicated by manufacturer's designations.
3. Shapes and Sizes:

a. Rectangular panel, **24 by 48 inches (610 by 1219 mm)**.

4. Dome Spacing and Configuration: Manufacturer's standard compliant spacing in manufacturer's standard pattern.
5. Mounting: Adhered to pavement surface with adhesive**.**

2.4 DETECTABLE WARNING UNIT PAVERS

A. Detectable Warning Concrete Unit Pavers: Solid paving units, made from normal-weight concrete with a compressive strength of not less than 5000 psi (34 MPa), water absorption of not more than 5 percent according to ASTM C 140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67, with accessible detectable warning truncated domes on exposed surface of units.
1. Shapes and Sizes:

a. Thickness: **2 inches (51 mm)** at field of tile.
b. Face Size: Nominal **12 by 12 inches (305 by 305 mm)**.

2. Dome Spacing and Configuration: Manufacturer's standard compliant spacing in manufacturer's standard pattern.
3. Color: As indicated by manufacturer's designations.

B. Setting Bed: Comply with requirements in Section 321400 "Unit Paving."

C. Aggregate Setting Bed:

1. Graded Aggregate for Base: Sound, crushed stone or gravel complying with ASTM D 448 for Size No. 8.
2. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33/C 33M for fine aggregate.
3. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve.

D. Mortar Setting Bed:

1. Portland Cement: ASTM C 150/C 150M, Type I or Type II.
2. Sand: ASTM C 33/C 33M.
3. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.
4. Thinset Mortar: Latex-modified portland cement mortar complying with ANSI A118.4.
5. Water: Potable.

2.5 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:

1. Furnish Type 304 stainless-steel fasteners for exterior use.
2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

B. Adhesive: As recommended by manufacturer for adhering tactile warning surfacing unit to pavement.

C. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions. Verify that installation of tactile warning surfacing will comply with accessibility requirements upon completion.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

3.3 INSTALLATION OF DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 321313 "Concrete Paving." Mix, place, and finish concrete to conditions complying with detectable warning tile manufacturer's written requirements for satisfactory embedment of tile.
2. Set each detectable warning tile accurately and firmly in place and completely seat tile back and embedments in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus 1/8 inch (3 mm) from flush.
4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
5. Clean tiles using methods recommended in writing by manufacturer.

B. Removable Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 321313 "Concrete Paving." Mix, place, and finish concrete to conditions complying with detectable warning tile manufacturer's written requirements for satisfactory embedment of removable tile.
2. Set each detectable warning tile accurately and firmly in place with embedding anchors and fasteners attached, and firmly seat tile back in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus 1/8 inch (3 mm) from flush.
4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
5. Clean tiles using methods recommended in writing by manufacturer.

C. Surface-Applied Detectable Warning Tiles:

1. Lay out detectable warning tiles as indicated and mark concrete pavement.
2. Prepare existing paving surface by grinding and cleaning as recommended by manufacturer.

    a. Cut perimeter kerf in existing concrete pavement to receive metal tile flange.

3. Apply adhesive to back of tiles in amounts and pattern recommended by manufacturer, and set tiles in place. Firmly seat tiles in adhesive bed, eliminating air pockets and establishing full adhesion to pavement. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
4. Install anchor devices through face of tiles and into pavement using anchors located as recommended by manufacturer. Set heads of anchors flush with top surface of mat.
5. Mask perimeter of tiles and adjacent concrete, and apply sealant in continuous bead around perimeter of tile installation.
6. Remove masking, adhesive, excess sealant, and soil from exposed surfaces of detectable warning tiles and surrounding concrete pavement using cleaning agents recommended in writing by manufacturer.
7. Protect installed tiles from traffic until adhesive has set.

3.4 INSTALLATION OF DETECTABLE WARNING MATS

A. Lay out detectable warning mats as indicated and mark concrete pavement at edges of mats.

B. Prepare existing paving surface by grinding and cleaning as recommended by manufacturer.

C. Apply adhesive to back of mat in amounts and pattern recommended by manufacturer, and set mat in place. Firmly seat mat in adhesive bed, eliminating air pockets and establishing full adhesion to pavement. If necessary, temporarily apply weight to mat to ensure full contact with adhesive.

D. Install anchor devices through face of mat and into pavement using anchors located as recommended by manufacturer. Set heads of anchors flush with mat surface.

E. Mask mat perimeter and adjacent concrete, and apply sealant in continuous bead around perimeter of mat.

F. Remove masking, adhesive, excess sealant, and soil from exposed surfaces of detectable warning mat and surrounding concrete pavement using cleaning agents recommended in writing by manufacturer.

G. Protect installed mat from traffic until adhesive has set.

3.5 INSTALLATION OF DETECTABLE WARNING UNIT PAVERS

A. Unit Paver Installation, General:

1. Setting-Bed and Unit Paver Installation: Comply with installation requirements in Section 321400 "Unit Paving."
2. Mix unit pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
3. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.
4. Tolerances: Do not exceed 1/4 inch in 10 feet (6 mm in 3 m) from level, or indicated slope, for finished surface of paving.

B. Aggregate Setting-Bed Applications:

1. Place aggregate base, compact by tamping with plate vibrator, and screed to depth indicated.
2. Place leveling course and screed to a thickness of 1 to 1-1/2 inches (25 to 38 mm), taking care that moisture content remains constant and density is loose and uniform until unit pavers are set and compacted.
3. Treat leveling course with herbicide to inhibit growth of grass and weeds.
4. Set unit pavers with a minimum joint width of 1/16 inch (1.5 mm) and a maximum of 1/8 inch (3 mm), being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines.
5. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf (16- to 22-kN) compaction force at 80 to 90 Hz.

6. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

C. Mortar Setting-Bed Applications:

1. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
2. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch (1.6-mm) thickness for bond coat.
3. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
4. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
5. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch- (1.5-mm-) thick bond coat to mortar bed or to back of each paver with a flat trowel.
6. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
7. Spaced Joint Widths: Provide **3/8-inch (10-mm)** nominal joint width with variations not exceeding plus or minus **1/16 inch (1.5 mm)**.
8. Grouted Joints: Grout paver joints complying with ANSI A108.10. Grout joints as soon as possible after initial set of setting bed.

    a. Force grout into joints, taking care not to smear grout on adjoining surfaces.
    b. Tool exposed joints slightly concave when thumbprint hard.
    c. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

9. Remove excess grout from exposed paver surfaces; wash and scrub clean.
10. Protect installation from traffic until grout has set.

3.6 CLEANING AND PROTECTION

A. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.

B. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION 321726

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Chain-link fences.
2. Swing gates.
3. Horizontal-slide gates.
4. Privacy slats.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete equipment bases/pads for gate operators and controls.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
2. Review sequence of operation for each type of gate operator.
3. Review coordination of interlocked equipment specified in this Section and elsewhere.
4. Review required testing, inspecting, and certifying procedures.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Fence and gate posts, rails, and fittings.
b. Chain-link fabric, reinforcements, and attachments.
c. Accessories: Privacy slats and Barbed wire.
d. Gates and hardware.
e. Gate operators, including operating instructions and motor characteristics.

B. Shop Drawings: For each type of fence and gate assembly.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include accessories, hardware, gate operation, and operational clearances.
3. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
4. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For each type of factory-applied finish.

D. Samples for Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:

1. Polymer-Coated Components: In 6-inch (150-mm) lengths for components and on full-sized units for accessories.

E. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer and/or testing agency.

B. Product Certificates: For each type of chain-link fence, and gate.

C. Product Test Reports: For framework strength according to ASTM F1043, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gate operators to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Emergency Access Requirements: According to requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

C. Mockups: Build mockups to set quality standards for fabrication and installation.

1. Build mockup for typical chain-link fence, including accessories.

a. Size: **10-foot (3 m)** length of fence.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.9 WARRANTY

A. Special Warranty: Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to comply with performance requirements.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
c. Faulty operation of gate operators and controls.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design chain-link fence and gate frameworks.

B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7.

1. Design Wind Load: Per structural drawings.

a. Minimum Post Size: Determine according to ASTM F1043 for post spacing not to exceed **10 feet (3 m)** for Material Group IA, ASTM F1043, Schedule 40 steel pipe.
b. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.

C. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: As indicated on Drawings.
2. Steel Wire for Fabric: Wire diameter per manufacturer's recommendation..

a. Mesh Size: Per manufacturer's recommendation.
b. Aluminum-Coated Fabric: ASTM A491, Type I, **0.40 oz./sq. ft. (122 g/sq. m)**.
c. Zinc-Coated Fabric: ASTM A392, Type II, Class 2, 2.0 oz./sq. ft. (610 g/sq. m) with zinc coating applied before weaving.
d. Zn-5-Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F1345, Type III, 2, 1.0 oz./sq. ft. (305 g/sq. m).
e. Polymer-Coated Fabric: ASTM F668, Class 1 over zinc coated steel wire.

1) Color: As selected by Engineer from manufacturer's full range, according to ASTM F934.

f. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

3. Aluminum Wire Fabric: ASTM F1183, with mill finish, and wire diameter of **0.148 inch (3.76 mm)**.

a. Mesh Size: **2 inches (50 mm)**.

b. Generally, retain first option in "Selvage" Subparagraph below for fabric less than 72 inches (1830 mm) high.

4. Selvage: Knuckled at both selvages.

2.3 FENCE FRAMEWORK

A. Posts and Rails: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F1043 based on the following:

1. Fence Height: As indicated on Drawings.
2. Light-Industrial-Strength Material: Group IC-L, round steel pipe, electric-resistance-welded pipe.

a. Line Post: **2.25 by 1.7 inches (57 by 43 mm).**
b. End, Corner, and Pull Posts: **2.875 inches (73 mm)**.

3. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40**.**

a. Line Post: **2.25 by 1.7 inches (57 by 43 mm).**
b. End, Corner, and Pull Posts: **2.875 inches (73 mm)**.

4. Horizontal Framework Members: Intermediate, top and bottom rails according to ASTM F1043.

    a. Top Rail: **1.25 by 1.63 inches (32 by 41 mm)**.

5. Brace Rails: ASTM F1043.
6. Metallic Coating for Steel Framework:

    a. Type A: Not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating according to ASTM A123/A123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating according to ASTM A653/A653M.
    b. Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
    c. External, Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil- (0.0076-mm-) thick, zinc-pigmented coating.
    d. Type C: Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. (0.55-kg/sq. m) coating.
    e. Coatings: Any coating above.

7. Polymer coating over metallic coating.

    a. Color: Match chain-link fabric, according to ASTM F934.

2.4 TENSION WIRE

A. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire according to ASTM A817 or ASTM A824, with the following metallic coating:
    1. Type II: Zinc coated (galvanized) by **hot-dip** process, with the following minimum coating weight:
        a. Matching chain-link fabric coating weight.

    2. Type III: Zn-5-Al-MM alloy with the following minimum coating weight:
        a. Matching chain-link fabric coating weight.

B. Polymer-Coated Steel Wire: **0.177-inch- (4.5-mm-)** diameter, tension wire according to ASTM F1664, Class 1 over zinc coated steel wire.

    1. Color: Match chain-link fabric according to ASTM F934.

C. Aluminum Wire: 0.192-inch- (4.88-mm-) diameter tension wire, mill finished, according to ASTM B211 (ASTM B211M), Alloy 6061-T94 with 50,000-psi (344-MPa) minimum tensile strength.

2.5 SWING GATES

A. General: ASTM F900 for gate posts and single and double swing gate types.

1. Gate Leaf Width: As indicated.
2. Framework Member Sizes and Strength: Based on gate fabric height as indicated.

B. Pipe and Tubing:

1. Zinc-Coated Steel: ASTM F1043 and ASTM F1083; manufacturer's standard protective coating and finish.
2. Aluminum: ASTM B429/B429M; manufacturer's standard finish.
3. Gate Posts: Round tubular steel.
4. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Welded or assembled corner fittings.

D. Extended Gate Posts and Frame Members: Fabricate gate posts and frame end members to extend **12 inches (300 mm)** above top of chain-link fabric at both ends of gate frame to attach barbed wire assemblies.

E. Hardware:

1. Hinges: 360-degree inward and outward swing.
2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
3. Lock: Manufacturer's standard internal device.
4. Padlock and Chain: Per Owner’s requirements.
5. Closer: Manufacturer's standard.

2.6 FITTINGS

A. Provide fittings according to ASTM F626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: **Pressed-steel or round-steel tubing** not less than 6 inches (152 mm) long.
2. Rail Clamps: Line and corner boulevard clamps for connecting rails to posts.

E. Tension and Brace Bands: **Pressed steel**.

F. Tension Bars: **Ste**, length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: **Steel Mill-finished aluminum** rod and turnbuckle or other means of adjustment.

H. Barbed Wire Arms: **Pressed steel or cast iro**n, with clips, slots, or other means for attaching strands of barbed wire**,** for each post unless otherwise indicated, and as follows:

1. Provide line posts with arms that accommodate top rail or tension wire.
2. Provide corner arms at fence corner posts unless extended posts are indicated.
3. Single-Arm Type: **Type I, slanted arm**.

I. Tie Wires, Clips, and Fasteners: According to ASTM F626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:

a. Hot-Dip Galvanized Steel: **Galvanized coating thickness matching coating thickness of chain-link fence fabric**.
b. Aluminum: ASTM B211 (ASTM B211M); Alloy 1350-H19; **0.148-inch- (3.76-mm-)** diameter, mill-finished wire.

J. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. (366 g/sq. m) of zinc.

a. Polymer coating over metallic coating.

2. Aluminum: Mill finish.

2.7 PRIVACY SLATS

A. Fiber-Glass-Reinforced Plastic Slats: UV-light-stabilized fiber-glass-reinforced plastic, not less than 0.06 inch (1.5 mm) thick, sized to fit mesh specified for direction indicated**.**

B. Tubular Polyethylene Slats: Minimum 0.023-inch (0.58-mm)-thick tubular polyethylene, manufactured for chain-link fences from virgin polyethylene with UV inhibitor, sized to fit mesh specified for direction indicated, with vandal-resistant fasteners and lock strips.

C. Aluminum Slats: Minimum 0.01-inch (0.25-mm)-thick aluminum, sized to fit mesh specified for direction indicated.

D. Redwood Slats: 5/16-inch (7.9-mm)-thick redwood, sized to fit mesh specified for direction indicated.

E. Hedge-Type Slats: UV-light-stabilized, flame resistant, PVC "needles" woven into braided, galvanized wire core, sized to fit mesh specified for direction indicated.

F. Color: **As indicated by manufacturer's designations**.

2.8 BARBED WIRE

A. Steel Barbed Wire: ASTM A121, two-strand barbed wire, 0.099-inch- (2.51-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point round barbs spaced not more than 5 inches (127 mm) o.c.

1. Aluminum Coating: Type A.
2. Zinc Coating: Type Z, Class 3.

B. Polymer-Coated, Galvanized-Steel Barbed Wire: ASTM F1665, two-strand barbed wire, 0.080-inch- (2.03-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point, round **aluminum alloy** barbs spaced not more than 5 inches (127 mm) o.c.:

1. Polymer Coating: **Class 1** over **aluminum**

a. Color: **Match chain-link fabric** according to ASTM F934.

2.9 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.10 GROUNDING MATERIALS

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches (16 by 2440 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for **a certified survey of property lines and legal boundaries,** site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts **in concrete** at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 2 inches (50 mm) above grade; shape and smooth to shed water.
    b. Concealed Concrete: Place top of concrete **2 inches (50 mm)** below grade to allow covering with surface material.
    c. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.
    d. Posts Set into Holes in Concrete: Form or core drill holes not less than 5 inches (127 mm) deep and 3/4 inch (20 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

3. Mechanically Driven Posts: Drive into soil to depth of **30 inches (762 mm)**. Protect post top to prevent distortion.

D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of as indicated on Drawings. For runs exceeding 500 feet (152 m), space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at distance that fits within project site, with a minimum of 6 feet (2m) o.c.

F. Post Bracing and Intermediate Rails: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches (1830 mm) or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-mm-) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 mm) o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along top and bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches (152 mm) of bottom of fabric and tie to each post with not less than same diameter and type of wire.
2. Extended along top of barbed wire arms or extended posts and top of fence fabric to support barbed tape.

H. Top Rail: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

I. Intermediate and Bottom Rails: Secure to posts with fittings.

J. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave **1-inch (25-mm)** bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

K. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches (380 mm) o.c.

L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches (300 mm) o.c. and to braces at 24 inches (610 mm) o.c.

M. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side.

N. Privacy Slats: Install slats in direction indicated, securely locked in place.

1. Vertical Direction and privacy factor as indicated on Drawings.

O. Barbed Wire: Install barbed wire uniformly spaced as indicated on drawings. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

P. Barbed Tape: Install according to ASTM F1911. Install barbed tape uniformly in configurations indicated and fasten securely to prevent movement or displacement.

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 GATE-OPERATOR INSTALLATION

A. Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation: Hand-excavate holes for posts, pedestals, and equipment bases/pads, in firm, undisturbed soil to dimensions and depths and at locations according to gate-operator component manufacturer's written instructions and as indicated.

C. Vehicle Loop Detector System: Bury wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.

D. Ground electric-powered motors, controls, and other devices according to NFPA 70 and manufacturer's written instructions.

3.6 GROUNDING AND BONDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fence and Gate Grounding:

1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
2. Install ground rods and connections at maximum intervals of **1500 feet (450 m)**.
3. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of **750 feet (225 m**).
4. Ground fence on each side of gates and other fence openings.

    a. Bond metal gates to gate posts.
    b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (457 mm) below finished grade.

C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of 150 feet (45 m) on each side of crossing.

D. Fences Enclosing Electrical Power Distribution Equipment: Ground according to IEEE C2 unless otherwise indicated.

E. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (152 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.

F. Connections:

1. Make connections with clean, bare metal at points of contact.
2. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
4. Make above-grade ground connections with mechanical fasteners.
5. Make below-grade ground connections with exothermic welds.
6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor according to NFPA 780.

H. Comply with requirements in Section 264113 "Lightning Protection for Structures."

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests.

B. Grounding Tests: Comply with requirements in Section 264113 "Lightning Protection for Structures."

C. Prepare test reports.

3.8 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Automatic Gate Operator: Energize circuits to electrical equipment and devices, start units, and verify proper motor rotation and unit operation.

1. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
2. Test and adjust operators, controls, and safety devices. Replace damaged and malfunctioning controls and equipment.
3. Lubricate operator and related components.

C. Lubricate hardware and other moving parts.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 323113

SECTION 334200 - STORMWATER CONVEYANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Backwater valves.
   2. Catch basins.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Catch basins, stormwater inlets, and dry wells: Include plans, elevations, sections, details, frames, covers, and grates.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet (1:500) and vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes in accordance with manufacturer's written rigging instructions.

D. Handle catch basins and stormwater inlets in accordance with manufacturer's written rigging instructions.

1.8 FIELD CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Construction Manager’s written permission.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. PVC Backwater Valves:
1. Source Limitations: Obtain PVC backwater valves from single manufacturer.
2. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

2.2 CATCH BASINS

A. Standard Precast Concrete Catch Basins:

1. Description: ASTM C478 (ASTM C478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
3. Riser Sections: 4-inch (102-mm) minimum thickness, 48-inch (1200-mm) diameter, and lengths to provide depth indicated.

4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: ASTM C990 (ASTM C990M), bitumen or butyl rubber.
6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 225-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and grate.
8. Steps: Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of catch basin to finished grade is less than **60** inches **(1500)** (mm).
9. Pipe Connectors: ASTM C923 (ASTM C923M), resilient, of size required, for each pipe connecting to base section.

B. Designed Precast Concrete Catch Basins: ASTM C913, precast, reinforced concrete; designed in accordance with ASTM C890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for joint sealants.

1. Joint Sealants: ASTM C990 (ASTM C990M), bitumen or butyl rubber.
2. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
3. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 225-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and grate.
4. Steps: Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of catch basin to finished grade is less than **60** inches **(1500)** (mm).
5. Pipe Connectors: ASTM C923 (ASTM C923M), resilient, of size required, for each pipe connecting to base section.

C. Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches (610 by 610 mm) minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

D. Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange, and 26-inch- (660-mm-) diameter flat grate with small square or short-slotted drainage openings.

1. Grate Free Area: Approximately 50 percent unless otherwise indicated.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

D. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

E. Install gravity-flow, nonpressure drainage piping in accordance with the following:

1. Install piping pitched down in direction of flow.
2. Install piping **NPS 6 (DN 150)** and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
3. Install piping with **36-** inch **(915-)**(mm) minimum cover.
4. Install hub-and-spigot, cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
6. Install ductile-iron piping and special fittings in accordance with AWWA C600 or AWWA M41.
7. Install corrugated-steel piping in accordance with ASTM A798/A798M.
8. Install corrugated-aluminum piping in accordance with ASTM B788/B788M.
9. Install ABS sewer piping in accordance with ASTM D2321 and ASTM F1668.
10. Install PE corrugated sewer piping in accordance with ASTM D2321.
11. Install PVC cellular-core piping in accordance with ASTM D2321 and ASTM F1668.
12. Install PVC sewer piping in accordance with ASTM D2321 and ASTM F1668.
13. Install PVC profile gravity sewer piping in accordance with ASTM D2321 and ASTM F1668.
14. Install PVC water-service piping in accordance with ASTM D2321 and ASTM F1668.
15. Install fiberglass sewer piping in accordance with ASTM D3839 and ASTM F1668.
16. Install nonreinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."

17. Install reinforced-concrete sewer piping in accordance with ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping in accordance with the following:

1. Join hub-and-spigot, cast-iron soil piping with gasketed joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with caulked joints in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum caulked joints.
3. Join hubless cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join ductile-iron culvert piping in accordance with AWWA C600 for push-on joints.
5. Join ductile-iron piping and special fittings in accordance with AWWA C600 or AWWA M41.
6. Join corrugated-steel sewer piping in accordance with ASTM A798/A798M.
7. Join corrugated-aluminum sewer piping in accordance with ASTM B788/B788M.
8. Join ABS sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
9. Join corrugated-PE piping in accordance with ASTM D3212 for push-on joints.
10. Join PVC cellular-core piping in accordance with ASTM D2321 and ASTM F891 for solvent-cemented joints.
11. Join PVC corrugated sewer piping in accordance with ASTM D2321 for elastomeric-seal joints.
12. Join PVC sewer piping in accordance with ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasketed joints.
13. Join PVC profile gravity sewer piping in accordance with ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.
14. Join fiberglass sewer piping in accordance with ASTM D3839 for elastomeric-seal joints.
15. Join nonreinforced-concrete sewer piping in accordance with ASTM C14 (ASTM C14M) and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
16. Join reinforced-concrete sewer piping in accordance with ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
17. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 BACKWATER VALVE INSTALLATION

A. Install horizontal-type backwater valves in piping where indicated.

B. Install combination horizontal and manual gate-valve type in piping and in manholes where indicated.

C. Install terminal-type backwater valves on end of piping and in manholes where indicated.

3.5 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, **18 by 18 by 12** inches **(450 by 450 by 300)**(mm) deep. Set with tops **1** inch(es) **(25)** (mm) above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.6 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.7 CONCRETE PLACEMENT

A. Place cast-in-place concrete in accordance withACI 318 (ACI 318M).

3.8 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 221413 "Facility Storm Drainage Piping."

B. Connect force-main piping to building's storm drainage force mains specified in Section 221413 "Facility Storm Drainage Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting into existing unit and creating an

opening large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.

a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

D. Connect to sediment interceptors specified in Section 221323 "Sanitary Waste Interceptors."

E. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

a. Unshielded flexible couplings for same or minor difference OD pipes.
b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure-type pipe couplings for force-main joints.

3.9 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least **8-** inch-**(203-)** (mm-) thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.
2. Remove top of manhole or structure down to at least **36** inches **(915)** (mm) below final grade. Fill to within **12** inches **(300)** (mm) of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade in accordance with Section 312000 "Earth Moving."

3.10 IDENTIFICATION

A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.11 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems in accordance with requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:

    a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
    b. Option: Test plastic piping in accordance with ASTM F1417.

6. Force-Main Storm Drainage Piping: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than **150** psig **(1035)** (kPa).

    a. Ductile-Iron Piping: Test in accordance with AWWA C600, "Hydraulic Testing" Section.
    b. PVC Piping: Test in accordance with AWWA M23, "Testing and Maintenance" Chapter.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.12 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION 334200

SECTION 334600 - SUBDRAINAGE

1.1 SUMMARY

A. Section Includes:

1. Perforated-wall pipe and fittings.
2. Drainage conduits.
3. Drainage panels.
4. Geotextile filter fabrics.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Drainage conduits, including rated capacities.
2. Drainage panels, including rated capacities.
3. Geotextile filter fabrics.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PE Pipe and Fittings:

1. NPS 6 (DN 150) and Smaller: ASTM F405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
2. NPS 8 (DN 200) and Larger: ASTM F667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
3. Couplings: Manufacturer's standard, band type.

B. Perforated PVC Sewer Pipe and Fittings: ASTM D2729, bell-and-spigot ends, for loose joints.

2.2 DRAINAGE CONDUITS

A. Molded-Sheet Drainage Conduits: Prefabricated geocomposite with cuspated, molded-plastic drainage core wrapped in geotextile filter fabric.
1. Nominal Size:

a. 12 Inches (305 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of **30 gpm (114 L/min.)** at hydraulic gradient of **1.0** when tested in accordance with ASTM D4716.
b. 18 Inches (457 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of **45 gpm (170 L/min.)** at hydraulic gradient of **1.0** when tested in accordance with ASTM D4716.

2. Filter Fabric: PP geotextile.
3. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.

B. Multipipe Drainage Conduits: Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D1248 and wrapped in geotextile filter fabric.
1. Nominal Size:

a. 6 Inches (152 mm) High by Approximately 1-1/4 Inches (31 mm) Thick: With minimum in-plane flow of **15 gpm (57 L/min.)** at hydraulic gradient of **1.0** when tested in accordance with ASTM D4716.

2. Filter Fabric: Nonwoven, needle-punched geotextile.
3. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
4. Couplings: HDPE.

C. Single-Pipe Drainage Conduits: Prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D3350 and wrapped in geotextile filter fabric.
1. Nominal Size:

a. 12 Inches (305 mm) High by Approximately 1 Inch (25 mm) Thick: With minimum in-plane flow of **30 gpm (114 L/min.)** at hydraulic gradient of **1.0** when tested in accordance with ASTM D4716.

2. Filter Fabric: PP geotextile.
3. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
4. Couplings: Corrugated HDPE band.

D. Mesh Fabric Drainage Conduits: Prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include fittings for bends and connection to drainage piping.
1. Nominal Size: 6 inches (150 mm) high by approximately 0.9 inch (23 mm) thick.

a. Minimum In-Plane Flow: **2.4 gpm (9.1 L/min.)** at hydraulic gradient of **1.0** when tested in accordance with ASTM D4716.

2. Filter Fabric: Nonwoven geotextile made of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested in accordance with ASTM D4491.

E. Ring Fabric Drainage Conduits: Drainage conduit with HDPE rings-in-grid pattern drainage core, for field-applied geotextile filter fabric. Include fittings for bends and connection to drainage piping.
1. Nominal Size:

a. 18 Inches (0.5 m) High by 1 Inch (25 mm) Thick: With minimum in-plane flow of **82 gpm (310 L/min.)** at hydraulic gradient of **1.0** when tested in accordance with ASTM D4716.

2. Filter Fabric: Comply with requirements for flat geotextile filter fabric specified in Part 2 "Geotextile Filter Fabrics" Article.

2.3 DRAINAGE PANELS

A. Molded-Sheet Drainage Panels: Prefabricated geocomposite, **36 to 60 inches (915 to 1525 mm)** wide with drainage core faced with geotextile filter fabric.
   1. Drainage Core: Three-dimensional, nonbiodegradable, molded PP.
      a. Minimum Compressive Strength: **10,000 lbf/sq. ft. (479 kPa)** when tested in accordance with ASTM D1621.
      b. Minimum In-Plane Flow Rate: **2.8 gpm/ft. (35 L/min. per m)** of unit width at hydraulic gradient of **1.0** and compressive stress of **25 psig (172 kPa)** when tested in accordance with ASTM D4716.
   2. Filter Fabric, Nonwoven: Needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined in accordance with AASHTO M 288:
      a. Survivability: Class 1.
      b. Apparent Opening Size: **No. 40 (0.425-mm)** sieve, maximum.
      c. Permittivity: **0.5** per second, minimum.
   3. Filter Fabric, Woven: Geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with the following properties determined in accordance with AASHTO M 288:
      a. Survivability: Class 1.
      b. Apparent Opening Size: **No. 40 (0.425-mm)** sieve, maximum.
      c. Permittivity: **0.5** per second, minimum.
   4. Film Backing: Polymeric film bonded to drainage core surface.

B. Mesh Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
   1. Drainage Core: Open-construction, resilient, plastic-filament mesh, approximately 0.4 inches (10.2 mm) thick.
      a. Minimum In-Plane Flow Rate: **2.4 gpm/ft. (30 L/min. per m)** of unit width at hydraulic gradient of **1.0** and normal pressure of 25 psig (172 kPa) when tested in accordance with ASTM D4716.
   2. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested in accordance with ASTM D4491.

C. Net Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.

1. Drainage Core: Three-dimensional, PE nonwoven-strand geonet, approximately 0.25 inches (6 mm) thick.

    a. Minimum In-Plane Flow Rate: **2.4 gpm/ft. (30 L/min. per m)** of unit width at hydraulic gradient of **1.0** and normal pressure of 25 psig (172 kPa) when tested in accordance with ASTM D4716.

2. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested in accordance with ASTM D4491.

D. Ring Fabric Drainage Panels: Drainage-core panel for field application of geotextile filter fabric.
1. Drainage Core: Three-dimensional, HDPE rings-in-grid pattern, approximately 1 inch (25 mm) thick.

    a. Minimum In-Plane Flow Rate: **40 gpm/ft. (500 L/min. per m)** of unit width at hydraulic gradient of **1.0** and normal pressure of 25 psig (172 kPa) when tested in accordance with ASTM D4716.

2.4 SOIL MATERIALS

A. Soil materials are specified in Section 312000 "Earth Moving."

2.5 WATERPROOFING FELTS

A. Material: Comply with ASTM D226, Type I, asphalt or ASTM D227, coal-tar-saturated organic felt.

2.6 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m) when tested in accordance with ASTM D4491.

B. Structure Type: Nonwoven, needle-punched continuous filament.

1. Survivability: AASHTO M 288 Class 2.
2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.

C. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 FOUNDATION DRAINAGE INSTALLATION

A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive.

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.

F. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.

H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

I. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches (100 mm).

J. Install drainage panels on foundation walls as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article.
3. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
4. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.

K. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.4 UNDERSLAB DRAINAGE INSTALLATION

A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches (150 mm) between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive.

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.

F. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.

H. Install horizontal drainage panels as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at inside edge of footing.
3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

3.5 RETAINING-WALL DRAINAGE INSTALLATION

A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches (100 mm).

C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive.

D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.

E. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.

F. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.

G. Place drainage course in layers not exceeding 3 inches (75 mm) in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches (100 mm).

I. Install drainage panels on wall as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
3. If weep holes are used instead of drainage pipe, cut 1/2-inch- (13-mm-) diameter holes on core side at weep-hole locations. Do not cut fabric.
4. Mark horizontal calk line on wall at a point 6 inches (150 mm) less than panel width above footing bottom. Before marking wall, subtract footing width.
5. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
6. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from 2 to 6 inches (50 to 150 mm) below top of panel, approximately 48 inches (1200 mm) apart. Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
7. If another panel is required on same row, cut away 4 inches (100 mm) of installed panel core and wrap fabric over new panel.
8. If additional rows of panel are required, overlap lower panel with 4 inches (100 mm) of fabric.
9. Cut panel as necessary to keep top 12 inches (300 mm) below finish grade.
10. For inside corners, bend panel. For outside corners, cut core to provide 3 inches (75 mm) for overlap.

J. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

3.6 LANDSCAPING DRAINAGE INSTALLATION

A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).

D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least 6 inches (150 mm) between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with adhesive.

E. Add drainage course to top of drainage conduits.

F. After satisfactory testing, cover drainage conduit to within 12 inches (300 mm) of finish grade.

G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches (100 mm).

I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

3.7 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions and other requirements indicated.

1. Foundation Subdrainage: Install piping level and with a minimum cover of **36 inches (915 mm)** unless otherwise indicated.
2. Underslab Subdrainage: Install piping level.
3. Plaza Deck Subdrainage: Install piping level.
4. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of **36 inches (915 mm)** unless otherwise indicated.
5. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of **0.5** percent and with a minimum cover of **36 inches (915 mm)** unless otherwise indicated.
6. Lay perforated pipe with perforations down.
7. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install thermoplastic piping in accordance with ASTM D2321.

3.8 PIPE JOINT CONSTRUCTION

A. Join perforated PE pipe and fittings with couplings in accordance with ASTM D3212 with loose banded, coupled, or push-on joints.

B. Join perforated PVC sewer pipe and fittings in accordance with ASTM D3212 with loose bell-and-spigot, push-on joints.

C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.9 BACKWATER VALVE INSTALLATION

A. Comply with requirements for backwater valves specified in Section 334100 "Storm Utility Drainage Piping."

B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.

C. Install horizontal backwater valves in piping **in manholes or pits** where indicated.

3.10 CLEANOUT INSTALLATION

A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."

B. Cleanouts for Foundation, Retaining-Wall, and Landscaping Subdrainage:

1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In vehicular-traffic areas, use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, **18 by 18 by 12 inches (450 by 450 by 300 mm)** deep. Set top of cleanout flush with grade.
3. In nonvehicular-traffic areas, use NPS 4 (DN 100) **PVC** pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, [**2 by 12 by 4 inches (300 by 300 by 100 mm)** deep. Set top of cleanout **1 inch (25 mm)** above grade.
4. Comply with requirements for concrete specified in Section 033000 "Cast-in-Place Concrete."

C. Cleanouts for Underslab Subdrainage:

1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. Use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.11 CONNECTIONS

A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect low elevations of subdrainage system to solid-wall-piping storm drainage system.

C. Where required, connect low elevations of foundation subdrainage to stormwater sump pumps. Comply with requirements for sump pumps specified in Section 221429 "Sump Pumps."

3.12 IDENTIFICATION

A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 312000 "Earth Moving."

1. Install PE warning tape or detectable warning tape over ferrous piping.
2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.13 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

B. Drain piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.14 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 334600

SECTION 41 22 13.13

UNDER RUNNING BRIDGE CRANE

PART 1 – GENERAL

1.1 SUMMARY

A. Work includes complete design, fabrication and installation of the following:

1. One (1) 1/2-ton electric travelling under running bridge crane for the Household Hazardous Waste area canopy:
    - Exterior application
    - CMAA Duty Classification B
    - Span: as indicated on drawings
    - Maximum Bridge Crane speed: 60-fpm
    - Maximum Trolley speed: 40 fpm
    - Hoist type: Electric
    - Hoist ASME Duty Classification: H4
    - Minimum Hook Height: 10-feet
    - Hoist Speed : 21-fpm (max.)

1.2 CAPACITY AND DESIGN LOADS

A. Cranes and hoists shall be designed to withstand the dead load (caused by the weight of the crane and components themselves), the live load and hoist load, and the inertia forces caused by movement of the crane, components, and loads during standard operation.

B. Standard capacity ratings shall represent the net rated load at the hook of any type of trolley hoist with the same load rating installed on the crane having a trolley hoist weight within the established limits.

C. All design loads shall meet CMAA requirements. The design load for stress calculations shall be based upon the capacity plus 15% for the weight of the hoist and trolley and an additional 25% for impact (capacity x 1.25). Design load for deflection calculations shall be based upon the capacity plus 15% for the weight of the trolley hoist (capacity x 1.15).

D. The rated load capacity of each crane or hoist shall be clearly labeled on each using a label size easily read from the floor level and/or loading position.

1.3 RELATED DOCUMENTS

A. Requirements for crane runway rail supporting structures are specified in Section 05 12 00.

1.4 WARRANTY

A. The manufacturer shall provide a warranty for all crane components for a period of two years. The warranty period will start after all field testing and certification and corrections are made and the crane has been accepted for ownership.

1.5 REFERENCES

A. American Gear Manufacturers Association (AGMA)
   1. AGMA 2001 Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
   2. AGMA 6013 Standard for Industrial Enclosed Gear Drives

B. American Institute of Steel Construction (AISC)
   1. AISC 325 Manual of Steel Construction

C. American Society of Mechanical Engineers (ASME)
   1. ASME B30.10 Hook Safety Standard
   2. ASME B30.16 Overhead Hoists (Underhung) Safety Standard
   3. ASME B30.17 Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)
   4. ASME HST-4 Performance Standard for Overhead Electric Wire Rope Hoists

D. ASTM International
   1. ASTM A 1023 Standard Specification for Stranded Carbon Steel Wire Rope
   2. ASTM A 492 Standard Specification for Stainless Steel Rope Wire
   3. ASTM A 275 Standard Test Method for Magnetic Particle examination of Steel forgings

E. American Welding Society (AWS)
   1. AWS D1.1 Structural Welding Code (Steel)
   2. AWS D14.1 Welding Industrial and Mill Cranes

F. Crane Manufacturers Association of America, Inc. (CMAA)
   1. CMAA 74 Top Running and Under Running Single Girder Overhead Cranes

G. National Electrical Manufacturers' Association (NEMA)
   1. NEMA 250 Enclosures for Electrical Equipment
   2. NEMA ICS 8 Crane and Hoist Controllers
   3. NEMA MG 1 Standard for Motors and Generator

H. National Fire Protection Association (NFPA)
   1. NFPA 70 National Electric Code (NEC)

1.6 COORDINATION OF CRANE IN EXISTING FACILITY

A. The Contractor is responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. Verify all dimensions of the building that relate to fabrication of the bridge crane system and notify the engineer of any discrepancy before finalizing the crane design.

1.7 SUBMITTALS

A. Make submittals with sufficient time for review and approval to meet the project schedule.

B. Crane General Arrangement Drawings- Include main features of the crane and clearances, lifts, hook approaches to the sides and ends, maximum crane wheel loads and simultaneous trolley wheel loads.
   1. Provide details of crane girders, crane runway beams, and connections, including plan, elevation, and end view.
   2. Plan and section views of the part of the building containing crane showing complete crane envelope of travel including required clearances.

C. Electrical drawings: General drawing of the electrical equipment and wiring diagrams. Include manufacturer's panel wiring diagrams with schematics and the interconnection of the panels shown and tied into the general wiring diagram.

D. Bill of Materials: All mechanical and electrical equipment and components, including manufacturer's name, model numbers and rating.

E. Technical Data Sheets: Catalog information, including performance data for all crane system features.

F. Testing Documents: Submit testing plans for factory and site testing for engineer review. Site test plans shall fully comply with operational and proof testing Section 3.4 of this document.

G. Calculations: Structural and mechanical calculations and drawings signed and stamped by registered engineers in the State of California.

H. Failure Modes Effects Analysis (FMEA): A report in accordance with MIL-STD-1629 to identify any single bridge, trolley or hoist electrical, control, structural or mechanical component failure that could result in the loss of load or personal injury.

I. Installation Risk Plan: A Report which identifies potential risk to personnel, products or the facility during the installation of the bridge crane, assesses their likelihood and impact and provides actions to eliminate or mitigate risks.

1.8 CERTIFIED TEST AND INSPECTION REPORTS

A. Wire rope certification and breaking strength test results.

B. Hook proof load test results and certification. Test shall be by either the hook manufacturer or an independent testing facility in accordance with ANSI/ASME B30.10. Test to 200% of its rated capacity, followed by volumetric and surface NDE on hook, shank and nut.

1.9 CLOSEOUT SUBMITTALS

A. As-Built Drawings: At the end of the project submit for approval complete as-built shop drawings.

B. Acceptance Testing Documents: At the end of the project furnish signed copies of completed acceptance and proof load testing documentation.

C. Operating and Maintenance Manuals: Furnish 2 sets of operation and maintenance manuals for the new crane features & modifications on compact disc in PDF format delivered to the owner at the time of final acceptance. Manuals shall include drawings, lubrication information, and complete installation, operation and maintenance data for all component parts of the new equipment and lists of recommended spare parts with unit prices and sources.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: A minimum of 5 years' experience in the installation of specified materials on comparable projects. The installer shall have the approval of the materials manufacturer.

B. Regulatory Requirements: Comply with the mandatory and advisory safety requirements of ASME B30.16, ASME B 30.17, ASME B 30.2, ASME HST-4, NPFA 70, CCR ESO

C. Quality Assurance Program:
1. Manufacturer shall furnish quality assurance program and facilities to be applied during fabrication and shop inspection and testing of equipment.
2. Program shall describe the measures to be used to control activities affecting quality of equipment in compliance with this specification.

D. Pre-Installation Meetings: Before the start of Work, meet at the Project site to review methods and sequence of installation, special details and conditions, quality standards, testing and quality control requirements, job organization and other pertinent topics related to the Work. The meeting shall include the owner's representative(s), engineer, Contractor, and subcontractors whose work is relevant to this Specification Section.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading: Deliver equipment and materials to building site and store in dry, clean location, protected from rust and other damage.

PART 2 — PRODUCTS

2.1 SYSTEM DESCRIPTION

A. General: (1) Under running electric bridge crane systems with trolley mounted hoist conforming to CMAA 74. Crane capacity, span, hook height at maximum position from operating floor and ambient temperature range shall be as indicated in the requirements document.

B. Crane Classification Requirements Table:

CMAA Service	Speed Configuration	Selector Switch	Hoist Control	Reeving	Hoist Braking Systems
Class B	3-step infinitely variable with Normal, Micro and Hoist Indexing speed control modes.	3 position rotary switch; Crane modes are Normal/Micro/Index	Flux Vector VFD with motor encoder feedback* VFD*	Redundant True Vertical Lift	1. Control (Flux Vector VFD) 2. Load Holding 3. Redundant Load Holding**

C. Seismic Design Criteria: Obtain accelerations at the crane rail elevation level from project structural engineer to determine allowable stress levels under this condition of loading prior to crane design.

D. Wheel Loads: Maximum crane wheel loads (without impact) due to dead and live loads, with the trolley in any position, shall not cause a more severe loading condition in the runway support structure than that produced by the design wheel loads and spacing indicated on the design drawings.

E. System Power: 230 volt- 60 hertz- 3 phases

2.2 SPEEDS AND CONTROL PARAMETER SETTINGS

Speed Configuration	Selector Switch
3 speeds in Normal Speed Mode, plus Micro Speed and Hoist Index	3 position rotary switch: Normal/Micro/Index

A. Speeds

1/2-ton bridge crane:

1. Hoist: 3-step Infinitely Variable with a maximum hoist speed of 21 feet per minute plus one micro speed of 1 inch per minute.

2. Trolley: 3-step Infinitely Variable with maximum trolley speed of 40 feet per minute plus one micro speed of 1 foot per minute.

B. Speeds: All speeds shall be non-load sensitive.

1. Normal: All normal hoist, trolley and bridge speeds are activated.

2. Micro: Only micro speeds for hoist, trolley and bridge are activated and all other speeds are disabled.

3. Hoist Index: Accomplished with the wiring of programmable input to the hoist drive which is energized when selector switch is in "index". Input shall be set to a value of "60", index enable. Parameter C13-05, Index count, shall be set to achieve 0.015" ±5% hook travel at each run command. Bridge and trolley shall only operate at micro speeds while in index mode.

2.3 RUNWAY RAILS

A. Runway Rails: Provide ASCE or AREA standard rails, straight, parallel, level and of equal elevation within a tolerance of plus or minus 1/8 inch as per CMAA 74 and AISC. Rail splices shall be staggered, manufactured splice plates and connection hardware shall be used.

2.4 SEISMIC RESTRAINTS

A. Provisions shall be made to prevent the bridge or trolley(s) from "jumping" the rails anywhere in the range of operations during a seismic event.

2.5 TROLLEY

A. Frame: Design to contact the trolley stops evenly and prevent a drop of more than one inch in the event of an axle or wheel failure. For top riding trolleys on double girder cranes, provide trolley frame consisting of two structural steel side frames or trucks welded together with one or more structural load girts to form a one-piece unit. Trolley end trucks shall be of the rotating axle type and shall have jack pads or other approved method for wheel or axle replacement.

B. Wheels: Double flanged, straight tread, non-geared manufactured of rolled or forged steel with a minimum tread hardness of 320 Brinell keyed or splined to the input shaft.

C. Drives: 2 motor driven gear reduction units direct coupled to driving wheels or single drive unit driving 2 wheels. Gears shall conform to applicable AGMA standards. Gear reducers shall be oil tight, totally enclosed with splash type lubrication.

D. Brake: Electromechanical brake conforming to the requirements of CMAA 74 with a minimum torque rating of 100% of the drive motor rated torque. Provide a manual release mechanism.

E. Bumpers and stops: Provide structural steel end stops for runways. Provide energy absorbing bumpers and stops conforming to CMAA guidelines and designed to minimize parts falling from the crane in case of breakage. Design and install bumpers with tethers or other positive means to prevent parts falling from the bridge in case of breakage.

2.6 HOIST

A. Provide a Yale heavy duty low headroom electric wire rope hoist compliant with ASME HST-4 with double reeving for true vertical lift (TVL). Hoisting machinery shall consist of an electric motor driving through gear reductions to a winding drum.

B. Provide drum of steel construction with helical grooves cut right and left hand to receive, in a single layer, the full winding length of the rope so that no less than two full dead wraps at each end when the hook is at its extreme low position.

C. Gears in the reduction unit shall be mounted on short shafts and all gears shall be supported between bearings. Drum gear shall be pressed on and keyed to the hub of the rope drum. All gearing shall be encased in oil-tight housing readily accessible for maintenance.

D. Wire Rope
   1. Material: Improved plow steel or non-lubricated stainless steel (if specified for certain clean room applications) with an independent wire rope core. The wire rope shall have a minimum safety factor of 5:1 on its breaking strength in accordance with CMAA 74.
   2. Certification: Wire rope shall be certified. The use of non-rotational wire rope is prohibited. All wire rope fittings utilized shall have a 100% efficiency factor.

3. Anchor hoist rope ends on the drum by means of swage fittings or by clamping (minimum of 2 each side) to the outside surface of the drum. Each clamp shall contain the rope end and first wrap. Dead ended rope shall be properly seized to prevent unwrapping.

E. Hoist Brakes

1. Holding Brakes- Provide redundant an electro-mechanical holding brakes which will be applied automatically on power removal. The holding brakes shall have a dynamic torque rating of 125% to 150% of the required hoist motor torque, but not less than 150% rated load static holding torque.
Control Braking- hoists: Hoist closed loop flux vector variable frequency drive with dynamic braking resistors.

F. Sheaves: Provide steel sheaves properly sized for wire rope with grooves smooth and free from surface irregularities that could cause rope damage.

G. Load Block: Heavy steel housing to support sheaves and hook, designed to preclude wire rope from being cut, pinched, crushed or chafed in case of two blocking.

H. Hook: Forged steel, supported on thrust bearing allowing for 360º rotation under all load conditions. Hook manufacturer shall provide reference marks on hook for hook opening measurements. The hook shall hang vertically in any load condition. Provide with lockable gate type safety latch.

2.8 STRUCTURAL

A. Structural Steel: Conform to ASTM A36 or approved equivalent.

B. Welding: Designs and procedures shall conform to applicable requirements of AWS D 14.1 and AWS D 1.1.

C. Structural Bolted Connections: Comply with CMAA 74.

2.9 MECHANICAL

A. Bearings: Provide heavy duty, anti-friction ball or roller type bearings. Use sealed, lifetime lubricated bearings for all available external applications. Any use of non- sealed bearings must be approved by engineer and if approved the vendor must provide means for lubrication of bearings and secondary containment to prevent contamination from excess grease.

B. Gears: Conform to the applicable requirements of AGMA 2001 and AGMA 6013.

C. Drip Pans: Provide drip pans of approved material for all motors and gearboxes for all cranes.

2.10 ELECTRICAL

A. General: Provide all necessary electrical work to operate the bridge crane.

B. Electrical components features shall be designed, factory assembled, tested and installed in accordance with applicable rules, recommendations or regulations of NEMA, NEC, NFPA and as specified herein.

C. All electrical material and equipment shall be listed or labeled by UL, Factory Mutual or equivalent testing laboratory. Material and equipment not available with such label or listing shall be built in accordance with latest published standards of UL, Factory Mutual or equivalent testing laboratory and approved by engineer.

D. Runway Power Conductors: Conductor bar system with 3 phases of 480V and dedicated grounding bar with tandem collectors, or flat cable festoon system with industrially rated trolleys and carriers on C-track, I-beam or other approved method. Hardware used for festoon systems shall incorporate locking devices or shall be staked to prevent parts falling from the crane.

E. Bridge Mounted Disconnect: Lockable disconnect switch capable of removing all power to all components on the bridge.

F. Bridge Mounted Conductors: Flat cable festoon system with industrially rated trolleys and carriers on C-track, I-beam, or other approved method, or an enclosed conductor bar system with tandem collectors. Hardware used for festoon systems shall incorporate locking devices or shall be staked to prevent parts falling from the crane.

G. Motors: Meet all applicable requirements of NEMA MG 1 and UL 1004. Provide Inverter-Duty, TEFC 60 Minute duty motors with Class H insulation and Class B temperature rise.

H. Motor Controls
   1. Supply cranes with Magnetek VG-Plus Series 4 flux vector drives for all hoists. Provide a Series 4 Datalogger in addition to the standard keypad for the hoist VFD. Provide Magnetek G- Plus or G- Plus Mini scalar type VFD or approved equal for bridge and trolley.
   2. Provide RC surge suppressors applied across all contactor and relay coils as specified by variable frequency drive manufacturer. Circuit breakers, fuses, braking resistors and wiring shall be properly sized as specified by variable frequency drive manufacturer. Control relays shall be furnished with pilot lights and mechanical actuators. Control voltage shall not exceed 120 volts and shall be fused.

I. Resistors: As recommended by the variable frequency drive manufacturer for continuous duty operations at low speeds.

J. Encoders: Hoists with flux vector drives shall have motors provided with a 1024 PPR, direct coupled encoder. Class I hoists with emergency drum brakes shall include a drum mounted encoder to enable differential speed comparison.

K. Enclosures: Use NEMA 4/12 with hinged covers for electrical devices, controls and radio receiver units (unless otherwise specified). Attach metal diagram holders to the inside doors of control enclosures. Provide proper clearance in front of the power and control panels per NEC.

L. Travel Limit Switches:
   1. Provide bridge & trolley slow down and stop limit switches. Trippers shall be provided to decelerate the motion so that only slow speed is available going toward the end stops but retain all speeds in the opposite direction. The exact location must be finalized and

approved by engineer. Stop limit switches shall be set to stop bridge & trolley travel one inch from the hard stops.

M. Hoist Limit Switches
   1. Provide geared upper and lower limit switches and an additional gravity upper limit switch. All hoist upper stop limit switches shall be hard wired (not software dependent).
   2. Hoists- provide a limit switch to detect the mis spooling of the wire rope that prevents further lifting but allows the load to be lowered.

N. Install a dedicated ground connection to the lower block serviced by a trolley mounted cord reel. This conductor is to be bonded to the crane grounding lugs and transmitted back to building ground

2.11 INDICATOR LIGHTS

A. Bridge Indicator Lights: Provide indicator lights for the following functions: Green for hoist holding brake released, Red for hoist brake alarm, Blue for hoist in micro speed mode, White for hoist in index mode. Indicator lights shall be mounted below the bridge girder and easily visible from the floor. Provide a circuit to test indicator lights using the "On/Alarm" button on the controller.

2.12 PENDANT CONTROLS

A. Push Button Pendant shall be primary method of control. Pendant control cable and push-button station shall be supported by a suitable strain relieving cable or chain to prevent load or strain on the pendant conductor cable. Length of pendant control cable shall be such that the controller will be approximately 3.5 ft. above floor level. Pendant shall be suspended from a sliding trolley with wheels running on C-Track the full-length span of bridge girder, 3 ft. or more from the hoist hook.

B. Pendant Hardware used for festoon and pendant support systems shall incorporate locking devices or shall be staked to prevent parts falling from the crane.

C. Festoon capability to travel without obstruction to each end of the crane

2.13 PAINTING

A. Crane: Apply one shop coat of primer and finish coats suitable for specified application. Cranes shall be safety yellow unless otherwise specified. Paint shall be applied in conformance with manufacturer's recommendations. All running surfaces (ex. sheaves, end truck wheels, wire rope drum, etc.) shall be furnished unpainted.

2.14 SIGNAGE

A. Capacity: Must be permanently marked on the hook block. Capacity must be marked on each the bridge girder, clearly visible from the operating floor.

B. Compass Markings: Installed on crane clearly visible from operating floor with directions corresponding to the controls.

C. Nameplates; Nameplates showing the crane's manufacturer shall be permanently attached to the bridge and visible from the operating floor. Nameplates showing manufacturer's name, model number, and serial number and vital equipment data shall be attached in a visible place on each major item.

PART 3 — EXECUTION

3.1 GENERAL

A. Furnish drawings, templates, and directions for installing crane system to supporting structure. Deliver to Project site in time for installation.

B. Pre-installation Inspection- Inspect area to identify any impediments to the installation and notify owner in writing of any required corrections.

C. Coordinate installation of crane. Coordinate power requirements, current characteristics and location of power interface of crane with building electrical system.

3.2 INSTALLATION

A. Assemble and install equipment in accordance with the manufacturer's installation instructions and approved drawings, and as approved by engineer.

B. Tie in the 230V 3 phase power to the crane electrical system.

C. Runway rail alignment procedures and alignment tolerances shall be in accordance with CMAA standards and manufacturer's instructions. All equipment alignments shall be verified. Components shall be installed accurately, and positions checked, aligned and leveled.

3.3 TOUCH-UP PAINTING

A. Painted surfaces of equipment installed, which are damaged or abraded during installation, shall be repaired and repainted using the same paint used at the factory. Contractor shall furnish required materials.

3.4 TESTING AND INSPECTION

A. General: All testing shall be conducted by the manufacturer's authorized representative and all test data shall be recorded on the approved testing documents. All testing must be witnessed and approved by designated representative of the owner.

B. Operational Testing: Prior to initial use the equipment shall be inspected to ensure that all components and subassemblies have been properly installed per manufacturer's instructions and field tested to ensure compliance with this specification including hoisting and lowering, carrier travel, all limit switches, bypasses, safety systems, festoon systems, brakes and controls.

C. Proof Test:

1. Visual inspections will be made for proper installation, operations, alignment and lubrication. Any failure during the proof test shall be corrected at the Contractor's expense.

D. No Load Test:

1. With no load on the hoist, operation of all crane functions including the minimum and maximum speeds and the micro speed of all motions shall be demonstrated by pendant controls. The limit switches, control functions, and interlocks shall be tested for satisfactory operation. Emergency stops and shutdown functions shall be operationally verified.

E. 100% Rated Load Test:

1. The crane shall be given a test under 100% loads to verify operation of all drive controller functions and setup, acceleration, deceleration and to verify and record all speeds.

2. All hoist failure protection systems including loss of facility power, hoist overspeed protection.

F. 125% Proof Load Test

1. The crane hoist shall be operated to raise, lower and hold test loads of 125% of its rated capacity. All hoist brake functions under static load condition shall be tested to verify brake torque and holding capability.

2. As part of the proof-test, the hoist will be operated with 125 % of the rated load at micro speed continuously for a minimum of 5 minutes to demonstrate the hoist motor operations without any overheating or tripping problem.

G. Any failure that occurs during testing must be corrected immediately with no cost to the owner.

3.5 TRAINING

A. Crane vendor shall supply training on all aspects of crane operation and maintenance to owner’s personnel, with special attention given to all safety devices, alarms, warning lights and the operation of the power off load lowering system.

END OF SECTION 412213

SECTION A
TRUCK SCALE

1. GENERAL

1.1. Summary

(a) This section sets forth the requirements for the purchase and complete installation of an Emery Winslow Hyweigh Series 40, or comparable approved equal, 10-foot wide by 70-foot long, deep pit-type, single platform, concrete deck truck scales.

1.2. Work Included

(a) All work necessary to provide complete and operational weighing systems including: installing, scale supports, bulkheads, interior digital weight indicators, and interface to fee collection computer application, in conformance with other applicable sections of these Specifications and Attachment A-1, Technical Equipment Specifications.

(b) Provide manufacturer's technical requirements, conceptual drawings, Manufacturer's Operations and Maintenance Manual, warranty, recommendations, and start-up assistance.

1.3. Submittals

(a) The Contractor shall thoroughly review the Specifications and identify all required Project submittals. The items listed below are intended as a general summary of outlining requirements of the submittal items contained in this section. This list does not release the Contractor from the responsibility of identifying and providing all information requested.

(i) Information to be submitted with Contractor's bid shall include the following:

(A) Manufacturer's literature describing all features.

(B) Manufacturer's recommended construction detail for scale foundation and approaches.

(C) A minimum of five (5) references of sites currently using the exact scale model, complete with contact name and telephone number.

(D) Complete details of the specified standard and extended warranties.

(E) Shop Drawings for scale weighbridge.

(F) Written warranty that includes:

(1) The Hydrostatic load cells shall be warranted for life against damage from lightning, electrical abuse, or water. The load cells shall further be warranted for ten (10) years against defects in material and workmanship.

(2) The weighbridge shall have a five (5) year warranty against defects in material and workmanship.

(3) The digital indicator shall be warranted for two (2) years against defects in material and workmanship.

(ii) Submittal information to be submitted within ten (10) calendar days after Award of Contract shall include:

(A) Complete details of the specified standard and extended warranties.

(B) Shop Drawings and decking design (stamped and signed by a State of California Registered Civil Engineer) for scale weighbridge.

(C) Shop Drawings and design calculations for foundations and stem walls (stamped and signed by a State of California Registered Civil Engineer), approach ramps, and expansion/construction joints, if applicable.

(D) Concrete mix design and reinforcing details for the weighbridge deck.

(b) Shop drawings submitted with the bid proposal will be reviewed by the Owner as a method to evaluate bid proposals and to verify conformity to the intended application and minimum equipment specifications. Acceptance of bid proposals by the Owner shall not constitute shop drawing approval. Shop drawings shall be approved by the Owner or an authorized representative following the bid award and prior to manufacture or installation.

(c) The Owner's approval of shop drawings shall not excuse the successful bidder for deviations from any requirement of the Specification. The Owner's review shall be only to determine if the items covered by the submittal will, after fabrication or installation, conform to the information given in the Specifications and be compatible with the design concepts and performance required in the Specifications. The Owner's review shall not extend to means, methods, techniques, sequences, procedures and methods of fabrication, design methods and assumptions, or safety features and elements. Owner's approval shall not relieve the successful bidder from responsibility for defective materials and workmanship or warranty items.

2. PRODUCTS

2.1. General

(a) The scale shall be designed specifically for heavy-duty use at a landfill or other similar type weighing application. Where a definite material or product description is specified, it is not the intent to discriminate against an "or equal" product, it is the intent to set a definitive standard. Open competition is expected and desired, but in all cases, complete supporting data must be submitted with the bid package on all substitutions and exceptions proposed. Samples and/or documentation shall be submitted for comparison test when requested.

(b) No substitutions or exceptions shall be made unless authorized in writing. If the Contractor intends to provide an "equal to" product, he shall make this fact known to the Owner and it should be clearly outlined in the bid package. Otherwise, the Contractor will be required to furnish materials and products as called for in these Specifications. Should substitutions be accepted, and should these substitutions prove defective or otherwise unsatisfactory for the service intended, the Contractor shall replace the unsatisfactory substitutions with the material and equipment as called for in these Specifications at no additional cost to the Owner.

2.2. Weigh Bridge

(a) Contractor shall furnish and install the Emery Winslow Hyweigh deck or comparable approved equivalent. Major specifications shall include:

(i) Each deck modular shall have a monolithic pour of double layer reinforced type IV, 5,000 psi compressive strength concrete.

(ii) Ten (10) feet wide by seventy (70) feet long.

(iii) Assembled and poured at the job site.

2.3. Load Cells and Summing Totalizer

(a) Contractor shall furnish and install the Emery Winslow Hydrostatic Compression Load Cell Model 136-75 or comparable approved equivalent. Major specifications shall include:

(i) Load cells shall be hydrostatic type, and non-electric.

(ii) Load cells shall be NTEP certified for accuracy and performance.

(iii) Load cells shall have a minimum capacity of 75,000 lbs. each.

(iv) Load cells shall be immune to electrical damage, water, welding currents, RFI/EMI noise, shall be electrically inert, and shall be intrinsically safe for use without barriers in hazardous environments.

(v) Load cell tubing and pressure fitting shall be manufactured out of copper.

(vi) Single summing totalizer shall be located in the scale house connected to microcomputer based digital indicators and be electronically isolated from voltage surges or lightning strikes that may strike the weighbridge.

(vii) Summing network shall not be located in the weighbridge or outdoors.

(viii) Summing Network shall be located in a NEMA enclosure.

(ix) Ethernet card.

2.4. Digital Weight Indicators

(b) Digital indicators shall be Model 7400E and supplied by the scale manufacturer, with 4" Matko display (Model SLB4).

2.5. Scale Drain Piping

(a) The pipe and fittings for the scale drain shall be Corrugated Smooth Wall HDPE pipe, as manufactured by ADS, or an approved equal, and furnished in accordance with Caltrans Standard Specifications Section 64, Type D and the details on the Plan.

2.6. Scale Pit

(a) The Contractor is to provide shop drawings and design calculations for scale and foundations, drawings shall be stamped and signed by a professional engineer, registered in the State of California. The concrete shall meet the requirements of the approved design.

(b) Special inspection of concrete for the speed bumps is required. The Contractor shall provide for an independent, third party special inspector, approved by the County of Merced, and a laboratory for compressive strength testing of concrete samples.

Special inspector reports and compressive strength test results shall be submitted to the Engineer.

3. EXECUTION

3.1. Scale Installation

(a) Installation of the new scales are to take place in a manner so that at least one scale is operating during business hours.

(b) Scale installation shall be performed in accordance with the manufacture's recommendation and pursuant to the approved shop drawings. Protection, maintenance, rerouting, and interfacing with existing electrical and communication systems shall be the responsibility of the Contractor and/or scale manufacturer/installer. Install new underground conduit(s) or modify existing underground conduits to accommodate completed scale.

(c) It is the Contractor's responsibility to ensure that the scale pit dimensions are complaint with the scale. If alterations are required to allow the scale to function properly, the costs of these alterations shall be borne by the Contractor.

3.2. Scale Drain

(a) Trench excavation and backfill shall be in accordance with the details on the Plans and Section 31 20 00 Earth Moving.

(b) Warning tape shall be included along entire length of pipe.

(c) Pipe shall be installed with watertight joints.

(d) The pipe shall not be concealed until a final record survey has been completed and the Engineer has approved the pipe installation.

3.3. Scale Pit Foundation

(a) The scale pit foundation shall be constructed in accordance with approved shop drawings and design calculations provided by the Contractor.

4. MEASUREMENT AND PAYMENT

See Section 01 29 00 Payment Procedures.

****END OF SECTION A****

ATTACHMENT A-1
TECHNICAL EQUIPMENT SPECIFICATIONS

1	**PERFORMANCE**
1.1	All material and equipment shall conform to the Plans and Specifications and shall be new and of the latest improved model under the current model year.
1.2	Scales shall be of one manufacture and design to maximize compatibility and availability of components.
1.3	Scales shall be designed to operate in all weather conditions.
1.4	The scales and associated equipment shall meet National Institute of Standards and Technology Handbook 44 (NIST H-44) requirements and guidelines and shall be NTEP certified.
1.5	Scales shall be certified "legal for trade."
1.6	Seller shall obtain certification from Merced County Sealer of Weights and Measures.
1.7	Scale and associated equipment shall be compatible with existing fee collection system (Carolina Software Inc.).
1.8	The scales and associated equipment shall have adequate lightening and power surge protection to protect load cells, wiring, and indicators.
1.9	The scales and indicators shall be designed to deliver an immediate signal to the fee collection software once a vehicle has stopped for weighing and motion has ceased.
1.10	All critical maintenance and inspection areas shall be readily accessible.
2.0	**WEIGHBRIDGE**
2.1	All steel structural components.
2.2	Each scale shall utilize a three-section modular platform, each modular shall be a monolithic poured concrete deck weighbridge. Weighbridge shall be a minimum 10" thick, steel reinforced concrete structure. Weighbridge deck to be field poured, using 5,000 PSI compressive strength concrete. Reinforcing bar shall be in a double layer.
2.3	The total weighbridge capacity shall be 200,000 pounds.
2.4	The minimum dual axle capacity shall be 60,000 pounds.
2.5	The weighbridge shall be free floating and shall not require stay bars or be rigidly checked.
2.6	The weighbridge shall provide top service ports for simplified access to the load cells.
3.0	**PAINT**
3.1	Surface preparation per Steel Structure Painting Council SSPC-SP-1 solvent cleaning and SSPC-SP-6 blast cleaning specifications.
3.2	All exposed steel members shall receive surface preparation, primer, and topcoat.
3.3	All exposed steel members shall be painted with a minimum two (2) coats of corrosion resistant acrylic enamel, or equal, applied to a minimum three (3) mil. film thickness. Primer to be applied to a minimum three (3) mil thickness.
3.4	Manufacturer recommended color.
4.0	**LOAD CELLS AND SUMMING TOTALIZER**
4.1	Load cells shall be manufactured out of grade 304 stainless steel or higher.
4.2	Load cells shall be NTEP certified.
4.3	Load cells shall be hydrostatic type, and non-electric.
4.4	Load cells shall have a minimum capacity of 75,000 lbs. each.
4.5	Load cells shall be immune to water.
4.6	Load cells shall be immune to electrical damage, including lightening or voltage surges. Load cells shall also be immune to welding currents on or around the weighbridge, at any time during the life of the scale.
4.7	The load cells shall be immune to RFI/EMI noise.
4.8	The load cells shall be electrically inert, and shall be intrinsically safe for use without barriers in hazardous environments.
4.9	Load cell tubing (signal line) shall be manufactured out of copper.
4.10	Pressure fittings shall be manufactured from grade 316 stainless steel.
4.11	Load cells shall be connected to a summing totalizer located inside the fee booth.
4.12	The summing totalizer shall be electronically isolated from voltage surges or lightning strikes that may strike the weighbridge.

4.13	Summing totalizer shall be connected to microcomputer based digital indicators.
5.0	**DIGITAL WEIGHT INDICATORS**
5.1	Desktop style digital weight indicators are required.
5.2	The digital indicators shall be NTEP certified.
5.3	The digital indicators shall be housed in stainless steel housing with a minimum NEMA 4 rating.
5.4	The digital indicators shall be equipped with output compatibility for printers and microcomputers (RS-232 serial ports). The output ports shall be selectable for on demand or continuous communications.
5.5	The digital indicators output signal shall be compatible with commercially available fee collection software.
5.6	The digital indicators shall be equipped with a battery back-up system.
5.7	The digital indicators shall be electronically isolated from voltage surges or lightning strikes that may strike the weighbridges or summing totalizer.
5.8	The digital indicators shall be of the same design and supplied by the scale manufacturer.
5.9	The digital indicators shall have numeric keyboard entry with alpha-numeric LCD or LED display.
6.0	**FOUNDATIONS, APPROACHES, AND TRAFFIC CONTROLS**
6.1	Shop drawings shall be approved by the Owner for all foundations and approaches.
6.2	Approach and departure aprons shall be constructed using the dimensions shown on the construction Plans.
6.3	Speed bump per construction Plans.
7.0	**WARRANTIES**
7.1	The weighbridges shall have a five (5) year warranty against defects in material and workmanship.
7.2	The seller shall offer an optional, additional five (5) year warranty on the weighbridges against defects in material and workmanship.
7.3	The load cells shall have a ten (10) year warranty against defects in material and workmanship.
7.4	The load cells shall be warranted for life against damage lightening, electrical surges, or water.
7.5	The digital indicators shall have a two (2) year warranty against defects in material and workmanship.
7.6	The summing totalizer shall have a two (2) year warranty against defects in material and workmanship.
7.7	Complete details of the standard and extended warranties shall be included in the bid proposal response.
7.8	Warranty on site work/approach work two (2) years.
8.0	**SERVICE AND REPAIR PERFORMANCE**
8.1	Seller shall be capable of providing full service and warranty claim work including calibration, maintenance and repair of the scales and all associated equipment furnished as part of the installation.
8.2	Seller shall have the ability to provide next day service for normal and warranted service work.
8.3	Seller shall furnish four (4) copies of operator manuals and parts manuals.

END OF ATTACHMENT A-1

SECTION B
BUILDING PROTECTION SYSTEM

1. GENERAL

1.1. Summary

(a) This section sets forth the requirements for the building protection system (BPS).

(b) The CONTRACTOR shall assure that the ENGINEER shall at all times have safe access to the work for the purpose of monitoring.

1.2. Work Included

(a) The specified building protection system shall be furnished and installed as shown on the Drawings and as required herein to protect closed structures from vapor intrusion from the underlying soils. The building protection system will provide a vapor barrier layer from the following gases: Methane, other Hydrocarbon vapors in concentrations up to 20,000ppm, Hydrogen Sulfide, and Radon.

1.3. Manufacturer Certification, and Quality Control (QC)

(a) Quality Control (QC) is the responsibility of the CONTRACTOR and shall consist of manufacturer's certification, manufacturer's quality control testing, installation quality control conformance testing. BPS Contractor shall be trained and approved by gas vapor barrier manufacturer. A pre-installation conference shall be held prior to application of building protection system to assure proper substrate and installation conditions, to include contractor, applicator, architect/engineer and special inspector.

1.4. Qualifications

(a) The manufacturer shall be a well-established firm with more than five years of experience in the manufacturing of vapor barrier systems.

(b) The installer shall have installed a minimum of five years of experience and have completed a minimum of five previous similar installations as determined by the engineer.

1.5. Submittals Required

(a) The CONTRACTOR shall thoroughly review the Specifications and identify all required project submittals. The submittals listed below are intended as a general summary of the submittal items contained in this Section. This submittal list does not release the CONTRACTOR from the responsibility of identifying and providing all information requested.

(b) Manufacturer's product certifications and certified quality control test results as specified herein.

(i) Samples of gas vapor barrier membrane material.

(ii) Geotextile.

(iii) Methane Detection Equipment

(iv) Manufacturer/CONTRACTOR'S installation procedures, and QC Plan.

(v) Warranty as specified herein.

(vi) Signage

(vii) PVC Pipe and Fittings

(viii) Galvanized Steel Pipe and Fittings

(ix) Gas Detection System Components

(x) Gradation and Certificate of Compliance for Gravel

2. PRODUCTS

2.1. Gas Barrier System

(a) Fluid applied gas vapor barrier system - LIQUID BOOT®; a single-course, high-build, polymer modified asphaltic emulsion. Water borne and spray applied at ambient temperatures. A minimum thickness of 60 dry mils, unless specified otherwise as some cities and engineers may require a thicker membrane. Non-toxic and odorless. LIQUID BOOT® Trowel Grade has similar properties with greater viscosity and is trowel applied. Manufactured by CETCO or equal.

(b) Physical Properties: Geotextile shall meet or exceed the following requirements:

GAS VAPOR MEMBRANE	TEST METHOD	VALUE
Acid Exposure (10% H_2SO_4 for 90 days)	ASTM D543	Less than 1% weight change
Benzene Diffusion	Tested at 43,000 ppm	2.90 x 10-11 m^2/day
Chemical Resistance: VOCs, BTEXs (tested at 20,000 ppm)	ASTM D543	Less than 1% weight change
Chromate Exposure (10% Chromium6+ salt for 31 days)	ASTM E96	Less than 1% weight change
Diesel (1000 mg/l), Ethylbenzene (1000 mg/l), Naphthalene (5000 mg/l) and Acetone (500 mg/l) Exposure for 7 days	ASTM D543	Less than 1% weight change, Less than 1% tensile strength change
Radon Permeability	Tested by US Dept. of Energy	Zero permeability to Radon (222Rn)
Bonded Seam Strength Tests	ASTM D6392	Passed*
Micro Organism Resistance (Soil Burial)- average weight change,	ASTM D4068-88	Passed*
Methane Permeability	ASTM 1434-82	Passed*
Oil Resistance Test- average weight change, average tensile strength change, average tensile stress change, average elongation change, bonded seams, methane permeability	ASTM D543-87	Passed*
Heat Aging- average tensile strength change, average tensile stress change, average elongation change, bonded seams	ASTM D4068-88	Passed*
Dead Load Seam Strength	City of Los Angeles	Passed*
Environmental Stress-Cracking	ASTM D1693-78	Passed*
PCE Diffusion Coefficient	Tested at 6,000 mg/m^3	2.74 x 10-14 m^2/sec
TCE Diffusion Coefficient	Tested at 20,000 mg/m^3	8.04 x 10-14 m^2/sec
Soil Burial	ASTM E154-88	Passed
Water Vapor Transmission	ASTM E96	0.069 perms
POTABLE WATER	TEST METHOD	VALUE
Toxicity Test	22 CCR 66696	Passed. CCR Bioassay—Flathead Minnow
Potable Water Containment	ANSI/NSF 61	NSF Certified for tanks >300,000 gal**
Hydrostatic Head Resistance	ASTM D751	Tested to 138 feet or 60 PSI
GENERAL INFORMATION	TEST METHOD	VALUE
Freeze-Thaw Resistance (100 Cycles)	ASTM A742	Meets criteria. No spalling or disbondment
Accelerated Weathering & Ultraviolet Exposure	ASTM D822	No adverse effect after 500 hours
Elongation	ASTM D412	1,332% - Ø reinforcement, 90% recovery
Tensile Strength	ASTM D412	58 PSI without reinforcement

Tensile Bond Strength to Concrete	ASTM D413	2,707 lbs./ft² uplift force

Notes:

(1) Per NSF approval for 80-mil Liquid Boot® potable water containment membrane.

2.2. Geotextile

(a) BaseFabric™ T-40 non-woven geotextile, unless otherwise specified and approved by membrane manufacturer. The heat-rolled side shall be used as the application surface. Some projects may require a heavier geotextile (BaseFarbic™ T-60).

2.3. Warranty

(a) The geotextile manufacturer shall furnish a written warranty on a prorata basis for a period of 12 months. The warranty shall be against manufacturing defects of workmanship and against deterioration due to ozone, ultraviolet and/or other normal weather aging.

2.4. PVC Pipes and Fittings

(a) PVC pipes and fittings shall be Schedule 80, conforming to the requirements of ASTM D1785, D2464, and D2466, and shall have been approved by the National Sanitation Foundation (NSF). As specified, saw cuts or perforations will be supplier installed.

2.5. PVC Valves

(a) Gas sampling valves shall be 1/4-inch PVC labcock. Labcock seat and seal shall be EPDM. Labcock shall have a 1/4-inch MPT one end, and hose connection on the other end, and shall be manufactured by Chemtrol Asahi/America, or approved equal.

2.6. Galvanized Steel Pipe

(a) Galvanized steel pipe shall conform to Section 209-3.5.2 of the SSPWC. Fittings shall be Class 150 malleable iron threaded fittings conforming to ASTM A197. Galvanizing shall conform to ASTM A153.

2.7. Gravel for Sub-Slab System

(a) Gravel (#3 Aggregate) shall consist of a clean, hard, durable, uniform product, free of limestone, organic, and other deleterious material. Gravel shall conform to the following gradation as determined by Sieve Analysis (ASTM D422):

U.S. Standard Sieve	Percent Passing by Weight
1/2 inch	100
3/8 inch	85-100
No. 4	0-30
No. 8	0-10
No. 200	0-2

(b) The Contractor shall submit, to the Engineer for approval, certified results of a sieve analysis on the proposed material, signed by a State of California registered Civil Engineer or Geotechnical Engineer.

(c) Gravel shall have a minimum permeability of 1.0 x 10-1 cm/sec. The Contractor shall submit, to the Engineer for approval, certified results of a permeability test on the

proposed material, signed by a State of California registered Civil Engineer or Geotechnical Engineer.

(d) The Contractor shall identify the potential source and provide Certificates of Compliance at least 15 working days prior to intended use. Should the County determine that confirmation testing is warranted, the County will bear the responsibility of costs for such additional testing. The Contractor shall reimburse the County for the confirmation tests, if such tests indicate that the proposed material does not conform to the Project Specifications. The Contractor shall bear the responsibility for the costs of gradation and permeability tests, listed above.

2.8. Methane Detection Sensors and Controller

(a) System controller shall be RKI Beacon 110 or approved equal.

(b) Methane and Hydrogen Sulfide Sensors

(i) LEL Sensor shall be RKI Instruments S2 Series Sensor/Transmitter (Model No. 65-2405RK) or approved equal.

(ii) H2S Sensor shall be RKI Instruments S2 Series Sensor/Transmitter (Model No. 65-2331RK) or approved equal.

(c) Alarm system shall Edwards Signaling 120V Horn Strobe with red lens (Model No. 868STRR-N5) or approved equal.

(d) Calibration Kits

(i) LEL Kit shall be RKI Instruments Model No. 81-F002RK-LV or approved equal.

(ii) H2S Kit shall be RKI Instruments Model No. 81-F101RK-LV or approved equal.

3. EXECUTION

3.1. Supporting Surfaces Inspection

3.1.1. Acceptance of Subgrade Surfaces

(a) The ENGINEER and CONTRACTOR/Installer will conduct a walk-through of all areas to a vapor barrier, at which time, the CONTRACTOR/Installer shall verify in writing that the supporting surface is acceptable for installation and that all required installation, testing, etc., of underlying materials or other supporting surfaces, has been performed. The areas to be covered will be turned over to the CONTRACTOR/Installer upon such acceptance. The CONTRACTOR shall be responsible for maintenance of these areas in accordance with Specification requirements until completion of the geotextile installation.

3.2. Surface Preparation

(a) Provide 24 inches of minimum clearance out from surfaces to receive the gas vapor barrier. The application surface shall be prepared and provided to the applicator in accordance with manufacturer's specifications. Concrete surfaces shall be light broom finish or smoother, free of any dirt, debris, loose material, release agents or curing compounds. Fill all voids more than 1/4 inch deep and 1/4 inch wide. Masonry joints, cold joints, and form joints shall be struck smooth. All penetrations shall be prepared in accordance with manufacturer's specifications. Provide a 3/4-inch minimum cant

of LIQUID BOOT®, or other suitable material as approved by manufacturer, at all horizontal to vertical transitions and other inside corners of 120° or less. Allow to cure overnight before the application of LIQUID BOOT®. All cracks or cold joints greater than 1/16 inch must be completely grouted with non-shrink grout as approved by engineer. Install Hardcast reinforcing tape over all cold joints, cracks, and form tie holes (after holes and cracks are grouted).

(b) Installation on concrete / shotcrete / masonry surfaces: Concrete surfaces shall be light broom finish or smoother, free of any dirt, debris, loose material, release agents or curing compounds. Fill all voids more than 1/4 inch deep and 1/4 inch wide. Masonry joints, cold joints, and form joints shall be struck smooth. All penetrations shall be prepared in accordance with manufacturer's specifications. Provide a 3/4-inch minimum cant of LIQUID BOOT®, or other suitable material as approved by manufacturer, at all horizontal to vertical transitions and other inside corners of 120° or less. Allow to cure overnight before the application of LIQUID BOOT®. All cracks or cold joints greater than 1/16 inch must be completely grouted with non-shrink grout as approved by engineer. Install Hardcast reinforcing tape over all cold joints, cracks, and form tie holes (after holes and cracks are grouted).

(c) Installation on soil subgrade: The sub-grade shall be moisture conditioned and compacted to a minimum relative compaction of 90 percent or as specified by civil/geotechnical engineer. The finished surface shall be smooth, uniform, and free of debris and standing water. Remove all stones or dirt clods greater than 1/4 inch. (NOTE: Aggregate sub-bases shall be rolled flat, free from any protruding sharp edges). Penetrations shall be prepared in accordance with manufacturer's specifications. All form stakes that penetrate the membrane shall be of rebar which shall be bent over and left in the slab. Trenches shall be cut oversize to accommodate gas vapor barrier membrane and protection course with perpendicular to sloped sides and maximum obtainable compaction. Adjoining grade shall be finish graded and compacted. Excavated walls shall be vertical or sloped back, free of roots and protruding rocks. Specific sub-grade preparation shall be designed by a qualified civil or geotechnical engineer. If organic materials with potential for growth (i.e.: seeds or grasses) exist within the sub-base, spray apply soil sterilant at the sterilant manufacturer's recommended rate

3.3. Installation

3.3.1. Installation on Concrete / Shotcrete / Masonry surfaces:

(a) Refer to Section 3.3.3, "Sealing Around Penetrations", for procedures to seal around penetrations.

(b) Provide a ¾" minimum cant of LIQUID BOOT®, or other suitable material as approved by manufacturer, at all horizontal to vertical transitions and other inside corners of 120° or less. Allow to cure overnight before the application of LIQUID BOOT®.

(c) Delineate a test area on site with a minimum dimension of 10 feet by 10 feet (3m by 3m). Apply LIQUID BOOT® to a thickness of 60 mils and let it cure for 24 hours.

Observe for blisters. If minor or no blistering occurs, proceed to the next step. (See note regarding blisters). If significant blistering does occur, apply a thin (10 mil) tack coat of LIQUID BOOT® "A" side without catalyst to the entire concrete surface and allow curing before proceeding. (See also information regarding blister repair).

(d) Spray-apply LIQUID BOOT® to a 60-mil minimum dry thickness. Increase thickness to 100 dry mils if shotcrete is to be applied directly to membrane. If a second coat is required, remove any standing water from the membrane before proceeding with the second application.

(e) Do not penetrate membrane. Keep membrane free of dirt and debris and traffic until a protective cover is in place. It is the responsibility of the General Contractor to ensure that the membrane and the protection system are not penetrated.

(f) After membrane has cured and checked for proper thickness and flaws, install protection material pursuant to manufacturer's instructions.

(g) NOTE: All testing or inspection to be performed prior to placing protection course.

(h) NON-HORIZONTAL SURFACES: Spray on non-horizontal surfaces should begin at the bottom and work towards the top. This method allows the product to adhere to the surface before hitting catalyst runoff.

(i) NOTE: Due to the nature of concrete as a substrate, it is normal for some blistering to occur. This is caused by either concrete's tendency to off-gas or water that is temporarily trapped between the concrete and the membrane. With time and the applied pressure of backfill or over-slab, blisters will absorb into the concrete without detriment to the membrane. A small number of blister heads should be sampled and checked for proper membrane thickness. If the samples have the minimum required membrane thickness, then the remaining blisters should not be punctured or cut. If the samples have less than the minimum required membrane thickness, then the area can either be re-sprayed to obtain the proper thickness, or the blisters can be cut out and the area re- sprayed or patched with LIQUID BOOT® Trowel Grade.

3.3.2. Installation on soil surfaces:

(a) Roll out BaseFabricTM geotextile on sub-grade with the heat-rolled side facing up. Overlap seams a minimum of 6 inches. Lay geotextile tight at all inside corners. Apply a thin 10 mil tack coat of LIQUID BOOT® "A" side without catalyst within the seam overlap. Line trenches with geotextile extending at least six inches (6") onto adjoining sub-grade if slab and footings are to be sprayed separately.

(b) Minimize the use of nails to secure the geotextile to the dirt subgrade. Remove all nails before spraying membrane, if possible. Nails that cannot be removed from the dirt subgrade are to be patched with geotextile or Hardcast reinforcing tape overlapping the nail head by a minimum of two inches (2"). Apply a thin tack coat of LIQUID BOOT® under the geotextile patch, when patching with geotextile.

(c) Refer to Section 3.3.3, "Sealing Around Penetrations", for procedures to seal around penetrations.

(d) Spray-apply LIQUID BOOT® onto geotextile to a 60-mil minimum dry thickness. Increase thickness to 100 dry mils if shotcrete is to be applied directly to membrane. If a second coat is required, remove any standing water from the membrane before proceeding with the second application.

(e) Do not penetrate membrane. Keep membrane free of dirt, debris and traffic until a protective cover is in place. It is the responsibility of the General Contractor to ensure that the membrane and the protection system are not penetrated.

(f) After membrane has cured and checked for proper thickness and flaws, install protection material pursuant to manufacturer's instructions.

(g) NOTE: All testing or inspection to be performed prior to placing protection course.

3.3.3. Sealing around penetrations:

(a) Clean all penetrations. All metal penetrations shall be sanded clean with emery cloth.

(b) For applications requiring BaseFabricTM geotextile, roll out geotextile on sub-grade with the heat-rolled side facing up, overlapping seams a minimum of six inches (6"). Cut the geotextile around penetrations so that it lays flat on the sub-grade. Lay geotextile tight at all inside corners. Apply a thin (10 mil) tack coat of LIQUID BOOT® "A" side without catalyst within the seam overlap.

(c) At the base of penetration install a minimum ¾ inch thick membrane cant of LIQUID BOOT®, or other suitable material as approved by manufacturer. Extend the membrane at a 60-mil thickness three inches (3") around the base of penetration and up the penetration a minimum of three inches (3"). Allow to cure overnight before the application of LIQUID BOOT® membrane. (See manufacturer's standard detail.)

(d) Spray apply LIQUID BOOT® to a 60 mils minimum dry thickness around the penetration, completely encapsulating the collar assembly and to a height of one- and one-half inches (1 1/2") minimum above the membrane as described in (c) above. Spray-apply LIQUID BOOT® to surrounding areas as specified for the particular application. (SEE MANUFACTURER'S STANDARD DETAIL)

(e) Allow LIQUID BOOT® to cure completely before proceeding to step "F".

(f) Wrap penetration with polypropylene cable tie at a point two inches (2") above the base of the penetration. Tighten the cable tie firmly to squeeze, but not cut, the cured membrane collar.

3.4. Construction Quality Control

(a) Applicators should check their own work for coverage, thickness, and all-around good workmanship before calling for inspections.

(b) The membrane must be cured at least overnight before inspecting for dry-thickness, holes, shadow shrinkage, and any other membrane damage. If water testing is to be performed, allow the membrane to cure at least 72 hours prior to the water test. When thickness or integrity is in question the membrane should be tested in the proper manner as described below. However, over-sampling defeats the intent of inspections. Inspectors should always use visual and tactile measurement to guide them. Areas suspected of being too thin to the touch should be measured with the gauges to

determine the exact thickness. With practice and by comparing tactile measurements with those of the gauges, fingers become very accurate tools.

3.4.1. On concrete/shotcrete/masonry & other hard surfaces.

(a) Membrane may be checked for proper thickness with a blunt-nose depth gauge, taking one reading every 500 square feet. Record the readings. Mark the test area for repair, if necessary.

(b) If necessary, test areas are to be patched over with LIQUID BOOT® to a 60 mils minimum dry thickness, extending a minimum of one inch (1") beyond the test perimeter.

3.4.2. On soil subgrade.

(a) Samples may be cut from the membrane and geotextile sandwich to a maximum area of 2 square inches. Measure the thickness with a mil- reading caliper, per 500 sq. feet. Deduct the plain geotextile thickness to determine the thickness of LIQUID BOOT® membrane. Mark the test area for repair.

(b) Voids left by sampling are to be patched with geotextile overlapping the void by a minimum of two inches (2"). Apply a thin tack coat of LIQUID BOOT® under the geotextile patch. Then spray or trowel-apply LIQUID BOOT® to a 60 mils minimum dry thickness, extending at least three inches (3") beyond geotextile patch.

3.4.3. Smoke testing for holes - Holes or other breaches in the membrane can be detected by conducting a smoke test. This involves pumping smoke under the membrane for a specified period of time, under a specified pressure, which varies from project to project. Contact CETCO for information about this test at 800-527-9948.

3.5. PVC Pipe and Fittings

(a) Plastic pipe, fittings and appurtenances shall be stored in a flat, horizontal position until ready for installation and protected from direct sunlight for extended periods of time.

(b) PVC pipe fittings and appurtenance shall be provided with solvent joints, except where otherwise shown.

(c) Solvent welded joints shall be made in accordance with ASTM D2855. The ends of the plastic pipe shall be cut square and smooth, beveled, and wiped clean.

(d) Primer shall first be applied to the outside of the pipe and the inside of the fitting socket with a small paint brush or other approved applicator.

(e) After priming, solvent cement shall be applied to the outside of the pipe and the inside of the fitting socket with a small paint brush or roller applicator. Solvent shall be applied in such a manner that no material is deposited on the interior surface of the pipe or extruded into the interior of the pipe during joining. The coated surfaces shall be immediately pushed snugly together, and the pipe rotated approximately 1/4 turn to ensure uniform distribution of cement. Excess cement on the exterior of the joint shall be wiped clean immediately after assembly.

(f) Care shall be exercised in assembling a pipeline with solvent welded joints so that stress on previously made joints is avoided. Handling of the pipe following jointing, such as lowering the assembled pipeline into the trench, shall not occur prior to set times specified in ASTM D2855.

(g) PVC piping installed above ground shall be protected against the effects of ultraviolet (UV) light by the application of a heavily pigmented, two part, self-priming, epoxy paint formulated for exterior use, and shall be manufactured with UV inhibitors. Paint shall be Hi-Build Epoxoline II L69F, and topcoat shall be Endura-Shield Series 1095 or approved equal. Paint coating shall have a minimum dry thickness of 4 microns (7 microns wet).

3.6. Gravel Layer

(a) Gravel for the collection layer shall be disturbed over the underlying geotextile to the thickness indicated on the drawings.

(b) The location of collection piping and the limits and depth of the collection gravel shall be verified by survey and reflected as part of the as-built drawings.

3.7. Gas Detection Equipment

(a) Equipment shall be installed at the locations indicated on the drawings, in accordance with local code requirements and the recommendations of the manufacturer.

4. MEASUREMENT AND PAYMENT

See Section 01 29 00 Payment Procedures.

****END OF SECTION B****

SECTION C
VEHICLE BARRIER GATES

1. GENERAL

1.1. Summary

(a) This section sets forth the requirements for vehicle barrier gates indicated on the Drawings.

1.2. Submittals

(a) The Contractor shall thoroughly review the Specifications and identify all required project submittals. The submittals listed below are intended as a general summary of the submittal items contained in this section. This submittal list does not release the Contractor from the responsibility of identifying and providing all information requested.

(i) Manufacturer's catalog cut sheets for:

(A) Traffic Barrier Gates and Detector Loops

2. MATERIAL

2.1. Traffic Barrier Gates

(a) The traffic barrier gates shall be PowerMaster Model D-SBG Barrier gate Operator ½ hp, 115V, 1PH w/ Battery Backup, 120 VAC. The gates will open with the use of Paradigm software. Barrier arm shall be 9.8 feet in length.

(b) Detector loops shall be provided in the approach slab at either end of the scale. (1) detector loop will be required 1" from each barrier gate to the fee booth for the control wiring and the appropriately sized power conduit.

3. CONSTRUCTION METHODS

3.1. General

(a) Traffic barrier gates and detector loops shall be installed in accordance with the manufacturer's recommendations.

4. MEASUREMENT AND PAYMENT

See Section 01 29 00 Payment Procedures.

****END OF SECTION C****

County of Santa Cruz

Department of Community Development & Infra

701 Ocean Street, 4th Floor, Santa Cruz, CA 95060-4070
(831) 454-2160

County of Santa Cruz
Community Development & Infrastructure
Reviewed for Code Compliance
By: JEH
Date: 08/08/2025
Master Permit: APP-251009
Bldg. Permits: B-251911, 12 & 13

Project Information & Threshold Determination - Ap

Completion of this form shall be used as a guidance by the applicant for determining the projects stormwater requirements. Applicants are encouraged to contact the Stormwater Management staff with any questions. Definitions, standard details and further guidance is provided within Part 3 of the **Design Criteria** linked on the Public Works website at https://dpw.co.santa-cruz.ca.us/Home.aspx

PROJECT & CONTACT INFORMATION

Project Site Address:
9835 Newell Creek Rd, Ben Lomond, CA 95005

Assessor's Parcel Number (APN):
076-261-03; 076-231-02; 076-241-05

Building Permit No. / Discretionary Application:

Property Owner, Applicant, or Representative Name:
Michael Hettenhausen - County GSD

Contact Phone Number:
(831) 454-2210

Flood Control District (additional permit fees for lot coverage may be assessed, refer to Unified Fee Schedule)
Zone 8

PROJECT DESCRIPTION

Lot Coverage	Actual		Adjusted	
A. Total lot size:	2,689,830	sq.ft.		
B. Existing Permitted Impervious Area:	224,383	sq.ft.		
C. Replaced Permitted Impervious Area:	24,626	sq.ft.		
D. Replaced Permitted Semi-Impervious* Area:	0	sq.ft.	0	sq.ft.
E. Total proposed Self-mitigating Area:	0	sq.ft.		
F. Proposed Impervious Area:	0	sq.ft.		
G. Proposed Semi-Impervious* Area:	0	sq.ft.	0	sq.ft.

Values in these tables are automatically calculated, user does not need to enter information here if filled out electronically.

Total **REPLACED** impervious & semi- impervious area [C + D]: 24,626 sq.ft.

Total **NEW** impervious & semi-impervious area [F + (0.5*G]: 0 sq.ft.

Project Threshold Classification

(Value will auto-sum if filled out electronically, otherwise add **REPLACED** *and* **NEW** *to obtain total for determining project size below)* 24,626 sq.ft.

☐ **Small Project** (less than 500 sq.ft. created and/or replaced) - Use *Appendix B 'Small Project Submittal Requirements'* for submittal requirement guidance.

☐ **Medium Project** (more than 500 sq.ft. but less than 5,000 sq.ft. created and/or replaced) - Use *Appendix C 'Medium Project Submittal Requirements'* for submittal requirement guidance.

☑ **Large Project** (more than 5,000 sq.ft. created and/or replaced **OR** 50% increase in permitted impervious area**) - Use *Appendix D 'Large Project Submittal Requirements'* for submittal requirement guidance.

1. Application is part of a phased project OR master plan?	Yes ☐	No ☑
2. No diversion is proposed and pre-development runoff patterns will be maintained.	Yes ☑	No ☐
3. Application complies with Part 3 of the Design Criteria requirements .	Yes ☑	No ☐
4. Drainage has been evaluated. There are no existing drainage issues on/near the site and none anticipated.	Yes ☑	No ☐
5. Safe stormwater overflow has been incorporated into the project design. No adverse impacts to neighboring properties, drainage pathways, or roadways are anticipated.	Yes ☑	No ☐

Signature Required

By signing this form, the signee agrees the information provided here represents, to the best of their knowledge the scope of work being proposed. Signee acknowledges this document is to be used as a guidance for determining the project size and stormwater requirements, additional requirements and clarification may be required.

Michael Hettenhausen

**Form will apply a 50% credit for semi-impervious areas as final count. Applicant shall not apply the credit.*
*** Projects that add more than 50% impervious area coverage are required to mitigate the entire site.*

TETRA TECH

Geotechnical Engineering ● Engineering Geology

Geotechnical Design Report Rev.1

BEN LOMOND TRANSFER STATION
NEW CANOPIES
AND
WATER INTRUSION ASSESSMENT

9835 Newell Creek Road
Ben Lomond, California

Prepared for:

County of Santa Cruz
701 Ocean Street, Room 410
Sant Cruz, California 95060

Prepared by:

Tetra Tech BAS, Inc.
21700 Copley Drive, Suite #200
Diamond Bar, California 91765

Project No. BAS 21-185E
(supersedes report dated July 11, 2022)
August 6, 2024

TETRA TECH

Project No. BAS 21-185E
(supersedes report dated July 11, 2022)
August 6, 2024

Ms. Nicole Steel
County of Santa Cruz
701 Ocean Street, Room 410
Sant Cruz, California 95060

Subject: **GEOTECHNICAL DESIGN REPORT Rev.1**
BEN LOMOND TRANSFER STATION
NEW CANOPIES AND WATER INTRUSION ASSESSMENT
9835 Newell Creek Road
Ben Lomond, California

Dear Ms. Steel:

Tetra Tech is pleased to submit our revised report including the results of our geotechnical investigation for the design of the new canopies at the transfer station located at 9835 Newell Creek Road, in Ben Lomond, California. This report supersedes our previous report dated July 11, 2022. Our scope included investigation to evaluate the subsurface conditions at the property in order to provide recommendations for design and construction of the 2 new canopies. In addition, an evaluation of water intrusion seepage at the toe of the stairs and the adjacent retaining wall inside of the transfer station building was performed.

This report includes a brief description of the proposed development, a discussion regarding the field exploration and laboratory testing, a description of subsurface conditions, a discussion on engineering seismology and geological hazards and provides geotechnical conclusions and recommendations for the design and construction of the proposed improvements and recommendations for mitigation of the water intrusion inside the transfer station building. The appendices to the report include logs of exploratory borings, results of laboratory tests, and calculations of the seismic demand.

We appreciate the opportunity to provide our professional services on this project. If you have any questions regarding this report or if we can be of further service, please do not hesitate to contact the undersigned.

Respectfully submitted,
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1. INTRODUCTION

This revised report presents the results of Tetra Tech's geotechnical engineering evaluation and recommendations for the design of new canopies at the transfer station located at 9835 Newell Creek Road in Ben Lomond, California. The report also presents our assessment of the water intrusion observed inside the transfer station building. The location of the site is shown in Figure 1 – Site Location Map. This report supersedes our previous report dated July 11, 2022.

Our scope included investigation to evaluate the subsurface conditions at the property in order to provide recommendations for design and construction of the 2 proposed canopies. In addition, an evaluation of water intrusion seepage at the toe of the stairs and the adjacent retaining wall inside of the transfer station building was performed.

This report includes a brief description of the proposed development, a discussion regarding the field exploration and laboratory testing, a description of subsurface conditions, a discussion on engineering seismology and geological hazards and provides geotechnical conclusions and recommendations for the design and construction of the proposed improvements and recommendations for mitigation of the water intrusion inside the transfer station building. The appendices to the report include logs of exploratory borings, results of laboratory tests, and calculations of the seismic demand.

2. PROJECT DESCRIPTION

The Ben Lomond transfer station canopy project entails the design and construction of 2 new steel canopy structures at locations shown on Figure 2 – Project Layout and Boring Locations Map and described below:

- A new canopy to cover the recycling area to the east of the existing transfer station building and the main access road to provide protection during rain events. The canopy will span over the existing retaining wall that separates the upper staging area from the sorting containers and the access road. The canopy will have a footprint of approximately of 118 feet in the east-west direction and extend along most of the length of the existing building in the north-south direction for a length of about 144 feet. The canopy will have 1 east-west span, and 5 spans in the north-south direction about 29 feet each. The canopy will be supported by columns founded on a single 42-inch cast-in-drilled-hole (CIDH) pile. Thus, the CIDH pile foundations will be configured in 2 parallel rows roughly oriented north-south:

  - The 1st row will be adjacent and along the east wall of the existing building; and
  - The 2nd row will be installed along the outside, east, edge of the access road.

  It is understood that the CIDH piles along the 1st and 2nd rows will be tied with grade beams in roughly the north-south direction only (no ties in the east-west direction). The following design loads per column were provided by the project Structural Engineer:

  - Axial compression force of 85 kips;
  - Uplift force of 13 kips;
  - Lateral shear force at the pile top of 58 kips;

- A new canopy to cover the existing household hazardous waste (HHW) area located to the south of the existing transfer station office and immediately to the east of the existing HHW facility. The canopy will have a footprint of approximately of 73 feet with 1 span in the east-west direction by 50 feet with 2 spans of 20 and 30 feet in the north-south direction. The columns will be supported on 30- and 42-inch CIDH piles. It is understood that tying of the piles is not being considered for this canopy. The following design loads per column were provided by the project Structural Engineer for the 30-inch piles:

  - Axial compression force of 23 kips;
  - Uplift force of 3 kips;
  - Lateral shear force at the pile top of 21 kips;

  and for the 42-inch piles:

  - Axial compression force of 53 kips;
  - Uplift force of 9 kips;
  - Lateral shear force at the pile top of 44 kips;

The columns will support prefabricated steel girders that in turn will support the canopy roof. Partial height walls will be constructed to provide protection from rainwater intrusion into the structure. Site grading plans are not available yet for the project. However, we anticipate the site grading will involve only minor cuts and fills to achieve the design levels.

In addition, there will be a total of 5 concrete rectangular pads located just west of the west end of the transfer station that will be used to support several types of electrical equipment (transformer, generator, automatic transfer switch, main distribution panel, universal motor controller). The pads vary in size between 14 feet by 7 feet (the largest) to about 4 feet by 7 feet (the smallest one). Dead load for the largest pad is about 28,000 lbs whereas for the smallest pad is about 1,800 lbs. The pads are expected to be at the ground surface or lightly embedded (embedment depth less than 1 foot).

The geotechnical support for the project entails preparation of the design recommendations for the considered foundations and evaluation of the static and seismic lateral earth pressures on the existing retaining wall located below the new canopy. Additionally, recommendations are provided for construction of new pavements.

In addition, water intrusion has been observed inside the transfer station building along the interior retaining wall at the bottom of the stairs and extending about 65 feet to the north along the joint between the retaining wall and the floor slab. Illustrative photographs are shown below. This report includes evaluation of the water intrusion causation and provides recommendations for mitigation.

Photo 1. Overall view of the impacted area along the interior retaining wall looking north (top photo) and south (bottom photo).

Photo 2. Water intrusion it the stairs area looking north (top photo) and front view (bottom photo).

3. SCOPE OF SERVICES

Tetra Tech's scope of services for this project consisted of the following tasks:

- Review aerial photographs, geotechnical literature, geologic maps, and seismic hazard maps relevant to the subject site.
- Notify Underground Service Alert (USA) prior to drilling for clearance of underground utilities.
- Mark boring locations at the site.
- Perform Ground Penetrating Radar (GPR) survey to locate underground utilities in the vicinity of the proposed boring locations.
- Core 5 small diameter inspection holes inside the transfer station building in the side walls of the stairs: 2 on the north wall, 2 on the south wall, and 1 in the concrete floor slab just in front of the stairs to observe groundwater conditions.
- Perform subsurface exploration consisting of drilling and sampling:
    - 12 hollow stem auger borings around the building footprint to a maximum depth of 11.5 feet;
    - 2 hand-augered boreholes through core holes drilled through the floor slab behind the interior retaining wall to a maximum depth of 6.8 feet;
    - 1 hand-augered borehole just outside to the south of the building to a depth of 1 foot;
    - 1 concrete core at the bottom of the stairs.
- Install 5 groundwater monitoring wells: 3 outside and 2 inside the transfer station building.
- Conduct laboratory testing on selected samples recovered from the exploratory borings to evaluate geotechnical properties of the on-site soils.
- Process and evaluate the collected geotechnical data for use in developing geotechnical recommendations for the proposed improvement including evaluation of the following items:
    - General subsurface conditions and description of types, distribution, and engineering characteristics of subsurface materials;
    - General groundwater conditions and their potential impact on the project design and construction;
    - Suitability of on-site soils and bedrock for support of the proposed canopy structures;
    - Seismic design parameters in accordance with 2022 California Building Code (2022 CBC);
    - Shallow and deep cast-in-drilled hole (CIDH) pile foundations for the support of the proposed canopy structures including allowable bearing pressures, lateral resistances, and settlement estimates;

- Lateral earth pressures for assessment and evaluation of the structural integrity of the existing retaining wall on the east side of the transfer station building under static and seismic conditions;
- Pavement design recommendations;
- Corrosion potential of the on-site soils to buried concrete and steel.

- Process the collected geotechnical data to evaluate the near-surface groundwater regime to assess the causation and provide recommendations for mitigation of the water intrusion along in the stair area of the interior retaining wall.

- Prepare this report documenting reference maps and illustrations, collected field and laboratory data, and preliminary geotechnical recommendations for the design and construction of the proposed development as well as recommendations for the mitigation of the water seepage inside the building.

4. SITE DESCRIPTION

Ben Lomond transfer station accepts Class III non-hazardous residential, commercial and industrial solid waste. The site is occupied by 3 main structures (see Photo 3):

- The transfer station is a steel frame building approximately 170 feet by 235 feet in footprint. The building is supported on a system of continuous strip footings about 3 feet wide and some 6-foot square spread footings with 4-foot-wide grade beams oriented roughly in the north-south direction. Inside the building there is a retaining wall roughly oriented in the north-south direction separating the higher public tipping area to the west from the lower commercial tipping area on the east. The retaining wall is about 7 feet high as measured from the top of the footing, with an exposed height of about 5.5 feet, and is founded on a 2-foot-wide footing. A set of stairs crosses the retaining wall near its south terminus (see Photo 2).

- The office/administration is a reinforced concrete masonry unit (CMU) block wall building approximately 38 feet by 45 feet in footprint with a metal roof. This building is located immediately to the south of the transfer station. and is supported on 1 foot wide continuous perimeter footing embedded about 2 feet, and a 1.5-foot square footing located at the center of the building; and

- The detached household hazardous waste (HHW) facility is a steel frame canopy structure approximately 45 feet by 40 feet footprint located immediately to the south of the office building. No information regarding the foundation type for this facility was made available.

Photo 3. Birds eye view of the transfer station looking east.

The transfer station building is located on two levels separated by the interior retaining wall. The office building and the HWW facility are located at about the same elevation as the upper level within the transfer station. The 3 structures are located in a bowl-shaped area created during grading by cutting into the native bedrock. The hills adjacent to the site ascend towards the north, west, and south. From the as-built plans some areas of minor fills (less than 3 feet in thickness) were identified immediately to the south and to the southeast of the transfer building.

There is a paved recycling area to the east of the building and a jagged-alignment concrete retaining wall 7.5 to 17.5 feet high (as measured from the top of the footing) located about 70 to 75 feet from the transfer station east wall. The retaining wall has a footing that is 6.5 to 8.5 feet wide with a toe extending 2 to 2.5 feet in front of the wall and a heel projecting backward about 3.5 to 4.5 feet. The backfill behind the retaining wall, as evaluated in our exploration, consists mostly of medium dense poorly graded sands with silt extending about 8 feet behind the retaining wall. Four-inch diameter PVC pipe weepholes are located about 3 inches above the grade in front of the wall. Evaluation of the structural capacity of this retaining wall is needed as a part of the engineering review and to assess surcharge on the wall from the proposed pile foundations.

5. FIELD INVESTIGATION

The subsurface soil and groundwater conditions were initially explored by Tetra Tech on March 1, 2022 and included drilling, logging, and sampling of 8 exploratory hollow stem auger borings, B-1 through B-5, and B-7 through B-9. (Initially planned boring B-6 was not performed.) In addition, 4 hand-augered borings HA-1 through HA-3 were advanced: 2 inside the building immediately behind the interior retaining wall and the third just to the west of the proposed HWW canopy (see Figure 2).

A follow-up subsurface exploration was conducted on May 26, 2022, with focus on the subsurface conditions along the 3rd row of the recycling area canopy piles, along the east edge of the access road and on the retaining wall backfill along the 2nd row of the recycling area piles. This investigation included drilling, logging, and sampling of 8 additional hollow stem auger borings B-11 through B-14. Borings B-13 and B-14 were in fact 6 borings denoted B-13A through D, and B-14A and B, drilled behind the recycling area retaining wall at close spacing of several feet in a line perpendicular to the retaining wall. Additionally, borehole HA-4 was cored at the bottom of the interior stairs to observe the groundwater conditions (Photo 4).

Photo 4. Location of borehole HA-4 at the bottom of the stairs.

Prior to initiation of the field exploration program, a field reconnaissance was conducted to observe surface conditions and to mark the locations of the planned subsurface explorations. Underground Service Alert was notified of the exploratory boring locations at least 48 hours prior to drilling.

The hollow stem borings were excavated using a truck-mounted CME 55 drill rig. The rig was equipped with 8-inch diameter augers. Bulk, driven California-type ring samples, and Standard Penetration Test (SPT) samples were collected during the drilling and transported to a laboratory for testing. The SPT sampler consisted of a 2-inch outside diameter, 1.4-inch inside diameter split barrel without liners, while the California-type sampler consisted of a 3-inch O.D., and a 2.4-inch I.D. split barrel. The interior of the California-type sampler was lined with 1-inch-long brass rings.

SPT testing was performed using an SPT sampler driven by an automatic 140-pound hammer with a drop of 30 inches in general accordance with ASTM D1586. The hammer calibration record indicated an average energy transfer ratio of 75 percent. Ring-type samples were collected by driving the California-type sampler using the same equipment as for the SPTs. Sampling was carried out at 2.5- or 5-foot vertical intervals.

The borings were surface-logged by a Geologist in general accordance with the visual-manual procedure for description and identification of soils per ASTM D2488. The Geologist prepared the recovered samples for subsequent reference and laboratory testing. At the completion of drilling, the borings were backfilled with tamped soil cuttings. The borings were capped with either concrete caps or asphalt patches. Five exploratory borings B-4, B-5, B-7, HA-1 and HA-2 were converted to monitoring wells MW-4, MW-5, MW-7, MW-1 and MW-2 respectively, and capped with traffic rated covers. The soil cuttings from the 6 borings converted to monitoring wells were spread neatly around the site. The exploratory boring logs are presented in Appendix A. Additionally, groundwater depth measurements were taken at all installed monitoring wells on March 2, March 30, and May 26, 2022.

The locations of the exploratory borings and the core are shown on Figure 2. Relevant boring information including latitude and longitude, exploration depth, and approximate ground surface elevation is included in Table 1.

Table 1
Exploration Locations Information

Exploration ID	General Location	Approximate			
		Latitude (degrees)	Longitude (degrees)	Depth (ft)	Ground Elevation (ft)
B-1	North center end of recycling area canopy	37.095503	-122.077708	3	491
B-2	South center end of recycling area canopy	37.095194	-122.077797	7.5	490
B-3	East end of HWW canopy	37.095135	-122.078381	4.8	494
B-4/MW-4	Near southwest corner of transfer station building	37.095394	-122.078758	10.7	496
B-5/MW-5	Near center of west side of transfer station building	37.095566	-122.078745	5.7	496
B-7/MW-7	Access road northwest of transfer station building	37.095912	-122.078740	5.9	478
B-8	Apex of access road turn northwest of transfer station building	37.096058	-122.078864	3.8	481
B-9	Near center of east side of transfer station building	37.095388	-122.077845	3.5	491
B-11	Southeast end of recycling area canopy	37.095094	-122.077557	11.5	484
B-12	Northeast end of recycling area canopy	37.095315	-122.077447	6.5	483
B-13 A, B, C, D	Near the recycling area retaining wall	37.095256	-122.077704	8/8.3/7.5/4.5	491
B-14 A, B	Near the recycling area retaining wall	37.095419	-122.077653	5.8/4	491
HA-1/MW-1	North of the top of interior retaining wall stairs	37.095389	-122.078512	4.2	496
HA-2/MW-2	At the top of interior retaining wall stairs	37.095538	-122.078459	6.8	496
HA-3	West end of HWW canopy	37.095292	-122.078686	1	496

Borings highlighted in blue were performed to investigate the water intrusion inside the building.
Borings highlighted in orange were performed to investigate subsurface conditions at the recycling area canopy.
Borings highlighted in green were performed to investigate conditions near the proposed HWW canopy.

In addition, a total of five ½-inch diameter holes were cored inside the building in the stair area on March 1, 2022, to observe near-surface groundwater conditions. Two horizontal holes were cored through each of the interior stairs walls and 1 vertical hole was cored in front of the stairs on the lower slab (see Photos 5, 6, and 7). The groundwater conditions at the cores were observed on March 1, March 30, May 19, and May 26, 2022. HA-4 core was a 4-inch diameter core through 9 inches of concrete floor slab and was extended by hand-auguring by about 9 inches into underlying fill. The details of the core holes are included in Table 2.

Table 2
Core Holes Information

Boring ID	General Location	Orientation	Details
P-1	South wall of interior stairs	Horizontal	About 11 inches above the bottom of the stairs
P-2			About 2.5 inches above the bottom of the stairs
P-3	North wall of interior stairs		About 11 inches above the bottom of the stairs
P-4			About 2.5 inches above the bottom of the stairs
P-5	Concrete floor slab at the toe of the stairs	Vertical	About 5 feet in front of the stairs at the same elevation as the bottom of the stairs
HA-4	Bottom of the interior stairs		Immediately in front of the bottom stair

Photo 5. Location of P-1 (higher) and P-2 (lower) on the south side stairs wall.

Photo 6. Location of P-3 (higher) and P-4 (lower) on the north side stairs wall.

Photo 7. Location of P-5 in front of the stairs.

6. LABORATORY TESTING

Laboratory tests were performed on selected samples recovered from the borings to aid in the classification of soils and to evaluate pertinent engineering properties of the site soils. The following tests were performed:

- In-situ Moisture Content and Dry Density, ASTM D2937;
- Percent Passing #200, ASTM D1140;
- Expansion Index, ASTM D4829;
- Direct Shear, ASTM D3080; and
- Corrosion Testing in Soils:
  - pH and resistivity, CTM 643;
  - Sulphates, CTM 417; and
  - Chlorides, CTM 422.

Laboratory testing was performed in general accordance with applicable ASTM Standards and California Test Methods. Results of all laboratory tests are presented in Appendix B. For ease of referral to the soil profile, selected laboratory results have been included on the boring logs in Appendix A.

7. GEOLOGY AND SUBSURFACE CONDITIONS

Regionally, the site is located in the Santa Cruz Mountains, part of the Coast Ranges of California. The Santa Cruz Mountains are located on the San Francisco Peninsula, where they separate the San Francisco Bay from the Pacific Ocean and the inland Santa Clara Valley. The range continues from the Bay Area down the California Central Coast to the Salinas Valley near Monterey Bay. The Santa Cruz Mountains are the result of compressive uplift caused by a leftward bend of the San Andreas Fault. Most of the range is largely underlain by the Salinian Block comprised mostly of granites. Overlying the Salinian Block over much of range are Tertiary land and deep marine sediments. Within the general vicinity of the site, as shown on Figure 3 – Geologic Map, the sedimentary units are primarily comprised of the middle Miocene-age Monterrey Formation (Tm) and the upper Miocene-age Santa Margarita Sandstone (Tsm). Based on Brabb (1989), the Monterrey Formation consists of medium- to thick-bedded and laminated olive-gray semi-siliceous organic mudstone and sandy siltstone. The Santa Margarita Sandstone unconformable overlies the Monterrey Formation and generally consists of thickly bedded to massive and cross-bedded yellowish gray to white friable granular medium to fine-grained arkose sandstone.

Main structural features in the project area include the Scotts Valley Syncline and the Ben Lomond fault, both located southwest of the site. Bedding structure in the immediate site vicinity, as shown on Figure 3, generally strikes southeast and southwest and dips at 16 to 21 degrees to the south.

The subsurface soils encountered during Tetra Tech's field exploration consisted of artificial fill soils over bedrock assigned to the Monterrey Formation (Tm). Bedrock assigned to the Santa Margarita Sandstone (Tms) was exposed in the cut slope located on the west side of the site. Detailed descriptions of the soil units encountered during our field exploration are presented below and in the boring logs presented in Appendix A.

7.1. Artificial Fill (Fill)

Artificial fill soils associated with previous site grading and retaining wall backfill construction are present throughout the site. These fills consist of dark brown, yellow brown and light, yellow-colored silty sands and poorly graded sands with silt that are fine to medium grained with traces of coarse sand, medium dense, damp to moist, and with trace amounts of siltstone rock fragments. Some trace amounts of gravel, concrete and/or plastic debris were also encountered in borings B-13B and B-13C. The fills encountered varied from 1 foot to 10.7 feet in depth. The deeper fills were generally associated with the retaining wall backfills.

7.2. Santa Margarita Sandstone (Tsm)

The Santa Margarita Sandstone unit was observed in the cut slope on the west side of the site but was not observed in our exploration excavations beneath the site. This unit consists of tan to white colored sandstone that is fine to medium grained, friable, and thickly bedded to massive.

7.3. Monterey Formation (Tm)

The Monterey Formation underlies the entire site and was encountered during our field exploration in all borings at depths ranging from near at grade to a depth of 11.5 feet. This bedrock unit consists of olive gray and reddish-brown sandy siltstone that is damp to moist, hard to very hard, micaceous and thinly laminated. Some carbonate stringers and staining were also locally encountered.

7.4. Groundwater

Although water intrusion was observed on the vertical surfaces of the stairs and retaining walls within the transfer station building, groundwater was not encountered during our subsurface exploratory drilling to the explored depths of 4.2 to 10.7 feet. However, groundwater was later recorded in wells MW-4, MW-5 and MW-7, which were installed in selected borings at the site (See Table 5A-Groundwater Depth Monitoring). Based on the geologic conditions of the site and the groundwater readings performed, the groundwater encountered appears to be perched in the shallow bedrock materials, near the fill/bedrock contact and is transient in nature likely in response to local precipitation and/or irrigation. A more detailed discussion of the groundwater conditions including the assessment of the water intrusion into the transfer station building is included in the "Water Intrusion Assessment and Mitigation Recommendations" section of this report.

8. GEOLOGIC HAZARDS

8.1. General Seismic Setting

The Northern California region is known to be seismically active. Earthquakes occurring within approximately 60 miles of the project sites are considered capable of generating ground shaking of engineering significance to the proposed construction. The project area is located in the general proximity of seismically active faults, as shown on Figure 4A – Regional Faults and Seismicity Map and Figure 4B – Fault Zone Hazard Areas.

The closest seismically active faults to the site include the Zayante-Vergeles fault located approximately 0.8 miles northeast of the site, the Butano fault located approximately 5.7 miles northeast of the site, and the San Andreas fault (north section) located approximately 6.9 miles northeast of the site. Table 3 summarizes known seismically active faults within a distance of approximately 60 miles from the project site as identified by the USGS Quaternary Fault Database and in the 2008 National Seismic Hazard Maps (https://usgs.maps.arcgis.com and https://earthquake.usgs.gov).

Table 3
Summary of Active Faults
Referenced Site Latitude and Longitude: 37.095512°, -122.078311°

Fault Name	Approximate Fault Distance to Site (miles)	Slip Sense	Maximum Moment Magnitude
Zayante-Vergeles[1]	0.8	strike slip	7.0
Butano[2]	5.7	strike slip	6.4
North San Andreas	6.9	strike slip	7.9
San Gregorio	10.6	strike slip	7.5
Monte Vista-Shannon	12.1	thrust	6.5
Monterey Bay-Tularcitos	12.3	strike slip	7.3
Calaveras	25.8	strike slip	6.4
Hayward	27.7	strike slip	7.3
Rinconada	34.0	strike slip	7.5
Greenville	40.6	strike slip	7.0
Quien Sabe	41.1	strike slip	6.6
Ortigalita	45.6	strike slip	7.1
Mount Diablo Thrust	45.9	thrust	6.7
Great Valley	52.3	strike slip	6.9
Green Valley	55.7	strike slip	6.8

[1] From County of Santa Cruz Fault Zone Hazard Areas Map, 2009 and https://earthquake.usgs.gov/hazards/interactive/
[2] Information from Hall and Sarna, 1974

8.1. Historical Earthquakes

Significant seismic events with epicenters surrounding the project site have been recorded. Table 4 summarizes historic earthquakes with magnitudes greater than M_w 6.5 within a distance of approximately 60 miles from the project site, obtained using the USGS Earthquake Catalog (https://earthquake.usgs.gov).

Table 4
Historic Earthquakes in the Vicinity of the Site
Referenced Site Latitude and Longitude: 37.095512°, -122.078311°

Earthquake Name	Year	Fault and Fault Type	Earthquake Magnitude*	Epicenter	
				Latitude	Longitude
Loma Prieta	1989	San Andreas Fault (strike-slip right lateral)	7.2 M_w	37.036°N	-121.880°W
Great San Francisco	1906	San Andreas Fault (strike-slip right lateral)	7.9 M_w	37.750°N	-122.550°W
Hayward Fault	1868	Hayward Fault (strike-slip right lateral)	6.8 M_L	37.700°N	-122.100°W
San Francisco South of San Jose	1865	San Andreas Fault (strike-slip right lateral)	6.5 M_w	37.200°N	-121.900°W
Near San Juan Bautista	1840	San Andreas Fault (strike-slip right lateral)	6.5 M_w	36.850°N	-121.500°W
San Andreas	1838	San Andreas Fault (strike-slip right lateral)	7.4 M_w	37.300°N	-122.150°W

Notes:
* M_w refers to Moment Magnitude scale
M_L refers to Local Magnitude scale

8.2. Seismic Hazards Zones and Surface Fault Rupture Zones

The engineering seismology study for the subject site included reviewing local and regional fault maps, reviewing historical earthquake data, and reviewing regulatory maps prepared by the State and local governing agencies. Specifically, the following engineering seismology issues were addressed:

8.2.1. Seismic Hazards Zones

The Seismic Hazards Mapping Act (SHMA) of 1990 directs the California Geological Survey (CGS, formerly California Department of Conservation, Division of Mines and Geology (CDMG)) to identify and map areas prone to earthquake hazards of liquefaction, earthquake-induced landslides.

Maps of seismic hazard zones are issued by the California Geological Survey (CGS, formerly California Department of Conservation, Division of Mines and Geology (CDMG)) in accordance

with the Seismic Hazards Mapping Act enacted in April 1990. The intent of the SHMA is to provide for a statewide seismic hazard mapping and technical advisory program to assist cities and counties in developing compliance requirements to protect the public health and safety from the effects of strong ground shaking, liquefaction, landslides, or other ground failure and other seismic hazards caused by earthquakes.

Although no seismic hazard maps have yet been generated by the CDMG for the Felton Quadrangle, the County of Santa Cruz has generated a similar map for liquefaction zones. The site is not located within an area identified by the County of Santa Cruz as subject to the hazard of liquefaction (see Figure 5A – Liquefaction Zones based on https://purl.stanford.edu).

8.2.2. Surface Fault Rupture Zone

Earthquake Fault Zones (known as Special Studies Zones prior to 1994) are regulatory zones established in accordance with the Alquist-Priolo Special Studies Zones Act enacted in 1972. The Act directs the State Geologist to delineate regulatory zones that encompass surface traces of all potentially and recently active faults that constitute a potential hazard to structures from surface faulting or fault creep. The purpose of the Alquist-Priolo Act is to regulate development near active faults in order to mitigate the hazard of surface fault rupture.

Based on our field exploration and literature review there are no known surface traces of any active or potentially active faults that pass directly through or project towards the site. The closest faults that have been zoned for surface fault rupture potential by the County of Santa Cruz are the Zayante-Vergeles fault located approximately 0.8 miles northeast of the site and the San Andreas fault (north section) located approximately 6.9 miles northeast of the site (Figure 4B – Fault Zone Hazard Areas). The closest mapped fault by the State is the Butano Fault Zone located in the Los Gatos Quadrangle, about 5.7 miles northeast of the site. Therefore, the potential for surface rupture due to faulting occurring beneath the site is considered low.

8.3. Liquefaction Potential Assessment

Liquefaction of soils is caused by ground shaking during earthquakes. Research and historical data indicate that loose, relatively clean granular soils and low plasticity silts are susceptible to liquefaction and dynamic settlement, whereas the stability of the majority of clayey silts, silty clays and clays is not typically adversely affected by ground shaking. Liquefaction is generally known to occur in saturated or near-saturated soils at depths shallower than about 50 feet. Materials that are above the groundwater table are not susceptible to liquefaction, although they may undergo settlement due to seismic shaking.

As previously discussed, the site is not within an area identified by the County of Santa Cruz as subject to the hazard of liquefaction. Because the subsurface materials are comprised of bedrock (siltstone) at the surface or within a couple of feet from the surface, liquefaction or seismically induced settlement are not considered a hazard at the site.

8.4. Lateral Spreading

Since liquefaction is not considered a hazard for the site, lateral spreading is also not considered to be a hazard at the site.

8.5. Landslide Hazard

The site is not located within an area mapped by the County of Santa Cruz as susceptible to the hazard of landslides (see Figure 5B – Landslide Hazard Zones). However, signs of surficial instability were observed on the cut slopes north of the access road north of the transfer station building (see Photo 8). Also, significant natural and graded cut slopes exist to the west and north of the transfer station area (see Photo 9). Evaluation of the slope surficial or global stability of the referenced slopes was not a part of the scope of the herein effort.

Photo 8. Surficial instability above the access road north of the transfer station building.

Photo 9. Cut slopes above the transfer station area

8.6. Expansive Soils

Expansive soils undergo significant volume changes (shrink or swell) due to variations in moisture content. Changes in soil moisture content can result from precipitation, landscape irrigation, utility leakage, roof drainage, perched groundwater, drought, or other factors which can cause unacceptable settlement or heave that could negatively affect the performance of foundations or slabs supported on grade.

Expansion Index (EI) testing of one siltstone bedrock sample yielded an EI value of 175, indicating that the surficial soils are significantly expansive. Consequently, expansive soils near the ground surface are a hazard to the project.

8.7. Collapsible Soils

The phenomenon of hydro-consolidation is typically exhibited in geologically young, unconsolidated, low-density, loose, dry soils commonly present in arid to semi-arid regions. Collapsible soils are usually composed of granular particles supported by clay or silt matrix that can be chemically cemented in place creating a metastable structure. The bonds supporting this

metastable structure have enough shear strength to support loads at low moisture contents, however, once water is introduced the cemented bonds break down and the granular particles re-arrange causing a volume loss. The subsurface fill and bedrock materials do not exhibit this behavior and therefore collapsible soils are not considered a hazard at the site.

8.8. Dam Inundation Hazard

Although the site is located about ½ mile downstream of the Newell Dam which presents an "extremely high" downstream inundation hazard, the site is mapped just outside of the inundation area (https://fmds.water.ca.gov). Therefore, inundation due to dam breach is not considered a hazard for the site.

9. WATER INTRUSION ASSESSMENT AND MITIGATION RECOMMENDATIONS

The site personnel reported a water intrusion in the stair area of the transfer station interior retaining wall as shown in Photos 1 and 2. The site personnel also reported that there is a French drain on the west side of the building (see Figure 2) extending to the top of the bedrock, which is expected to be no more than about 2.5 feet deep. The presence, configuration, extent, condition and functionality of the drain could not be verified, and no outlet was observed.

The investigation program inside the transfer station building and immediately outside of it consisted of drilling, stratigraphy logging, installation of groundwater wells, and subsequent monitoring at the groundwater wells to assess the area groundwater conditions and the extent of the water intrusion.

During the 4 visits performed by Tetra Tech on March 1, March 30, May 19 and May 26, 2022, water intrusion was observed on the vertical surfaces of the stairs and the retaining wall. The intrusion has manifested as wet staining of the concrete surfaces along the joint between the stairs and the stair walls and along the joint between the toe of the retaining wall and the concrete floor up to about 65 feet north of the stairs. No water staining was observed along the same joint to the south of the stairs. On the stairs the wet staining was observed about 6 and 3 inches above the bottom/first and the second step, respectively and along the joint at the bottom step (see Photos 5 through 7). Overall, the water intrusion is considered to be minor and largely of cosmetic nature.

Efflorescence was observed on the north stairs wall up to 3 feet high, and on the south wall up to 1.5 feet high (see Photos 10 and 11). It was not possible to observe the concrete face of the interior retaining wall because it is covered by a protective steel plate. However, the bottom of the steel plate was corroded at several locations up to 6 inches high as measured from the plate bottom edge (see Photos 11 and 12).

Photo 10. Efflorescence on South Wall.

Photo 11. Efflorescence on North Wall and Corrosion of the Steel Plate.

Photo 12. Corroded Protective Steel Plate on the Face of The Retaining Wall

A total of 5 monitoring wells, MW-1, MW-2, MW-4, MW-5, and MW-7 were installed near the impacted area and just outside the building (see Figure 2). Monitoring wells MW-1, MW-2, MW-4 and MW-5 were deemed most relevant and essential for understanding the groundwater regime. In addition, core holes were drilled through the stair walls and in front of the stairs to observe the groundwater conditions. The groundwater measurements and observations are summarized in Tables 5A and 5B and are corroborated below.

Groundwater observations during drilling and in the course of subsequent readings indicated noticeably variable conditions. All wells except for MW-4 were dry during and immediately after completion of drilling. During the subsequent readings shallow groundwater, typically at or below top of bedrock, was observed in monitoring wells MW-4, MW-5 and MW-7; all drilled outside the building, and surprisingly no groundwater was ever observed in MW-1 and MW-2 installed immediately behind the interior retaining wall.

Small core holes drilled through the sidewalls of the stairs and in front of the bottom of the stairs yielded no water seepage during installation and in the course of subsequent observations. However, varying intensity of wetness was observed. The large core (HA-4) drilled in front of the bottom of the stairs that exposed the floor slab subgrade encountered saturated condition.

Table 5A
Groundwater Depth Monitoring

Monitoring Well	Location	Installed on	Surface Elevation (feet)	Exploration Depth (feet)	Depth to Bedrock (feet)	March 2, 2022		March 30, 2022		May 26, 2022	
						Depth	Elev.	Depth	Elev.	Depth	Elev.
						(feet)					
MW-1	Inside building	3/1/2022	496	4.2	4	dry	–	dry	–	dry	–
MW-2	Inside building	3/1/2022		6.8	6.8	dry	–	dry	–	dry	
MW-4	SWC of building	2/28/2022		10.7	2.5	4.5	491.5	3.6	492.4	4.8	491.2
MW-5	W of building	2/28/2022		5.7	2	dry	–	2.4	493.6	dry	–
MW-7	Access road below building	3/1/2022	478	5.9	0.5	dry	–	0.9	472.1	2.2	475.8

Table 5B
Seepage Observations in Monitoring Core Holes in the Stair Area

Core Hole	Location	Elevation (feet)	March 1	March 30	May 19	May 26
P-1	2nd stair step	492	dry			
P-2	1st step	491.2	dry	moist	moist	dry
P-3	2nd stair step	492	dry			
P-4	1st step	491.2	dry	moist	moist/wet	moist
P-5	At the bottom of the stairs	491	dry			
HA-4			Not applicable			Immediately below surface

Overall, no consistent or continuous groundwater regime was observed in the vicinity of the impacted area. It was initially anticipated that groundwater will perch on top of the bedrock and saturate the fill at the building floor slab subgrade and behind the interior retaining wall. Also, the small diameter core holes drilled through the sides of the stairs, where water intrusion was observed, were expected to drain a significant amount of water immediately after drilling. However, these expectations were decisively not met as the fill is not saturated and was observed to be only moist, even though relatively consistent groundwater was present below the top of the bedrock just outside the building and only some drops of water seepage were observed.

It is of interest, that the weepholes of the retaining wall by the recycling area to the east of the building, i.e., about 225 feet to the east of the interior retaining wall, have not been observed nor have been reported to yield any water. This observation indicates that groundwater is likely not present under the building and the recycling area to the east.

Whereas the groundwater regime is not clear, it is our opinion that the groundwater flow is likely controlled by the fractures, joints, or more permeable beds within the underlying bedrock with groundwater fed from the surrounding steep hills. However, it is apparent that only limited and transient groundwater is present in the impacted area. Therefore, the following recommendations could be implemented:

1. First install weep holes about 2 inches in diameter spaced no more than 5 feet in the impacted area of the stair walls and the retaining wall stem. Given the small and slow yield of water, it is expected that the weep holes will effectively drain any water that would build up behind the retaining wall.

2. If the seepage continues, install a French cut-off drain at least 5 feet deep as close as practical, i.e., about 5 feet west of the building.

Alternatively, a significantly more extensive investigation consisting of installation of 5 to 8 additional more monitoring wells both inside and outside the building and an investigation of the functionality of the reported French drain could be implemented to attempt to pinpoint the groundwater regime impacting the stair and interior retaining wall area. Additionally, concrete specialists should be engaged to evaluate if there is a degradation of the retaining wall concrete. It should be noted that the on-site soils are shown to possess moderate potential for sulfate attack on concrete, i.e., Exposure Class 2 (see “Soil Corrosion” section of this report).

10. DESIGN RECOMMENDATIONS

10.1. General

Based on the results of the field explorations and engineering analyses, the construction of the proposed canopies is feasible provided that the recommendations contained in this report are incorporated into the design plans and implemented during construction.

The primary geotechnical considerations for this project include:

- Presence of relatively shallow groundwater within the foundation depth.
- Presence of expansive bedrock.
- Evaluation of lateral earth pressures for evaluation of stability of the recycling area retaining wall.

The design recommendations presented below are based on Tetra Tech's current understanding of the project and the subsurface conditions of the site. Once the project configuration is finalized and the design is complete, Tetra Tech should review the plans and specifications to evaluate if the geotechnical design recommendations presented herein have been incorporated as intended.

10.2. Site Preparation

The following sections present recommendations for the preparation of the foundation subgrade for the proposed canopies, partial height walls, and pavements

10.2.1. Clearing and Grubbing

The foundation areas should be cleared of any pavement, vegetation, undocumented fills, existing structures, trash and debris. Any subterranean installations not to be preserved, such as electrical lines, pipes, utility collectors, tanks, etc., should be relocated and/or abandoned in accordance with the recommendation of the Geotechnical Engineer and applicable regulations.

10.2.2. Subgrade Preparation

In order to create uniform and competent bearing conditions for the proposed canopy foundations the subgrade should be prepared in accordance with the recommendations provided below.

- Recycling area and HWW canopies. No subgrade preparation is required if CIDH pile foundations are selected.

- Equipment Mats/Pads. For any concrete mat/pad foundations the soils should be overexcavated to the top of the bedrock. The overexcavation should extend horizontally for a nominal distance to facilitate the forming of the foundation concrete.

- HWW canopy area and partial height walls. For any shallow foundations the soils should be overexcavated to the top of the bedrock. The overexcavation should extend horizontally for a nominal distance to facilitate the forming of the foundation concrete.

- Pavement and flatwork areas should be overexcavated and recompacted to a depth of at least 1 foot below the proposed subgrade or to uniform competent soils, whichever is deeper. To the extent practicable, the zone of overexcavation should extend a horizontal distance of at least 1 foot beyond the flatwork or pavement perimeter.

- Disturbed soils in structural and non-structural areas that may occur after demolition of existing site improvements or during overexcavation should be overexcavated and recompacted to the total depth of the disturbed material.

The exposed overexcavation subgrade should be probed and accepted by the Geotechnical Engineer.

10.2.3. Fill Placement

Only minimal fill placement is anticipated for the proposed construction. Fill placed to build-up the overexcavated subgrade to the foundation subgrade or to achieve design grades should consist of predominantly granular soil with an Expansion Index less than 20. Due to the high expansion potential of the native siltstone material, overexcavated siltstone is not considered suitable to be used as backfill.

On-site coarse-grained soils that meet the requirements for imported fills listed above can be used as backfill materials and compacted as indicated above, as long as they are free of organics, deleterious materials, debris, and particles over 3 inches in largest dimension. In the event that any soil materials are imported to the site, such soils should be sampled, tested, and approved by the Geotechnical Engineer prior to arrival on-site.

Fill materials should be moisture-conditioned to at least 110 percent of the optimum moisture content and compacted to at least 90 percent of relative compaction per ASTM D1557. The upper 1 foot of soils below pavements and any flatwork should be compacted to at least 95 percent relative compaction. Fill should be placed in horizontal lifts not more than 8 inches in loose, uncompacted thickness.

Additional recommendations for site grading are provided in the “General Site Grading Recommendations” section of this report.

10.3. Excavation Characteristics, Temporary Slopes and Trench Excavations

The on-site bedrock materials are expected to be relatively difficult to excavate although, due to the small grading volumes, heavy duty attachments to conventional grading equipment or use of mechanized hand equipment is expected to be adequate. Excavations in the bedrock less than 5 feet in depth can be performed vertically and without the need for shoring. Excavations within on-site fills, e.g., behind the retaining walls, should be performed using sloped sides. Where space

for sloped sides is not available and shoring will be required, Tetra Tech can provide appropriate shoring recommendations.

All excavations should be performed in accordance with CalOSHA regulations. The on-site bedrock and existing backfill materials may be considered a Type A and Type C soil respectively, as defined the current CalOSHA soil classification.

Stockpiled (excavated) materials should be placed no closer to the top of an excavation than a distance defined by a line drawn upward from the bottom of the trench at an inclination of 1(H):1(V), but no closer than 4 feet. A greater setback may be necessary when considering significant surcharge loads such as heavy vehicles, concrete trucks and cranes. Tetra Tech should be advised of such heavy surcharges so that specific setback requirements can be established. Alternatively, a shoring system may be designed to allow reduction in the setback distance.

The Geotechnical Engineer should observe the excavation progress so that appropriate modifications to the excavation design may be recommended, if necessary, due to conditions differing from the design assumptions and potentially adverse bedrock bedding conditions.

10.4. Seismic Design Parameters

The seismic design coefficients provided below in Table 6 are based on Chapter 16 Section 1613 of the 2022 CBC and obtained from the Structural Engineers Association of California (SEAOC) and the Office of Statewide Health Planning and Development (OSHPD) website application (https://www.seaoc.org).

Table 6
2022 CBC and ASCE 7-16 Seismic Design Parameters
Referenced Site Latitude and Longitude: 37.095512°, -122.078311°

Site Class Table 20.3-1 ASCE 7-16		B
Coefficients for the Maximum Considered Earthquake, MCE_R, for Site Class B	Short Period (0.2 seconds), S_S	1.970*
	1 Second Period, S_1	0.783*
Coefficients for the Maximum Considered Earthquake, MCE_R (Site Modified)	Short Period (0.2 seconds), S_{MS}	1.773*
	1 Second Period, S_{M1}	0.626*
Coefficients for the Design Earthquake	Short Period (0.2 seconds), S_{DS}	1.182*
	1 Second Period, S_{D1}	0.418*
Design PGA (risk-targeted maximum rotated direction)		0.473g*
Site Modified Peak Ground Acceleration PGAM (geometric mean)		0.76g*

* Values obtained from Structural Engineers Association of California (SEAOC) and the Office of Statewide Health Planning and Development (OSHPD) website application, https://www.seaoc.org/page/seismicdesignmaptool based on ASCE7-16 and 2021 International Building Code.

10.5. Shallow Foundations

Foundations should be designed and reinforced in accordance with the recommendations of the Structural Engineer and should conform to the 2022 CBC.

10.5.1. Design Parameters for Partial Height Wall – Shallow Footings

Partial height walls are recommended to be founded on continuous footings. The subgrade for the shallow foundations should be prepared in accordance with recommendations provided in the "Site Preparation" section of this report, however, due to the presence of expansive soils it is recommended that control joints be provided in the stem of the walls (i.e., not through the foundation) at a minimum of 10 feet horizontal spacing.

Footings for the proposed partial height walls can be designed based on the parameters presented in Table 7. Shallow footings should be laid out such that they are located at a horizontal distance of least 5 feet from any existing foundation to minimize the interference. If a closer setting is required, this office should be contacted to evaluate the actual configuration and provide additional recommendations, if necessary.

10.5.2. Equipment on Pads/Mat Foundations

Mat/pad foundations can be designed using the design parameters provided in Table 8. Mats should be designed and reinforced in accordance with the recommendations of the Structural Engineer and should conform to the 2022 CBC.

10.5.3. Foundations Adjacent to Utility Trenches

The bottom of trenches for any buried utilities should be kept outside a zone defined by a 1(H):1(V) plane projected downward from the outside bottom edge of any existing or proposed foundation. Backfill materials and procedures shall conform to the recommendations provided in the "Site Preparation" and "General Site Grading Recommendations" sections of this report. If any utilities need to be placed within the zone of influence, the utility conduit (pipes, cables) should be designed to account for the increased surcharge from the foundation pressures and to withstand potential differential settlement between the surcharged and unsurcharged segments of the pipe. Generally, the utility conduits within the impacted zone should be protected by concrete encasement or utilidors.

For utility conduits that cross underneath foundations the piping and encasement should be designed to withstand differential settlements of up to 1 inch over a distance equal to half of the depth of the pipe crown below the bottom of the foundation element. Tetra Tech should be contacted to review any specific utility interaction configurations and their proposed mitigation.

Table 7
Design Parameters for Shallow Footings

Continuous Footings	
Dimensions	• Minimize the footing width by maximizing the bearing pressure to confine and reduce potential post-construction swelling of the expansive siltstone.
Depth of Embedment	• At least 24 inches below the lowest adjacent grade
Allowable Bearing Pressure	• 3,500 psf
Spread Footings	
Dimensions (feet)	• At least 2 feet but less than 6 feet wide
Depth of Embedment	• At least 18 inches below the lowest adjacent grade
Allowable Bearing Pressure	• 6,000 psf • Minimize the footing dimensions by maximizing the bearing pressure to confine and reduce potential post-construction swelling of the expansive siltstone. Thus, select foundation dimensions so that the bearing pressure is as close as practicable to 6,000 psf and no less than 3,500 psf under dead loads.
All Footings	
Allowable Bearing Pressure for Transient Live Loads	• The allowable bearing pressure value may be increased by one-third for transient live loads from wind or seismicity.
Estimated Settlement	• Approximate 1 inches of static settlement. • Approximate differential settlement of 0.5 inches between supports or over a distance of 30 feet.
Allowable Coefficient of Friction at Bottom of Footing Includes Factor of Safety of 1.5	• 0.4 concrete on bedrock
Allowable Lateral Passive Resistance Includes Factor of Safety of 2	• 210 pcf (EFD, equivalent fluid density, for compacted fill with ϕ=33^{o}) • The passive resistance derived of the upper 12 inches should be neglected.
Allowable Combined Lateral Resistance	• Total allowable resistance to lateral loads can be calculated by combining lateral resistance due to friction at foundation bottom and lateral passive resistance. • Passive resistance values may be increased by one-third when considering transient wind or seismic loading
Uplift Capacity	• The weight of soil that contributes to uplift capacity can be estimated as a zone defined by an angle of 30 degrees from vertical projected from top edge of footing to adjacent grade. • A total unit weight of 125 pcf may be used for the soil. • The lowest depth of embedment from the adjacent grade shall be used in the estimations.

Table 8
Design Parameters for Mats

Embedment depth	• At ground surface and up to 3 feet deep
Allowable Bearing Pressure	• Average allowable bearing pressure 2,000 psf • The allowable bearing value may be increased by one-third for transient live loads from wind and seismic loading.
Dimensions	• Up to 10 by 15 feet
Estimated Settlement	• Approximate 1 inch of static settlement. • Differential settlement of approximately 0.5 inches over a distance of 30 feet.
Modulus of Subgrade Reaction	• For design of mats supported on siltstone, a reference modulus of subgrade reaction k_1 of 200 pci derived for a square bearing plate with 1-foot x 1-foot dimensions may be used. For the on-site siltstone, the modulus of subgrade reaction k (in pci) for the design of a concrete element of given dimensions can be calculated as: $$k = k_1 \frac{1 + 0.5 * \frac{B}{L}}{1.5 * B}$$ where B and L are the governing width and the length of the element in feet, but no more than 14 times the thickness of the element. • For design of mats supported directly on granular fill, a reference modulus of subgrade reaction k_1 of 170 pci derived for a square bearing plate with 1-foot x 1-foot dimensions may be used. The modulus of subgrade reaction k (in pci) for the design of a concrete element of given dimensions can be calculated as: $$k = k_1 \frac{(B+1)^2}{4B^2} \frac{1 + 0.5\frac{B}{L}}{1.5}$$
Allowable Coefficient of Friction or Adhesion at Bottom of Mat Includes Factor of Safety of 1.5	• 0.4 coefficient of friction for concrete on compacted granular fill • 670 psf allowable adhesion for concrete on siltstone
Allowable Lateral Passive Resistance Includes Factor of Safety of 2	• 200 pcf (EFD, equivalent fluid density, for compacted fill with ϕ=33°) • The passive resistance derived of the upper 12 inches should be neglected.
Allowable Combined Lateral Resistance	• Total allowable resistance to lateral loads can be calculated by combining lateral resistance due to friction/adhesion at foundation bottom and lateral passive resistance. • Passive resistance values may be increased by one-third when considering transient wind or seismic loading
Uplift Capacity	• The weight of soil that contributes to uplift capacity can be estimated as a zone defined by an angle of 30 degrees from vertical projected from top edge of footing to adjacent grade. • A total unit weight of 125 pcf may be used for the soil. • The lowest depth of embedment from the adjacent grade shall be used in the estimations.

10.6. Canopy Foundations – CIDH Piles

CIDH piles are expected to be utilized for the recycling area canopy and for the HWW canopy. As discussed in the "Project Description" section of this report, the following load demand on the 42-inch recycling area canopy piles is expected:

- Axial compression force of 85 kips;
- Uplift force of 13 kips;
- Lateral shear force at the pile top of 58 kips;

For the 30-inch HWW canopy piles the load demand is as follows:

- Axial compression force of 23 kips;
- Uplift force of 3 kips;
- Lateral shear force at the pile top of 21 kips;

And for the 42-inch HWW canopy piles the load demand is as follows:

- Axial compression force of 53 kips;
- Uplift force of 9 kips;
- Lateral shear force at the pile top of 44 kips;

Given the competent subsurface materials, single pile per column foundation is expected, i.e., there is no need for a pile group. Given the presence of tie beams connecting the pile tops in the north-south direction within the recycling area canopy footprint, it is anticipated that the pile caps of the CIDH piles in the north-south direction will produce a fixed-head pile condition. A free-head is assumed in the east-west direction as they will be able to rotate since there are no tie-beams in this direction. A single CIDH pile diameter of 42 inches is considered for this canopy.

For piles in the HWW canopy area, the piles are assumed to have a free-head condition since there are no tie-beams. The bottom of the pile cap has been assumed to be at least 2 feet below the adjacent grade and the CIDH piles are expected to be embedded at least 8 feet below the bottom of the pile cap. The maximum allowable lateral deflection at the top is 1 inch. Two CIDH pile diameters are considered herein, 30 and 42 inches.

A groundwater depth of 4 feet was assumed for the design of the 1st row of the recycling area canopy CIDH piles. A groundwater depth of 2 feet was assumed for the 2nd pile row and conservatively also for the HWW canopy piles.

The design recommendations presented below should be reviewed if the loading, pile head conditions, pile dimension, group configuration, pile cap thickness or design requirements change.

10.6.1. Axial Capacity

Vertical compressive forces may be resisted by a combination of the shaft friction generated along the sides of the pile and the end bearing. The recommended allowable compression capacity is

presented in Table 9A below and incorporates a Factor of Safety of 2 for shaft friction resistance and 3 for end bearing.

Table 9A
Allowable Axial Compression Capacity for CIDH Pile Foundations

Depth Below Bottom of Pile Cap (ft)	Recycling Area Canopy 1st Row	Recycling Area Canopy 2nd Row and HWW Canopy
42-inch-diameter		
8	350	293
10	401	344
15	532	472
30-inch-diameter (applicable only to HWW piles)		
8	Not applicable	152
10		179
15		247

The allowable uplift capacity is provided in Table 9B. The capacity utilizes only the shaft friction and considers a Factor of Safety of 3, but the weight of the pile should be added to the uplift capacity of the pile. No contribution to uplift resistance from the grade beams has been considered in the analyses, and thus, these estimates are conservative for the recycling area piles.

Table 9B
Allowable Axial Uplift Capacity for CIDH Pile Foundations

Depth Below Bottom of Pile Cap (ft)	Recycling Area Canopy 1st Row	Recycling Area Canopy 2nd Row and HWW Canopy
42-inch-diameter		
8	9	7
10	12	10
15	22	18
30-inch-diameter (applicable only to HWW piles)		
8	Not applicable	5
10		7
15		13

The allowable axial capacity values may be increased by one-third to account for transient loads such as earthquake and wind. The compression and uplift capacity of the pile sections should be checked by the Structural Engineer to verify the pile structural capacity.

10.6.2. Settlement

The total settlement of the CIDH piles is estimated to be less than ½ inch.

10.6.3. Lateral Resistance

Resistance to lateral loads will be provided by the resistance of the soil and the bedrock against the pile and by the bending stiffness of the pile itself. Lateral capacity of the CIDH pile was calculated using computer program LPILE (by Ensoft, Inc.) that models the pile response to lateral loading using the soil-pile deflection model, i.e., p-y curves. The geotechnical design parameters presented in Table 10 below may be used for LPILE analysis. A concrete compressive strength of 4,000 psi has been assumed. The 30-inch and 42-inch diameter pile has been assumed to be reinforced with 12 #8 steel bars and with 16 #10 steel bars, respectively. The analyses were performed for a single pile.

Table 10
Summary of LPILE Parameters

Depth below Grade (ft)	Model (p-y Curve)	Effective Unit Weight (pcf)	Friction Angle (deg)	Cohesion (psf)	k_s (pci)
0 – 2	API Sand	120	33	0	75
2 – 15	Silt/Cemented Soil	120/57.6 (above/below GW)	38	500	350

The results of the LPILE analyses for the recycling area canopy CIDH piles for the 1st and 2nd row of piles are summarized in Tables 11A and 11B respectively.

The results of the LPILE analyses for the HWW CIDH piles with a free-head condition are summarized in Table 11C.

Table 11A
Summary of LPILE Analyses for a Single CIDH Pile
Recycling Area Canopy 1st Row

Pile Head Condition	**Fixed Head Condition In the north-south direction**			**Free Head Condition In the west-east direction**		
CIDH Pile Diameter (inches)	42					
Pile length below bottom of pile cap (feet)	8	10	15	8	10	15
Lateral Load at Pile Head (kips)	58					
Vertical Load (kips)	85					
Pile Head Deflection (inches)	0.03	0.03	0.03	0.15	0.10	0.07
Maximum Moment @ Depth below Top of Pile (kips-inch @ feet)	-3,150 @ 0	-3,560 @ 0	-3,480 @ 0 200 @ 10	1,120 @ 3.2	1,380 @ 3.8	2,020 @ 5.8

Table 11B
Summary of LPILE Analyses for a Single CIDH Pile
Recycling Area Canopy 2nd Row

Pile Head Condition	**Fixed Head Condition In the north-south direction**			**Free Head Condition In the west-east direction**		
CIDH Pile Diameter (inches)	42					
Pile length below bottom of pile cap (feet)	8	10	15	8	10	15
Lateral Load at Pile Head (kips)	58					
Vertical Load (kips)	85					
Pile Head Deflection (inches)	0.03	0.03	0.03	0.17	0.11	0.07
Maximum Moment @ Depth below Top of Pile (kips-inch @ feet)	-3,240 @ 0	-3,640 @ 0	-3,500 @ 0 200 @ 10	1,240 @ 3.2	1,450 @ 3.8	2,150 @ 5.8

Table 11C
Summary of LPILE Analyses for a Single CIDH Pile
HWW Canopy

CIDH Pile Diameter (inches)	30			42		
Pile length below bottom of pile cap (feet)	8	10	15	8	10	15
Pile Head Condition	**Free Head Condition**					
Lateral Load at Pile Head (kips)	21			44		
Vertical Load (kips)	23			53		
Pile Head Deflection (inches)	0.05	0.04	0.03	0.11	0.08	0.05
Maximum Moment @ Depth below Top of Pile (kips-inch @ feet)	400 @ 3.0	510 @ 3.8	660 @ 5	860 @ 3.2	1,100 @ 3.8	1,620 @ 5.8

It is noted that all the calculated pile deflections are quite small and well below the maximum allowable displacement of 1 inch for all pile diameters, lengths and head conditions and it is the axial capacity that governs the design.

It is also noted that for CIDH piles with a fixed-head condition under the recycling area canopy where grade beams are installed, the lateral capacity will be further increased, i.e., deflections will further decrease, by considering the resistance provided by the pile cap and the connected tie beams. In calculating such a resistance, the soil resistance provided by the soil within the upper 12 inches below grade should be ignored.

10.6.4. Installation Considerations

The performance of CIDH piles is significantly influenced by the construction methods and procedures. Construction methods that create large zones of disturbance around the drilled piles can lead to lower-than-expected lateral resistance and axial capacity. Consequently, it is recommended that the following measures be adopted to minimize the potential for diminished capacity.

- The installation of CIDH piles should be carried out under the continuous observation of the Geotechnical Engineer to verify the design assumptions are in conformance with the intent of the recommendations and to provide additional recommendations as appropriate.

- Minor amounts of water seepage into the pile boreholes should be anticipated. Contractor should be prepared to stabilize and/or dewater the hole as needed.

- Since the CIDH axial pile capacity relies also on the end bearing, it will be necessary for the contractor to remove any disturbed materials from the bottom of the pile hole.

- Tremie method of concrete placement should be used so that the concrete delivery begins at the bottom of the hole and is always below the rising level of concrete so that all water and/or drilling fluid is removed from the boring. The concrete should be first placed to develop a minimum head of 5 feet of concrete above the bottom of the tremie and then the tremie pipe can be withdrawn in step with the placement of concrete, always maintaining a head of concrete of at least 5 feet above the delivery point. If casing is used, the pipe should be pulled by keeping a positive concrete head above the bottom of the casing.

- Pile excavations should be filled with concrete within the same day of drilling. Pile excavations should not be left open overnight.

- Concrete should be placed and vibrated throughout the full length of the pile so that voids in pile concrete are minimized.

- The CIDH piles should be checked for alignment and plumbness. The amount of acceptable misalignment of a pile is approximately 2 to 3 inches from the exact location and it is usually acceptable to be out of plumb 1 inch over 10 feet of the length of the pile.

10.7. Lateral Earth Pressures on Existing Retaining Walls in Recycling Area

Static and seismic lateral earth pressures presented in Table 12 are provided for the purpose of evaluating the capacity of the existing retaining walls in the recycling area on the east side of the site. The existing retaining walls should be considered cantilevered and able to deflect at the top and therefore the assessment and design should consider active pressure conditions.

Based on the 2022 CBC, the design of retaining walls higher than 6 feet, as measured from the bottom of the footing, requires the inclusion of not only static lateral pressures, but also of seismically induced lateral earth pressure increment. According to the 2022 CBC the seismic lateral earth pressures on foundation walls and retaining walls should be determined using the Design Earthquake Ground Motions. Based on the USGS U.S. Seismic Design Maps website application (http://earthquake.usgs.gov), the peak ground acceleration (PGA) from the Design Response Spectrum is approximately 0.473g, where the design PGA is calculated as $0.4*S_{DS}$ and S_{DS} is the risk-targeted, maximum rotated acceleration direction design response spectrum parameter for short periods (see Table 6).

The combined static and seismic lateral passive earth pressure resistance during the design seismic event described above were computed as recommended by Taciroglu (2013). These passive pressures are included in Table 12. These lateral passive pressures consider that the water table is at the top of the footing.

The values provided in Table 12 are for level backfill condition. The effect of any surcharge (dead or live load) located within a 1(H):1(V) plane drawn upward from the heel of the wall foundation should be added to the lateral earth pressures. It is a specific intent for the assessment and design of the existing retaining wall to avoid surcharging the wall by the proposed 2nd row of CIDH pile foundation supporting the recycling area canopy. The CIDH piles are intended to carry the axial compression loads to deeper depths so that the retaining wall will not be surcharged. The

calculated lateral deflection of the CIDH piles is very small and is expected to be further reduced by the presence of the connected tie beams. Therefore, in order to minimize the surcharge on the existing retaining wall, it is recommended that the closest edge of the CIDH piles be set back at least 8 feet from the back of the retaining wall.

Since the existing weepholes were observed to be in good condition and the retaining wall backfill consists of coarse-grained materials, there is no need to consider hydrostatic forces acting upon the wall.

Table 12
Lateral Pressures due to Static and Seismic Loads

Active Pressure for Yielding Walls	
Static active pressure (psf)	40z + 0.33Q
Seismic active pressure increment (psf)	15z
Lateral Passive Resistance	
Allowable static lateral passive pressure (psf) Includes a Factor of Safety of 2	$85z_1$
Ultimate total (i.e., static + seismic increment) seismic passive resistance (psf) No Factor of Safety	$110z_1$

Notes:
- Lateral Pressures due to seismic loading are based on a design PGA=0.473g. The resulting total seismic force (active plus seismic increment for yielding walls) should be calculated by assuming a triangular equivalent fluid density distribution. The resulting force should be assumed to act at 1/3 of the height of the wall above the bottom of the wall.
- Pressures based on soil backfill (both behind and in front of the retaining wall) with $\phi = 30^o$, c = 0 psf, γ_t = 120 pcf

Legend:
z … Depth (ft) below the grade behind the wall – depth measured from the ground surface to the depth where the soil lateral pressure is being evaluated;
z_1 … Depth (ft) below the grade where passive conditions apply, i.e., usually in front of the wall, to the depth where the soil lateral pressure is being evaluated;
Q … Uniform surcharge (psf) within a 0.6(H):1(V) plane drawn upward from the heel of the wall footing

For evaluation of the lateral resistance due to friction between the retaining wall footings bottom and the bedrock subgrade, the parameters presented in Table 13 can be used.

Table 13
Lateral Resistance Under the Retaining Wall Footings

Allowable Coefficient of Friction Inlcudes Factor of Safety of 1.5	• 0.4 concrete on bedrock
Allowable Combined Lateral Resistance	• Total allowable resistance to lateral loads can be calculated by combining lateral resistance due to friction at the base and lateral passive resistance. • Passive resistance values may be increased by one-third when considering transient wind or seismic loading

10.8. Asphalt Pavement Design

In the recycling and HHW area, asphalt pavement section consisting of 3 to 5 inches, typically 4 inches, of asphalt concrete over 1 to 2 inches of sand course overlying sandy fill or bedrock was observed. The existing pavement, although still functional, appears to be experiencing a notable distress as shown on Photos 13 and 14 below.

Photo 13. Pavement condition in the recycling area.

Photo 14. Pavement condition in the HHW canopy area.

It is generally expected that any pavement disturbed by the canopy construction will be simply matched to the existing pavement section. However, given that the existing pavement is showing a notable distress, recommendations are provided below for flexible (asphalt) pavement sections for various traffic loading. It is recommended that to select an appropriate pavement section the operations personnel decide about the appropriate traffic loading.

10.8.1. Pavement Subgrade Preparation

The subgrade preparation and fill placement in all paved areas should follow the recommendations provided in the "Site Preparation" section of this report. Paved areas should be properly sloped, and surface drainage established to reduce water infiltration into the pavement subgrade. Curbing located adjacent to paved areas should be founded in the soil subgrade in order to provide a cutoff to reduce water infiltration into the base course.

10.8.2. Pavement Design

Asphalt (flexible) pavement sections have been designed in general accordance with the Caltrans Highway Design Manual method for flexible pavement design using the 20-year design life period. An R-value of 40 for the subgrade was used for pavement design. The recommended pavement sections for several assumed Traffic Indices are presented in Table 14.

Table 14
Asphalt Pavement Sections

Dump Trucks per Day (60 kips gross weight, 2 axles)	**Traffic Index**	**Composite Section**		**Full Depth Asphalt Concrete Alternative (inches)**
		Asphalt Concrete (inches)	**Aggregate Base** (inches)	
12	7.5	4.5	7.5	8.5
20	8	5	8	9
32	8.5	5	9	9.5

Asphalt concrete and Aggregate Base (AB) should conform to the Specifications for Public Works Construction (Greenbook) Sections 203-6 and 200-2, respectively. The AB course should be compacted to 95 percent of relative compaction per ASTM D1557.

10.9. Soil Corrosion

The corrosion potential of the on-site materials to buried concrete and steel was evaluated based on laboratory testing of the combined fill and bedrock sample from boring B-1. Table 15 below presents the results of the corrosivity testing.

Table 15
Corrosivity Test Results

Boring ID	**Sample ID**	**Depth (feet)**	**pH** CTM 643	**Minimum Resistivity (ohm-cm)** CTM 643	**Soluble Sulfate Content (ppm / %)** CTM 417	**Soluble Chloride Content (ppm / %)** CTM 422
B-1	SK-1	0-3	5.3	545	3,062 / 0.3062	324 / 0.0324

Per 2022 CBC, Section 1904.1, concrete subject to exposure to sulfates shall comply with the requirements set forth in ACI 318, Section 19.3. Based on the measured water-soluble sulfate results the exposure of buried concrete to sulfate attack should be exposure class S2 per ACI 318, Table 19.3.1.1. Consequently, Type V cement with a minimum 28-day compressive strength of 4,500 psi and a maximum water to cementitious materials ratio of 0.45 should be used to prevent injurious sulfate attack on concrete.

Per 2022 CBC, Section 1904.1, concrete reinforcement should be protected from corrosion and exposure to chlorides in accordance with ACI 318, Section 19.3.

The evaluation of potential for corrosion of buried metals was based on the minimum resistivity per NACE (1984) and our experience with similar soils. The on-site soils are anticipated to have a "corrosive" potential to buried ferrous metals. A corrosion specialist should be consulted regarding suitable types of piping and necessary protection for underground metal conduits. The corrosion potential of the on-site soils should be verified during construction for each encountered soil type. Imported fill materials should be tested prior to placement to confirm that their corrosion potential is not more severe than the one assumed for the project.

10.10. Drainage Control

The intent of this section is to provide general information regarding the control of surface water. The control of surface water is essential to the satisfactory performance of the building construction and site improvements. Surface water should be controlled so that conditions of uniform moisture are maintained beneath and adjacent to the structure, even during periods of heavy rainfall. The following recommendations should be considered as minimal.

- Ponding and areas of low flow gradients should be avoided.

- Paved surfaces within 10 feet from the building foundation should be provided with a gradient of at least 2 percent sloping away from improvements.

- Bare soil, e.g., planters, within 10 feet of the structure should be sloped away from the improvement at a gradient of 5 percent.

- Positive drainage devices, such as graded swales, paved ditches, and/or catch basins should be employed to accumulate and convey water to appropriate discharge points.

- Positive drainage devices, such as graded swales, paved ditches, and/or catch basins should be employed to accumulate and convey water to appropriate discharge points.

- Concrete walks and flatwork should not obstruct the free flow of surface water.

- Area drains should be recessed below grade to allow free flow of water into the basin.

- Enclosed raised planters should be sealed at the bottom and provided with an ample flow gradient to a drainage device. Recessed planters and landscaped areas should be provided with area inlet and subsurface drainpipes.

- To the extent practicable, planters should not be located adjacent to the structure. If planters are to be located adjacent to the structure, the planters should be positively sealed, should incorporate a subdrain, and should be provided with free discharge capacity to a drainage device.

- Planting areas at grade should be provided with positive drainage. Wherever possible, the grade of exposed soil areas should be established above adjacent paved grades. Drainage devices and curbing should be provided to prevent runoff from adjacent pavement or walks into planted areas.

- Gutter and downspout systems should be provided to capture discharge from roof areas. The accumulated roof water should be conveyed to an off-site disposal area by a pipe or concrete swale system.

- Landscape watering should be performed judiciously to preclude either soaking or desiccation of soils. The watering should be such that it just sustains plant growth without excessive infiltration. Sprinkler systems should be checked periodically to detect leakage and irrigation efforts should be reduced or halted during the rainy season.

11. GENERAL SITE GRADING RECOMMENDATIONS

The intent of this section is to provide general information regarding the site grading. Site grading operations should conform with applicable local building and safety codes and to the rules and regulations of those governmental agencies having jurisdiction over the subject construction.

The grading contractor is responsible for notifying governmental agencies, as required, the Geotechnical Engineer at the start of site cleanup, at the initiation of grading, and any time that grading operations are resumed after an interruption. Each step of the grading should be accepted in a specific area by the Geotechnical Engineer, and where required, should be approved by the applicable governmental agencies prior to proceeding with subsequent work.

The following site grading recommendations should be regarded as minimal. The site grading recommendations should be incorporated into the project plans and specifications.

- Prior to grading, existing vegetation, trash, surface structures and debris should be removed and disposed off-site at a legal dumpsite. Any existing utility lines, or other subsurface structures which are not to be utilized, should be removed, destroyed, or abandoned in compliance with current governmental regulations.

- After cleanup operations, and prior to initial grading, a reasonable search should be made for subsurface obstructions and/or possible loose fill or detrimental soil types. This search should be conducted by the contractor, with advice from and under the observation of the Geotechnical Engineer.

- Prior to the placement of fill or foundations within the building area, the site should be prepared in accordance with the recommendations presented in the "Site Preparation" section of this report. All undocumented fill or disturbed soils within the building areas should be removed and processed as recommended by the Geotechnical Engineer.

- The exposed subgrade and/or excavation bottom should be observed and approved by the Geotechnical Engineer for conformance with the intent of the recommendations presented in this report and prior to any further processing or fill placement. It should be understood that the actual encountered conditions may warrant excavation and/or subgrade preparation beyond the extent recommended and/or anticipated in this report.

- On-site inorganic granular soils that are free of debris or contamination are considered suitable for placement as compacted fill.

- Any imported fill material required for backfill or grading should be tested and approved prior to delivery to the site.

- Visual observations and field tests should be performed during grading by a Geotechnical Engineer. This is necessary to assist the contractor in obtaining the proper moisture content and required degree of compaction. Wherever, in the opinion of the Geotechnical Engineer,

an unsatisfactory condition is being created in any area, whether by cutting or filling, the work should not proceed in that area until the condition has been corrected.

12. DESIGN REVIEW AND CONSTRUCTION SUPPORT

Geotechnical review of plans and specifications and participation during construction are an integral part of the geotechnical design practice. The following sections present our recommendations relative to the review of construction documents and the monitoring of construction activities.

12.1. Plans and Specifications

Upon completion, the civil, structural, and shoring design plans and specifications should be reviewed and approved by Tetra Tech prior to submittal for issuance of grading and construction permit and prior to bidding of construction tasks as the geotechnical recommendations may need to be re-evaluated based on the actual design configuration and loads. This review is necessary to evaluate whether the recommendations contained in this report have been incorporated into the project plans and specifications as intended.

12.2. Construction Monitoring

The objective of the construction quality assurance (CQA) is to assist in the construction of the soils and soils-structure interaction components of the project. Continuous observation of site excavation, processing and assessment of fill materials, fill placement, footings installation, CIDH installation, and other site grading operations by a representative of the Geotechnical Engineer should be implemented during construction to allow for evaluation of the geotechnical-related conditions as they are encountered. This process provides the Geotechnical Engineer with the opportunity to recommend appropriate revisions as needed.

12.3. Grading Observations

The Geotechnical Engineer should observe the excavation, subgrade preparation for foundations and pavements, and fill placement so that appropriate modifications to the design, extent, or procedure may be provided, as necessary, should conditions encountered during grading differ from the design assumptions.

12.4. Pavement Construction Observations

Preparation of the pavement subgrade and the placement of base course and pavement sections should be observed by the Geotechnical Engineer. Careful observation is recommended to evaluate that the pavement subgrade is uniformly compacted, and the recommended pavement and base course thicknesses are achieved.

12.5. Construction Quality Assurance Reporting

The following list is intended to provide basic minimum guidelines for the reporting during the geotechnical construction quality assurance efforts:

- A Daily Field Report should be generated each time a representative of the Geotechnical Engineer is performing QA work at the site.

- The Daily Field Reports should contain, at a minimum, a detailed description of the field activities, utilized equipment, areas of work, date, time, weather, and locations and results of all observations and performed tests.

- Provisions should be made for vertical and horizontal control for recording observations and test locations.

- A complete set of Daily Field Reports should be submitted as a part of formal final reporting.

13. LIMITATIONS

The recommendations and opinions expressed in this report are based on Tetra Tech's review of background documents and on information obtained from field explorations and associated laboratory testing. It should be noted that this study did not evaluate the possible presence of hazardous materials on any portion of the site.

Due to the limited nature of the field explorations, conditions not observed and described in this report may be present on the site. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation, infiltration testing, and laboratory testing can be performed upon request. It should be understood that conditions different from those anticipated in this report may be encountered during grading operations, for example the extent of unsuitable soils and overexcavation which may result in an additional mitigation effort. In addition, once the locations of the stormwater infiltration areas and depths are defined, the Geotechnical Engineer should be contacted to perform the appropriate infiltration testing.

Site conditions can change with time as a result of natural processes or the activities of man. Changes to the applicable laws, regulations, codes, and standards of practice may occur as a result of government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Tetra Tech has no control. Therefore, this report should be reviewed and recertified by Tetra Tech if it were to be used for a project design commencing more than one year after the date of issuance of this report.

Tetra Tech's recommendations for this site are, to a high degree, dependent upon appropriate quality control of subgrade preparation, fill placement, and foundation construction and on verification of the foundation conditions. Accordingly, the recommendations are made contingent upon the opportunity for Tetra Tech to observe all aspects of grading operations and foundation excavations for the proposed construction. If parties other than Tetra Tech are engaged to provide such services, Tetra Tech expressly stops being the Geotechnical Engineer of Record and such parties are automatically assuming complete responsibility as the Geotechnical Engineer of Record for the Project and are deemed concurring with the recommendations provided in this report or are obligated to provide alternative recommendations.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the Project described herein. Tetra Tech should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document. Reliance by others on the data presented herein or for purposes other than those stated in the text is authorized only if so permitted in writing by Tetra Tech. Such an authorization may incur additional expenses and charges.

Tetra Tech has endeavored to perform its evaluation using the degree of care and skill ordinarily exercised under similar circumstances by reputable geotechnical professionals with experience in this area in similar soil conditions. No other warranty, either expressed or implied, is made as to the conclusions and recommendations contained in this report.

14. SELECTED REFERENCES

American Concrete Institute (ACI 318R-14), 2014. Building Code Requirements for Structural Concrete and Commentary, 2014.

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Figures

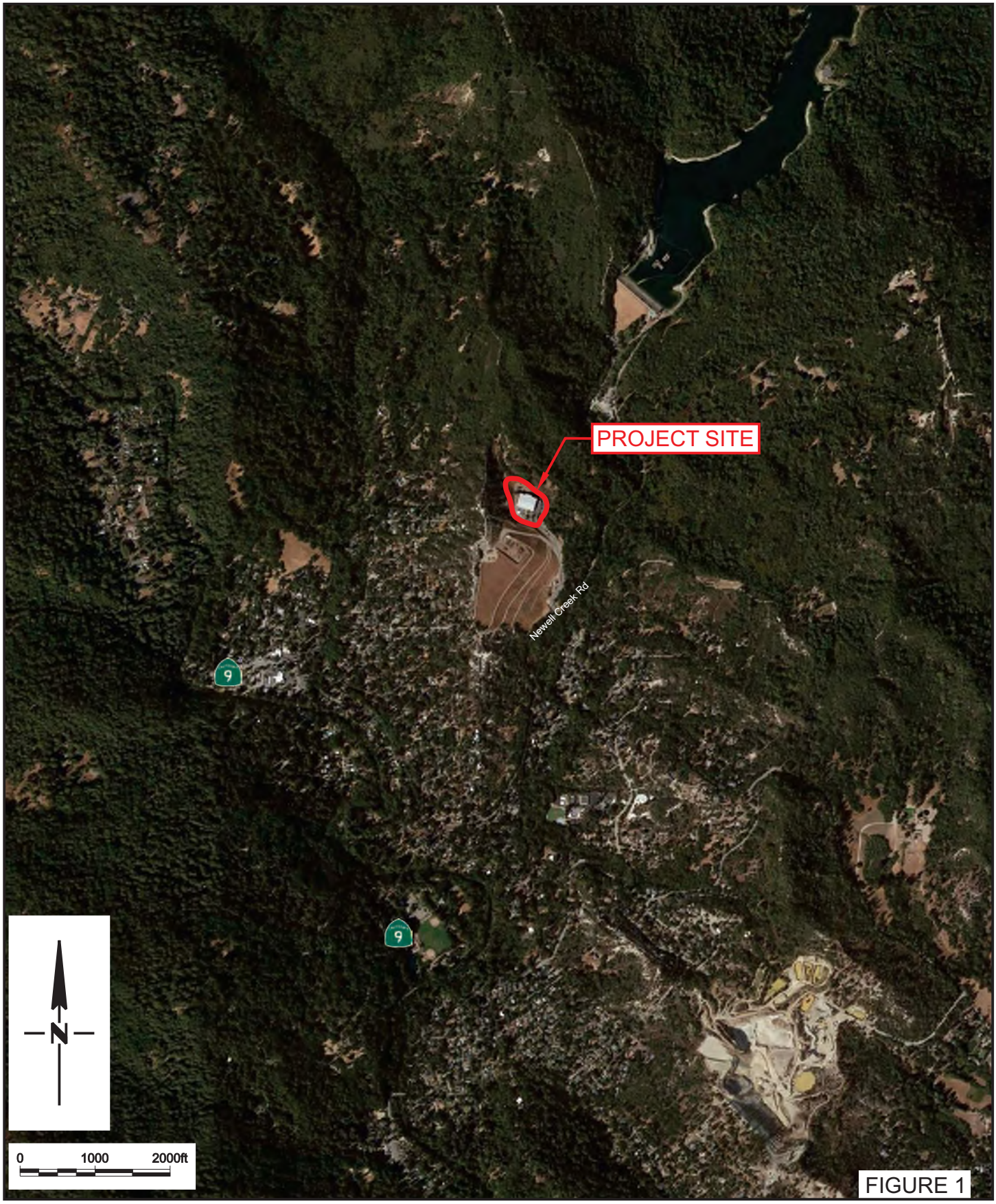

FIGURE 1

TETRA TECH
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TEL 909.860.7777 www.tetratech.com

BEN LOMOND TRANSFER STATION - BEN LOMOND, CA

SITE LOCATION MAP

JOB NO.	BAS 21-185E
DATE	JUL 2022
DRAWN BY	TAC
CHECKED BY	FC

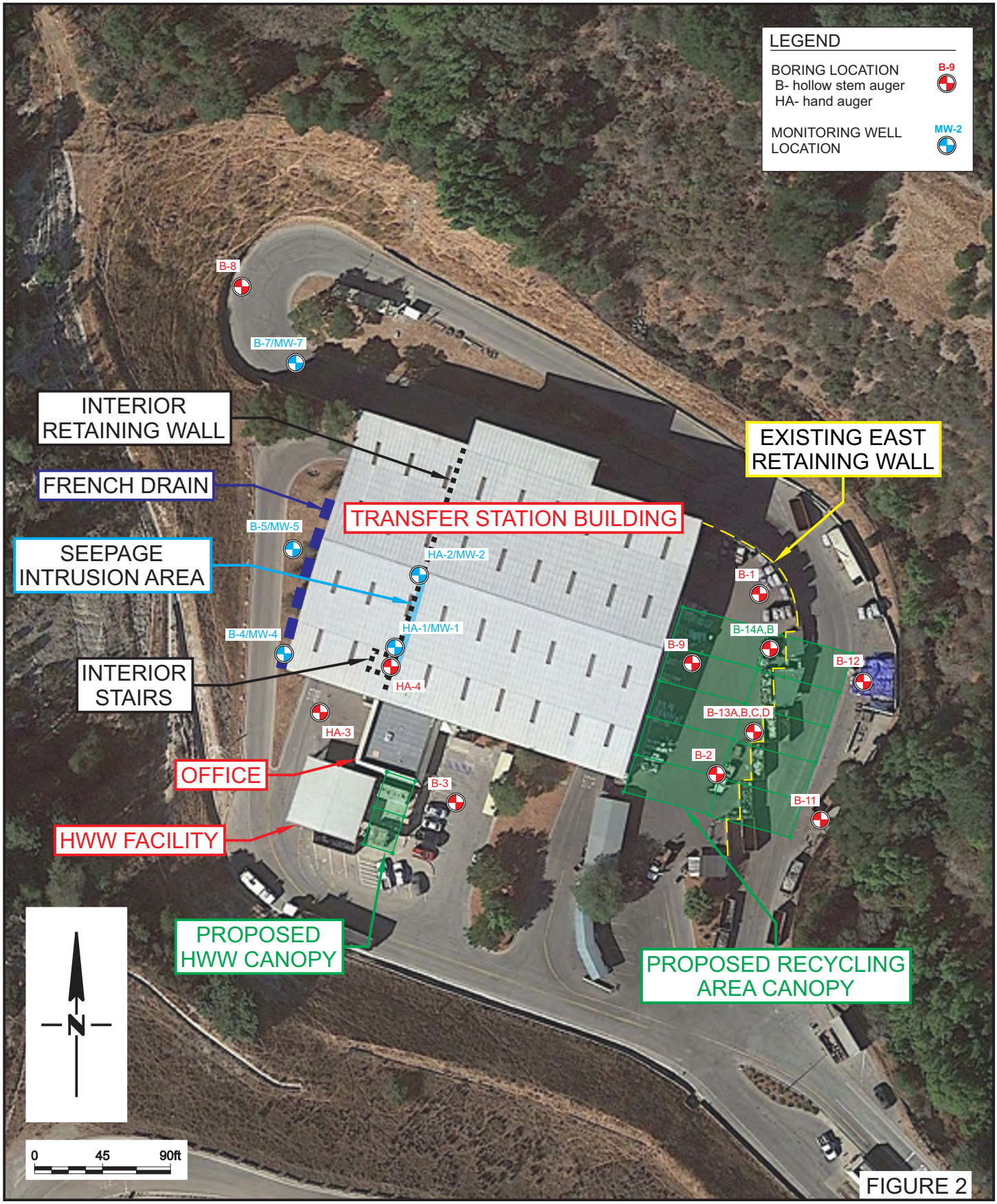

FIGURE 2

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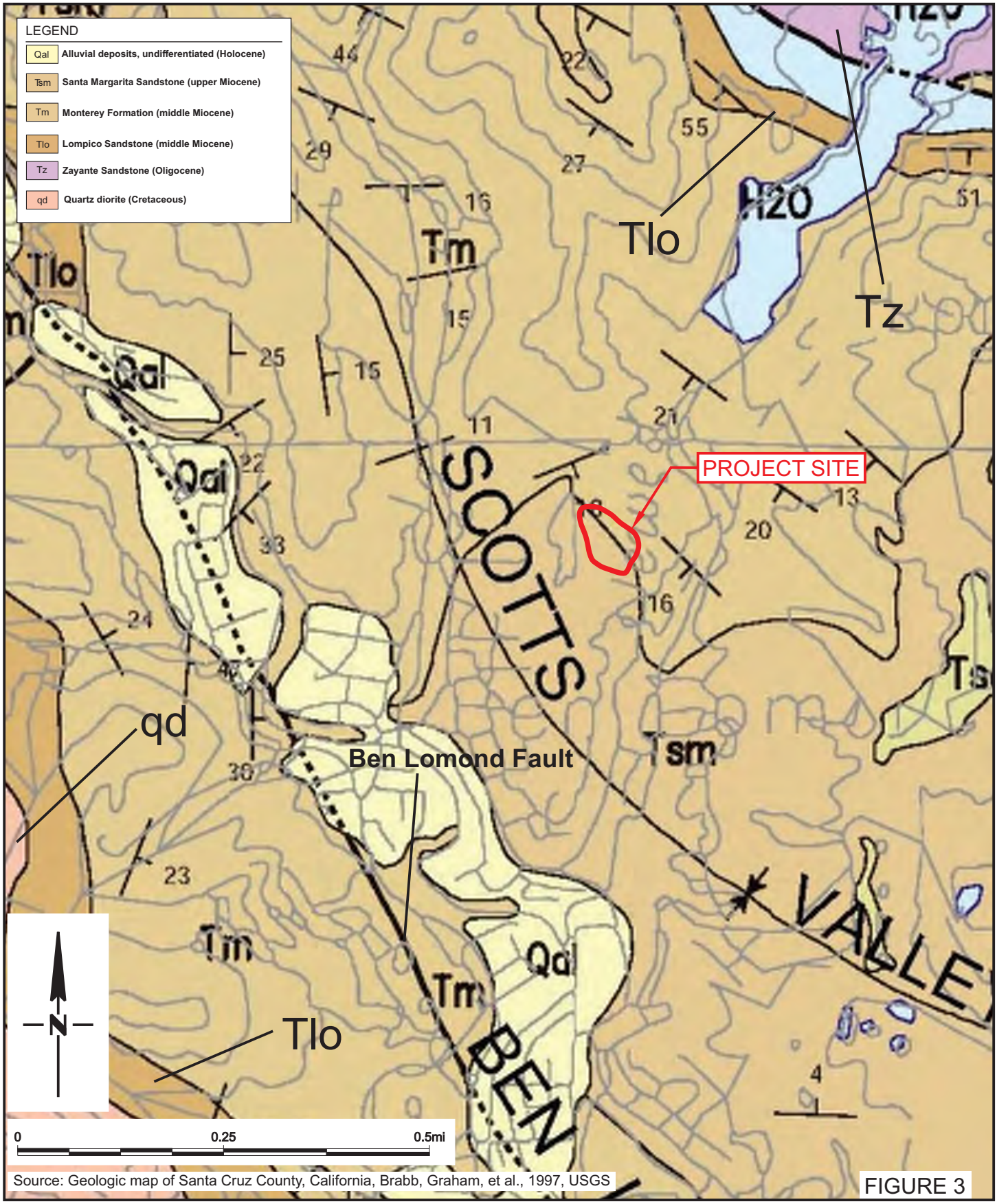
BEN LOMOND TRANSFER STATION - BEN LOMOND, CA

PROJECT LAYOUT AND BORING LOCATIONS MAP

JOB NO.	BAS 21-185E
DATE	JUL 2022
DRAWN BY	TAC/SCM
CHECKED BY	FC



Source: Geologic map of Santa Cruz County, California, Brabb, Graham, et al., 1997, USGS

FIGURE 3

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BEN LOMOND TRANSFER STATION - BEN LOMOND, CA

GEOLOGIC MAP

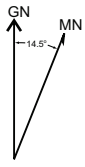
JOB NO.	BAS 21-185E
DATE	JUL 2022
DRAWN BY	TAC
CHECKED BY	FC

Map Reference: Google Earth 2015, Faults and EQ epicenters: USGS
http://earthquake.usgs.gov/regional/nca/virtualtour/bayarea.php

EXPLANATION

- Historical Earthquake Location
- Fault Name and Location

LOCATION MAP



0 18 ~ 36 Miles

FIGURE 4A

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BEN LOMOND TRANSFER STATION - BEN LOMOND, CA

REGIONAL FAULT AND SEISMICITY MAP

JOB NO.	BAS 21-185E
DATE	JUL 2022
DRAWN BY	TAC/SCM
CHECKED BY	FC

Fault Zone Hazard Areas

County of Santa Cruz

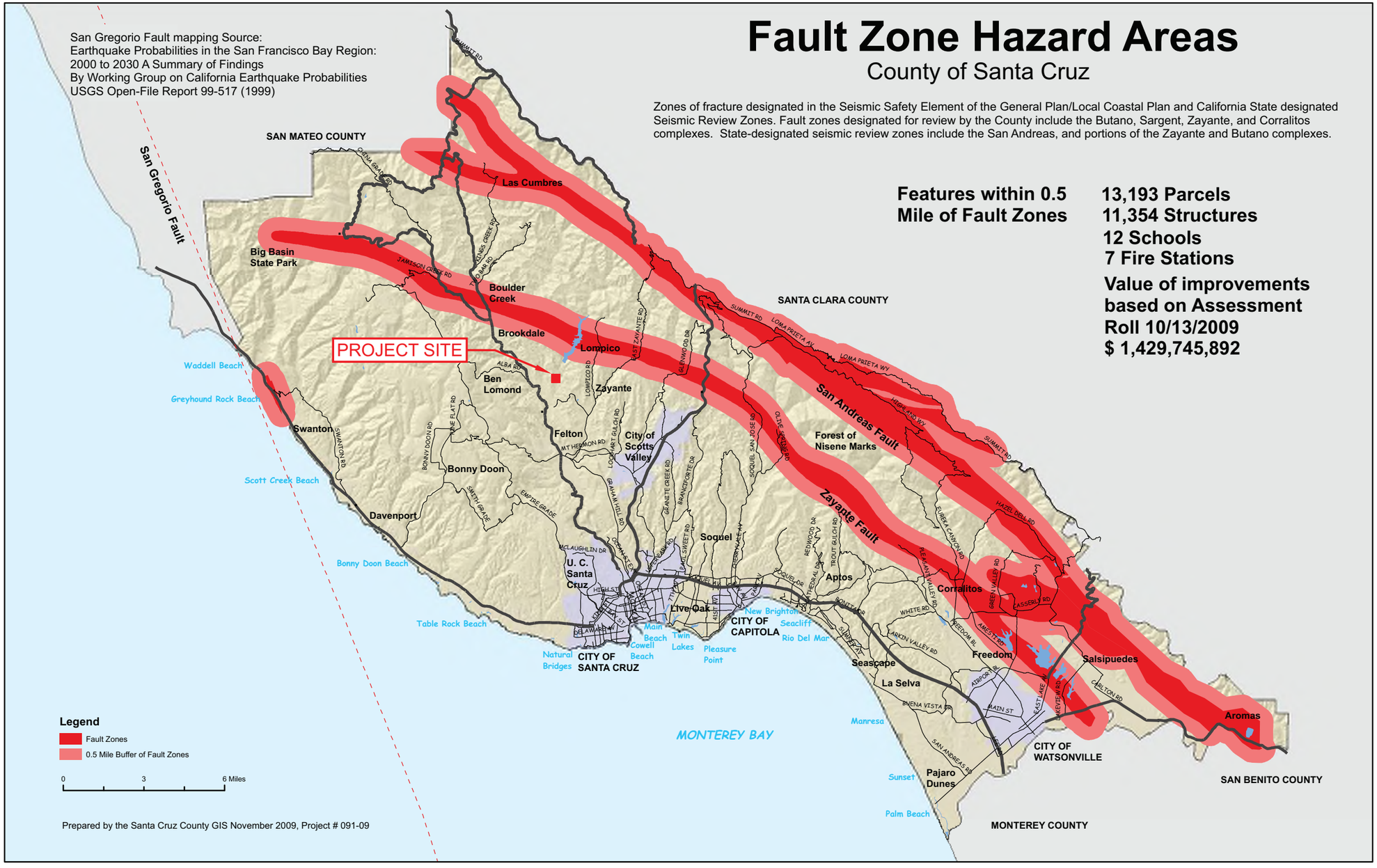
Zones of fracture designated in the Seismic Safety Element of the General Plan/Local Coastal Plan and California State designated Seismic Review Zones. Fault zones designated for review by the County include the Butano, Sargent, Zayante, and Corralitos complexes. State-designated seismic review zones include the San Andreas, and portions of the Zayante and Butano complexes.

San Gregorio Fault mapping Source:
Earthquake Probabilities in the San Francisco Bay Region:
2000 to 2030 A Summary of Findings
By Working Group on California Earthquake Probabilities
USGS Open-File Report 99-517 (1999)

Features within 0.5 Mile of Fault Zones

13,193 Parcels
11,354 Structures
12 Schools
7 Fire Stations

Value of improvements based on Assessment Roll 10/13/2009
$ 1,429,745,892



Prepared by the Santa Cruz County GIS November 2009, Project # 091-09

FIGURE 4B

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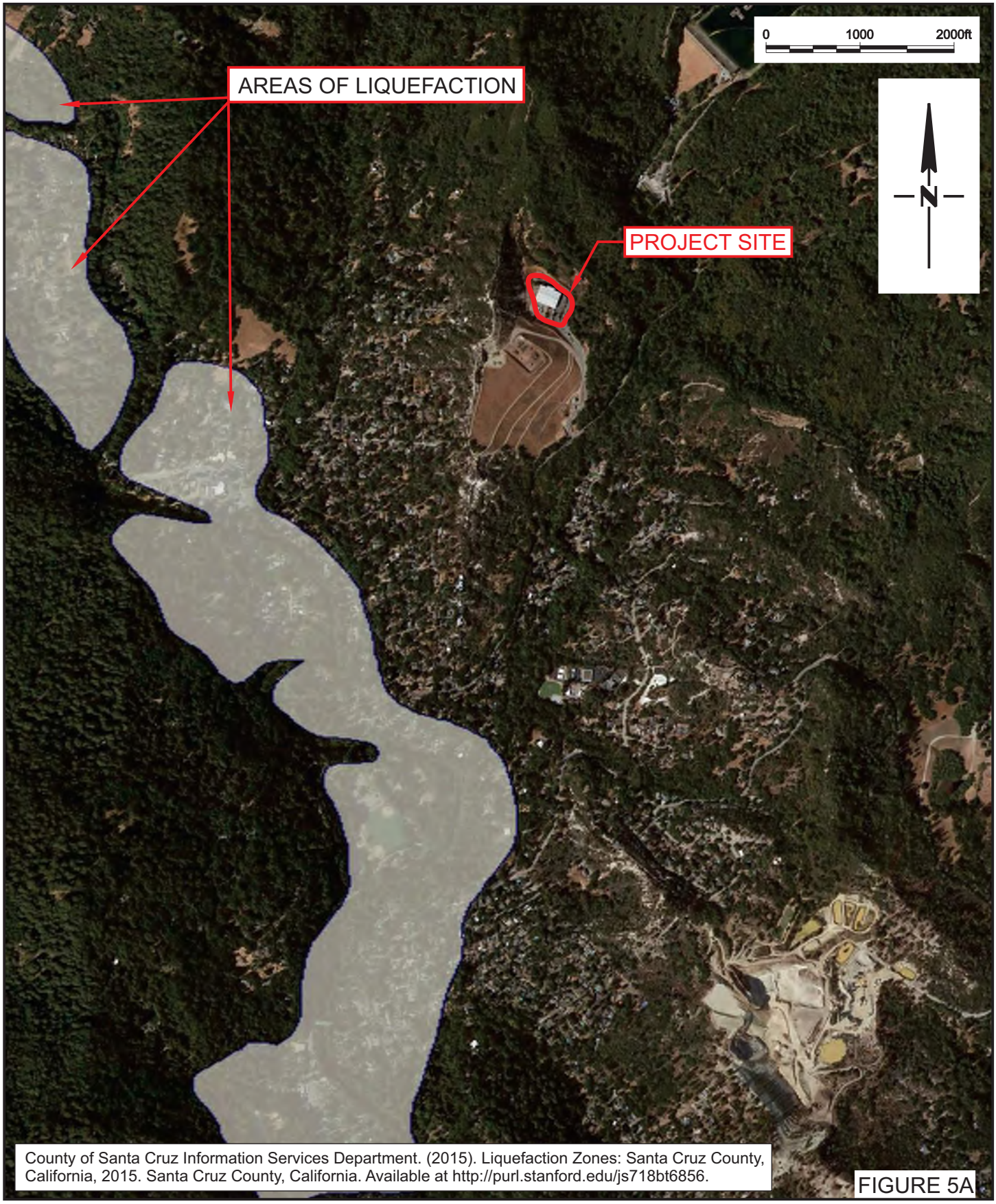
BEN LOMOND TRANSFER STATION - BEN LOMOND, CA

FAULT ZONE HAZARD AREAS

JOB NO.	BAS 21-185E
DATE	JUL 2022
DRAWN BY	TAC
CHECKED BY	FC



County of Santa Cruz Information Services Department. (2015). Liquefaction Zones: Santa Cruz County, California, 2015. Santa Cruz County, California. Available at http://purl.stanford.edu/js718bt6856.

FIGURE 5A

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BEN LOMOND TRANSFER STATION - BEN LOMOND, CA

LIQUEFACTION ZONES

JOB NO.	BAS 21-185E
DATE	JUL 2022
DRAWN BY	TAC
CHECKED BY	FC

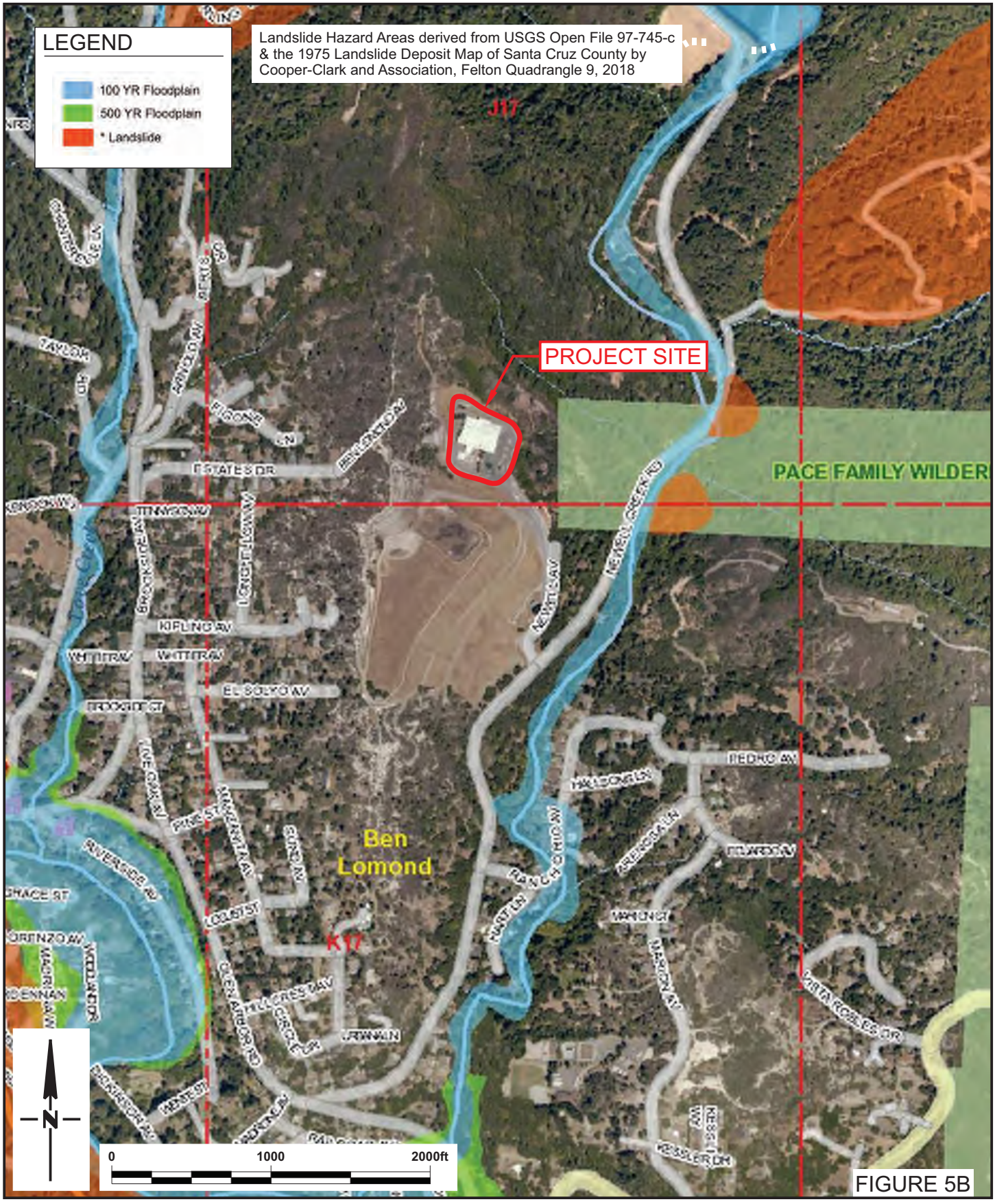

FIGURE 5B

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BEN LOMOND TRANSFER STATION - BEN LOMOND, CA

LANDSLIDE HAZARD ZONES

JOB NO.	BAS 21-185E
DATE	JUL 2022
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CHECKED BY	FC

Appendix A

Logs of Exploratory Borings

Appendix A

Logs of Exploratory Borings

Bulk and relatively undisturbed drive samples were obtained in the field during our subsurface evaluation. The samples were tagged in the field and transported to our laboratory for observation and testing. The drive samples were obtained using the California Split Barrel Drive and Standard Penetration Test (SPT) sampler as described below.

California-Type Split Barrel Drive Sampler
The split barrel drive sampler was driven with a 140-pound hammer allowed to drop freely 30 inches. The number of blows per foot recorded during sampling is presented in the logs of exploratory borings. The sampler has external and internal diameters of approximately 3.0 and 2.4 inches, respectively, and the inside of the sampler is lined with 1-inch-long brass rings. The relatively undisturbed soil sample within the rings is removed, sealed, and transported to the laboratory for observation and testing.

Standard Penetration Test Sampler
The standard penetration test sampler is driven with a 140-pound hammer allowed to drop freely 30 inches in general accordance with ASTM D1586. The number of blows (N-value) required to drive the SPT sampler 12 inches is shown on the borings logs. The sampler has external and internal diameters of approximately 2.0 and 1.4 inches respectively. The sampling tube consists of an unlined split-tube barrel. The disturbed soil sample is removed, sealed, and transported to the laboratory for testing.

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BORING B-1

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 491 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 3/1/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 3 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hollow Stem Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095503, -122.077708 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Cuttings, concrete cap

LOCATION DESCRIPTION North end of proposed east canopy

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					4" Asphalt				
				SP	1" Poorly graded SAND, reddish yellow (5YR 6/6), damp, fine to coarse grained, quartz rich base				
				SM	[FILL] Silty SAND, dark brown (7.5YR 3/4), damp, fine to medium grained, trace coarse sand				490.0
	SK-1							CORR: Resistivity = 545 ohm-cm, pH = 5.3, SO4 = 3062 ppm, Cl = 324 ppm	
2.5					[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, olive gray (5Y 4/2), damp, fine sand, micaceous, difficult drilling				
	SPT-2	50			...(2.5 ft) as above				

Notes:
1. Total Depth: 3.0 ft
2. Groundwater not encountered
3. Backfilled with cuttings and concrete cap flush with ground surface
4. Location from handheld GPS, elevation from site plan

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BORING B-2

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 490 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 3/1/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 7.5 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hollow Stem Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095194, -122.077797 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Cuttings, concrete cap

LOCATION DESCRIPTION South end of proposed east canopy

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0				4" Asphalt				490.0
	SK-2		SP-SM / SP-SM	2" Poorly graded SAND with Silt, reddish yellow (5YR 6/6), damp, fine to coarse grained, base material [FILL] Poorly graded SAND with Silt, light yellowish brown (10YR 6/4), damp, fine to medium grained, trace coarse sand, siltstone fragments			#200 = 6%	
2.5	SK-1			[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, dark reddish brown (2.5YR 3/), damp, fine sand, micaceous, heavily weathered, oxidized staining				487.5
	R-3 SK-4	14-33-50/4"					DS ATT: PL = 40, LL = 56, PI = 16	
5.0								485.0
	SPT-5	7-50/5"		...(5.0 ft) as above, reddish brown (2.5YR 5/4) to dark reddish brown (2.5YR 3/)				
7.5	SPT-6	50		...(7.0 ft) as above				482.5

Notes:
1. Total Depth: 7.5 ft
2. Groundwater not encountered
3. Backfilled with cuttings and concrete cap flush with ground surface
4. Location from handheld GPS, elevation from site plan

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Tetra Tech
21700 Copley Drive
Diamond Bar, CA 91765
909-860-7777

BORING B-3

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 494 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 3/1/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 4.8 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hollow Stem Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095135, -122.078381 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Cuttings, concrete cap

LOCATION DESCRIPTION East side of proposed south canopy

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0				SP	3" Asphalt 2" Poorly graded SAND, reddish yellow (5YR 6/6), damp, fine to coarse grained, base material				
				SM	[FILL] Silty SAND, light yellowish brown (10YR 6/4), damp, fine to medium grained, trace coarse sand, siltstone fragments				492.5
2.5	SK-1				[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, dark reddish brown (2.5YR 3/), damp, fine sand, micaceous, massive				
	SPT-2	9-29-50/4"							
	SPT-3	35-50/3"			...(4.0 ft) as above, 2" poorly graded sand bed, greenish gray (5G 5/1), damp, fine to medium grained, contact is sharp, contact has oxidized clay seam along siltstone				490.0

Notes:
1. Total Depth: 4.8 ft
2. Groundwater not encountered
3. Backfilled with cuttings and concrete cap flush with ground surface
4. Location from handheld GPS, elevation from site plan

Tetra Tech
21700 Copley Drive
Diamond Bar, CA 91765
909-860-7777

BORING B-4

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 496 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 2/28/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 10.7 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hollow Stem Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095394, -122.078758 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Monitoring well installed

LOCATION DESCRIPTION South west corner of transfer station building

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0								496.0
			SM	[FILL] Silty SAND, dark brown (7.5YR 3/4), damp, fine to medium grained, trace coarse sand, trace fine gravel, rootlets				
2.5	SK-1							
	SPT-2	25-50/3"		[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, olive gray (5Y 4/2), dry, fine sand, carbonate staining and stringers, slight laminated bedding			EI = 176	492.5
				...(4.0 ft) fine to coarse subangular to angular gravel in cuttings				
5.0								
	R-3	15-50/4"		...(5.0 ft) as above, moist, massive, micaceous	78.2	17.5		490.0
7.5								
	SPT-4	23-50/3"		...(7.5 ft) as above, dry				487.5
10.0								
	R-5	21-50/2"		...(10.0 ft) as above, damp, faint petroleum smell			DS	

Notes:
1. Total Depth: 10.7 ft
2. Groundwater not encountered
3. Backfilled with monitorinig well (slotted 2" diameter PVC and #2 monterey sand) finished with irrigation box
4. Location from handheld GPS, elevation from site plan

Tetra Tech
21700 Copley Drive
Diamond Bar, CA 91765
909-860-7777

BORING B-5

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 496 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 2/28/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 5.7 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hollow Stem Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095566, -122.078745 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Monitoring well installed

LOCATION DESCRIPTION Center west side of transfer station building

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0				SM	[FILL] Silty SAND, dark brown (7.5YR 3/4), damp, fine to medium grained, trace coarse sand, siltstone fragments				495.0
2.5	SK-1 R-2	33-50/5"			[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, olive gray (5Y 4/2), fine sand, micaceous, damp, difficult drilling ...(2.5 ft) as above	98.3	16.8		492.5
5.0	SPT-3	35-50/2"			...(5.0 ft) as above, massive				

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

Notes:
1. Total Depth: 5.7 ft
2. Groundwater not encountered
3. Backfilled with monitorinig well (slotted 2" diameter PVC and #2 monterey sand) finished with irrigation box
4. Location from handheld GPS, elevation from site plan

Tetra Tech
21700 Copley Drive
Diamond Bar, CA 91765
909-860-7777

BORING B-7

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 478 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 3/1/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 5.9 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hollow Stem Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095912, -122.078740 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Monitoring well installed

LOCATION DESCRIPTION Near toe of northwest retaining wall

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					5" Asphalt				477.5
				SP	1" Poorly graded SAND, reddish yellow (5YR 6/6), damp, fine to coarse grained, quartz rich base				
					[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, olive gray (5Y 4/2), moist, fine sand, micaceous				
2.5	SK-1								
	SPT-2	23-50			...(2.5 ft) as above				475.0
5.0									
	R-3	36-50/5"			...(5.0 ft) as above, becomes damp	86.6	16.7		472.5

Notes:
1. Total Depth: 5.9 ft
2. Groundwater not encountered
3. Backfilled with monitorinig well (slotted 2" diameter PVC and #2 monterey sand) finished with traffic rated well box
4. Location from handheld GPS, elevation from site plan

Tetra Tech
21700 Copley Drive
Diamond Bar, CA 91765
909-860-7777

BORING B-8

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 481 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 2/28/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 3.8 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hollow Stem Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.096058, -122.078864 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Cuttings, concrete cap

LOCATION DESCRIPTION Apex of road curve northwest of retaining wall

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					4" Asphalt				
					[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, olive gray (5Y 4/2), damp, fine sand, massive, micaceous				480.0
	SK-1								
2.5									
	SPT-2	20-30-50/3"							477.5

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

Notes:
1. Total Depth: 3.8 ft
2. Groundwater not encountered
3. Backfilled with cuttings and concrete cap flush with ground surface
4. Location from handheld GPS, elevation from site plan

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Tetra Tech
21700 Copley Drive
Diamond Bar, CA 91765
909-860-7777

BORING B-9

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 490.5 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 3/1/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 3.5 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hollow Stem Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095388, -122.077845 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Cuttings, concrete cap

LOCATION DESCRIPTION Center east side of transfer station building, proposed east canopy

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					3" Asphalt				490.0
				SP	2" Poorly graded SAND, reddish yellow (5YR 6/6), damp, fine to coarse grained, base material				
					[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, olive gray (5Y 4/2), damp, fine sand, micaceous, difficult drilling				
	SK-1								
2.5					...(2.5 ft) as above				487.5
	SPT-2	19-50							

Notes:
1. Total Depth: 3.5 ft
2. Groundwater not encountered
3. Backfilled with cuttings and concrete cap flush with ground surface
4. Location from handheld GPS, elevation from site plan

Tetra Tech
21700 Copley Drive
Diamond Bar, CA 91765
909-860-7777

BORING B-11

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 484 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 5/26/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 11.5 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hollow Stem Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095094, -122.077557 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Cuttings, concrete cap

LOCATION DESCRIPTION Southeast end of recycling area canopy

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					5" Asphalt				
				SP-SM	[FILL] Poorly graded SAND with Silt, reddish yellow (5YR 6/6), damp, fine to coarse grained, trace fine gravel				482.5
2.5	R-1	14-35-50/5"			...(2.5 ft) as above, very dense				
					[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, dark reddish brown (2.5YR 3/3), damp, fine sand, micaceous, heavily weathered				480.0
5.0	R-2	20-37-47 (84)			...(5.0 ft) as above, micaceous				477.5
7.5	R-3	20-23-32 (55)			...(7.5 ft) as above				475.0
10.0	R-4	14-28-40 (68)			...(10.0 ft) as above				472.5

Notes:
1. Total Depth: 11.5 ft
2. Groundwater not encountered
3. Backfilled with cement bentonite grout, concrete cap flush with ground surface
4. Location from handheld GPS, elevation from site plan

Tetra Tech
21700 Copley Drive
Diamond Bar, CA 91765
909-860-7777

BORING B-12

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 483 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 5/26/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 6.5 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hollow Stem Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095315, -122.077447 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Cuttings, concrete cap

LOCATION DESCRIPTION Northeast end of recycling area canopy

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					4" Asphalt				482.5
				SP-SM	[FILL] Poorly graded SAND with Silt, reddish yellow (5YR 6/6), damp, fine to coarse grained, trace fine gravel				
					[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, dark reddish brown (2.5YR 3/3), damp, fine sand, micaceous, heavily weathered, oxidized staining				
2.5	R-1	18-20-16 (36)						Ring sampler broke	480.0
5.0	SPT-2	10-20-28 (48)						SPT sampler broke	477.5

Notes:
1. Total Depth: 6.5 ft
2. Groundwater not encountered
3. Backfilled with cement bentonite grout, concrete cap flush with ground surface
4. Location from handheld GPS, elevation from site plan

Tetra Tech
21700 Copley Drive
Diamond Bar, CA 91765
909-860-7777

BORING B-13A

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 491 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 5/26/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 8 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hand Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095256, -122.077704 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Cuttings, concrete cap

LOCATION DESCRIPTION Near retaining wall on the east end of the recycling area and located at the north center of recycling area canopy

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					4" Asphalt				
	SK-1			SP-SM	[FILL] Poorly graded SAND with Silt, brown (10YR 4/3), damp, fine to coarse grained, trace fine gravel				490.0
	SK-2								
2.5				SP	Poorly graded SAND, pale yellow (2.5Y 7/3), damp, fine to medium grained, trace fine gravel				487.5
5.0									485.0
7.5					...(7.5 ft) as above, becomes moist				
					...(8.0 ft) concrete footing				

Notes:
1. Total Depth: 8.0 ft
2. Groundwater not encountered
3. Backfilled with cement bentonite grout, concrete cap flush with ground surface
4. Location from handheld GPS, elevation from site plan

Tetra Tech
21700 Copley Drive
Diamond Bar, CA 91765
909-860-7777

BORING B-13B

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 491 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 5/26/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 8.3 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hand Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095256, -122.077704 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Cuttings, concrete cap

LOCATION DESCRIPTION Near retaining wall on the east end of the recycling area and located at the north center of recycling area canopy

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					4" Asphalt				
				SP-SM	[FILL] Poorly graded SAND with Silt, brown (10YR 4/3), damp, fine to coarse grained, trace fine gravel				490.0
2.5				SP	Poorly graded SAND, pale yellow (2.5Y 7/3), damp, fine to medium grained, trace fine gravel				487.5
					...(4.0 ft) as above, pieces of plastic				
5.0									485.0
7.5					[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, dark reddish brown (2.5YR 3/3), damp, fine sand, micaceous, heavily weathered, oxidized staining				

Notes:
1. Total Depth: 8.3 ft
2. Groundwater not encountered
3. Backfilled with cement bentonite grout, concrete cap flush with ground surface
4. Location from handheld GPS, elevation from site plan

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Tetra Tech
21700 Copley Drive
Diamond Bar, CA 91765
909-860-7777

BORING B-13C

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 491 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 5/26/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 7.5 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hand Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095256, -122.077704 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Cuttings, concrete cap

LOCATION DESCRIPTION Near retaining wall on the east end of the recycling area and located at the north center of recycling area canopy

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					4" Asphalt				
				SP-SM	[FILL] Poorly graded SAND with Silt, brown (10YR 4/3), damp, fine to coarse grained, trace fine gravel				490.0
2.5				SP	Poorly graded SAND, pale yellow (2.5Y 7/3), damp, fine to medium grained, trace fine gravel				487.5
5.0									485.0
7.5					[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, dark reddish brown (2.5YR 3/3), damp, fine sand, micaceous, heavily weathered, oxidized staining				

Notes:
1. Total Depth: 7.5 ft
2. Groundwater not encountered
3. Backfilled with cement bentonite grout, concrete cap flush with ground surface
4. Location from handheld GPS, elevation from site plan

Tetra Tech
21700 Copley Drive
Diamond Bar, CA 91765
909-860-7777

BORING B-13D

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 491 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 5/26/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 4.5 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hand Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095256, -122.077704 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Cuttings, concrete cap

LOCATION DESCRIPTION Near retaining wall on the east end of the recycling area and located at the north center of recycling area canopy

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					4" Asphalt				
				SP-SM	[FILL] Poorly graded SAND with Silt, brown (10YR 4/3), damp, fine to coarse grained, trace fine gravel				490.0
2.5				SP	Poorly graded SAND, pale yellow (2.5Y 7/3), damp, fine to medium grained, trace fine gravel				487.5
					[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, dark reddish brown (2.5YR 3/3), damp, fine sand, micaceous, heavily weathered, oxidized staining				

Notes:
1. Total Depth: 4.5 ft
2. Groundwater not encountered
3. Backfilled with cement bentonite grout, concrete cap flush with ground surface
4. Location from handheld GPS, elevation from site plan

Tetra Tech
21700 Copley Drive
Diamond Bar, CA 91765
909-860-7777

BORING B-14A

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 491 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 5/26/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 5.8 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hand Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095419, -122.077653 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Cuttings, concrete cap

LOCATION DESCRIPTION East side of transfer station building, atop retaining wall

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					5" Asphalt				
	SK-1			SP-SM	[FILL] Poorly graded SAND with Silt, brown (10YR 4/3), damp, fine to coarse grained, trace fine gravel				490.0
2.5				SP	Poorly graded SAND, pale yellow (2.5Y 7/3), damp, fine to medium grained, trace fine gravel				487.5
5.0					[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, dark reddish brown (2.5YR 3/3), damp, fine sand, micaceous, heavily weathered, oxidized staining				

Notes:
1. Total Depth: 5.8 ft
2. Groundwater not encountered
3. Backfilled with cement bentonite grout, concrete cap flush with ground surface
4. Location from handheld GPS, elevation from site plan

Printed on: 7/5/22 18:00

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BORING B-14B

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 491 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 5/26/2022 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 4 ft

LOGGED/CHECKED BY TAC/FC | **DRILLING METHOD** Hand Auger | **BOREHOLE DIAMETER** 8 in

COORDINATES 37.095256, -122.077704 | **HAMMER DATA** Automatic, 140 Lbs, 30" drop | **BACKFILL** Cuttings, concrete cap

LOCATION DESCRIPTION Near retaining wall on the east end of the recycling area and located at the center of recycling area canopy

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					5" Asphalt				
				SP-SM	[FILL] Poorly graded SAND with Silt, brown (10YR 4/3), damp, fine to coarse grained, trace fine gravel				490.0
	SK-1			SP	Poorly graded SAND, pale yellow (2.5Y 7/3), damp, fine to medium grained, trace fine gravel				
2.5									487.5
					[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, dark reddish brown (2.5YR 3/3), damp, fine sand, micaceous, heavily weathered, oxidized staining				

Notes:
1. Total Depth: 4.0 ft
2. Groundwater not encountered
3. Backfilled with cement bentonite grout, concrete cap flush with ground surface
4. Location from handheld GPS, elevation from site plan

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909-860-7777

BORING HA-1

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 496 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 3/1/2022 | **DRILLING CONTRACTOR** Tetra Tech | **BOREHOLE DEPTH** 4.2 ft

LOGGED/CHECKED BY SCM/FC | **DRILLING METHOD** Hand Auger | **BOREHOLE DIAMETER** 4 in

COORDINATES 37.095538, -122.078459 | **HAMMER DATA** N/A | **BACKFILL** Monitoring well installed

LOCATION DESCRIPTION Near retaining wall on the east end of the recycling area and located at the center of recycling area canopy

Standard Penetration Test (SPT) | No Recovery | Shelby Tube | California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					4" Reinforced concrete				
					2" Void space (open space to north)				
				SP-SM	2" Concrete slurry				495.0
					[FILL] Poorly graded SAND with Silt, light yellowish brown (10YR 6/4), moist, fine to medium grained, trace coarse sand, trace siltstone fragments				
2.5	SK-1							#200 = 11%	
									492.5
					[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, olive gray (5Y 4/2), damp, fine sand, micaceous				

Notes:
- Total Depth: 4.2 feet.
- Groundwater not encountered.
- Backfilled with monitoring well (slotted 2" diameter PVC and #2 monterey sand), finished with traffic rated well box.
- Location and elevation from site plan.

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BORING HA-2

PROJECT NAME Ben Lomond Transfer Station | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 496 ft

PROJECT NUMBER 197-2021-0162 | **PROJECT LOCATION** Ben Lomond, CA | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 3/1/2022 | **DRILLING CONTRACTOR** Tetra Tech | **BOREHOLE DEPTH** 6.8 ft

LOGGED/CHECKED BY SCM/FC | **DRILLING METHOD** Hand Auger | **BOREHOLE DIAMETER** 4 in

COORDINATES 37.095389, -122.078512 | **HAMMER DATA** N/A | **BACKFILL** Monitoring well installed

LOCATION DESCRIPTION Interior of building atop retaining wall (center of building)

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					4" Reinforced concrete				
				SM	[FILL] Silty SAND, light yellowish brown (10YR 6/4), moist, fine to medium grained, trace coarse sand, trace siltstone fragments				495.0
2.5	SK-1								492.5
5.0					[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, olive gray (5Y 4/2), damp, fine sand, micaceous				490.0

Notes:
- Total Depth: 6.8 feet.
- Groundwater not encountered.
- Backfilled with monitoring well (slotted 2" diameter PVC and #2 monterey sand), finished with traffic rated well box.
- Location and elevation from site plan.

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BORING HA-3

PROJECT NAME Ben Lomond Transfer Station **CLIENT** County of Santa Cruz **GROUND ELEVATION** 496 ft

PROJECT NUMBER 197-2021-0162 **PROJECT LOCATION** Ben Lomond, CA **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 3/1/2022 **DRILLING CONTRACTOR** Tetra Tech **BOREHOLE DEPTH** 1 ft

LOGGED/CHECKED BY SCM/FC **DRILLING METHOD** Hand Auger **BOREHOLE DIAMETER** 4 in

COORDINATES 37.095292, -122.078686 **HAMMER DATA** N/A **BACKFILL** Cuttings, concrete cap

LOCATION DESCRIPTION Southwest corner of transfer building near access road entrance

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					3" Asphalt				
1.0				SP	9" Poorly graded SAND, reddish yellow (5YR 6/6), damp, fine to coarse grained, quartz rich base				495.0
					[BEDROCK] Monterey Formation (Tm) Sandy SILTSTONE, olive gray (5Y 4/2), damp, fine sand, micaceous				

Notes:
- Total Depth: 1.0 feet.
- Groundwater not encountered.
- Backfilled with cuttings and concrete cap flush with ground surface.
- Location from handheld GPS, elevation from site plan.

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BORING HA-4

PROJECT NAME Ben Lomond Transfer Station
CLIENT County of Santa Cruz
GROUND ELEVATION 491 ft
PROJECT NUMBER 197-2021-0162
PROJECT LOCATION Ben Lomond, CA
GROUNDWATER DEPTH Not encountered
DATES DRILLED 5/26/2022
DRILLING CONTRACTOR Penhall Company
BOREHOLE DEPTH 1.42 ft
LOGGED/CHECKED BY TAC/FC
DRILLING METHOD Hand Auger
BOREHOLE DIAMETER 4 in
COORDINATES 37.095381, -122.078515
HAMMER DATA N/A
BACKFILL Cuttings, concrete cap
LOCATION DESCRIPTION Bottom of the interior stairs

Standard Penetration Test (SPT) | No Recovery | Shelby Tube
California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					9" Reinforced concrete				
1.0	SK-1			SP-SM	[FILL] Poorly graded SAND with Silt, light yellowish brown (10YR 6/4), wet, fine to medium grained, trace coarse sand				490.0

Notes:
- Total Depth: 1.4 feet.
- Groundwater not encountered.
- Backfilled with cuttings and protected with grate.
- Location from handheld GPS, elevation from site plan.

Appendix B

Results of Laboratory Testing

Appendix B
Results of Current Laboratory Testing

Classification
Soils were visually and texturally classified in accordance with the Unified Soil Classification System. Soil classifications are indicated on the logs of the exploratory borings in Appendix A.

In-Place Moisture and Dry Density Tests
The moisture contents and dry densities of relatively undisturbed samples obtained from the exploratory boreholes were evaluated in general accordance with the latest version of ASTM D2937. The test results are presented on the log of the exploratory borings in Appendix A.

Particle Size Analysis
An evaluation of the particle size analysis for selected soil samples were performed in general accordance with ASTM D422. The results of the analysis are presented the borehole logs in Appendix A and in the back of this Appendix B.

Percent Passing #200 Sieve
An evaluation of the percent passing #200 sieve for selected soil samples were performed in general accordance with ASTM D1140. The results of the analysis are presented the borehole logs in Appendix A and in the back of this Appendix B.

Atterberg Limits Tests
Liquid Limit, Plastic Limit, and Plasticity Index of selected and representative on-site materials were performed in general accordance with ASTM D4318. The results of this test are presented on the borehole logs in Appendix A and in the back of this Appendix B.

Direct Shear Tests
The sample were tested under three different normal loads. The samples were sheared at a constant rate of strain selected in general accordance with the consolidation characteristics of the soils (Section 7.3 of ASTM D3080). The samples were inundated during shearing to represent potentially adverse field conditions. The strain rate used for shear tests was 0.002 inches per minute. Shearing of the specimens was continued until the shear stress became essentially constant or until a deformation of approximately 10 percent of the original diameter had been reached. The results of 3-point direct shear tests are presented in the back of this Appendix B.

Corrosivity Series
The corrosivity of a selected sample was evaluated in general accordance with the latest version of California Test Method (CTM) No. 417, 422 and 643. The results of these tests are presented in Table 15 in the report and in the back of this Appendix B.

TETRA TECH

MOISTURE CONTENT AND DENSITY

ASTM D7263

Job Name:	**Ben Lomond Transfer Station**	**Date Sampled:**	3/8/2022
Job Number:	**BAS-21-185E**	**Date Completed:**	3/21/2022
Tested By:	**MG**	**Note:**	

Boring / Test Pit / Trench		**B-4**	**B-5**	**B-7**						
Sample Number		**R-3**	**R-2**	**R-3**						
Sample Depth	*ft*	**5**	**2.5**	**5**						
USCS Soil Description		Dark Olive Gray Siltstone Bedrock	Dark Olive Gray Siltstone Bedrock	Dark Olive Gray Siltstone Bedrock						
Number of Rings		6	6	6						
Total Weight Rings + Soil	*grams*	920.00	1085.30	986.20						
Volume of Rings	ft^3	0.0159	0.0159	0.0159						
Weight of Rings	*grams*	255.26	255.26	255.26						
Weight of Soil	*grams*	664.74	830.04	730.94						
Wet Density	*pcf*	91.91	114.77	101.06						
Container ID		X21	X53	X55						
Tare	*grams*	10.5	10.5	10.5						
Wet Soil + Tare	*grams*	246.4	251.9	291.6						
Dry Soil + Tare	*grams*	211.2	217.2	251.3						
Weight of Water	*grams*	35.2	34.7	40.3						

Dry Density	***pcf***	**78.2**	**98.3**	**86.6**						
Moisture Content	***%***	**17.5**	**16.8**	**16.7**						

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TETRA TECH

PERCENT PASSING # 200 SIEVE

ASTM D1140

Job Name:	Ben Lomond Transfer Station	**Date Completed:**	3/8/2022
Job Number:	BAS-21-185E	**Date Sampled:**	March 21, 2022
Note:			
Tested By :	MG		

Boring Number	Sample Number	Depth (ft)	Weight Before Wash - Dry (grams)	Weight After Wash - Dry (grams)	Percent Passing # 200 Sieve	USCS Classification
B-2	**SK-2**	0.5-2	440.6	414	6%	SP-SM
HA-1	**GB-1**	2.5-3	376.1	335.2	11%	SP-SM

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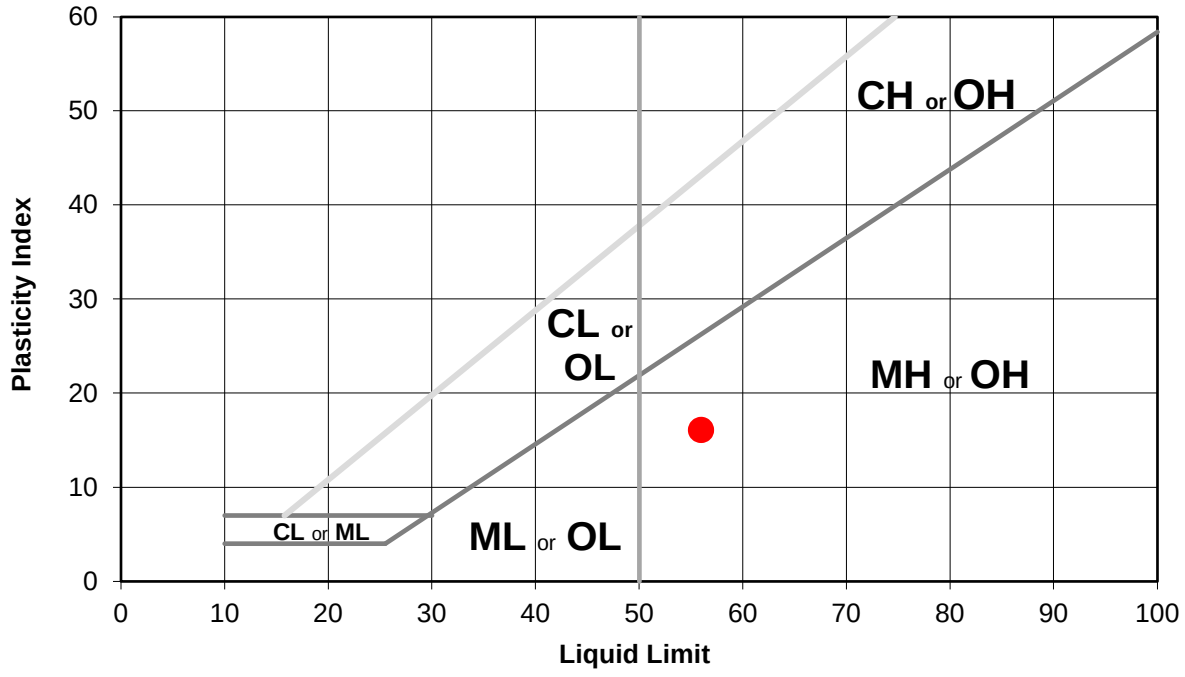
TETRA TECH

ATTERBERG LIMITS

ASTM D4318

Job Name:	Ben Transfer Station	**Date Sampled:**	3/8/2022
Job Number:	BAS-21-185E	**Date Completed:**	3/22/2022
Tested By:	MG	**Sample Identification:**	B-2, GB-4
Note:		**Sample Depth:**	3-3.5 ft
Sample Description:	Reddish brown Siltstone Bedrock, ML		

		Plastic Limit		Liquid Limit			
Test No.		**1**	**2**	**1**	**2**	**3**	**4**
Number of Blows				35	25	17	
Container ID		F7	F3	T38	S5	N11	
Wet Weight of Soil + Cont.	*grams*	21.30	20.00	51.20	47.50	49.50	
Dry Weight of Soil + Cont.	*grams*	18.80	17.80	42.20	39.70	40.80	
Weight of Container	*grams*	12.40	12.40	25.80	25.70	25.50	
Moisture Weight	*grams*	2.50	2.20	9.00	7.80	8.70	
Weight of Dry Soil	*grams*	6.40	5.40	16.40	14.00	15.30	
Moisture Content	*%*	**39.1**	**40.7**	**54.9**	**55.7**	**56.9**	



Plastic Limit	**40**
Liquid Limit	**56**
Plasticity Index	**16**

USCS Classification	**ML**
Based on Atterberg Limits only	

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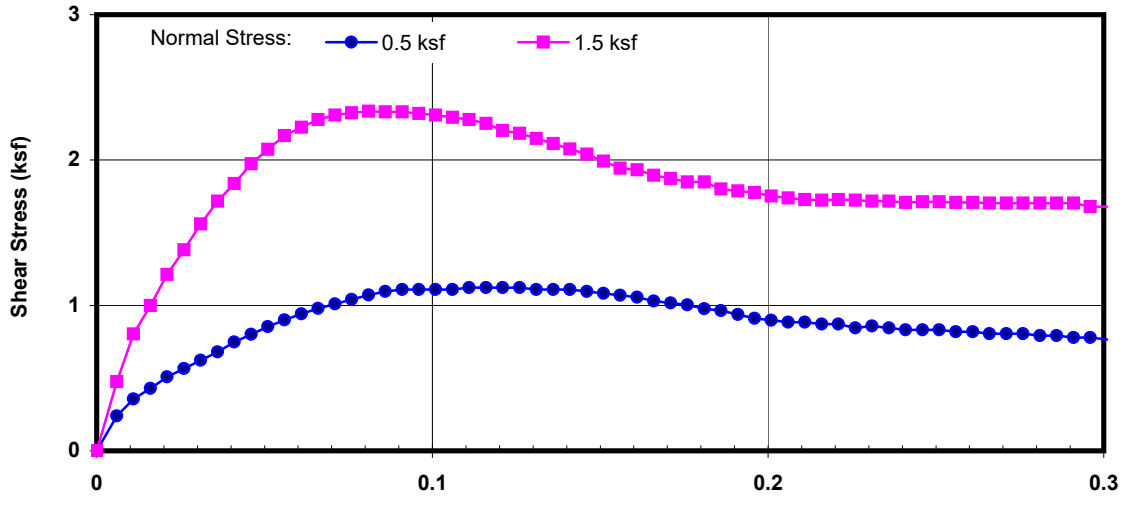
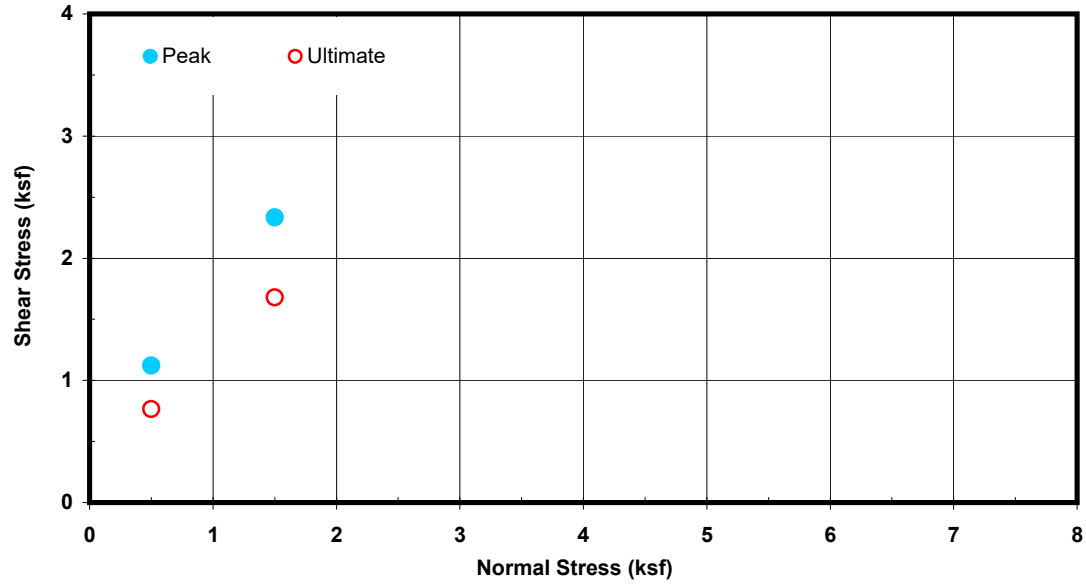
DIRECT SHEAR TEST RESULTS
ASTM D 3080

Client:	Tetra Tech		**Tested By:**	LS	**Date:** 03/15/22
Project Name:	Ben Lomond Transfer Station, Santa Cruz		**Computed By:**	NR	**Date:** 03/16/22
Project No.:	BAS 21-185		**Checked by:**	AP	**Date:** 03/18/22
Boring No.:	R-2				
Sample No.:	R-3	**Depth (ft):** 2.5			
Sample Type:	Mod. Cal.				
Soil Description:	Siltstone				
Test Condition:	Inundated	**Shear Type:** Regular			

Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Initial Moisture Content (%)	Final Moisture Content (%)	Initial Degree Saturation (%)	Final Degree Saturation (%)	Normal Stress (ksf)	Peak Shear Stress (ksf)	Ultimate Shear Stress (ksf)
103.9	83.5	24.4	34.0	65	90	0.5	1.122	0.766
						1.5	2.335	1.680





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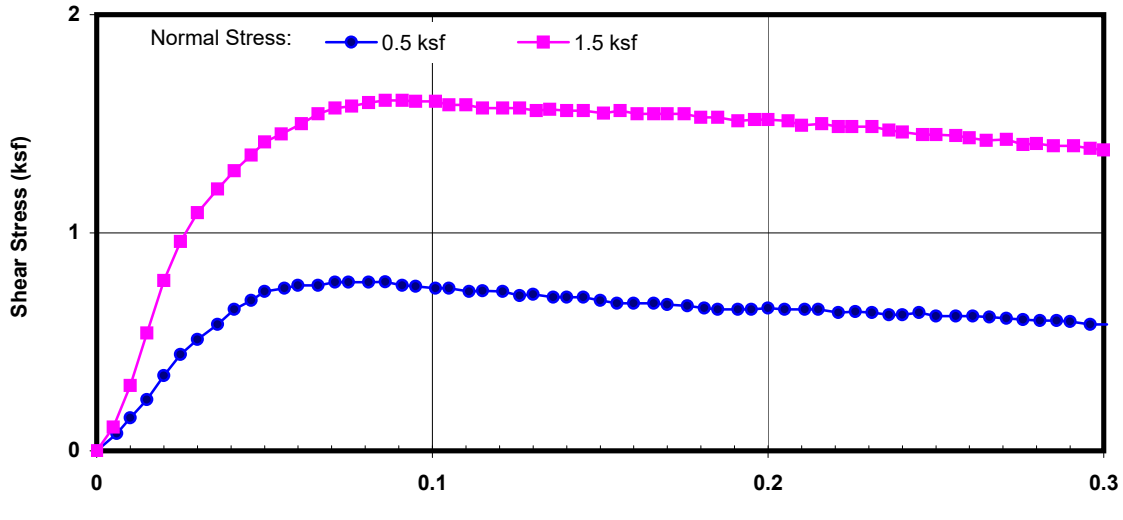
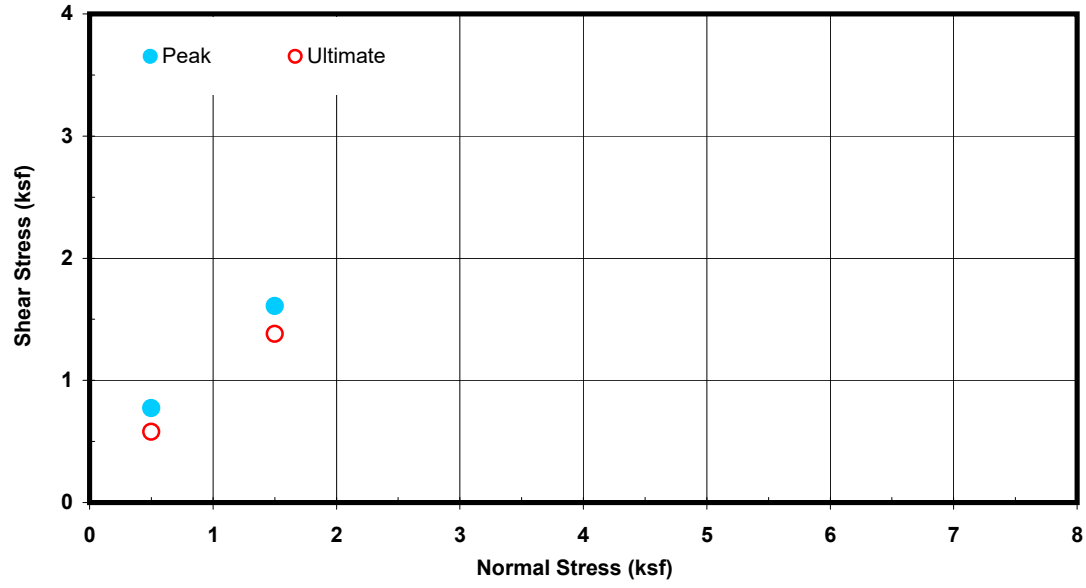
DIRECT SHEAR TEST RESULTS
ASTM D 3080

Client:	Tetra Tech		**Tested By:**	LS	**Date:** 03/15/22
Project Name:	Ben Lomond Transfer Station, Santa Cruz		**Computed By:**	NR	**Date:** 03/16/22
Project No.:	BAS 21-185		**Checked by:**	AP	**Date:** 03/18/22
Boring No.:	B-4				
Sample No.:	R-5	**Depth (ft):** 10			
Sample Type:	Mod. Cal.				
Soil Description:	Siltstone				
Test Condition:	Inundated	**Shear Type:** Regular			

Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Initial Moisture Content (%)	Final Moisture Content (%)	Initial Degree Saturation (%)	Final Degree Saturation (%)	Normal Stress (ksf)	Peak Shear Stress (ksf)	Ultimate Shear Stress (ksf)
103.3	88.4	16.8	29.8	50	89	0.5	0.773	0.580
						1.5	1.608	1.380





TETRA TECH

EXPANSION INDEX

ASTM D4829

Job Name:	Ben Lomond Transfer Station	**Date Sampled:**	3/8/2022
Job Number:	BAS-21-185E	**Date Completed:**	3/21/2022
Tested By:	MG	**Sample Identification:**	B-4, SPT 2
Note:		**Sample Depth:**	2.5 ft
Sample Description:	Siltstone, Bedrock, ML		

SAMPLE PROCESSING		
Percentage Passing #4 Sieve		
Total Air Dry Weight	*grams*	6.62
Weight Retained on #4	*grams*	0.07
*% Retained	*%*	1.01
***% Passing # 4 Sieve**	***%***	**99.0**

SAMPLE DIMENSIONS		
Sample Height	*inches*	1.00
Sample Diameter	*inches*	4.01

MOISTURE CALCS		INITIAL	FINAL
Tare ID or #		P7	P8
Wet Weight of Soil + Tare	*grams*	117.3	468.9
Dry Weight of Soil + Tare	*grams*	98.7	335.7
Weight of Tare	*grams*	16.9	58.1
* Moisture Weight	*grams*	18.6	133.2
* Weight of Dry Soil	*grams*	81.8	277.6
*** Moisture Content**	*%*	**22.7**	**48.0**

AFTER REMOLDING		INITIAL	FINAL
Weight of Ring and Sample	*grams*	514.6	611.8
Weight of Ring	*grams*	201.2	201.2
*Remolded Wet Weight	*grams*	313.4	410.6
*Wet Density	*pcf*	94.5	105.5
*Dry Density	*pcf*	77.0	71.3
Assumed/Measured Specific Gravity		2.7	2.7
***Degree of Saturation**	*%*	**51.7**	**95.0**

EXPANSION INDEX TEST			
DATE	**TIME**	**DIAL**	**Δ H %**
3/23/2016	11:23 AM	0.0000	0.0
		0.0140	1.4
		0.0878	8.8
		0.1308	13.1
		0.1590	15.9
		0.1670	16.7
3/25/2016	1:03 PM	0.1736	17.3
***Total**		**0.1736**	**17.3**

EI	Expansion Potential
0 to 20	Very Low
21 to 50	Low
51 to 90	Medium
90 to 130	High
>130	Very High

UNCORRECTED EXPANSION INDEX 173

CORRECTED EXPANSION INDEX **176**

For degrees of Saturation ≠ 50%, >40% and <60%

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CORROSION TEST RESULTS

Client Name: Tetra Tech
Project Name: Ben Lomond Transfer Station, Santa Cruz
Project No.: BAS 21-185

AP Job No.: 22-0332
Date: 03/16/22

Boring No.	Sample No.	Depth (feet)	Soil Description	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
B-1	SK-1	0-3	Clay	545	5.3	3062	324

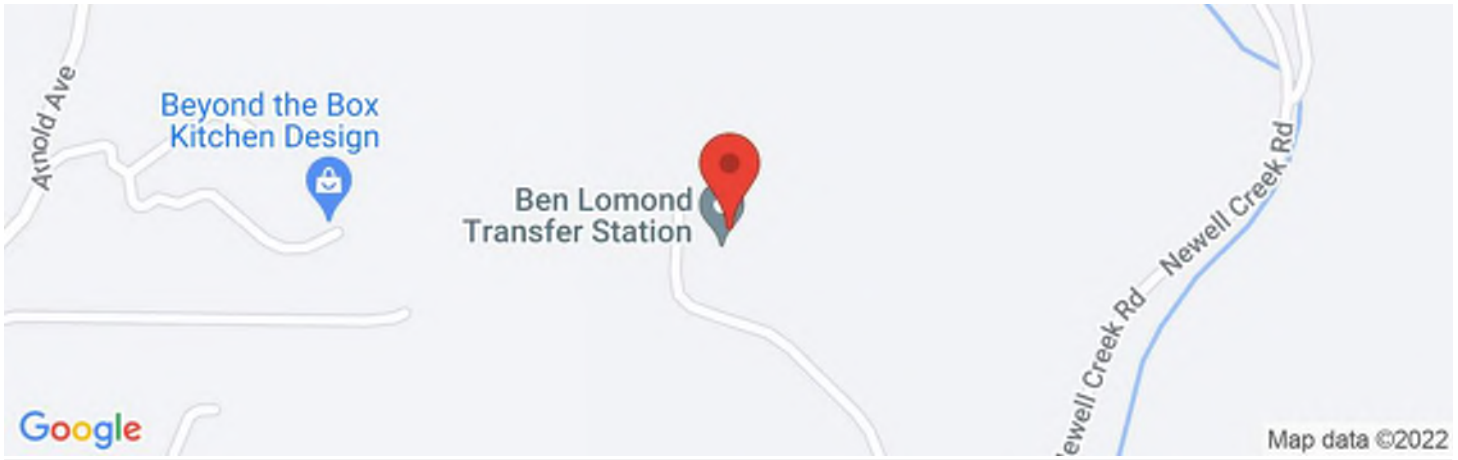
NOTES: Resistivity Test and pH: California Test Method 643
Sulfate Content : California Test Method 417
Chloride Content : California Test Method 422
ND = Not Detectable
NA = Not Sufficient Sample
NR = Not Requested

Appendix C

Seismic Demand

Ben Lomond Transfer Station

Latitude, Longitude: 37.095512, -122.078311



Date	6/2/2022, 1:17:27 PM
Design Code Reference Document	ASCE7-16
Risk Category	II
Site Class	B - Rock

Type	Value	Description
S_S	1.97	MCE_R ground motion. (for 0.2 second period)
S_1	0.783	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.773	Site-modified spectral acceleration value
S_{M1}	0.626	Site-modified spectral acceleration value
S_{DS}	1.182	Numeric seismic design value at 0.2 second SA
S_{D1}	0.418	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	E	Seismic design category
F_a	0.9	Site amplification factor at 0.2 second
F_v	0.8	Site amplification factor at 1.0 second
PGA	0.844	MCE_G peak ground acceleration
F_{PGA}	0.9	Site amplification factor at PGA
PGA_M	0.76	Site modified peak ground acceleration
T_L	12	Long-period transition period in seconds
SsRT	1.97	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	2.155	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	2.503	Factored deterministic acceleration value. (0.2 second)
S1RT	0.783	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.873	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.939	Factored deterministic acceleration value. (1.0 second)
PGAd	1.046	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.914	Mapped value of the risk coefficient at short periods
C_{R1}	0.896	Mapped value of the risk coefficient at a period of 1 s

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U.S. Geological Survey - Earthquake Hazards Program

Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Dynamic: Conterminous U.S. 2014 (up…

Spectral Period

Peak Ground Acceleration

Latitude

Decimal degrees

37.095512

Time Horizon

Return period in years

2475

Longitude

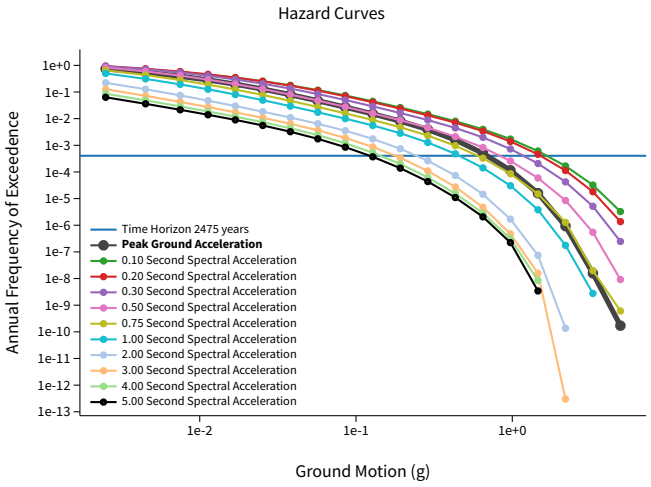
Decimal degrees, negative values for western longitudes

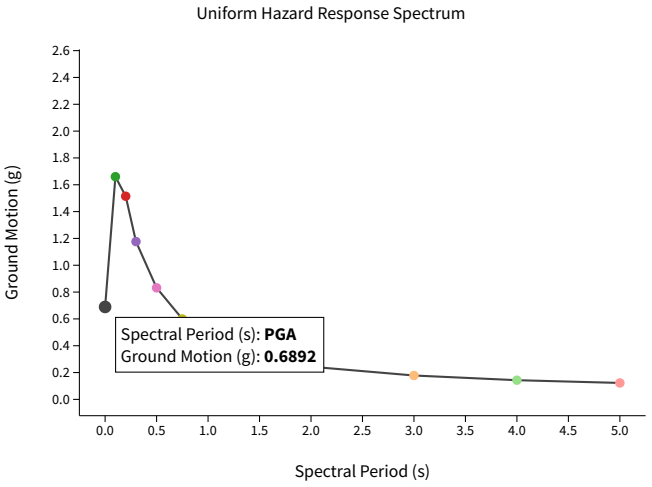
-122.078311

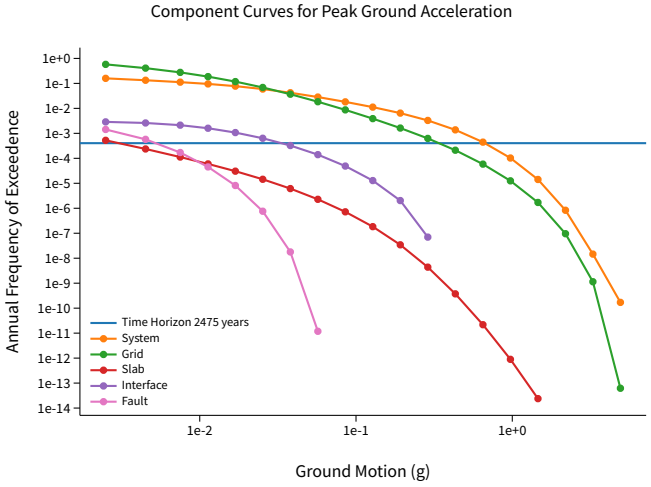
Site Class

1150 m/s (Site class B)

Hazard Curve





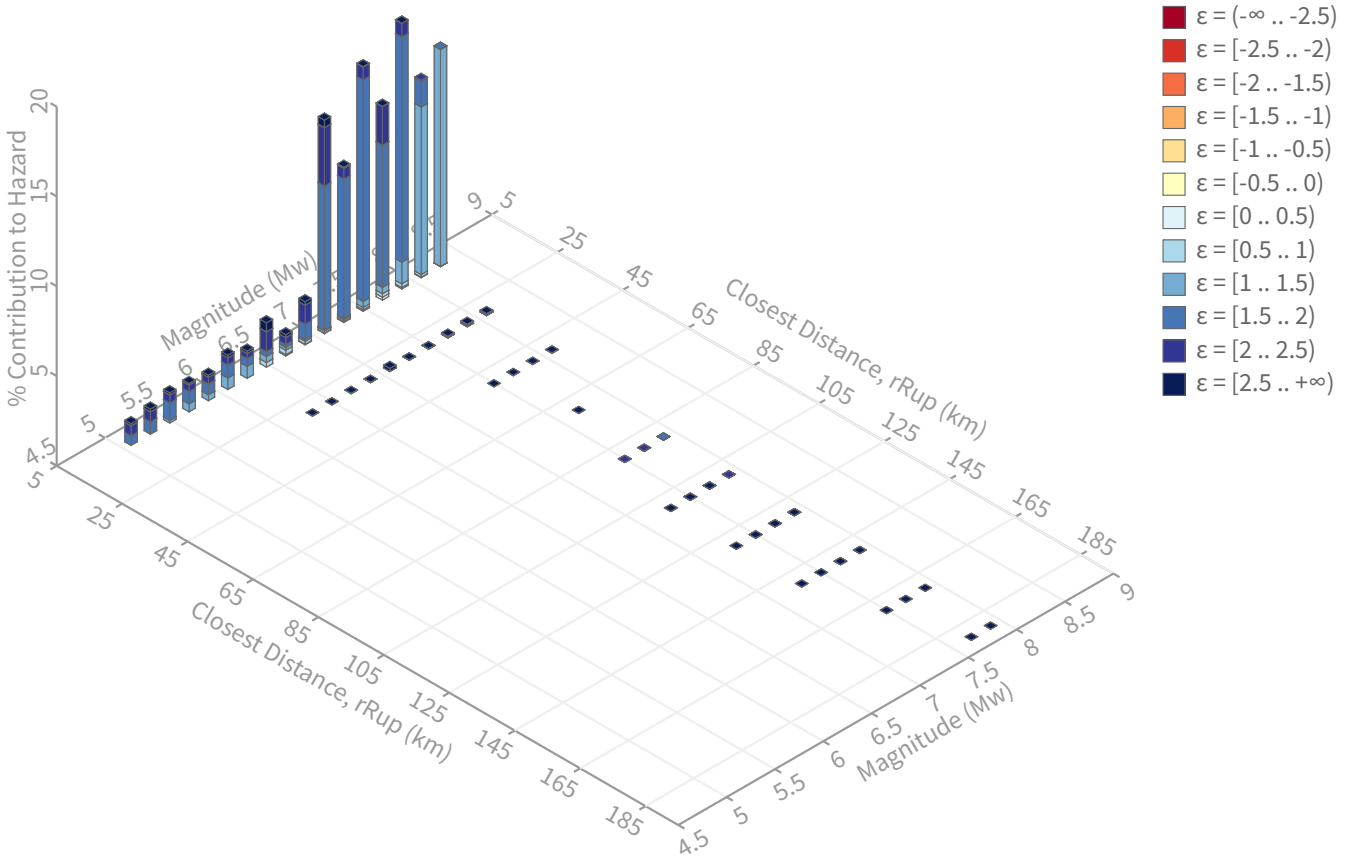


View Raw Data

Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 2475 yrs
Exceedance rate: 0.0004040404 yr^{-1}
PGA ground motion: 0.68916878 g

Recovered targets

Return period: 3103.6693 yrs
Exceedance rate: 0.00032219927 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 0.05 %

Mean (over all sources)

m: 7.44
r: 10.87 km
ε_0: 1.68 σ

Mode (largest m-r bin)

m: 7.88
r: 11.27 km
ε_0: 1.58 σ
Contribution: 14.79 %

Mode (largest m-r-ε_0 bin)

m: 7.87
r: 11.24 km
ε_0: 1.59 σ
Contribution: 12.54 %

Discretization

r: min = 0.0, max = 1000.0, Δ = 20.0 km
m: min = 4.4, max = 9.4, Δ = 0.2
ε: min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0: [-∞ .. -2.5)
ε1: [-2.5 .. -2.0)
ε2: [-2.0 .. -1.5)
ε3: [-1.5 .. -1.0)
ε4: [-1.0 .. -0.5)
ε5: [-0.5 .. 0.0)
ε6: [0.0 .. 0.5)
ε7: [0.5 .. 1.0)
ε8: [1.0 .. 1.5)
ε9: [1.5 .. 2.0)
ε10: [2.0 .. 2.5)
ε11: [2.5 .. +∞]

Deaggregation Contributors

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
UC33brAvg_FM31	System							44.36
San Andreas (Santa Cruz Mts) [0]		10.94	7.75	1.59	122.002°W	37.175°N	37.37	32.42
San Gregorio (North) [18]		16.75	7.62	2.17	122.263°W	37.066°N	258.70	2.28
San Andreas (Santa Cruz Mts) [1]		12.59	7.12	1.97	121.943°W	37.134°N	70.25	2.23
Butano [1]		9.42	7.54	1.58	122.012°W	37.161°N	39.07	1.87
Zayante-Vergeles [2]		1.23	7.61	0.55	122.082°W	37.097°N	303.71	1.30
UC33brAvg_FM32	System							43.77
San Andreas (Santa Cruz Mts) [0]		10.94	7.74	1.60	122.002°W	37.175°N	37.37	33.56
San Andreas (Santa Cruz Mts) [1]		12.59	7.14	1.97	121.943°W	37.134°N	70.25	2.33
San Gregorio (North) [18]		16.75	7.63	2.16	122.263°W	37.066°N	258.70	2.25
Butano [1]		9.42	7.59	1.56	122.012°W	37.161°N	39.07	1.70
UC33brAvg_FM32 (opt)	Grid							6.33
PointSourceFinite: -122.078, 37.109		5.09	5.80	1.57	122.078°W	37.109°N	0.00	2.20
PointSourceFinite: -122.078, 37.109		5.09	5.80	1.57	122.078°W	37.109°N	0.00	2.20
UC33brAvg_FM31 (opt)	Grid							5.54
PointSourceFinite: -122.078, 37.109		5.33	5.69	1.65	122.078°W	37.109°N	0.00	1.57
PointSourceFinite: -122.078, 37.109		5.33	5.69	1.65	122.078°W	37.109°N	0.00	1.57

TETRA TECH

Geotechnical Engineering ● Engineering Geology

Geotechnical Design Report Rev.1

BEN LOMOND TRANSFER STATION
NEW SCALE HOUSE,
SCALES AND OVERHEAD SIGN

9835 Newell Creek Road
Ben Lomond, California

Prepared for:

County of Santa Cruz
701 Ocean Street, Room 410
Sant Cruz, California 95060

Prepared by:

Tetra Tech BAS, Inc.
21700 Copley Drive, Suite #200
Diamond Bar, California 91765

Project No. BAS 21-185E
(supersedes report dated February 9, 2024)
May 10, 2024

TETRA TECH

Project No. BAS 21-185E
(supersedes report dated February 9, 2024)
May 10, 2024

Ms. Nicole Steel
County of Santa Cruz
701 Ocean Street, Room 410
Sant Cruz, California 95060

Subject: **GEOTECHNICAL DESIGN REPORT Rev.1**
BEN LOMOND TRANSFER STATION
NEW SCALE HOUSE, SCALES AND OVERHEAD SIGN
9835 Newell Creek Road
Ben Lomond, California

Dear Ms. Steel:

Tetra Tech is pleased to submit this revised Geotechnical Design Report which presents the results of our geotechnical investigation for the design of a new scale house, 2 new scales and a new overhead sign at the Ben Lomond transfer station located at 9835 Newell Creek Road, in Ben Lomond, California. This revised report supersedes our previous report dated February 9, 2024. Our scope included investigation to evaluate the subsurface conditions at the site in order to provide geotechnical recommendations for the design and construction of the proposed improvements.

This report includes a brief description of the proposed development, a discussion regarding the field exploration and laboratory testing, a description of subsurface conditions, a discussion on engineering seismology and geological hazards and provides geotechnical conclusions and recommendations for the design and construction of the proposed improvements. The appendices to the report include logs of exploratory borings, results of laboratory tests and evaluation of the seismic demand.

We appreciate the opportunity to provide our professional services on this project. If you have any questions regarding this report or if we can be of further service, please do not hesitate to contact the undersigned.

Respectfully submitted,
Tetra Tech BAS, Inc.

Fernando Cuenca, PhD, GE
Senior Engineer

REGISTERED PROFESSIONAL ENGINEER FERNANDO AUGUSTO CUENCA GE 3128 GEOTECHNICAL STATE OF CALIFORNIA

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Distribution: Addressee (pdf by email nicole.steel@santacruzcounty.us)
Filename: 2024-02-09 Ben Lomond Scale House GDR.docx

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1. INTRODUCTION

This revised Geotechnical Design Report presents the results of Tetra Tech's geotechnical engineering evaluation and geotechnical recommendations for the design of a new scale house, 2 new scales and a new overhead sign at the Ben Lomond transfer station located at 9835 Newell Creek Road in Ben Lomond, California. The location of the site is shown in Figure 1 – Site Location Map. This revised report supersedes our previous report dated February 9, 2024.

This report includes a brief description of the proposed development, a discussion regarding the field exploration and laboratory testing, a description of subsurface conditions, a discussion on engineering seismology and geological hazards, and provides geotechnical conclusions and recommendations for the design and construction of the proposed improvements. The appendices to the report include logs of exploratory borings, results of laboratory tests, and evaluation of the seismic demand.

2. PROJECT DESCRIPTION

2.1. Site Conditions

The site is located adjacent to the Ben Lomond transfer station and sits approximately 1,000 feet north from the entrance to the property. Currently the site is occupied by a scale house and 2 scales. There is an asphalt paved road that splits off right after the entrance, into a road leading to the top deck of the landfill while the other road continues to the existing scale house and scales. As it approaches the scale house and scales, the paved road widens to allow for a bypass lane in either direction. The existing scale house footprint is approximately 30' x 15' and sits on a concrete median with two 70' x 10' scales embedded approximately 4' into the ground, located directly adjacent to the scale house (see Figure 2 – Project Layout and Boring Locations Map). The thickness of the scale stem walls and supporting mat are unknown. The site is relatively flat as it approaches the transfer station, sloping downwards gently to the northwest (towards the transfer station). A descending slope is located to the northeast of the site, with a 7' setback from the edge of the paved road to the top of slope, which is about 30' high and has a 3(H):1(V) descending gradient. A natural drainage channel runs directly adjacent to the toe of the slope. The Ben Lomond Landfill is located to the southwest of the site. There is an ascending slope towards the southwest that leads to the access road leading to the top of the landfill.

2.2. Proposed Construction

The proposed improvements at the Ben Lomond transfer station include the demolition of the existing scale house and existing scales, and the construction of the following new structures:

- A new scale house with an approximate footprint of 17 by 34 feet. There are 3 different foundation systems being considered for the scale house:
  - Slab on grade with thickened edge embedded 2 feet below finished grade.
  - Continuous perimeter footing embedded 2 feet below finished grade with slab-on-grade.
  - Stem walls that would be supported on a large mat foundation about 40 feet wide by 100 feet long embedded about 4 to 5 feet that would also support the scales (see below) with a raised floor slab on compacted backfill.

- Two new scales located on each side of the scale house. The scales would be supported on one of the following 2 mat configurations:
  - Individual mat foundations for each scale about 4 to 5 feet deep with an approximate footprint of 10 by 70 feet each, with stem walls on the perimeter of the mats.
  - A large mat foundation about 40 feet wide by 100 feet long embedded about 4 to 5 feet, which would also support the scale house, with perimeter and interior stem walls.

- An overhead sign across the access road will be supported on 2 metal posts spaced about 80 feet apart. The top of the sign will be about 18 to 20 feet above finished grade. It is anticipated that the posts will be supported on 42-inch-diameter cast-in-drilled-hole (CIDH)

concrete piles. Preliminary loads at the top of the pile, i.e., at the base of the posts/columns are as follows:

- Shear due to seismic loading of 8 kips.
- Moment due to seismic loading of 115 kip-ft.
- Shear due to wind of 9 kips.
- Moment due to wind of 157 kip-ft.
- Axial load due to dead load of 13 kips.

3. SCOPE OF SERVICES

Tetra Tech's scope of services for this project consisted of the following tasks:

- Review aerial photographs, geotechnical literature, geologic maps, and seismic hazard maps relevant to the subject site.
- Notify Underground Service Alert (USA) prior to drilling for clearance of underground utilities.
- Mark boring locations.
- Perform Ground Penetrating Radar (GPR) survey to locate underground utilities in the vicinity of the boring locations.
- Perform subsurface exploration consisting of drilling and sampling of 4 hollow stem auger borings within the proposed project footprint to drilling refusal at a maximum depth of 8 feet.
- Conduct laboratory testing on selected samples recovered from the exploratory borings to evaluate geotechnical properties of the on-site soils.
- Process and evaluate the collected geotechnical data for use in developing geotechnical recommendations for the proposed improvement including evaluation of the following items:
    - General subsurface conditions and description of types, distribution, and engineering characteristics of subsurface materials;
    - General groundwater conditions and their potential impact on the project design and construction;
    - Seismicity and other geological hazards;
    - Suitability of on-site soils and bedrock for support of the proposed structures;
    - Seismic design parameters in accordance with 2022 California Building Code (2022 CBC);
    - Shallow foundations for the support of the proposed scale house and scales including allowable bearing pressures, lateral resistances, and settlement estimates;
    - Deep cast-in-drilled hole (CIDH) pile foundations to support the proposed overhead sign;
    - Lateral earth pressures for the design of the stem walls for the scales and scale house;
    - Pavement design recommendations;
    - Corrosion potential of the on-site soils to buried concrete and steel.
- Prepare this report documenting reference maps and illustrations, collected field and laboratory data, and preliminary geotechnical recommendations for the design and construction of the proposed development.

4. FIELD INVESTIGATION

The subsurface soil and groundwater conditions were explored by Tetra Tech on December 7, 2023, and included drilling, logging, and sampling of 4 exploratory hollow stem auger borings, B-1 through B-4 at the locations indicated in Figure 2.

Prior to initiation of the field exploration program, a field reconnaissance was conducted to observe surface conditions and to mark the locations of the planned subsurface explorations. Underground Service Alert was notified of the exploratory boring locations at least 48 hours prior to drilling.

The borings were excavated to depths ranging from about 4 to 8 feet using a truck-mounted CME 55 drill rig. The rig was equipped with 6-inch-diameter hollow stem augers. All the borings were terminated at a depth where very hard drilling was encountered (i.e., refusal).

Bulk, driven California-type ring samples, and Standard Penetration Test (SPT) samples were collected during the drilling and transported to a laboratory for testing. The SPT sampler consisted of a 2-inch outside diameter, 1.4-inch inside diameter split barrel without liners, while the California-type sampler consisted of a 3-inch O.D., and a 2.4-inch I.D. split barrel. The interior of the California-type sampler was lined with 1-inch-long brass rings.

SPT testing was performed using an SPT sampler driven by an automatic 140-pound hammer with a drop of 30 inches in general accordance with ASTM D1586. The hammer calibration record indicated an average energy transfer ratio of 71 percent. Ring-type samples were collected by driving the California-type sampler using the same equipment as for the SPTs. Sampling was carried out at 2.5-foot vertical intervals.

The borings were surface-logged by a Civil Engineer in general accordance with the visual-manual procedure for description and identification of soils per ASTM D2488. The Engineer prepared the recovered samples for subsequent reference and laboratory testing. At the completion of drilling, the borings were backfilled with tamped soil cuttings. The borings were capped with cold asphalt patches. The exploratory boring logs are presented in Appendix A.

The locations of the exploratory borings are shown on Figure 2. Relevant boring information including latitude and longitude, exploration depth, and approximate ground surface elevation is included in Table 1.

Table 1
Boring Location Information

Exploration ID	General Location – Applicable Structures	Approximate			
		Latitude (degrees)	Longitude (degrees)	Depth (ft)	Ground Elevation (ft)
B-1	Northwest of scale house – scale house and scales	37.094509	-122.077543	4	467
B-2	Southeast of scale house – scale house and scales	37.094239	-122.077211	7.7	467
B-3	Inbound bypass lane, northeast of the scale house – sign foundation	37.094490	-122.077348	6.5	467
B-4	Outbound bypass lane, southwest of the scale house – sign foundation	37.094371	-122.077474	8	468

5. LABORATORY TESTING

Laboratory tests were performed on selected samples recovered from the borings to aid in the classification of soils and to evaluate pertinent engineering properties of the site soils. The following tests were performed:

- In-situ Moisture Content and Dry Density, ASTM D2937;
- Percent Passing #200, ASTM D1140;
- Expansion Index, ASTM D4829;
- Direct Shear, ASTM D3080;
- R-value, ASTM D2844; and,
- Corrosion Testing in Soils:
  - pH and resistivity, CTM 643;
  - Sulphates, CTM 417; and,
  - Chlorides, CTM 422.

Laboratory testing was performed in general accordance with applicable ASTM Standards and California Test Methods. Results of all laboratory tests are presented in Appendix B. For ease of referral to the soil profile, selected laboratory results have been included on the boring logs in Appendix A.

6. GEOLOGY AND SUBSURFACE CONDITIONS

Regionally, the site is located in the Santa Cruz Mountains, part of the Coastal Ranges of California. The Santa Cruz Mountains are located on the San Francisco Peninsula, where they separate the San Francisco Bay from the Pacific Ocean and the inland Santa Clara Valley. The range continues from the Bay Area south the California Central Coast to the Salinas Valley near Monterey Bay. The Santa Cruz Mountains are the result of compressive uplift caused by a leftward bend of the San Andreas Fault. Most of the range is largely underlain by the Salinian Block comprised mostly of granites. Overlying the Salinian Block over much of range are Tertiary land and deep marine sediments. Within the general vicinity of the site, as shown on Figure 3 – Geologic Map, the sedimentary units are primarily comprised of the middle Miocene-age Monterrey Formation (Tm) and the upper Miocene-age Santa Margarita Sandstone (Tms). Based on Brabb (1989), the Monterrey Formation consists of medium- to thick-bedded and laminated olive-gray semi-siliceous organic mudstone and sandy siltstone. The Santa Margarita Sandstone unconformably overlies the Monterrey Formation and generally consists of thickly bedded to massive and cross-bedded yellowish gray to white friable granular medium to fine-grained arkose sandstone.

Main structural features in the project area include the Scotts Valley Syncline located about 0.2 miles southwest of the site and the Ben Lomond fault located about 0.4 miles southwest of the site. Bedding structure in the immediate site vicinity, as shown on Figure 3, generally strikes southeast and southwest and dips at 16 to 21 degrees to the south.

The subsurface soils encountered during Tetra Tech's field exploration consisted of artificial fill soils over bedrock assigned to the Monterey Formation (Tm). Detailed descriptions of the soil units encountered during our field exploration are presented below and in the boring logs presented in Appendix A.

6.1. Artificial Fill (Fill)

Artificial fill soils associated with previous site grading are present throughout the site. The encountered fills varied from a few inches to up to 5 feet in depth. The deeper fills are generally present along the southwesterly side of the road. The fill materials encountered consist primarily of yellowish brown and reddish yellow, poorly graded sands with silt that are fine to coarse-grained, medium dense to dense and damp to moist. Also locally encountered in the fills are layers of brown and dark brown sand and silty sand that contain trace amounts of dark brown siltstone rock fragments.

6.2. Monterey Formation (Tm)

Bedrock assigned to the Monterey Formation underlies the entire site to the maximum depths explored of 8 feet. The bedrock materials generally consist of brown to dark brown sandy siltstone that is dry to damp, moderately hard to very hard, micaceous, and moderately cemented. The bedrock also emitted a petroliferous odor during drilling.

6.3. Groundwater

Groundwater was not encountered during our subsurface exploratory drilling to the maximum explored depth of 8 feet. Regional groundwater at the site has been mapped and reported in the San Lorenzo Vallet Water District Water Supply Master Plan (Johnson, 2009) at an elevation of about 400 feet, i.e., at depth of about 70 feet.. Based on the research and observed conditions, groundwater is not expected to impact the construction of the proposed development.

Fluctuations of the groundwater level, localized zones of perched water, and increased soil moisture content should be anticipated during and following the rainy season. Irrigation of landscaped areas on or adjacent to the site can also cause a fluctuation of local groundwater levels. Evaluation of such factors is beyond the scope of our services.

7. GEOLOGIC HAZARDS

7.1. General Seismic Setting

The Northern California region is known to be seismically active. Earthquakes occurring within approximately 60 miles of the project sites are considered capable of generating ground shaking of engineering significance to the proposed construction. The project area is located in the general proximity of seismically active faults, as shown on Figure 4A – Regional Faults and Seismicity Map and Figure 4B – Fault Zone Hazard Areas.

The closest seismically active faults to the site include the Zayante-Vergeles fault located approximately 1.3 miles northeast of the site, the Butano fault located approximately 5.7 miles northeast of the site, and the San Andreas fault (north section) located approximately 6.9 miles northeast of the site. Table 2 summarizes known seismically active faults within a distance of approximately 60 miles from the project site as identified by the USGS Quaternary Fault Database and in the 2008 National Seismic Hazard Maps (https://usgs.maps.arcgis.com and https://earthquake.usgs.gov).

Table 2
Summary of Active Faults
Referenced Site Latitude and Longitude: 37.094461°, -122.077463°

Fault Name	Approximate Fault Distance to Site (miles)	Slip Sense	Maximum Moment Magnitude
Zayante-Vergeles[1]	1.3	strike slip	7.0
Butano[2]	5.7	strike slip	6.4
North San Andreas	6.9	strike slip	7.9
San Gregorio	10.6	strike slip	7.5
Monte Vista-Shannon	12.1	thrust	6.5
Monterey Bay-Tularcitos	12.3	strike slip	7.3
Calaveras	25.8	strike slip	6.4
Hayward	27.7	strike slip	7.3
Rinconada	34.0	strike slip	7.5
Greenville	40.6	strike slip	7.0
Quien Sabe	41.1	strike slip	6.6
Ortigalita	45.6	strike slip	7.1
Mount Diablo Thrust	45.9	thrust	6.7
Great Valley	52.3	strike slip	6.9
Green Valley	55.7	strike slip	6.8

[1] From County of Santa Cruz Fault Zone Hazard Areas Map, 2009 and https://earthquake.usgs.gov/hazards/interactive/
[2] Information from Hall and Sarna, 1974

7.1. Historical Earthquakes

Significant seismic events with epicenters surrounding the project site have been recorded. Table 3 summarizes historic earthquakes with magnitudes greater than M_w 6.5 within a distance of approximately 60 miles from the project site, obtained using the USGS Earthquake Catalog (https://earthquake.usgs.gov).

Table 3
Historic Earthquakes in the Vicinity of the Site
Referenced Site Latitude and Longitude: 37.094461°, -122.077463°

Earthquake Name	Year	Fault and Fault Type	Earthquake Magnitude*	Epicenter	
				Latitude	Longitude
Loma Prieta	1989	San Andreas Fault (strike-slip right lateral)	7.2 M_w	37.036°N	-121.880°W
Great San Francisco	1906	San Andreas Fault (strike-slip right lateral)	7.9 M_w	37.750°N	-122.550°W
Hayward Fault	1868	Hayward Fault (strike-slip right lateral)	6.8 M_L	37.700°N	-122.100°W
San Francisco South of San Jose	1865	San Andreas Fault (strike-slip right lateral)	6.5 M_w	37.200°N	-121.900°W
Near San Juan Bautista	1840	San Andreas Fault (strike-slip right lateral)	6.5 M_w	36.850°N	-121.500°W
San Andreas	1838	San Andreas Fault (strike-slip right lateral)	7.4 M_w	37.300°N	-122.150°W

Notes:
* M_w refers to Moment Magnitude scale
M_L refers to Local Magnitude scale

7.2. Seismic Hazards Zones and Surface Fault Rupture Zones

The engineering seismology study for the subject site included reviewing local and regional fault maps, reviewing historical earthquake data, and reviewing regulatory maps prepared by the State and local governing agencies. Specifically, the following engineering seismology issues were addressed:

7.2.1. Seismic Hazards Zones

The Seismic Hazards Mapping Act (SHMA) of 1990 directs the California Geological Survey (CGS, formerly California Department of Conservation, Division of Mines and Geology (CDMG)) to identify and map areas prone to earthquake hazards of liquefaction, earthquake-induced landslides.

Maps of seismic hazard zones are issued by the California Geological Survey (CGS, formerly California Department of Conservation, Division of Mines and Geology (CDMG)) in accordance

with the SHMA enacted in April 1990. The intent of the SHMA is to provide for a statewide seismic hazard mapping and technical advisory program to assist cities and counties in developing compliance requirements to protect the public health and safety from the effects of strong ground shaking, liquefaction, landslides, or other ground failure and other seismic hazards caused by earthquakes.

Although no seismic hazard maps have yet been generated by the CDMG for the Felton Quadrangle, the County of Santa Cruz has generated a similar map for liquefaction zones. The site is not located within an area identified by the County of Santa Cruz as subject to the hazard of liquefaction (see Figure 5A – Liquefaction Zones based on https://purl.stanford.edu).

7.2.2. Surface Fault Rupture Zone

Earthquake Fault Zones (known as Special Studies Zones prior to 1994) are regulatory zones established in accordance with the Alquist-Priolo Special Studies Zones Act enacted in 1972. The Act directs the State Geologist to delineate regulatory zones that encompass surface traces of all potentially and recently active faults that constitute a potential hazard to structures from surface faulting or fault creep. The purpose of the Alquist-Priolo Act is to regulate development near active faults in order to mitigate the hazard of surface fault rupture.

Based on our field exploration and literature review there are no known surface traces of any active or potentially active faults that pass directly through or project towards the site. The closest faults that have been zoned for surface fault rupture potential by the County of Santa Cruz are the Zayante-Vergeles fault located approximately 1.3 miles northeast of the site and the San Andreas fault (north section) located approximately 6.9 miles northeast of the site (Figure 4B – Fault Zone Hazard Areas). The closest mapped fault by the State is the Butano Fault Zone located in the Los Gatos Quadrangle, about 5.7 miles northeast of the site. Therefore, the potential for surface rupture due to faulting occurring beneath the site is considered low.

7.3. Liquefaction and Seismically Induced Settlement Potential Assessment

Liquefaction of soils is caused by ground shaking during earthquakes. Research and historical data indicate that loose, relatively clean granular soils and low plasticity silts are susceptible to liquefaction and dynamic settlement, whereas the stability of the majority of clayey silts, silty clays and clays is not typically adversely affected by ground shaking. Liquefaction is generally known to occur in saturated or near-saturated soils at depths shallower than about 50 feet. Materials that are above the groundwater table are not susceptible to liquefaction, although they may undergo settlement due to seismic shaking.

As previously discussed, the site is not within an area identified by the County of Santa Cruz as subject to the hazard of liquefaction. Because the subsurface materials are comprised of bedrock (siltstone) at the surface or within a couple of feet from the surface and the regional groundwater is at least 50 feet deep, liquefaction or seismically induced settlement are not considered a hazard at the site.

7.4. Lateral Spreading

Since liquefaction is not considered a hazard for the site, lateral spreading is also not considered to be a hazard at the site.

7.5. Landslide Hazard

The site is not located within an area mapped by the County of Santa Cruz as susceptible to the hazard of landslides (see Figure 5B – Landslide Hazard Zones).

7.6. Expansive Soils

Expansive soils undergo significant volume changes (shrink or swell) due to variations in moisture content. Changes in soil moisture content can result from precipitation, landscape irrigation, utility leakage, roof drainage, perched groundwater, drought, or other factors which can cause unacceptable settlement or heave that could negatively affect the performance of foundations or slabs supported on grade.

Expansion Index (EI) testing on 2 samples taken from the sandy fill materials and from the siltstone bedrock materials indicated an EI of 4 and 18 respectively, which indicates that the subsurface materials are non-expansive. Thus, expansive soils are not considered a hazard to the project.

7.7. Collapsible Soils

The phenomenon of hydro-consolidation is typically exhibited in geologically young, unconsolidated, low-density, loose, dry soils commonly present in arid to semi-arid regions. Collapsible soils are usually composed of granular particles supported by clay or silt matrix that can be chemically cemented in place creating a metastable structure. The bonds supporting this metastable structure have enough shear strength to support loads at low moisture contents, however, once water is introduced the cemented bonds break down and the granular particles re-arrange causing a volume loss. The subsurface fill and bedrock materials do not exhibit this behavior and therefore collapsible soils are not considered a hazard at the site.

7.8. Dam Inundation Hazard

Although the site is located about ½ mile downstream of the Newell Dam which presents an "extremely high" downstream inundation hazard, the site is mapped just outside of the inundation area (https://fmds.water.ca.gov). Therefore, inundation due to dam breach is not considered a hazard for the site.

8. DESIGN RECOMMENDATIONS

8.1. General

Based on the results of the field explorations and engineering analyses, the construction of the proposed scale house, scales and overhead sign is feasible provided that the recommendations contained in this report are incorporated into the design plans and implemented during construction.

The primary geotechnical considerations for this project include:

- Evaluation of allowable bearing pressures for the different considered foundation systems; and,
- Evaluation of lateral earth pressures for the design of the stem walls for the buried scales.

The design recommendations presented below are based on Tetra Tech's current understanding of the project and the subsurface conditions of the site. Once the project configuration is finalized and the design is complete, Tetra Tech should review the plans and specifications to evaluate if the geotechnical design recommendations presented herein have been incorporated as intended.

8.2. Site Preparation

The following sections present recommendations for the preparation of the foundation subgrade for the proposed canopies, partial height walls, and pavements

8.2.1. Clearing and Grubbing

The foundation areas should be cleared of any pavement, vegetation, undocumented fills, existing structures including existing scale house and scales, trash and debris. Any subterranean installations not to be preserved, such as electrical lines, pipes, utility collectors, tanks, etc., should be relocated and/or abandoned in accordance with the recommendation of the Geotechnical Engineer and applicable regulations.

8.2.2. Subgrade Preparation

In order to create uniform and competent bearing conditions for the proposed structures the subgrade should be prepared in accordance with the recommendations provided below.

- Scale house and scales. For any shallow foundations the soils should be overexcavated to the top of the bedrock. The overexcavation should extend horizontally for a nominal distance to facilitate the forming of the foundation concrete.

- Overhead sign. No subgrade preparation is required if CIDH pile foundations are selected.

- Pavement and flatwork areas should be overexcavated and recompacted to a depth of at least 1 foot below the proposed subgrade or to uniform competent soils, whichever is deeper. To

the extent practicable, the zone of overexcavation should extend a horizontal distance of at least 1 foot beyond the flatwork or pavement perimeter.

- Disturbed soils in structural and non-structural areas that may occur after demolition of existing site improvements or during overexcavation should be overexcavated and recompacted to the total depth of the disturbed material.

The exposed overexcavation subgrade should be probed and accepted by the Geotechnical Engineer.

8.2.3. Fill Placement

All fill placement associated with the replacement of the overexcavated soils, fill placed to achieve finish grade or subgrade, or utility trench backfill should be moisture-conditioned to at least 110 percent of the optimum moisture content and compacted to at least 90 percent relative compaction per ASTM D1557. The upper 1 foot of soils below pavements and any flatwork should be processed and compacted to at least 95 percent of relative compaction. Fill should be placed in horizontal lifts not more than 8 inches in loose, uncompacted thickness.

On-site coarse-grained soils that meet the requirements for imported fills listed above can be used as backfill materials and compacted as indicated above, as long as they are free of organics, deleterious materials, debris, and particles over 3 inches in largest dimension. In the event that any soil materials are imported to the site, such soils should be sampled, tested, and approved by the Geotechnical Engineer prior to arrival on-site. In general, any soils imported to the site for use as fill should be predominantly granular and have an Expansion Index less than 20. Additional recommendations for site grading are provided in the "General Site Grading Recommendations" section of this report.

8.3. Excavation Characteristics, Temporary Slopes and Trench Excavations

The on-site bedrock materials are expected to be relatively difficult to excavate although, due to the small grading volumes, heavy duty attachments to conventional grading equipment or use of mechanized hand equipment are expected to be adequate.

All excavations should be performed in accordance with Cal/OSHA regulations. The on-site bedrock and existing fill materials may be considered a Type A and Type C soil respectively, as defined the current Cal/OSHA soil classification. Excavations in the bedrock less than 5 feet in depth can be performed vertically and without the need for shoring. Excavations within on-site fills behind the stem walls for the scales, should be performed using sloped sides with a maximum slope gradient of 1.5(H):1(V).

Stockpiled (excavated) materials should be placed no closer to the top of an excavation than a distance defined by a line drawn upward from the bottom of the trench at an inclination of 1(H):1(V), but no closer than 4 feet. A greater setback may be necessary when considering significant surcharge loads such as heavy vehicles, concrete trucks and cranes. Tetra Tech should

be advised of such heavy surcharges so that specific setback requirements can be established. Alternatively, a shoring system may be designed to allow reduction in the setback distance.

8.4. Seismic Design Parameters

The seismic design coefficients provided below in Table 4 are based on Chapter 16 Section 1613 of the 2022 CBC and obtained from the Structural Engineers Association of California (SEAOC) and the Office of Statewide Health Planning and Development (OSHPD now known as HCAI) website application (https://www.seismicmaps.org/).

Table 4
2022 CBC and ASCE 7-16 Seismic Design Parameters
Referenced Site Latitude and Longitude: 37.094461°, -122.077463°

Site Class Table 20.3-1 ASCE 7-16		B
Coefficients for the Maximum Considered Earthquake, MCE_R, for Site Class B	Short Period (0.2 seconds), S_S	1.968
	1 Second Period, S_1	0.782
Coefficients for the Maximum Considered Earthquake, MCE_R (Site Modified)	Short Period (0.2 seconds), S_{MS}	1.772
	1 Second Period, S_{M1}	0.626
Coefficients for the Design Earthquake	Short Period (0.2 seconds), S_{DS}	1.181
	1 Second Period, S_{D1}	0.417
Design PGA (risk-targeted maximum rotated direction)		0.472g
Site Modified Peak Ground Acceleration PGAM (geometric mean)		0.759g
Seismic design parameters values based on ASCE7-16 and 2021 International Building Code were obtained from Structural Engineers Association of California (SEAOC) and Office of Statewide Health Planning and Development (OSHPD) website application, https://www.seaoc.org/page/seismicdesignmaptool.		

8.5. Scale house – Shallow Footings

The proposed scale house may be supported on isolated footings. The decision to use shallow foundations vs. a mat foundation will be based on considerations of space availability, structural interaction with the adjacent foundations and stem walls for the scales, and the logistics of foundations construction. The subgrade for the shallow foundations should be prepared in accordance with recommendations provided in the "Site Preparation" section of this report.

Footings for the proposed scale house can be designed based on the parameters presented in Table 5. Foundations should be designed and reinforced in accordance with the recommendations of the Structural Engineer and should conform to the 2022 CBC. Shallow footings should be laid out such that they are located at a horizontal distance of least 5 feet from any existing foundation to minimize the interference. If a closer setting is required, this office should be contacted to evaluate the actual configuration and provide additional recommendations, if necessary.

Table 5
Design Parameters for Shallow Footings

Continuous Footings	
Dimensions	• Footing width less than 4 feet and greater than 1 foot.
Depth of Embedment	• At least 24 inches below the lowest adjacent grade
Allowable Bearing Pressure	• 3,500 psf for foundations placed on bedrock • 2,500 psf for foundations placed on more than 1 foot of compacted fill
Spread Footings	
Dimensions (feet)	• At least 2 feet but less than 6 feet wide
Depth of Embedment	• At least 18 inches below the lowest adjacent grade
Allowable Bearing Pressure	• 6,000 psf for foundations placed on bedrock or less than 2 feet of engineered fill placed on bedrock
All Footings	
Allowable Bearing Pressure for Transient Live Loads	• The allowable bearing pressure value may be increased by one-third for transient live loads from wind or seismicity.
Estimated Settlement	• Approximate 1 inches of static settlement. • Approximate differential settlement of 0.5 inches between supports or over a distance of 30 feet.
Allowable Coefficient of Friction or Adhesion at Bottom of Footing Inlcudes Factor of Safety of 1.5	• 0.4 coefficient of friction for concrete on compacted granular fill • 670 psf allowable adhesion for concrete on siltstone
Allowable Lateral Passive Resistance Inlcudes Factor of Safety of 2	• 200 pcf (EFD, equivalent fluid density, for compacted fill with ϕ=33°) • The passive resistance derived of the upper 12 inches should be neglected.
Allowable Combined Lateral Resistance	• Total allowable resistance to lateral loads can be calculated by combining lateral resistance due to friction/adhesion at foundation bottom and lateral passive resistance. • Passive resistance values may be increased by one-third when considering transient wind or seismic loading
Uplift Capacity	• The weight of soil that contributes to uplift capacity can be estimated as a zone defined by an angle of 30 degrees from vertical projected from top edge of footing to adjacent grade. • A total unit weight of 125 pcf may be used for the soil. • The lowest depth of embedment from the adjacent grade shall be used in the estimations.

8.6. Scales and Scale House on Mat Foundations

The scales may be founded on 2 separate mat foundations. Alternatively, the scales may be placed on one large mat foundation that could be extended to also support the scale house . In such a case

the scale house would likely be supported directly on stem walls standing on the large mat foundation. Another considered alternative is for the scale house to be supported on a mat separate from the mats for the scales. Mat foundations can be designed using the design parameters provided in Table 6. Mats should be designed and reinforced in accordance with the recommendations of the Structural Engineer and should conform to the 2022 CBC.

Table 6
Geotechnical Design Parameters – Mats

Embedment depth	• At least 2 feet below the existing grade
Allowable Bearing Pressure	• Average allowable bearing pressure 2,000 psf • The allowable bearing value may be increased by one-third for transient live loads from wind and seismic loading.
Dimensions	• Up to 40 feet by 100 feet
Estimated Settlement	• Approximate 1 inch of static settlement. • Differential settlement of approximately 0.5 inches over a distance of 30 feet.
Modulus of Subgrade Reaction	• For design of mats supported on siltstone, a reference modulus of subgrade reaction k_1 of 200 pci derived for a square bearing plate with 1-foot x 1-foot dimensions may be used. For the on-site siltstone, the modulus of subgrade reaction k (in pci) for the design of a concrete element of given dimensions can be calculated as: $$k = k_1 \frac{1 + 0.5 * \frac{B}{L}}{1.5 * B}$$ where B and L are the governing width and the length of the element in feet, but no more than 14 times the thickness of the element.
Allowable Adhesion at Bottom of Mat Inlcudes Factor of Safety of 1.5	• 670 psf allowable adhesion for concrete on siltstone
Allowable Lateral Passive Resistance Inlcudes Factor of Safety of 2	• 200 pcf (EFD, equivalent fluid density, for compacted fill with ϕ=33°) • The passive resistance derived of the upper 12 inches should be neglected.
Allowable Combined Lateral Resistance	• Total allowable resistance to lateral loads can be calculated by combining lateral resistance due to friction/adhesion at foundation bottom and lateral passive resistance. • Passive resistance values may be increased by one-third when considering transient wind or seismic loading
Uplift Capacity	• The weight of soil that contributes to uplift capacity can be estimated as a zone defined by an angle of 30 degrees from vertical projected from top edge of footing to adjacent grade. • A total unit weight of 125 pcf may be used for the soil. • The lowest depth of embedment from the adjacent grade shall be used in the estimations.

8.6.1. Foundations Adjacent to Utility Trenches

The bottom of trenches for any buried utilities should be kept outside a zone defined by a 1(H):1(V) plane projected downward from the outside bottom edge of any existing or proposed foundation. Backfill materials and procedures shall conform to the recommendations provided in the "Site Preparation" and "General Site Grading Recommendations" sections of this report. If any utilities need to be placed within the zone of influence, the utility conduit (pipes, cables) should be designed to account for the increased surcharge from the foundation pressures and to withstand potential differential settlement between the surcharged and unsurcharged segments of the pipe. Generally, the utility conduits within the impacted zone should be protected by concrete encasement or utilidors.

For utility conduits that cross underneath foundations the piping and encasement should be designed to withstand differential settlements of up to 1 inch over a distance equal to half of the depth of the pipe crown below the bottom of the foundation element. Tetra Tech should be contacted to review any specific utility interaction configurations and their proposed mitigation.

8.7. Lateral Earth Pressures on Stem Walls for Scales

Static earth pressures presented in Table 7 are provided for the purpose of evaluating the capacity of proposed stem walls around the scales.

Based on the 2022 CBC, the design of retaining walls higher than 6 feet, as measured from the bottom of the footing, requires the inclusion of not only static lateral pressures, but also of seismically induced lateral earth pressure increment. Since the maximum anticipated depth of the stem walls is about 4 to 5 feet, no seismic design is anticipated. It is required that a drainage system be installed behind the wall so that external water pressures will not develop. If a drainage system is not installed, hydrostatic pressures need to be incorporated into the design.

The values provided in Table 7 are for level backfill condition. The effect of any surcharge (dead or live load) located within a 1(H):1(V) plane drawn upward from the heel of the wall foundation should be added to the lateral earth pressures.

Determination of whether the active or at-rest condition is appropriate for the design will depend on the flexibility of the walls. In granular soils, assumed as the backfill of the subject walls, walls that are free to rotate at least 0.001 radians (deflection at the top of the wall of at least 0.001 x H) may be designed for the active condition. Walls that are not capable of this movement should be assumed non-yielding and designed for the at-rest condition. Walls that are required to minimize the lateral movements should be designed as non-yielding walls for the at-rest condition.

If control of efflorescence on the air side of the wall due to moisture transmission through the wall is desired, the wall should be appropriately waterproofed in accordance with 2022 CBC Section 1805.3. However, efflorescence can also develop from the air side due to climate effects.

Table 7
Lateral Pressures due to Static Loads

Active Pressure for Yielding Walls	
Static active pressure (psf)	35z + 0.30Q
At-rest Pressure for Non-Yielding Walls	
Static at-rest pressure (psf)	65z + 0.46Q
Lateral Passive Resistance	
Allowable static lateral passive pressure (psf) Includes a Factor of Safety of 2	$200z_1$

Notes: Pressures based on soil backfill (both behind and in front of the retaining wall) with $\phi = 33^o$, c = 0 psf, $\gamma_t = 120$ pcf

Legend:
z … Depth (ft) below the grade behind the wall – depth measured from the ground surface to the depth where the soil lateral pressure is being evaluated;
z_1 … Depth (ft) below the grade where passive conditions apply, i.e., usually in front of the wall, to the depth where the soil lateral pressure is being evaluated;
Q … Uniform surcharge (psf) within a 1(H):1(V) plane drawn upward from the heel of the wall footing

Adequate drainage and waterproofing behind the wall may be provided by a backdrain consisting of a geosynthetic drainage composite such as TerraDrain, MiraDrain, or approved equivalent, placed against the entire backside of the wall. The drainage composite should be connected to a 4-inch-diameter perforated ABS or PVC Schedule 40 drainpipe, or an approved equivalent, placed at the base of the wall. The drainpipe should be sloped at least 2 percent and surrounded by 1 cubic foot per foot of the Class II Permeable Material (Caltrans Standard Specifications - Section 68), or by ¾-inch crushed rock (Standard Specification for Public Works Construction ("Greenbook") - Section 200-1.2) wrapped in suitable non-woven filter fabric, e.g., Mirafi 140NL or approved equivalent. Perforations in the drainpipe should have a maximum diameter of 0.25 inches or 3/8 inches for Class 2 Permeable Base or ¾-inch crushed rock drain material, respectively, spaced 3 inches on center, and be arranged in 2 rows at a radial spacing of approximately 120 degrees. The axis of the included angle between the perforation rows should be positioned downward to form a flowline. The drainpipe should discharge through a solid pipe to appropriate outlets, such as the storm drain system or through the wall. The maximum length of the drainpipe between discharge outlets should not exceed 100 feet.

8.8. Concrete Slab-On-Grade for the Scale House

Concrete slabs-on-grade should be placed on subgrade soils prepared in accordance with the recommendations provided in the "Subgrade Preparation" section of this report. These recommendations provided are intended to provide a firm bearing subgrade to help reduce the occurrence of cracks in concrete and associated horizontal separation and vertical offset. The recommendations provided in this section include the modulus of subgrade reaction for the slab-on-grade design and additional general design and construction recommendations intended to help with the design of concrete slabs for typical applications and standard conditions based on

encountered soil conditons and local experience and practice. Reinforcement recommendations provided herein are based on soil conditions only and are not intended to be used in lieu of the reinforcement required for structural purposes. It must be recognized that even when these general recommendations are implemented concrete slabs may still crack due to structural design or detailing, joint design and location, curing, construction execution, or end use. Therefore, the concrete slab design is ultimately the responsibility of the project Structural Engineer who can account for all adverse factors and loading and provide reinforcement, concrete mix, and curing specifications to minimize their adverse effects.

8.8.1. Floor Slab-On-Grade

For the design of the floor slab-on-grade for the scale house supported on compacted granular fill a reference modulus of subgrade reaction k_1 of 150 pci derived for a square bearing plate with 1-foot x 1-foot dimensions may be used. The modulus of subgrade reaction k (in pci) for the expected granular slab-on-grade subgrade fill soil can be calculated as follows:

$$k = k_1 \frac{(B+1)^2}{4B^2} \frac{1 + 0.5\frac{B}{L}}{1.5}$$

Where B and L are the width and length of the element in feet, respectively, while B is no more than 14 times the thickness of the element, i.e., floor slab, and k_1 is as defined above.

In order to assist with initiation of the floor slab design, the slab-on-ground should have a minimum thickness of 5 inches. The minimum reinforcement to reduce separation and offset of potential concrete cracks should consist of No. 4 reinforcing bars spaced at 18 inches on-center, each way, placed in the middle one-third of the section. The slab should be doweled into the perimeter building footings to reduce the potential for differential movement. Reinforcement should be properly placed and supported on blocks or "chairs." Welded wire mesh reinforcement is not recommended.

An allowable coefficient of friction of 0.4 at the contact between the concrete and the granular fill material can be used to provide sliding resistance. In no case, the lateral resistance can exceed 50 percent of the dead load.

8.8.2. Moisture Vapor Mitigation for Floor Slabs

Per 2022 CBC §1907.1 a minimum 6-mil thick vapor retarder is required for moisture intrusion control. Tetra Tech does not practice in the field of moisture vapor transmission evaluation/mitigation. However, to assist with the selection of the slab underlayment system, Table 7 provides alternatives for control of vapor transmission through concrete slab-on-grade that go beyond the minimum code requirements. Generally, where moisture-sensitive floor coverings, coatings, adhesives, moisture sensitive goods, humidity-controlled environments, or climate-cooled environments are anticipated, vapor retarder should be replaced with a vapor barrier consisting of a minimum 15 mil extruded polyolefin plastic membrane with permeance of less than 0.01 perms (e.g., 15 mil Stego Wrap vapor barrier).

The alternatives provided in Table 8 are based on local experience and may be considered appropriate for standard applications. It should be noted that the underslab vapor retarder system is only one aspect affecting the moisture vapor transmission through concrete slabs. Other factors include maintaining a low water-cement ratio for the concrete used for the floor slab or effective sealing of joints and edges (particularly at pipe penetrations). If moisture vapor transmission is considered a risk to use and operation of the proposed structure, we recommend that a qualified professional be engaged to evaluate the general and specific moisture vapor transmission paths and any impact on the proposed construction and to provide recommendations for mitigation of potential adverse impact of moisture vapor transmission on various components of the structure as deemed appropriate.

Table 8
Alternatives for Control of Vapor Migration through Concrete Slab

Protection against vapor intrusion	Recommendation
"Best"	• Concrete floor slab-on-grade placed directly on a plastic membrane at least 10 mils in thickness[1] (ACI 302.1R). • The membrane should be placed on at least 2 inches of naturally moist silty sand[2]. • The silty sand should be separated from the underlying capillary break layer by non-woven geotextile, Mirafi 140N or equivalent. Alternatively, the voids at the top of the aggregate course may be filled with fine sand to minimize potential for tearing and damage to the membrane. • The geotextile should be placed on at least 4 inches of ¾-inch crushed rock[3] or clean gravel[4] to act as a capillary break placed on prepared finished grade.
"Better"	• Concrete floor slab-on-grade placed directly on a plastic membrane at least 10 mils in thickness[1] (ACI 302.1R). • The membrane may be placed on at least 2 inches of naturally moist silty sand[2,5] placed on prepared finished grade.
Standard	• Concrete floor slab-on-grade placed on 2 inches of naturally moist silty sand[2] • The silty sand should be placed over plastic membrane at least 10 mils in thickness. • The membrane may be placed on at least 2 inches of naturally moist silty sand[2,5] placed on prepared finished grade.

[1] If additional protection is desired, the plastic membrane may be replaced with a 10-mil-thick moisture vapor retarder that meets the requirements of ASTM E 1745 Class C (for example, Stego Wrap or similar).
[2] The silty sand should have a gradation between approximately 15 and 35 percent passing the No. 200 sieve and a plasticity index (PI) of less than 4.
[3] The ¾-inch crushed rock should conform to Section 200-1.2 of the latest edition of the Standard Specifications for Public Works Construction (Greenbook).
[4] The gravel should contain less than 10 percent of material passing the No.4 sieve and less than 3 percent passing the No.200 sieve.
[5] The silty sand layer is intended as a levelling course and to protect the membrane from any gravel grains that may be at the finished subgrade. It is not strictly required for vapor migration protection. It is recognized that the silty sand course may be difficult to protect during construction activities, consequently if a thicker/stronger membrane is utilized, e.g., 15-mil Stego Wrap, and an adequate caution is taken during the subgrade preparation and slab construction, then the silty sand course may be eliminated.

All underslab materials should be nominally compacted and moisture-conditioned prior to the placement of concrete. Care should be taken during placement of the concrete to prevent displacement of the underslab materials. The concrete slab should be allowed to sufficiently cure prior to placing vinyl or other moisture-sensitive floor covering.

8.8.3. Exterior Concrete Slabs-On-Grade

Exterior slabs should be placed on subgrade prepared in accordance with the recommendations provided in the "Site Preparation" section of this report. As indicated above, a Structural Engineer or an Engineer specialized in concrete design should be consulted if cracking of the exterior slabs is to be minimized. As a minimum for exterior walkways, it is recommended that narrow strip concrete slabs, such as sidewalks, be reinforced with at least No. 4 reinforcing bars placed longitudinally at 18 inches on center. Wide exterior slabs should be reinforced with at least No. 4 reinforcing bars placed 18 inches on center, each way. Placement of control joints within exterior slabs should follow the recommendations presented for floor slabs. Reinforcement should extend through the control joints to reduce the potential for differential movement. Control joints should be constructed in accordance with recommendations from the Structural Engineer and Architect.

8.8.4. Control Joints

Control joints should be constructed in accordance with recommendations from the Structural Engineer and the Architect. For preliminary design, control joints should be provided in concrete slabs-on-grade as recommended by American Concrete Institute (ACI PRC-224.3-95) guidelines and at a maximum spacing (in feet) of 2 to 3 times of the slab thickness (in inches), but generally no more than 10 feet. All joints should form approximately square patterns to reduce potential for randomly oriented shrinkage cracks. The control joints should be tooled at the time of the pour or sawcut to ¼ of slab depth within 6 to 8 hours of concrete placement. All joints in flatwork should be sealed to prevent moisture, vermin, or foreign material intrusion. Precautions should be taken to prevent curling of slabs (refer to ACI guidelines). Reinforcement should extend through the control joints to reduce the potential for differential movement.

8.9. Overhead Sign – CIDH Piles

CIDH piles are expected to be utilized to support the overhead signposts. Given the competent subsurface materials, single pile per column, i.e., monopole, foundation is expected and there is no need for a pile group. It is anticipated that a free-head pile condition will result under lateral loading as the piles are considered able to rotate. The pile head has been assumed to be at least 2 feet below the adjacent grade and the CIDH are expected to at least 8 feet long (i.e., 10 feet below ground surface). A 42-inch-diameter CIDH pile has been considered herein. For the CIDH pile to the northeast of the proposed scale house a reduction in the lateral capacity was considered to account for a downhill sloping condition 2(H):1(V).

The design recommendations presented below should be reviewed if the loading, pile head conditions, pile dimension, group configuration, or design requirements change.

8.9.1. Axial Capacity

Axial capacities for stated pile configurations and for a cut-off depth of 2 feet, i.e., pile top depth bellow adjacent grade are provided in Table 9 below. Vertical compressive forces may be resisted by a combination of the shaft friction generated along the sides of the pile and the end bearing. The recommended allowable compression capacities incorporate a Factor of Safety of 2 for shaft friction resistance and 3 for end bearing. The uplift capacities utilize only the shaft friction and consider a Factor of Safety of 3. The weight of the CIDH pile may be added to increase the presented uplift capacity of the pile.

Table 9
Allowable Axial Capacity for CIDH Pile Foundations

Depth below Cut-off Depth (ft)	Compression Capacity (kips)	Uplift Capacity (kips)
42-inch-diameter		
8	516	11
10	624	16
15	900	32

The allowable axial capacity values may be increased by one-third to account for transient loads such as earthquake and wind. The compression and uplift capacity of the pile sections should be checked by the Structural Engineer to verify the pile structural capacity.

8.9.2. Settlement

The total settlement of the CIDH piles is estimated to be less than ½ inch.

8.9.3. Lateral Resistance

Resistance to lateral loads will be provided by the resistance of the soil and the bedrock against the pile and by the bending stiffness of the pile itself. Lateral capacity of the CIDH pile was calculated using computer program LPILE (by Ensoft, Inc.) that models the pile response to lateral loading using the soil-pile deflection model, i.e., p-y curves. The geotechnical design parameters presented in Table 10 below may be used for LPILE analysis. A concrete compressive strength of 4,000 psi has been assumed for the analyses performed herein. A 42-inch diameter pile has been considered and reinforced with 10 #14 steel bars with a minimum yield stress of 60 ksi. The analyses were performed for a single pile considering the worst loading condition (wind). The results of the LPILE analyses are summarized in Table 10 for the pile to the southwest of the scale house (flat ground condition) and for the pile to northeast of the scale house (adverse descending 2(H):1(V) slope condition).

Table 10
Summary of LPILE Parameters

Depth below Grade (feet)	**Model (p-y Curve)**	**Effective Unit Weight** (pcf)	**Friction Angle** (deg)	**Cohesion** (psf)	**k_s** (pci)
0 – 2	API Sand	120	33	0	75
2 – 15	Silt/Cemented Soil	120	32	180	370

Table 11
Summary of LPILE Analyses for a Single CIDH Pile

CIDH Pile Diameter (inches)	42		
Cut-off Depth	2 feet		
Depth below Cut-off Depth (feet)	8	10	15
Pile Head Condition	**Free Head Condition**		
Vertical Load (kips)	13		
Shear at top (kips)	9		
Pile southwest of the scale house (flat ground condition)			
Moment at Top / Maximum Moment @ depth below cut-off (kips-inch)	1,884 / 1,940 @ 1.1’	1,884 / 1,960 @ 1.3’	1,884 / 2,020 @ 2.2’
Pile Head Deflection (inches)	0.10	0.06	0.03
Pile northeast of the scale house (descending 2(H):1(V) slope)			
Moment at Top / Maximum Moment @ depth below cut-off (kips-inch)	1,884 / 1,980 @ 1.5’	1,884 / 2,000 @ 1.8’	1,884 / 2,020 @ 2.1’
Pile Head Deflection (inches)	0.58	0.08	0.03

It is noted that the calculated pile deflections for all considered pile diameters and lengths are quite small and well below the maximum allowable displacement of 1 inch.

8.9.4. Installation Considerations

The performance of CIDH piles is significantly influenced by the construction methods and procedures. Construction methods that create large zones of disturbance around the drilled piles can lead to lower-than-expected lateral resistance and axial capacity. Consequently, it is recommended that the following measures be adopted to minimize the potential for diminished capacity.

- The installation of CIDH piles should be carried out under the continuous observation of the Geotechnical Engineer to verify the design assumptions are in conformance with the intent of the recommendations and to provide additional recommendations as appropriate.

- Very minor amounts of water seepage into the pile boreholes should be anticipated. Contractor should be prepared to stabilize and/or dewater the hole as needed.

- Since the CIDH axial pile capacity relies also on the end bearing, it will be necessary for the contractor to remove any disturbed materials from the bottom of the pile hole.

- Tremie method of concrete placement should be used so that the concrete delivery begins at the bottom of the hole and is always below the rising level of concrete so that all water and/or drilling fluid is removed from the boring. The concrete should be first placed to develop a minimum head of 5 feet of concrete above the bottom of the tremie and then the tremie pipe can be withdrawn in step with the placement of concrete, always maintaining a head of concrete of at least 5 feet above the delivery point. If casing is used, the pipe should be pulled by keeping a positive concrete head above the bottom of the casing.

- Pile excavations should be filled with concrete within the same day of drilling. Pile excavations should not be left open overnight.

- Concrete should be placed and vibrated throughout the full length of the pile so that voids in pile concrete are minimized.

- The CIDH piles should be checked for alignment and plumbness. The amount of acceptable misalignment of a pile is approximately 2 to 3 inches from the exact location and it is usually acceptable to be out of plumb 1 inch over 10 feet of the length of the pile.

8.10. Asphalt Pavement Design

The asphalt pavement sections at the boring locations consisted of 2 to 6inches, typically 4 inches, of asphalt concrete overlying fill consisting of poorly graded sand with silt.

8.10.1. Pavement Subgrade Preparation

The subgrade preparation and fill placement in all paved areas should follow the recommendations provided in the "Site Preparation" section of this report. Paved areas should be properly sloped, and surface drainage established to reduce water infiltration into the pavement subgrade. Curbing

located adjacent to paved areas should be founded in the soil subgrade in order to provide a cutoff to reduce water infiltration into the base course.

8.10.2. Pavement Design

Asphalt (flexible) pavement sections have been designed in general accordance with the Caltrans Highway Design Manual method for flexible pavement design using the 20-year design life period. An R-value of 35 for the subgrade based on laboratory testing results was used for pavement design. The recommended pavement sections for several assumed Traffic Indices are presented in Table 12.

Table 12
Asphalt Pavement Sections

Dump Trucks per Day (60 kips gross weight, 2 axles)	**Traffic Index**	**Composite Section**		**Full Depth Asphalt Concrete Alternative** (inches)
		Asphalt Concrete (inches)	**Aggregate Base** (inches)	
18	7.5	5	8	9
32	8	5	9	10
50	8.5	5	11	10
86	9	5.5	11	11
205	10	6.5	12	12

Asphalt concrete and Aggregate Base (AB) should conform to the Specifications for Public Works Construction (Greenbook) Sections 203-6 and 200-2, respectively. The AB course should be compacted to 95 percent of relative compaction per ASTM D1557.

8.11. Soil Corrosion

The corrosion potential of the on-site materials to buried concrete and steel was evaluated based on laboratory testing of the combined fill and bedrock sample from boring B-1. Table 13 below presents the results of the corrosivity testing.

Table 13
Corrosivity Test Results

Boring ID	**Sample ID**	**Depth** (feet)	**pH** CTM 643	**Minimum Resistivity** (ohm-cm) CTM 643	**Soluble Sulfate Content** (ppm / %) CTM 417	**Soluble Chloride Content** (ppm / %) CTM 422
B-3	SK-1	0-5	3.9	1,317	1,281 / 0.1281	200/ 0.0200

Per 2022 CBC, Section 1904.1, concrete subject to exposure to sulfates shall comply with the requirements set forth in ACI 318, Section 19.3. Based on the measured water-soluble sulfate results the exposure of buried concrete to sulfate attack should be exposure class S1 per ACI 318, Table 19.3.1.1. Consequently, Type II cement with a minimum 28-day compressive strength of 4,000 psi and a maximum water to cementitious materials ratio of 0.50 should be used to prevent injurious sulfate attack on concrete.

Per 2022 CBC, Section 1904.1, concrete reinforcement should be protected from corrosion and exposure to chlorides in accordance with ACI 318, Section 19.3.

The evaluation of potential for corrosion of buried metals was based on the minimum resistivity per NACE (1984) and our experience with similar soils. The on-site soils are anticipated to have a "moderately corrosive" potential to buried ferrous metals. A corrosion specialist should be consulted regarding suitable types of piping and necessary protection for underground metal conduits. The corrosion potential of the on-site soils should be verified during construction for each encountered soil type. Imported fill materials should be tested prior to placement to confirm that their corrosion potential is not more severe than the one assumed for the project.

8.12. Drainage Control

The intent of this section is to provide general information regarding the control of surface water. The control of surface water is essential to the satisfactory performance of the building construction and site improvements. Surface water should be controlled so that conditions of uniform moisture are maintained beneath and adjacent to the structure, even during periods of heavy rainfall. The following recommendations should be considered as minimal.

- Ponding and areas of low flow gradients should be avoided.
- Paved surfaces within 10 feet from the building foundation should be provided with a gradient of at least 2 percent sloping away from improvements.
- Bare soil, e.g., planters, within 10 feet of the structure should be sloped away from the improvement at a gradient of 5 percent.
- Positive drainage devices, such as graded swales, paved ditches, and/or catch basins should be employed to accumulate and convey water to appropriate discharge points.
- Positive drainage devices, such as graded swales, paved ditches, and/or catch basins should be employed to accumulate and convey water to appropriate discharge points.
- Concrete walks and flatwork should not obstruct the free flow of surface water.
- Area drains should be recessed below grade to allow free flow of water into the basin.

- Enclosed raised planters should be sealed at the bottom and provided with an ample flow gradient to a drainage device. Recessed planters and landscaped areas should be provided with area inlet and subsurface drainpipes.

- To the extent practicable, planters should not be located adjacent to the structure. If planters are to be located adjacent to the structure, the planters should be positively sealed, should incorporate a subdrain, and should be provided with free discharge capacity to a drainage device.

- Planting areas at grade should be provided with positive drainage. Wherever possible, the grade of exposed soil areas should be established above adjacent paved grades. Drainage devices and curbing should be provided to prevent runoff from adjacent pavement or walks into planted areas.

- Gutter and downspout systems should be provided to capture discharge from roof areas. The accumulated roof water should be conveyed to an off-site disposal area by a pipe or concrete swale system.

- Landscape watering should be performed judiciously to preclude either soaking or desiccation of soils. The watering should be such that it just sustains plant growth without excessive infiltration. Sprinkler systems should be checked periodically to detect leakage and irrigation efforts should be reduced or halted during the rainy season.

9. GENERAL SITE GRADING RECOMMENDATIONS

The intent of this section is to provide general information regarding the site grading. Site grading operations should conform with applicable local building and safety codes and to the rules and regulations of those governmental agencies having jurisdiction over the subject construction.

The grading contractor is responsible for notifying governmental agencies, as required, the Geotechnical Engineer at the start of site cleanup, at the initiation of grading, and any time that grading operations are resumed after an interruption. Each step of the grading should be accepted in a specific area by the Geotechnical Engineer, and where required, should be approved by the applicable governmental agencies prior to proceeding with subsequent work.

The following site grading recommendations should be regarded as minimal. The site grading recommendations should be incorporated into the project plans and specifications.

- Prior to grading, existing vegetation, trash, surface structures and debris should be removed and disposed off-site at a legal dumpsite. Any existing utility lines, or other subsurface structures which are not to be utilized, should be removed, destroyed, or abandoned in compliance with current governmental regulations.

- Any imported soil material required for backfill or grading should be tested and approved prior to delivery to the site.

- The exposed subgrade and/or excavation bottom should be observed and approved by the Geotechnical Engineer for conformance with the intent of the recommendations presented in this report and. It should be understood that the actual encountered conditions may warrant excavation and/or subgrade preparation beyond the extent recommended and/or anticipated in this report.

- Visual observations and field tests should be performed during grading by the Geotechnical Engineer. Wherever, in the opinion of the Geotechnical Engineer, an unsatisfactory condition is being created in any area, whether by cutting or filling, the work should not proceed in that area until the condition has been corrected.

- The Geotechnical Engineer shall provide sufficient inspections during the preparation of the natural ground and the placement and compaction of the fill to certify the work is being performed in accordance with the approved grading plans and geotechnical requirements.

- Site safety is the responsibility of the contractor. Potentially hazardous site conditions should be anticipated while working above or below steep temporary slopes. A site-specific health and safety plan should be prepared by the contractor.

10. DESIGN REVIEW AND CONSTRUCTION SUPPORT

Geotechnical review of plans and specifications and participation during construction are an integral part of the geotechnical design practice. The following sections present our recommendations relative to the review of construction documents and the monitoring of construction activities.

10.1. Plans and Specifications

Upon completion, the civil, structural, and shoring design plans and specifications should be reviewed and approved by Tetra Tech prior to submittal for issuance of grading and construction permit and prior to bidding of construction tasks as the geotechnical recommendations may need to be re-evaluated based on the actual design configuration and loads. This review is necessary to evaluate whether the recommendations contained in this report have been incorporated into the project plans and specifications as intended.

10.2. Construction Monitoring

The objective of the construction quality assurance (CQA) is to assist in the construction of the soils and soils-structure interaction components of the project. Continuous observation of site excavation, processing and assessment of fill materials, fill placement, footings installation, CIDH installation, and other site grading operations by a representative of the Geotechnical Engineer should be implemented during construction to allow for evaluation of the geotechnical-related conditions as they are encountered. This process provides the Geotechnical Engineer with the opportunity to recommend appropriate revisions as needed.

10.3. Grading Observations

The Geotechnical Engineer should observe the excavation, subgrade preparation for foundations and pavements, and fill placement so that appropriate modifications to the design, extent, or procedure may be provided, as necessary, should conditions encountered during grading differ from the design assumptions.

10.4. Pavement Construction Observations

Preparation of the pavement subgrade and the placement of base course and pavement sections should be observed by the Geotechnical Engineer. Careful observation is recommended to evaluate that the pavement subgrade is uniformly compacted, and the recommended pavement and base course thicknesses are achieved.

10.5. Construction Quality Assurance Reporting

The following list is intended to provide basic minimum guidelines for the reporting during the geotechnical construction quality assurance efforts:

- A Daily Field Report should be generated each time a representative of the Geotechnical Engineer is performing QA work at the site.

- The Daily Field Reports should contain, at a minimum, a detailed description of the field activities, utilized equipment, areas of work, date, time, weather, and locations and results of all observations and performed tests.

- Provisions should be made for vertical and horizontal control for recording observations and test locations.

- A complete set of Daily Field Reports should be submitted as a part of formal final reporting.

11. LIMITATIONS

The recommendations and opinions expressed in this report are based on Tetra Tech's review of background documents and on information obtained from our field exploration and associated laboratory testing. It should be noted that this study did not evaluate the possible presence of hazardous materials on any portion of the site.

Due to the limited nature of the field explorations, conditions not observed and described in this report may be present on the site. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation and laboratory testing can be performed upon request. Conditions different from those anticipated in this report may be encountered during grading operations, for example, the extent of unsuitable soil and the associated additional effort required to mitigate them.

Site conditions can change with time because of natural processes or the activities of man. Changes to the applicable laws, regulations, codes, and standards of practice may occur because of government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Tetra Tech has no control. Therefore, this report should be reviewed and recertified by Tetra Tech if it were to be used for a project design commencing more than one year after the date of issuance of this report.

Tetra Tech's recommendations for this site are dependent upon appropriate quality control of the excavation, subgrade preparation, and fill placement. Accordingly, the recommendations are made contingent upon the opportunity for Tetra Tech to observe grading operations for the proposed construction. If parties other than Tetra Tech are engaged to provide such services, such parties are automatically and expressly assuming complete responsibility as the Geotechnical Engineer of Record for the project and are deemed concurring with the recommendations in this report and/or are obligated to provide alternative recommendations.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the Project described herein. Tetra Tech should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document. Reliance by others on the data presented herein or for purposes other than those stated in the text is authorized only if permitted in writing by Tetra Tech. Such an authorization may incur additional expenses and charges.

Tetra Tech has endeavored to perform its evaluation using the degree of care and skill ordinarily exercised under similar circumstances by reputable geotechnical professionals with experience in this area in similar soil conditions. No other warranty, either expressed or implied, is made as to the conclusions and recommendations contained in this report.

12. SELECTED REFERENCES

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Figures

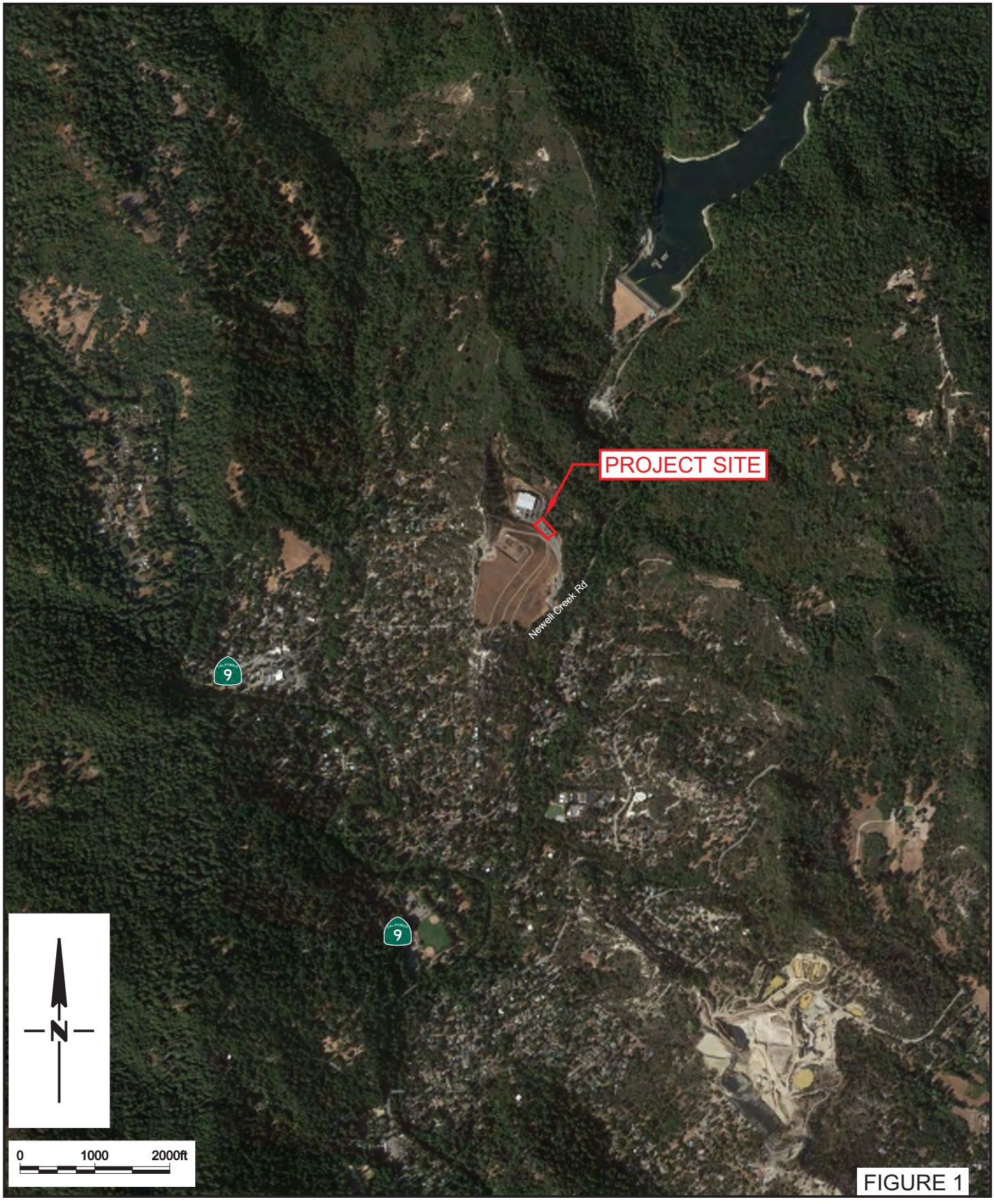

FIGURE 1

TETRA TECH
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TEL 909.860.7777 www.tetratech.com

BEN LOMOND SCALEHOUSE - BEN LOMOND, CA

SITE LOCATION MAP

JOB NO.	BAS 21-185E
DATE	FEB 2024
DRAWN BY	MKM
CHECKED BY	FC

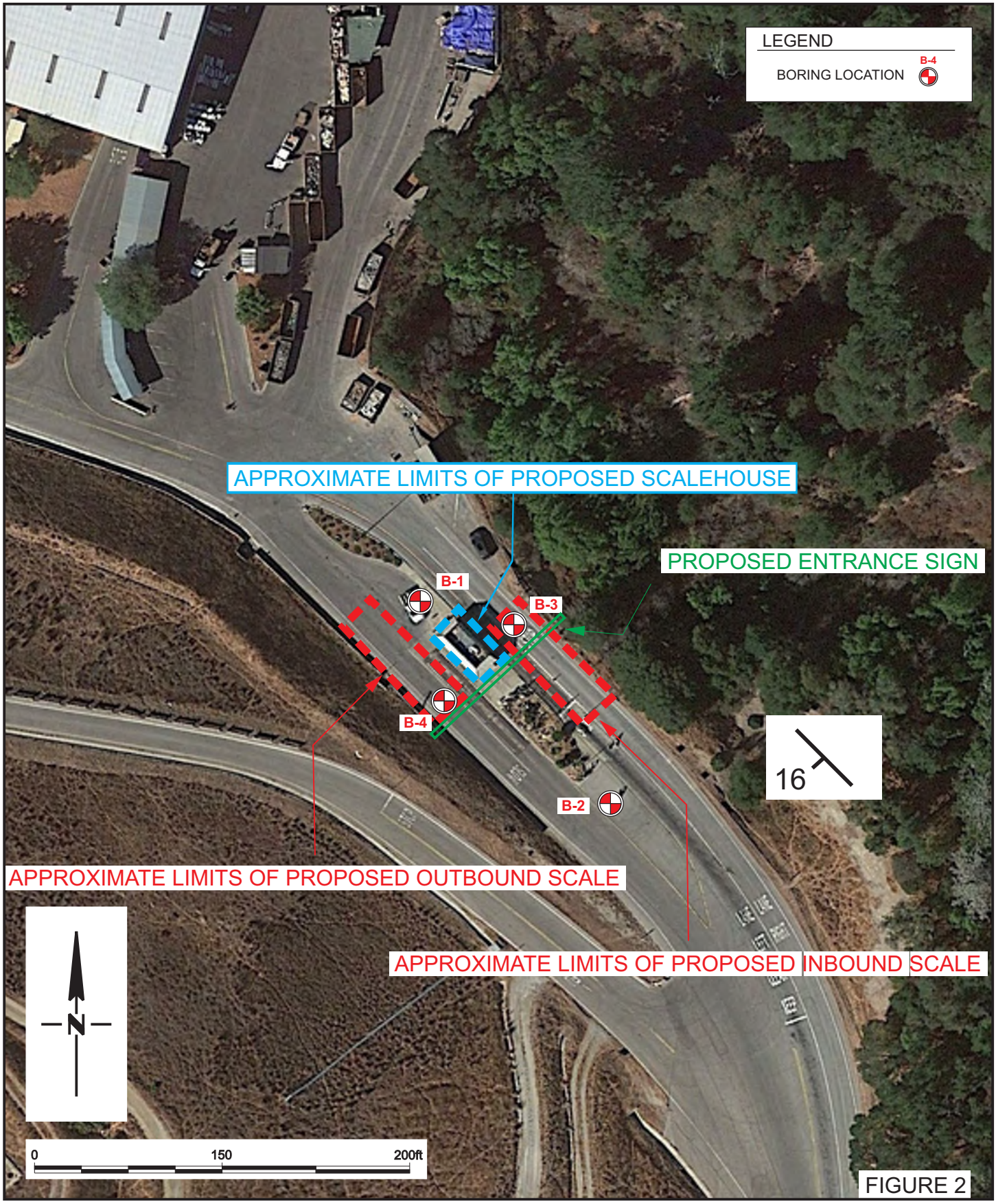

FIGURE 2

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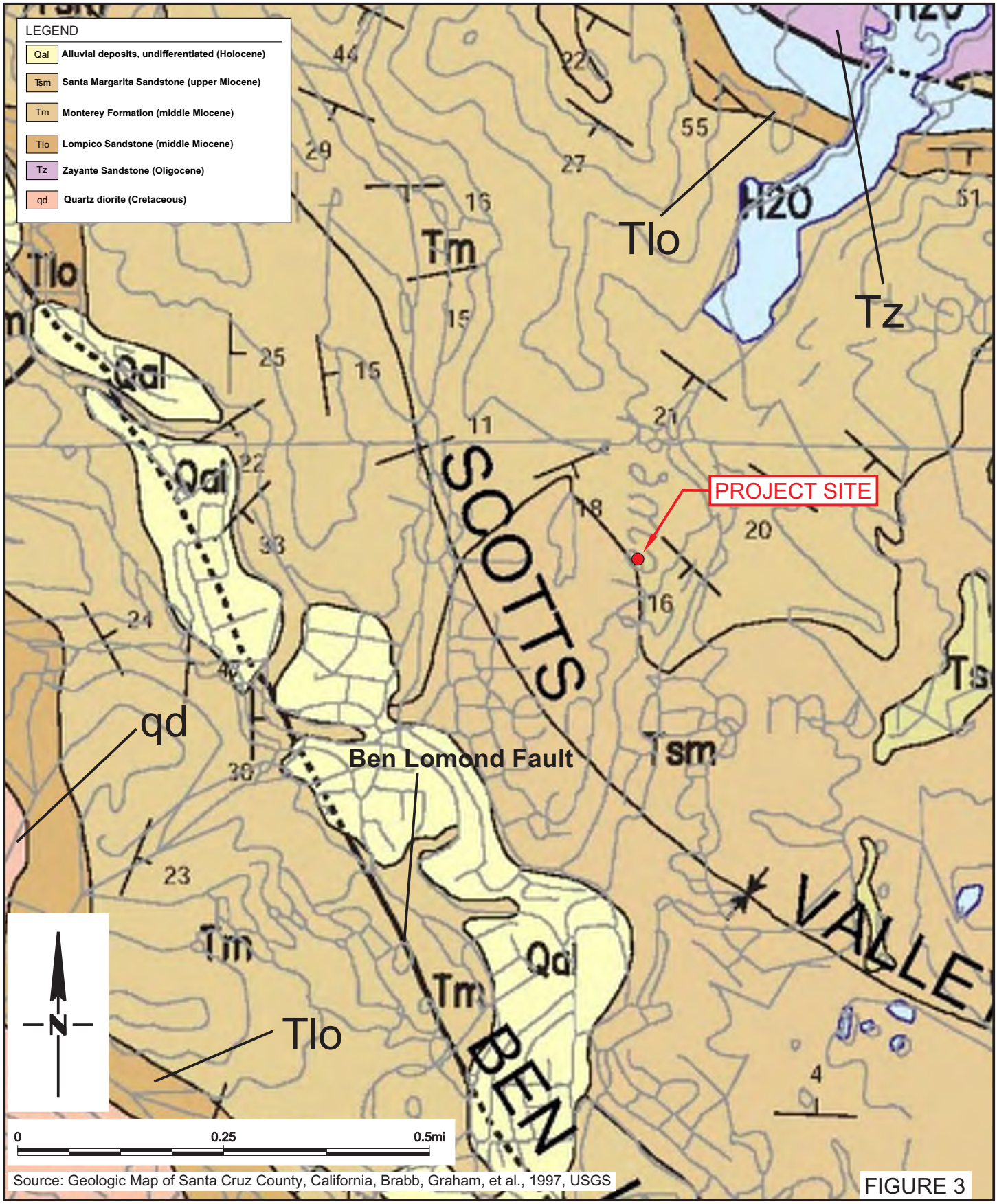
BEN LOMOND SCALEHOUSE - BEN LOMOND, CA

PROJECT LAYOUT AND BORING LOCATIONS MAP

JOB NO.	BAS 21-185E
DATE	FEB 2024
DRAWN BY	MKM
CHECKED BY	FC



Source: Geologic Map of Santa Cruz County, California, Brabb, Graham, et al., 1997, USGS

FIGURE 3

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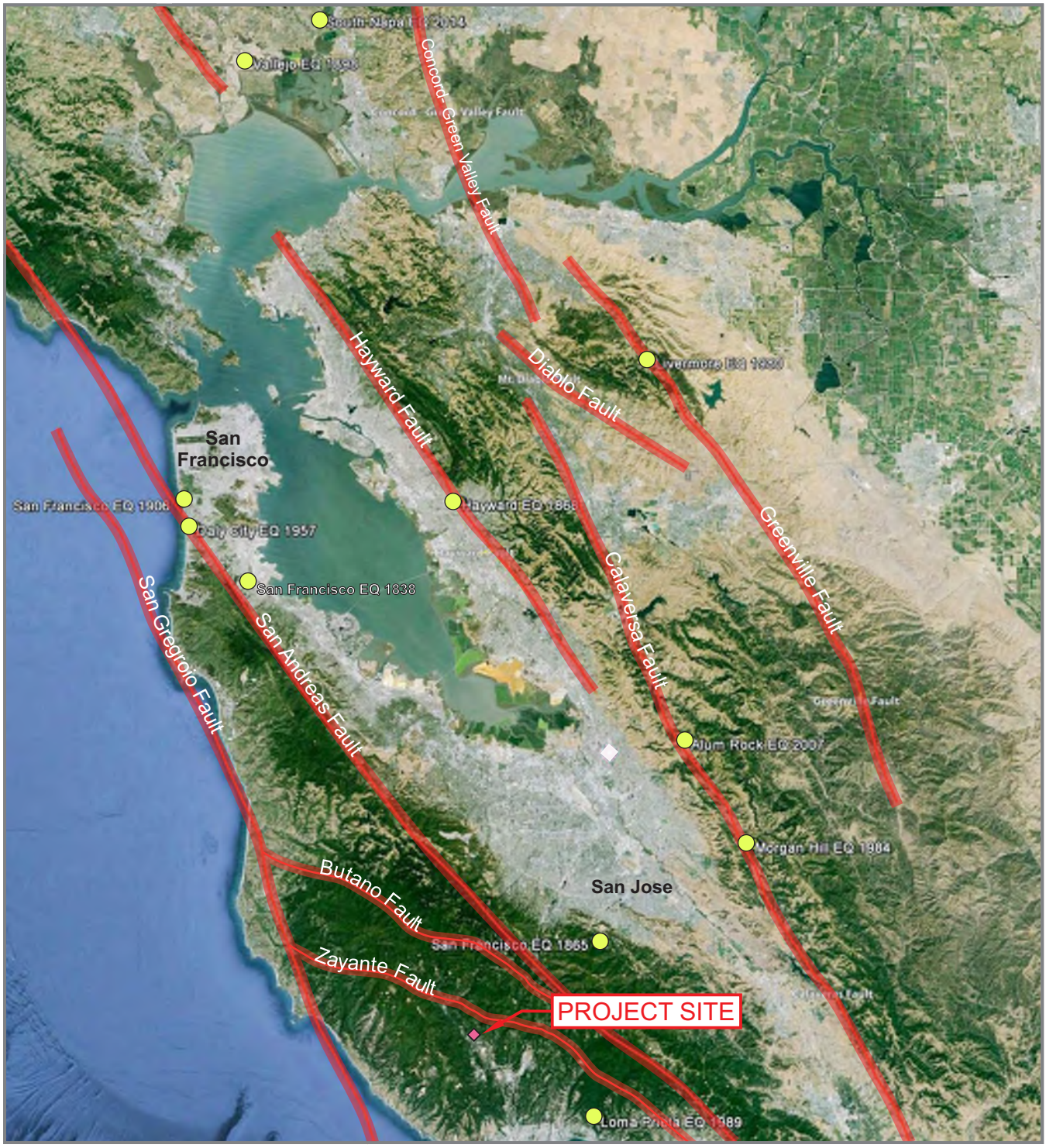
BEN LOMOND SCALEHOUSE - BEN LOMOND, CA

GEOLOGIC MAP

JOB NO.	BAS 21-185E
DATE	FEB 2024
DRAWN BY	MKM
CHECKED BY	FC

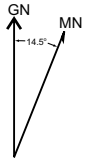


Map Reference: Google Earth 2015, Faults and EQ epicenters: USGS
http://earthquake.usgs.gov/regional/nca/virtualtour/bayarea.php

EXPLANATION

- Historical Earthquake Location
- Fault Name and Location

LOCATION MAP



0 18 ~ 36 Miles

FIGURE 4A

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BEN LOMOND SCALEHOUSE - BEN LOMOND, CA

REGIONAL FAULT AND SEISMICITY MAP

JOB NO.	BAS 21-185E
DATE	FEB 2024
DRAWN BY	MKM
CHECKED BY	FC

Fault Zone Hazard Areas

County of Santa Cruz

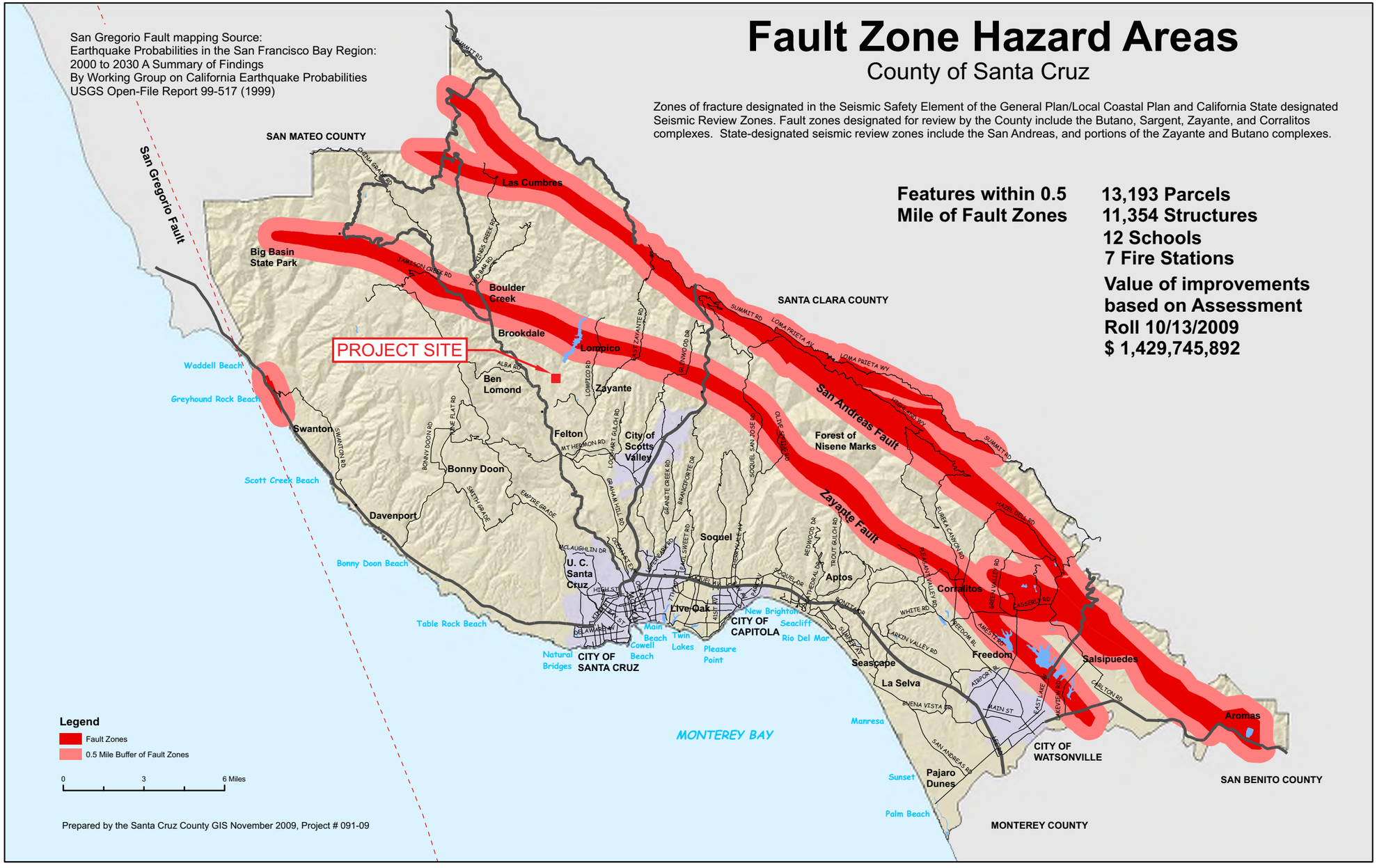
Zones of fracture designated in the Seismic Safety Element of the General Plan/Local Coastal Plan and California State designated Seismic Review Zones. Fault zones designated for review by the County include the Butano, Sargent, Zayante, and Corralitos complexes. State-designated seismic review zones include the San Andreas, and portions of the Zayante and Butano complexes.

San Gregorio mapping Source:
Earthquake Probabilities in the San Francisco Bay Region:
2000 to 2030 A Summary of Findings
By Working Group on California Earthquake Probabilities
USGS Open-File Report 99-517 (1999)

Features within 0.5 Mile of Fault Zones

13,193 Parcels
11,354 Structures
12 Schools
7 Fire Stations

Value of improvements based on Assessment Roll 10/13/2009
$ 1,429,745,892



Prepared by the Santa Cruz County GIS November 2009, Project # 091-09

FIGURE 4B

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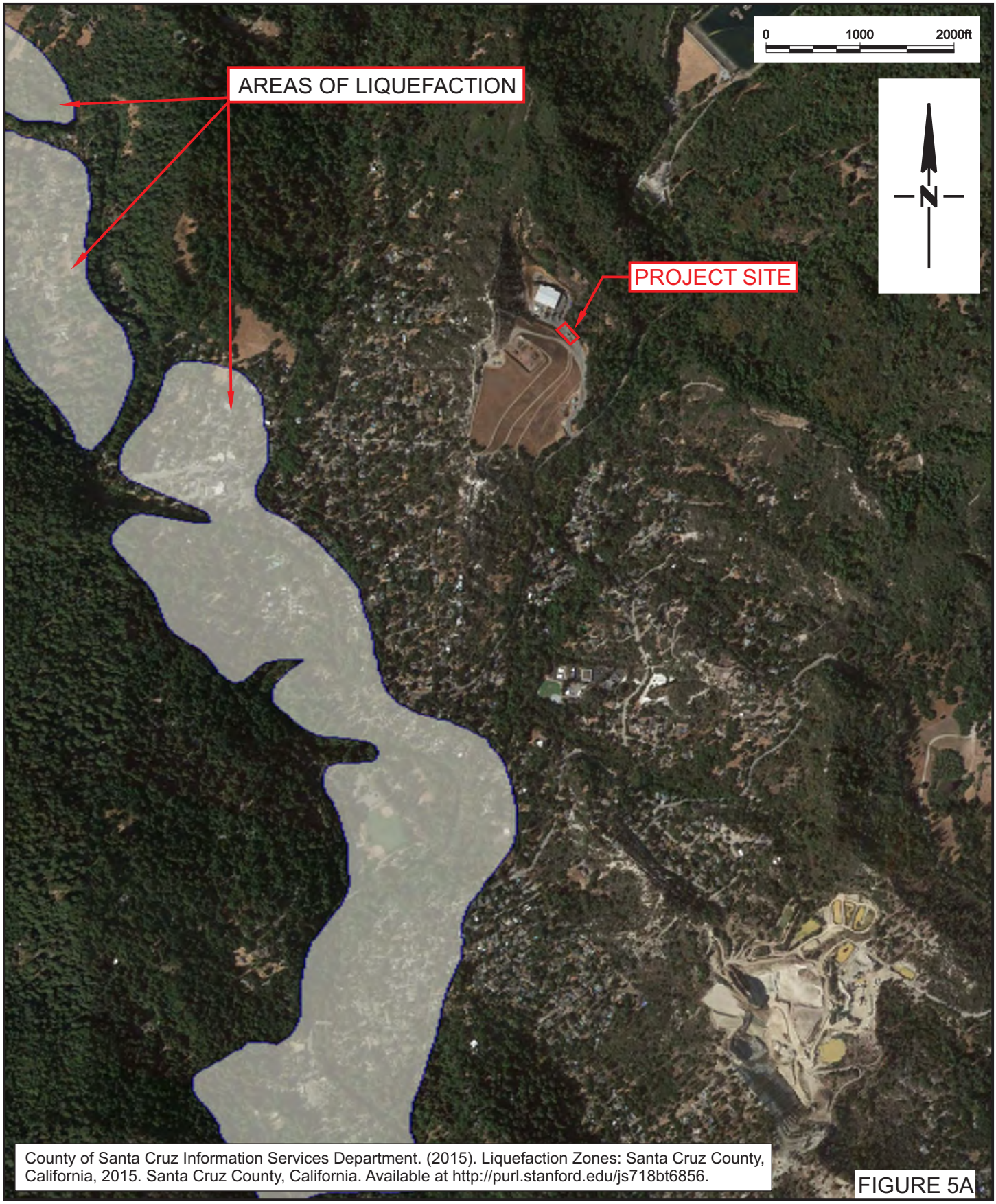
BEN LOMOND SCALEHOUSE - BEN LOMOND, CA

FAULT ZONE HAZARD AREAS

JOB NO.	BAS 21-185E
DATE	FEB 2024
DRAWN BY	MKM
CHECKED BY	FC



County of Santa Cruz Information Services Department. (2015). Liquefaction Zones: Santa Cruz County, California, 2015. Santa Cruz County, California. Available at http://purl.stanford.edu/js718bt6856.

FIGURE 5A

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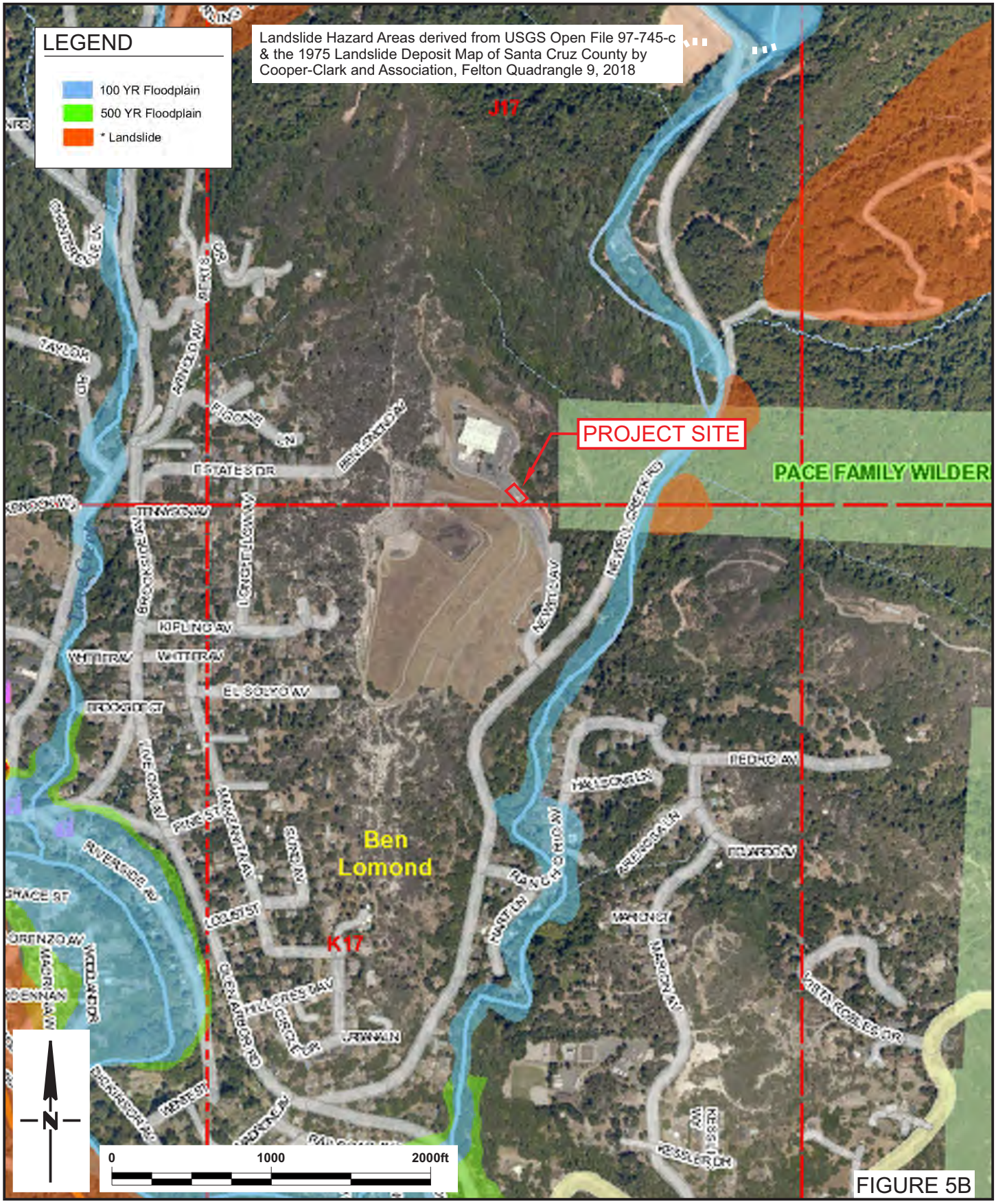
BEN LOMOND SCALEHOUSE - BEN LOMOND, CA

LIQUEFACTION ZONES

JOB NO.	BAS 21-185E
DATE	FEB 2024
DRAWN BY	MKM
CHECKED BY	FC



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BEN LOMOND SCALEHOUSE - BEN LOMOND, CA

LANDSLIDE HAZARD ZONES

JOB NO.	BAS 21-185E
DATE	FEB 2024
DRAWN BY	MKM
CHECKED BY	FC

Appendix A

Logs of Exploratory Borings

Appendix A

Logs of Exploratory Borings

Bulk and relatively undisturbed drive samples were obtained in the field during our subsurface evaluation. The samples were tagged in the field and transported to our laboratory for observation and testing. The drive samples were obtained using a California Split Barrel Drive and a Standard Penetration Test (SPT) sampler as described below.

California-Type Split Barrel Drive Sampler
The split barrel drive sampler was driven with a 140-pound hammer allowed to drop freely 30 inches. The number of blows per foot recorded during sampling is presented in the logs of exploratory borings. The sampler has external and internal diameters of approximately 3.0 and 2.4 inches, respectively, and the inside of the sampler is lined with 1-inch-long brass rings. The relatively undisturbed soil sample within the rings is removed, sealed, and transported to the laboratory for observation and testing.

Standard Penetration Test Sampler
The standard penetration test sampler is driven with a 140-pound hammer allowed to drop freely 30 inches in general accordance with ASTM D1586. The number of blows (N-value) required to drive the SPT sampler 12 inches is shown on the borings logs. The sampler has external and internal diameters of approximately 2.0 and 1.4 inches respectively. The sampling tube consists of an unlined split-tube barrel. The disturbed soil sample is removed, sealed, and transported to the laboratory for testing.

Tetra Tech

BORING B-1

Sheet 1 of 1

PROJECT NAME Ben Lomond - Scale House | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 467 ft

PROJECT NUMBER BAS 21-185E | **PROJECT LOCATION** Ben Lomond | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 12/7/2023 -12/7/2023 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 4 ft

LOGGED/CHECKED BY DL/FC | **DRILLING METHOD** Hollow-Stem Auger | **BOREHOLE DIAMETER** 6" in

COORDINATES 37.094509, -122.077543 | **HAMMER DATA** 140 lbs Autohammer, 30" drop | **BACKFILL** Tamped cuttings

LOCATION DESCRIPTION Northwest of scale house

Standard Penetration Test (SPT) | No Recovery | Shelby Tube

California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					AC 4"				
				SP-SM	[FILL] Poorly-Graded SAND with Silt, reddish yellow, damp, fine to course grained. [BEDROCK] Monterey Formation (Tm): Sandy SILTSTONE, moderately hard to hard, brown (10YR 5/3) to dark brown (7.5YR 3/4), dry, fine to medium grained, micaceous, white sand infilled in fracture, petroliferous odor.				465.0
	SK-1								
2.5					...(2.5 ft) as above.				
	SPT-2	22-45-50/2"						EI=18	
								Melting bits and teeth. Poor recovery.	

Total Depth: 4 ft.
Terminated due to refusal.
No groundwater encountered
Backfilled with tamped cuttings and capped with asphalt cold patch.

BA BORINGS - GINT STD US LAB.GDT - L:\03 - TECHNICAL RESOURCES\02 SOFTWARE LIBRARY\GINT\PROJECTS\BAS 21-185E BEN LOMOND SCALE HOUSE.GPJ

Printed on: 2/2/24 15:05

Tetra Tech

BORING B-2

Sheet 1 of 1

PROJECT NAME Ben Lomond - Scale House | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 467 ft

PROJECT NUMBER BAS 21-185E | **PROJECT LOCATION** Ben Lomond | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 12/7/2023 -12/7/2023 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 7.7 ft

LOGGED/CHECKED BY DL/FC | **DRILLING METHOD** Hollow-Stem Auger | **BOREHOLE DIAMETER** 6" in

COORDINATES 37.094239, -122.077211 | **HAMMER DATA** 140 lbs Autohammer, 30" drop | **BACKFILL** Tamped cuttings

LOCATION DESCRIPTION Southeast of scale house

Standard Penetration Test (SPT) | No Recovery | Shelby Tube | California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					AC 6"				
				SP-SM	[FILL] Poorly-Graded SAND with Silt, medium dense, yellowish brown (10YR 5/6), damp, fine to coarse grained, oxidized, siltstone fragments embedded with brown (10YR 4/3) and dark brown sand (7.5 YR 3/4), some brown silty sand (10YR 4/3), black staining.				465.0
2.5	SK-1				...(2.5 ft) as above.			R-Val = 35	
	R-2	8-13-14 (27)				103.6	9.5	G/S/F/2μ=29/61/10/1	
5.0									462.5
	SPT-3	12-50/3"			[BEDROCK] Monterey Formation (Tm): Sandy SILTSTONE, moderately hard to hard, dark brown (7.5YR 3/4), moderately cemented, dry, fine to medium grained, petroliferous odor.			Very little sample recovery.	
									460.0
7.5	SPT-4	50/2"			...(7.5 ft) as above.				

Total Depth: 7.7 ft.
Terminated due to refusal.
No groundwater encountered
Backfilled with tamped cuttings and capped with asphalt cold patch.

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Tetra Tech

BORING B-3

Sheet 1 of 1

PROJECT NAME Ben Lomond - Scale House | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 467 ft

PROJECT NUMBER BAS 21-185E | **PROJECT LOCATION** Ben Lomond | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 12/7/2023 -12/7/2023 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 6.5 ft

LOGGED/CHECKED BY DL/FC | **DRILLING METHOD** Hollow-Stem Auger | **BOREHOLE DIAMETER** 6" in

COORDINATES 37.094490, -122.077348 | **HAMMER DATA** 140 lbs Autohammer, 30" drop | **BACKFILL** Tamped cuttings

LOCATION DESCRIPTION Inbound bypass lane, northeast of scale house

Standard Penetration Test (SPT) | No Recovery | Shelby Tube

California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0					AC 2"				
				SP-SM	[FILL] Poorly-Graded SAND with Silt, reddish yellow, damp, fine to course grained, oxidzed.				
					[BEDROCK] Monterey Formation (Tm): Sandy SILTSTONE, moderately hard to hard, reddish brown (5YR 6/6), disturbed, oxidized, dry to damp, fine to medium grained, moderately cemented, micaceous, petroliferous odor.				465.0
2.5	SK-1 SPT-2	50/4"			...(2.5 ft) as above.			EI = 4. Corrosion.	
									462.5
5.0	SPT-3	30-50/2"			...(5.0 ft) color change to brown (10YR 4/3), less oxidation.			Hard drilling. LL=47/PL=32/PI=15	
								Hard drilling. Lifts up the rig.	

Total Depth: 6.5 ft.
Terminated due to refusal.
No groundwater encountered
Backfilled with tamped cuttings and capped with asphalt cold patch.

BA BORINGS - GINT STD US LAB.GDT - L:\03 - TECHNICAL RESOURCES\02 SOFTWARE LIBRARY\GINT\PROJECTS\BAS 21-185E BEN LOMOND SCALE HOUSE.GPJ

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Tetra Tech

BORING B-4

Sheet 1 of 1

PROJECT NAME Ben Lomond - Scale House | **CLIENT** County of Santa Cruz | **GROUND ELEVATION** 468 ft

PROJECT NUMBER BAS 21-185E | **PROJECT LOCATION** Ben Lomond | **GROUNDWATER DEPTH** Not encountered

DATES DRILLED 12/7/2023 -12/7/2023 | **DRILLING CONTRACTOR** Pitcher Services, LLC | **BOREHOLE DEPTH** 8 ft

LOGGED/CHECKED BY DL/FC | **DRILLING METHOD** Hollow-Stem Auger | **BOREHOLE DIAMETER** 6" in

COORDINATES 37.094371, -122.077474 | **HAMMER DATA** 140 lbs Autohammer, 30" drop | **BACKFILL** Tamped cuttings

LOCATION DESCRIPTION Outbound bypass lane, southwest of scale house

Standard Penetration Test (SPT) | No Recovery | Shelby Tube | California-Type Ring Sample | No Recovery | Grab/Bulk Sample

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOWCOUNT blows/6" (bpf)	USCS	MATERIAL DESCRIPTION	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	Notes	ELEVATION (ft)
0.0				AC 4"				467.5
			SP-SM	[FILL] Poorly-Graded SAND, dense, reddish yellow (5YR 6/6), moist, fine to coarse grained, some dark brown (7.5YR 3/4) silt fragments, oxidized.				
2.5	SK-1							
	R-2	8-17-21 (38)		...(2.5 ft) as above.	114.5	10.7		465.0
5.0				[BEDROCK] Monterey Formation (Tm): Sandy SILTSTONE, moderately hard to hard, brown (10YR 4/3) and dark brown (7.5YR 3/4), dry to damp, moderately cemented, fine-medium grained, micaceous, petroliferous odor				
	R-3	17-50		...(5.0 ft) as above.			DS.	462.5
7.5								
	SPT-4	50		...(7.5 ft) as above.			Poor recovery. Hard drilling, bits wearing down.	460.0

Refusal at 8.0 ft.
Terminated due to refusal.
No groundwater encountered
Backfilled with tamped cuttings and capped with asphalt cold patch.

BA BORINGS - GINT STD US LAB.GDT - L:\03 - TECHNICAL RESOURCES\02 SOFTWARE LIBRARY\GINT\PROJECTS\BAS 21-185E BEN LOMOND SCALE HOUSE.GPJ

Printed on: 2/2/24 15:05

Appendix B

Results of Laboratory Testing

TETRA TECH

MOISTURE CONTENT AND DENSITY

ASTM D7263

Job Name:	**Ben Lomond Scale House**	**Date Sampled:**	12/11/2023
Job Number:	**BAS-21-185**	**Date Completed:**	12/16/2023
Tested By:	**MG**	**Note:**	

Boring / Test Pit / Trench		**B-2**	**B-4**							
Sample Number		**R-2**	**R-2**							
Sample Depth	*ft*	**2.5**	**2.5**							
USCS Soil Description		Reddish Brown SP-SM Fill	TAN SP-SM Fill							
Number of Rings		6	6							
Total Weight Rings + Soil	*grams*	1077.40	1173.10							
Volume of Rings	ft^3	0.0159	0.0159							
Weight of Rings	*grams*	256.80	256.80							
Weight of Soil	*grams*	820.60	916.30							
Wet Density	*pcf*	113.46	126.69							
Container ID		C18	C23							
Tare	*grams*	12	12							
Wet Soil + Tare	*grams*	275.4	255.7							
Dry Soil + Tare	*grams*	252.6	232.2							
Weight of Water	*grams*	22.8	23.5							

Dry Density	***pcf***	**103.6**	**114.5**							
Moisture Content	***%***	**9.5**	**10.7**							
Assumed/Measured Gs		2.65	2.65							

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TETRA TECH

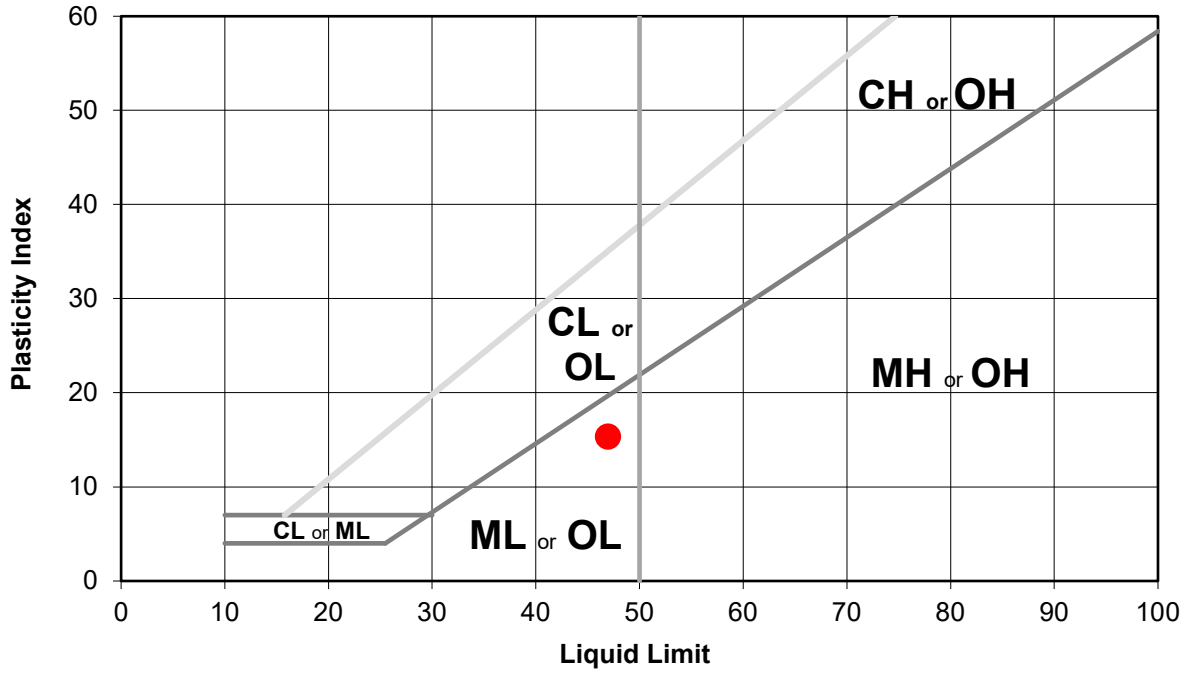
ATTERBERG LIMITS

ASTM D4318

Job Name:	Ben Lomond Scale House	**Date Sampled:**	12/11/2023
Job Number:	BAS-12-185	**Date Completed:**	12/18/2023
Tested By:	MG	**Sample Identification:**	B-3, SPT-3
Note:		**Sample Depth:**	5ft
Sample Description:	Dark Brown Silt Stone, ML		

		Plastic Limit	
Test No.		**1**	**2**
Number of Blows			
Container ID		S18	S12
Wet Weight of Soil + Cont.	*grams*	13.69	14.06
Dry Weight of Soil + Cont.	*grams*	12.01	12.37
Weight of Container	*grams*	6.77	6.96
Moisture Weight	*grams*	1.68	1.69
Weight of Dry Soil	*grams*	5.24	5.41
Moisture Content	*%*	**32.1**	**31.2**

Liquid Limit			
1	**2**	**3**	**4**
36	23	15	
C2	C8	C22	
31.13	28.60	31.97	
25.27	23.31	25.43	
12.00	12.00	12.00	
5.86	5.29	6.54	
13.27	11.31	13.43	
44.2	**46.8**	**48.7**	



Plastic Limit	**32**
Liquid Limit	**47**
Plasticity Index	**15**

USCS Classification **ML**

Based on Atterberg Limits only

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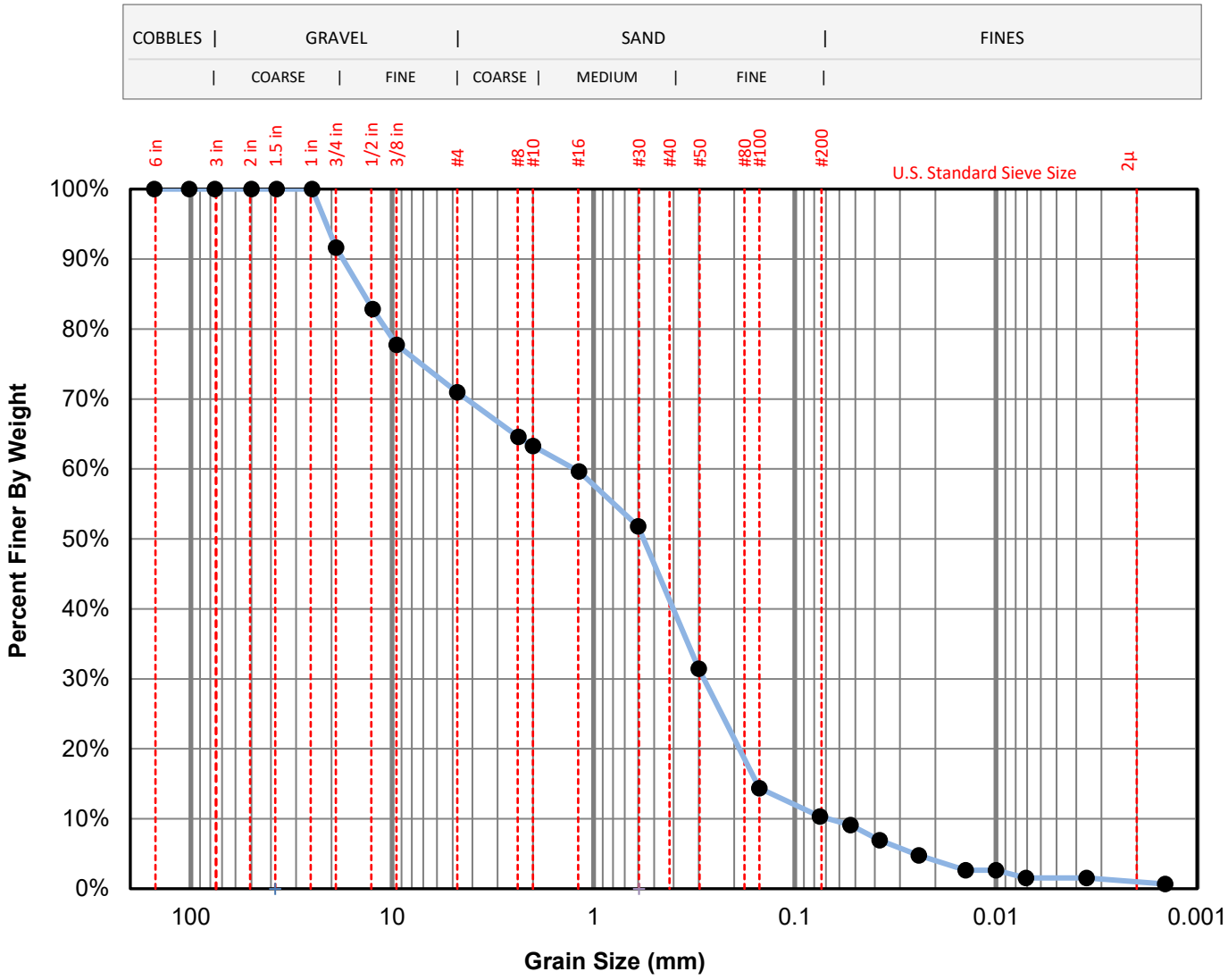
TETRA TECH

GRAIN SIZE DISTRIBUTION ANALYSIS

ASTM C136/C117/D7928/D6913

Job Name:	Billy Wright Land Fill	**Date Sampled:**	12/11/2023
Job Number:	BAS-12-185	**Date Completed:**	12/18/2023
Tested By:	MG	**Sample Identification:**	B-2, R-2
Note:		**Sample Depth:**	2.5 ft
Sample Description:	Reddish Brown Poorly Graded SAND with Silt and Gravel, SP-SM		



Symbol	Boring No.	Sample No.	Depth	LL	PI	USCS	Cobbles	Gravel	Sand	Fines	2µ
●	B-2, R-2					SP-SM	**0%**	**29%**	**61%**	**10%**	**1%**

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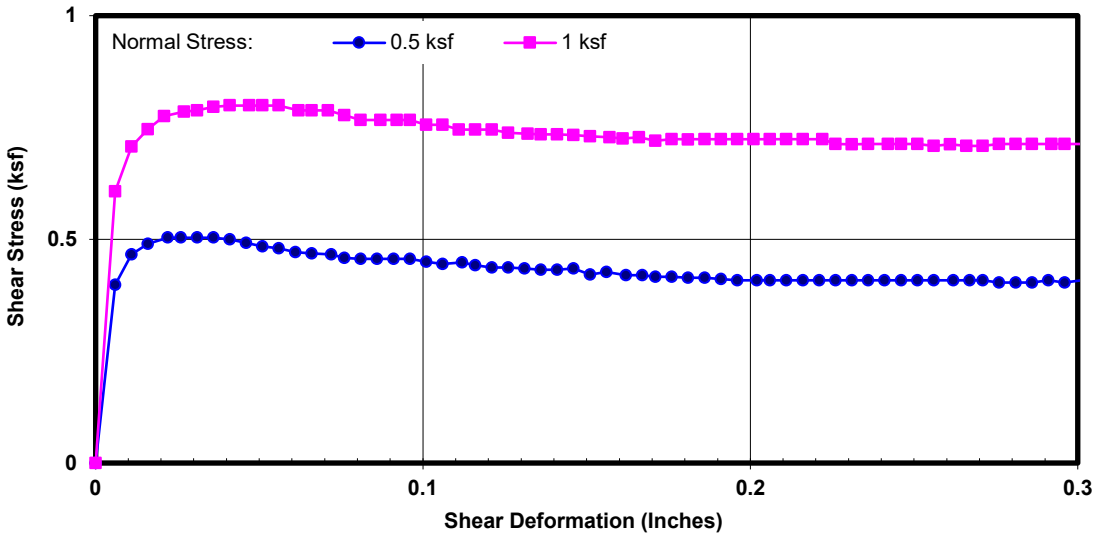
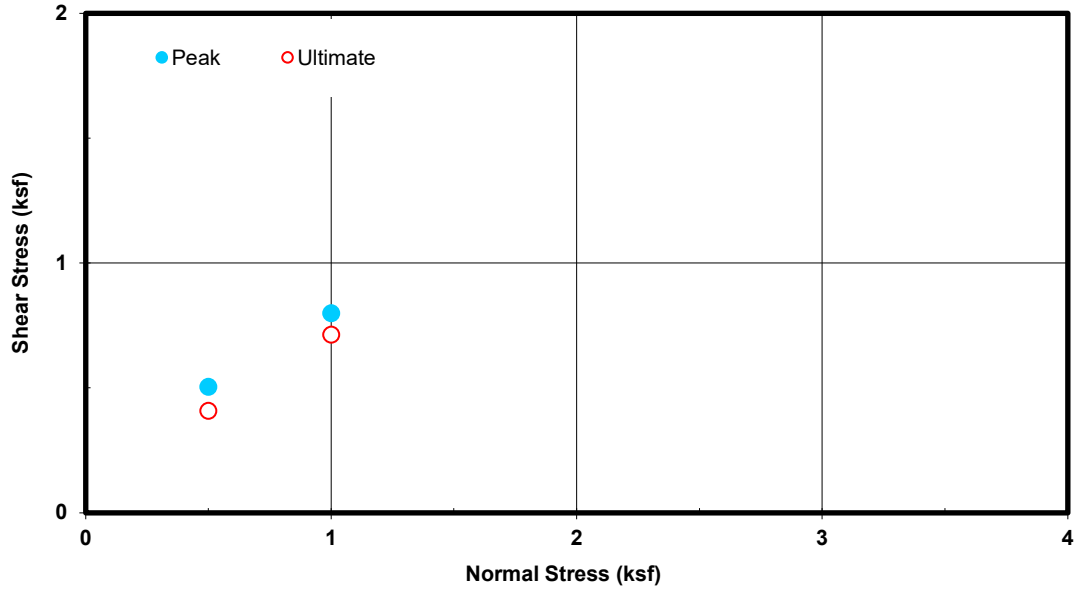
DIRECT SHEAR TEST RESULTS
ASTM D 3080

Project Name:	Ben Lomond Scale House, Santa Cruz		**Tested By:**	ST	**Date:** 12/18/23
Project No.:	BAS 21-185		**Computed By:**	NR	**Date:** 12/19/23
Boring No.:	B-4		**Checked by:**	AP	**Date:** 12/19/23
Sample No.:	R-3	**Depth (ft):** 5			
Sample Type:	Mod. Cal.				
Soil Description:	Clay				
Test Condition:	Inundated	**Shear Type:** Regular			

Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Initial Moisture Content (%)	Final Moisture Content (%)	Initial Degree Saturation (%)	Final Degree Saturation (%)	Normal Stress (ksf)	Peak Shear Stress (ksf)	Ultimate Shear Stress (ksf)
108.9	90.3	20.6	28.4	64	89	0.5	0.504	0.408
						1	0.799	0.713





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EXPANSION INDEX TEST RESULTS

ASTM D 4829

Client Name: Tetra Tech
Project Name: Ben Lomond Scale House, Santa Cruz
Project No.: BAS 21-185

AP Job No.: 23-1230
Date: 12/14/23

Boring No.	Sample No.	Depth (ft)	Soil Description	Molded Dry Density (pcf)	Molded Moisture Content (%)	Init. Degree Saturation (%)	Measured Expansion Index	Corrected Expansion Index
B-3	SK-1	0-5	Sandy Silt	93.3	15.4	51.7	3	4

ASTM EXPANSION CLASSIFICATION

Expansion Index	Classification
0-20	V. Low
21-50	Low
51-90	Medium
91-130	High
>130	V. High

TETRA TECH

EXPANSION INDEX

ASTM D4829

Job Name:	Ben Lomond LF	**Date Sampled:**	12/30/2023
Job Number:	197-2021-0162	**Date Completed:**	1/13/2024
Tested By:	MG	**Sample Identification:**	B-1 SK-1
Note:		**Sample Depth:**	0-5ft
Sample Description:	Dark Olive Gray Silt Stone		

SAMPLE PROCESSING		
Percentage Passing #4 Sieve		
Total Air Dry Weight	*grams*	999.00
Weight Retained on #4	*grams*	0.07
*% Retained	*%*	0.01
***% Passing # 4 Sieve**	*%*	**100.0**

SAMPLE DIMENSIONS		
Sample Height	*inches*	1.00
Sample Diameter	*inches*	4.01

MOISTURE CALCS		INITIAL	FINAL
Tare ID or #		K15	A13
Wet Weight of Soil + Tare	*grams*	184.7	371.3
Dry Weight of Soil + Tare	*grams*	163.1	288.0
Weight of Tare	*grams*	15.0	8.8
* Moisture Weight	*grams*	21.6	83.3
* Weight of Dry Soil	*grams*	148.1	279.2
*** Moisture Content**	*%*	**14.6**	**29.9**

AFTER REMOLDING		INITIAL	FINAL
Weight of Ring and Sample	*grams*	549.8	549.8
Weight of Ring	*grams*	202.2	202.2
*Remolded Wet Weight	*grams*	347.6	347.6
*Wet Density	*pcf*	104.8	102.8
*Dry Density	*pcf*	91.5	79.2
Assumed/Measured Specific Gravity		2.7	2.7
***Degree of Saturation**	*%*	**46.8**	**71.4**

EXPANSION INDEX TEST			
DATE	**TIME**	**DIAL**	**Δ H %**
1/8/2024	7:30 PM	0.0176	0.0
1/8/2024	7:40 PM	0.0176	0.0
		0.0223	0.5
		0.0228	0.5
		0.0320	1.4
		0.0371	1.9
1/9/2024	7:45 PM	0.0371	1.9
***Total**		**0.0371**	**1.9**

EI	Expansion Potential
0 to 20	Very Low
21 to 50	Low
51 to 90	Medium
90 to 130	High
>130	Very High

UNCORRECTED EXPANSION INDEX 19

CORRECTED EXPANSION INDEX **18**

For degrees of Saturation ≠ 50%, >40% and <60%

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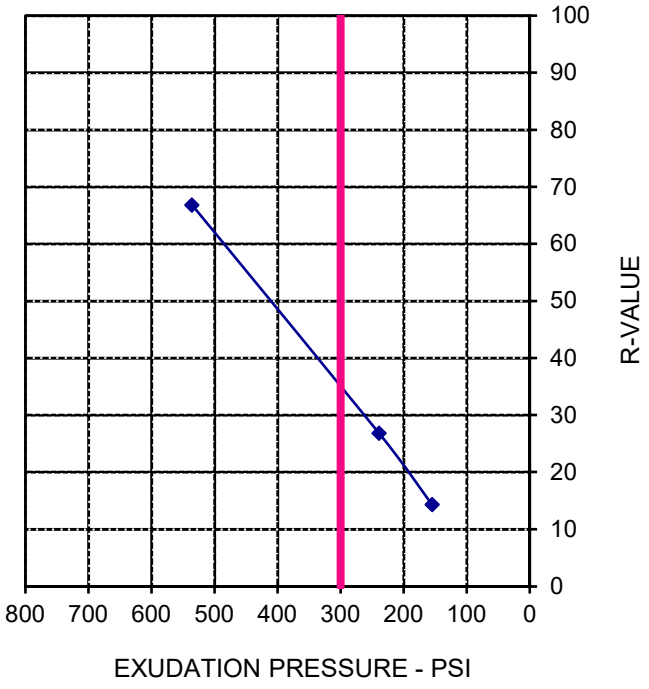
R-VALUE TEST DATA

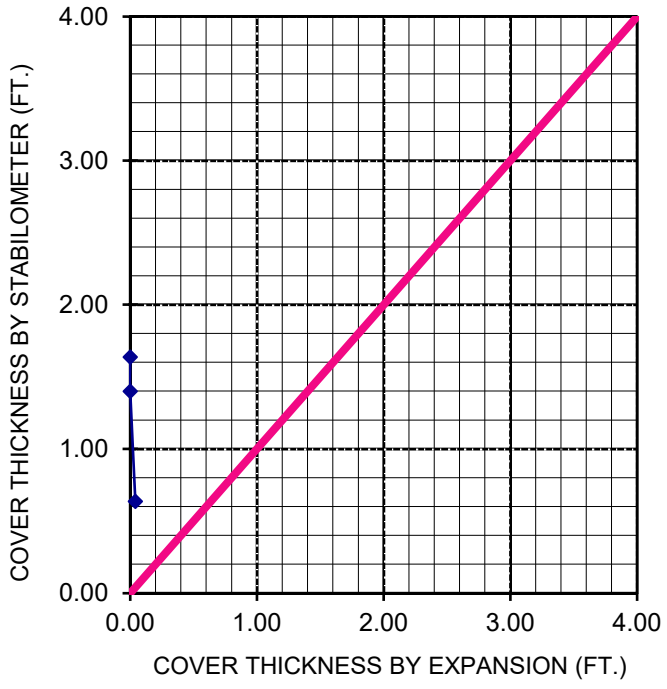
ASTM D2844

Project Name:	Ben Lomond Scale House, Santa Cruz		Tested By:	ST	Date: 12/14/23
Project Number:	BAS 21-185		Computed By:	KM	Date: 12/15/23
Boring No.:	B-2		Checked By:	AP	Date: 12/19/23
Sample No.:	SK-1	Depth (ft.): 0-5			
Location:	N/A				
Soil Description:	Clayey Sand				

Mold Number	G	H	I	
Water Added, g	31	16	0	
Compact Moisture(%)	21.0	19.4	17.7	
Compaction Gage Pressure, psi	80	150	250	
Exudation Pressure, psi	155	239	536	
Sample Height, Inches	2.7	2.7	2.7	
Gross Weight Mold, g	2898	2949	2914	
Tare Weight Mold, g	1826	1835	1818	
Net Sample Weight, g	1072	1113	1096	
Expansion, inchesx10^{-4}	0	0	12	
Stability 2,000 (160 psi)	55/124	42/102	16/42	
Turns Displacement	4.96	4.57	4.22	
R-Value Uncorrected	13	24	62	
R-Value Corrected	14	27	67	
Dry Density, pcf	99.4	104.7	104.5	
Traffic Index	8.0	8.0	8.0	
G.E. by Stability	1.64	1.40	0.63	
G.E. by Expansion	0.00	0.00	0.04	

R-VALUE		
	By Exudation:	35
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	35
Remarks	Gf = 1.34, and 2.5 % Retained on the ¾" *Not Applicable	





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CORROSION TEST RESULTS

Client Name: Tetra Tech
Project Name: Ben Lomond Scale House, Santa Cruz
Project No.: BAS 21-185

AP Job No.: 23-1230
Date: 12/15/23

Boring No.	Sample No.	Depth (feet)	Soil Description	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
B-3	SK-1	0-5	Sandy Silt	1,317	3.9	1281	200

NOTES: Resistivity Test and pH: California Test Method 643
Sulfate Content : California Test Method 417
Chloride Content : California Test Method 422
ND = Not Detectable
NA = Not Sufficient Sample
NR = Not Requested

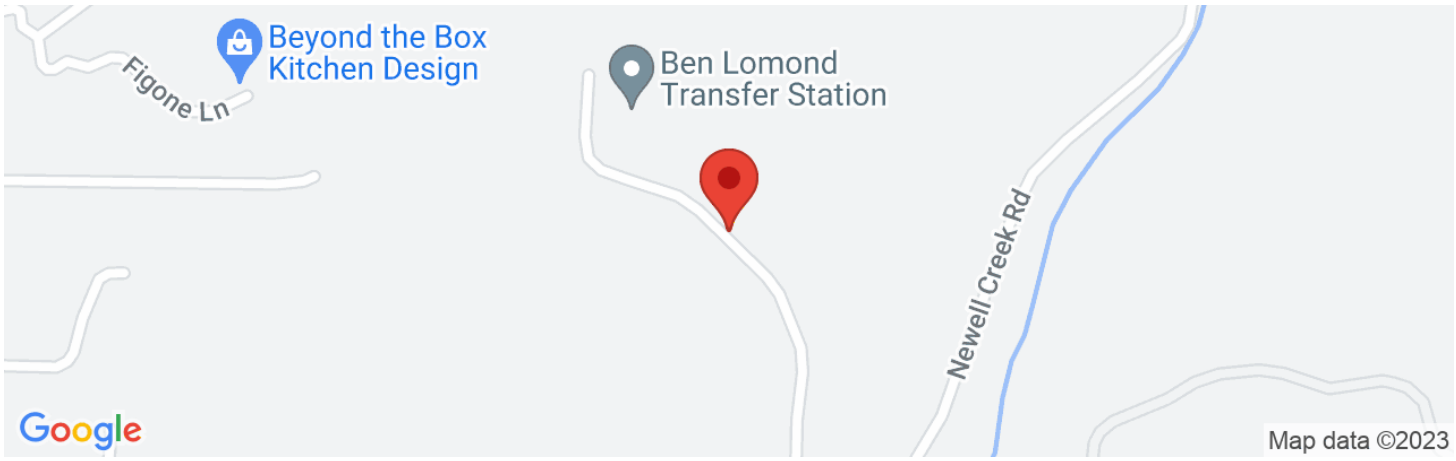
Appendix C

Seismic Demand

USGS web services were down for some period of time and as a result this tool wasn't operational, resulting in *timeout* error.
USGS web services are now operational so this tool should work as expected.

Ben Lomond Scale House

Latitude, Longitude: 37.094461, -122.077463



Date	12/22/2023, 1:08:29 PM
Design Code Reference Document	ASCE7-16
Risk Category	II
Site Class	B - Rock

Type	Value	Description
S_S	1.968	MCE_R ground motion. (for 0.2 second period)
S_1	0.782	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.772	Site-modified spectral acceleration value
S_{M1}	0.626	Site-modified spectral acceleration value
S_{DS}	1.181	Numeric seismic design value at 0.2 second SA
S_{D1}	0.417	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	E	Seismic design category
F_a	0.9	Site amplification factor at 0.2 second
F_v	0.8	Site amplification factor at 1.0 second
PGA	0.843	MCE_G peak ground acceleration
F_{PGA}	0.9	Site amplification factor at PGA
PGA_M	0.759	Site modified peak ground acceleration
T_L	12	Long-period transition period in seconds
SsRT	1.968	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	2.153	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	2.541	Factored deterministic acceleration value. (0.2 second)
S1RT	0.782	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.872	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.948	Factored deterministic acceleration value. (1.0 second)
PGAd	1.061	Factored deterministic acceleration value. (Peak Ground Acceleration)

Type	Value	Description
PGA_{UH}	0.843	Uniform-hazard (2% probability of exceedance in 50 years) Peak Ground Acceleration
C_{RS}	0.914	Mapped value of the risk coefficient at short periods
C_{R1}	0.896	Mapped value of the risk coefficient at a period of 1 s
C_V	0.9	Vertical coefficient

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U.S. Geological Survey - Earthquake Hazards Program

Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Please also see the new USGS Earthquake Hazard Toolbox for access to the most recent NSHMs for the conterminous U.S. and Hawaii.

Input

Edition

Dynamic: Conterminous U.S. 2014 (u…

Spectral Period

Peak Ground Acceleration

Latitude

Decimal degrees

37.094461

Time Horizon

Return period in years

2475

Longitude

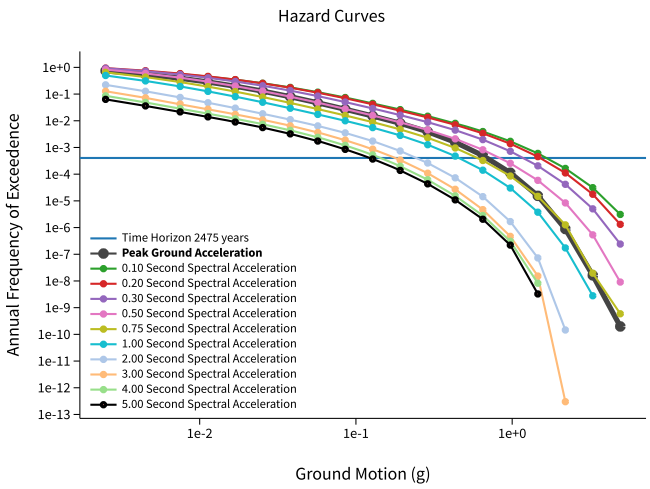
Decimal degrees, negative values for western longitudes

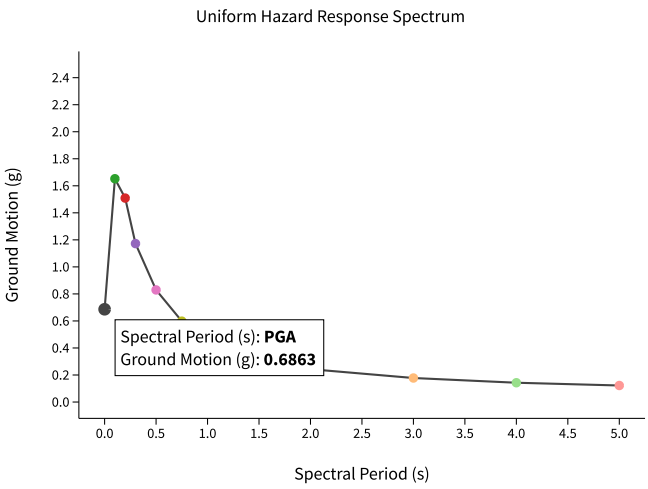
-122.077463

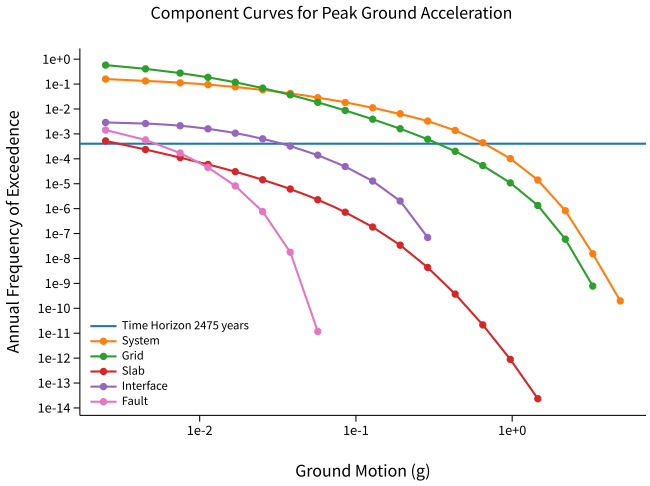
Site Class

1150 m/s (Site class B)

Hazard Curve





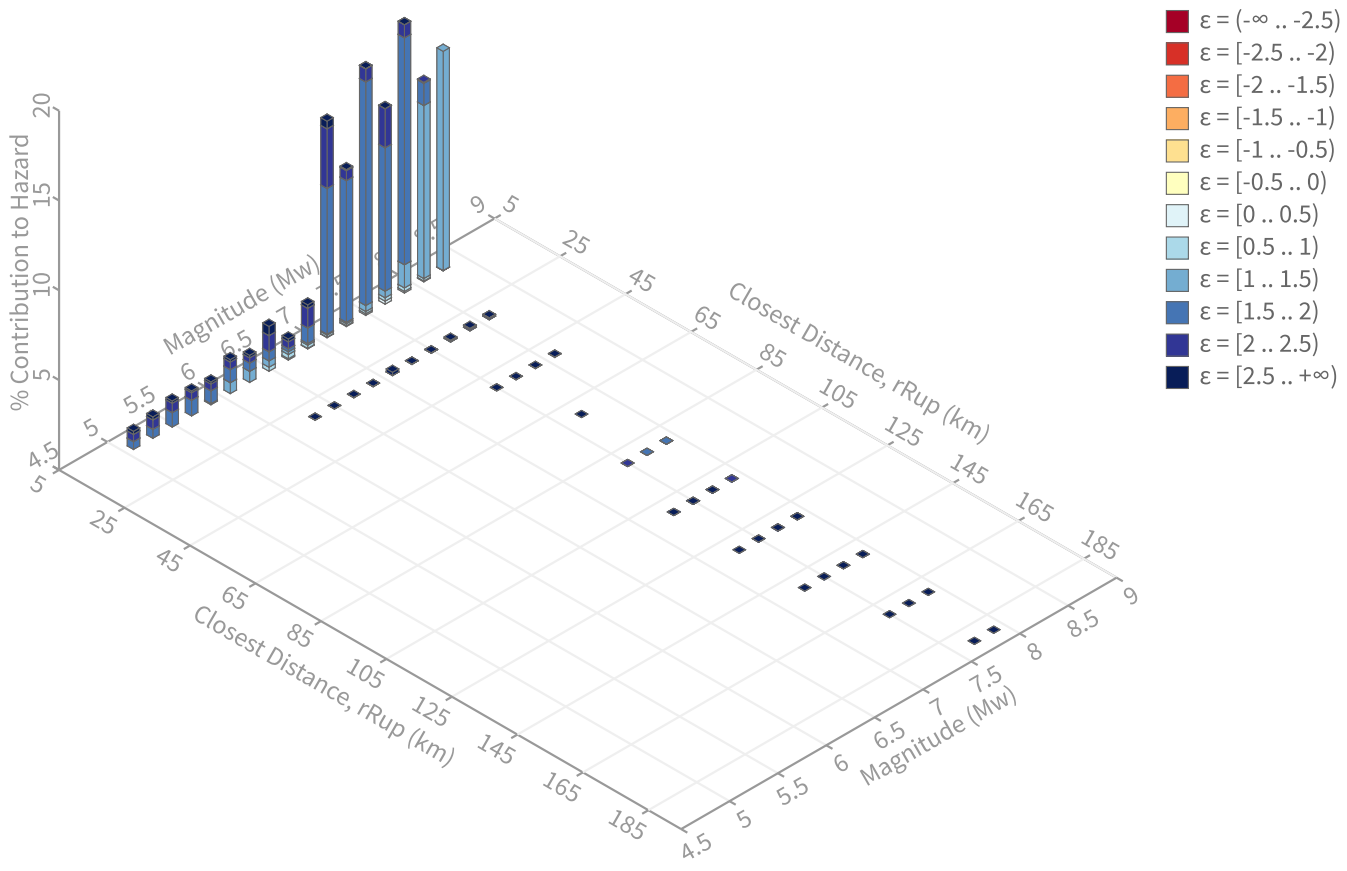


View Raw Data

Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 2475 yrs
Exceedance rate: 0.0004040404 yr^{-1}
PGA ground motion: 0.68628929 g

Recovered targets

Return period: 3109.3728 yrs
Exceedance rate: 0.00032160827 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 0.05 %

Mean (over all sources)

m: 7.46
r: 10.99 km
ε_0: 1.68 σ

Mode (largest m-r bin)

m: 7.88
r: 11.31 km
ε_0: 1.58 σ
Contribution: 14.94 %

Mode (largest m-r-ε_0 bin)

m: 7.87
r: 11.3 km
ε_0: 1.59 σ
Contribution: 12.63 %

Discretization

r: min = 0.0, max = 1000.0, Δ = 20.0 km
m: min = 4.4, max = 9.4, Δ = 0.2
ε: min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0: [-∞ .. -2.5)
ε1: [-2.5 .. -2.0)
ε2: [-2.0 .. -1.5)
ε3: [-1.5 .. -1.0)
ε4: [-1.0 .. -0.5)
ε5: [-0.5 .. 0.0)
ε6: [0.0 .. 0.5)
ε7: [0.5 .. 1.0)
ε8: [1.0 .. 1.5)
ε9: [1.5 .. 2.0)
ε10: [2.0 .. 2.5)
ε11: [2.5 .. +∞]

Deaggregation Contributors

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
UC33brAvg_FM31	System							44.89
San Andreas (Santa Cruz Mts) [0]		10.98	7.75	1.59	121.993°W	37.169°N	41.78	32.73
San Gregorio (North) [18]		16.80	7.62	2.17	122.263°W	37.066°N	259.14	2.31
San Andreas (Santa Cruz Mts) [1]		12.56	7.12	1.96	121.943°W	37.134°N	69.64	2.30
Butano [1]		9.46	7.54	1.58	122.012°W	37.161°N	38.26	1.89
Zayante-Vergeles [2]		1.28	7.61	0.54	122.082°W	37.097°N	310.16	1.32
UC33brAvg_FM32	System							44.28
San Andreas (Santa Cruz Mts) [0]		10.98	7.74	1.59	121.993°W	37.169°N	41.78	33.87
San Andreas (Santa Cruz Mts) [1]		12.56	7.14	1.96	121.943°W	37.134°N	69.64	2.39
San Gregorio (North) [18]		16.80	7.63	2.16	122.263°W	37.066°N	259.14	2.28
Butano [1]		9.46	7.59	1.55	122.012°W	37.161°N	38.26	1.71
UC33brAvg_FM32 (opt)	Grid							5.72
PointSourceFinite: -122.077, 37.117		5.43	5.84	1.61	122.077°W	37.117°N	0.00	1.87
PointSourceFinite: -122.077, 37.117		5.43	5.84	1.61	122.077°W	37.117°N	0.00	1.87
UC33brAvg_FM31 (opt)	Grid							5.11
PointSourceFinite: -122.077, 37.117		5.70	5.72	1.71	122.077°W	37.117°N	0.00	1.32
PointSourceFinite: -122.077, 37.117		5.70	5.72	1.71	122.077°W	37.117°N	0.00	1.32

IN# 124222
(JOURNAL) PAID 2/12/25 #190

County of Santa Cruz

Health Services Agency - Environmental Health

701 Ocean Street, Room 312, Santa Cruz, CA 95060
(831) 454-2022 TDD/TTY - Call 711 http://www.scceh.org
Landuse@santacruzcountyca.gov

ENVIRONMENTAL HEALTH BUILDING CLEARANCE

APPROVED ☒ DENIED ☐

STATE OF CALIFORNIA · HEATHER REYNOLDS REHS #7553 · DEPARTMENT OF PUBLIC HEALTH

REHS:	DATE:	EA #:	SWI#:
Heather Reynolds	2/12/25	12627	16461

Site Address:	APN:
9835 Newell Creek Rd, Ben Lomond, CA 95005	076-261-03; 076-231-02; 076-241-05

Property Owner's Name:	Property Owner's Phone Number:
Santa Cruz County Flood Control District	(831) 566-0265
Property Owner's Mailing Address: 701 Ocean Street, Room 330	City, State, Zip: Santa Cruz, CA 95060
Property Owner's Email Address: Michael.Hettenhausen@santacruzcountyca.gov	Additional Email/Phone Number: Kasey.Kolassa@santacruzcountyca.gov / (831) 454-2377

Contact Person Information: (Name and title)	Contact Person Phone Number:
Michael Hettenhausen	(831) 566-0265
Contact Person Mailing Address: 701 Ocean Street, Room 330	Contact Person Email Address: Michael.Hettenhausen@santacruzcountyca.gov

Required attachments:

- ☐ Pumping inspection report within the last 3 years for a major clearance (bedrooms, ADU, >500 sq. ft.)
- ☐ Pumping inspection report within the last 5 years for a minor clearance (<500 sq. ft., garage, pool, deck)
- ☐ Site plan with the onsite wastewater treatment system location and setbacks
- ☐ Floor plan of structure(s) showing existing and proposed additions

I certify under penalty of perjury that the forgoing information is true and correct and that the accompanying septic tank pumping inspection report is accurate for the subject sewage disposal system.

Applicant Name:	Applicant Signature:	Date:
Michael Hettenhausen	Michael Hettenhausen	1/8/25

When approved by an authorized Environmental Health Staff, this application shall be deemed an Evaluation of the onsite wastewater treatment system (OWTS) from Environmental Health for only the work described below and is not a "permit for development" as that term is used in the California Subdivision Map Act. This Evaluation is limited to the following checked statement and is not to be construed as a warranty of proper operation or future life expectancy of the OWTS. An Environmental Health Building Clearance is valid for a period of 1 year from the date of issuance.

TO BE COMPLETED BY APPLICANT:

Building Project description:

This County project involves repairs and modernizations to the transfer station facility to meet current needs. The proposed project includes installation of a new 14,000 square foot canopy roof over the existing recycling area, upgrading the existing containment area and adding a new 1,000 square foot canopy roof over the existing household hazardous waste area, performing repairs to an existing concrete retaining wall, installing electrical upgrades and interior structural fixes to the existing buildings, and installing an overhead directional sign. The project includes demolition of the existing scale house and reconstruction of a new scale house with new scales and installation of a new service connection from PG&E. All proposed improvements will occur in existing paved areas within the developed transfer station facility.

ENVIRONMENTAL HEALTH BUILDING CLEARANCE

Dwelling Type served by OWTS: (check all that apply)

- ☐ Proposed addition or remodel
- ☐ Existing structure only
- ☐ Main Dwelling: Existing # of bedrooms: Additional # of bedrooms: Total =
- ☐ Additional dwelling unit/THOW (Tiny House on Wheels): # of bedrooms:
- ☑ Structure (Garage, office, barn, shop, studio, pool, pool house, retaining wall) (Circle all that apply)

Description of structure(s):
The existing OWTS serves the administrative office and scale house staff for washing hands and lavatory facilities.

Commercial/Industrial/Institutional:

Type of Business:	Peak Daily Flow:
County Recycling and Solid Waste Transfer Station	
Number of People Using System: Existing:	Proposed:
8	No change.

Indicate the Water Source for the Parcel:

- ☑ Public; indicate the water company/district name: San Lorenzo Water District
- ☐ Private; indicate source: ☐ Individual ☐ Shared ☐ Mutual

Details of Onsite Wastewater Treatment System:

- ☑ Enhanced treatment system: ☐ YES ☑ NO
- ☑ Multiple systems on site: ☐ YES ☑ NO
- ☐ Tank material: Concrete
- ☑ Tank size in gallons: 1800 Pump chamber size in gallons: 1200
- ☐ Dispersal field type:
  - ☑ Rock Trench ☐ Seepage Pits ☐ Geoflow Drip ☐ Chambers

Dispersal field size (square feet): 1800

APPLICATION STATUS DEFICIENCIES:

OWTS tank capacity inadequate for proposed project
Minimum setbacks not met
Insufficient area set aside for future expansion area of dispersal area
System failure noted on pumping inspection report or in field
Other:

Environmental Health Specialist: Heather Reyes 2/12/25
Date

Comments: