ONE BUILDING SYSTEMS CONSULTANTS
Strength in Engineering
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SHOP DRAWING REVIEW COMMENTS

PROJECT NAME: Building 4 HVAC, VAMC

PROJECT LOCATION: St. Coud, MN

ONE PROJECT # 2009254 **SHOP DRAWING No.** M4

CONTRACTOR: El-Jay Plumbing & Heating

PRODUCT MATERIAL/PRODUCT: Side Stream Filter, Glycol Pump & Tank

MANUFACTURER: Lakos, B&G

SPECIFICATION SECTION: 232500 **SCHEDULE SHEET:** -

Checking of shop drawings is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Review of the shop drawings by the Engineer or others does not relieve the contractor from his/her obligation to perform in accordance with the contract, the Drawings and Specifications, nor does it constitute an approval of any deviation from the Drawings and Specifications.

☑ NO EXCEPTIONS NOTED ☐ MAKE CORRECTIONS NOTED ☐ REVISE / RESUBMIT ☐ REJECTED

DATE 12/5/2011 **BY:** Jim Nelson

COMMENTS:

ONE

MULCAHY
Engineered Fluid Handling and HVAC Solutions

2700 Blue Water Road, Suite #100 Eagan, Minnesota 55121
Phone (651)-686-8580 ▪ Fax (651)-686-8588
www.mulcahyco.com

Quote ID: GG110823A

11-15-2011 P02:35

Job Name: St. Cloud VA Medical Center - Bldg 4 HVAC Upgrade
Location: St. Cloud, MN
Engineer:
Today's Date: 11/3/11
Customer: El-Jay Plumbing & Heating
PO#: 65198

Submitted by Tara Syring

Submittal

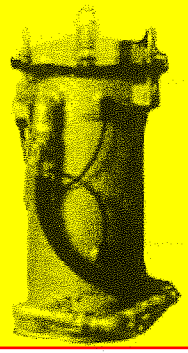
Qty	Description & Tag
	23 25 00 SIDE STREAM FILTER FOR CLOSED LOOP
2	Lakos SRI-816 Indicator Package for SRV-816 to facilitate bag change Wt.: 15 lbs ea.
2	Lakos SRV-816 Solid Recovery Vessel (for 8 inch separators and smaller) Wt.: 61 lbs ea.
	23 25 00 GLYCOL MAKE UP UNITS (BID ALT. #1)
1	B&G Glycol Makeup Unit 60P Wt.: 145 lbs ea. **Tag:** GMU-1

NOV 2011 RECEIVED

REVIEWED BY
SAGINAW CONTRACTING, INC.
BY SE DATE 11-14-11
23 25 00-01

EL-JAY PLUMBING & HEATING
REVIEWED
NOV 9 2011
EXCELLENCE BEGINS WITH "E"

Upon engineer's approval please state date equipment is required so sufficient time is allowed to meet your schedule.



Solids Recovery Vessel

SRV-816

An effective closed-tank method forhandling purged solids and liquids.

Capturing separated solids for easy handling and returning purged liquid back into the system, this compact package eliminates costly liquid loss, messy open containers and the problems often encountered when drains or other means of solids/liquids disposal are remote or nonexistent. Separated solids are simply purged at a continuous rate directly into a solids recovery vessel, which is integrally equipped with a solids collection bag in a stainless steel basket. Purged liquid, passing through the polyester-felt bag is then drawn back into the system, either by the separator's Vortube connection or by means of the system pump's suction (see diagram).

Basic SRV Package

Retention Vessel: 304 stainless steel.
Retention Vessel Lid: Epoxy-coated carbon steel.
Internal Baskets: One, stainless steel.
Purge Collector Bags: Polyester-felt material, 25-micron rating. NOTE: an optional 50-micronbag may be specified. Two bags provided.
Air Relief Valve: 1/4" Float vent valve.

NOTE: Manual valves are required, but not included in basic package.

Optional Indicator Package

SRI-816
To help determine when bag change-out is necessary, choose the Optional Indicator Package. Responsive to increased pressure differential as the vessel accumulates with purged solids, this assembly identifies when the solids collection bag is full, minimizing routine servicing.

❶ **Ball Valves:** Two per package; 3/4-inch (female, N.P.T.) manual; bronze body[1], stainless steel ball, teflon seat.
❷ **Sightglasses:** Two per package; 3/4-inch (female, N.P.T.); bronze[1].
❸ **Annunciator:** One per package; 1/8-inch (female, N.P.T.); tubing connections; "pressure indicator" style[2].
❹ **Flow Control Orifice:** One per package; 3/4-inch (female,N.P.T.); bronze[1]. For 3-inch and larger, use 10 U.S. gpm (2.3 m^3/hr). For 2-inch and smaller, use 2 U.S. gpm (0.5 m^3/hr).

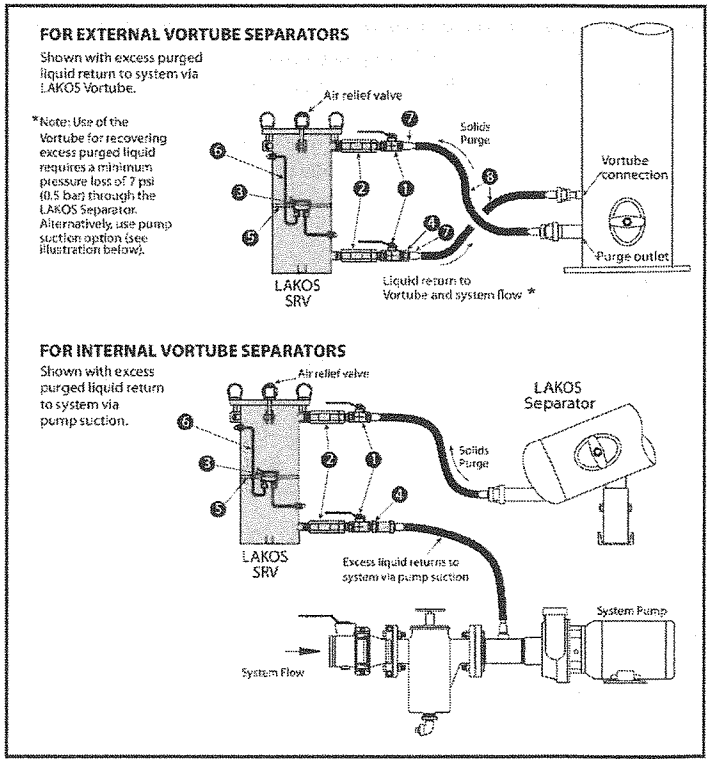
See reverse for additional specifications

❺ **Clamp:** Stainless steel band with hardware to mount annunciator to body of SRV vessel.
❻ **Tubing:** To hook up high/low pressure connections on annunciator; 1/4-inch diameter poly tubing for 150 psi (10.3 bar) or less; water use only; 6 feet (1.8m). End connectors also provided.
❼ **Hose Connections:** 3/4-inch, barbed x male thread connections.
❽ **Hose:** Reinforced rubber, 3/4-inch.

1 Also available in stainless steel. Consult factory for any special application requirements.

2 Optional electronic contact switch (DEC-100) is available to operate a 12 W light; 125/250 VAC-28 VDC, 2 amp. (Voltage booster relay available to activate buzzer or other indicator device).

NOTE: Annunciator is pre-set by the factory at a prescribed pressure differential of 15 psi (1 bar).



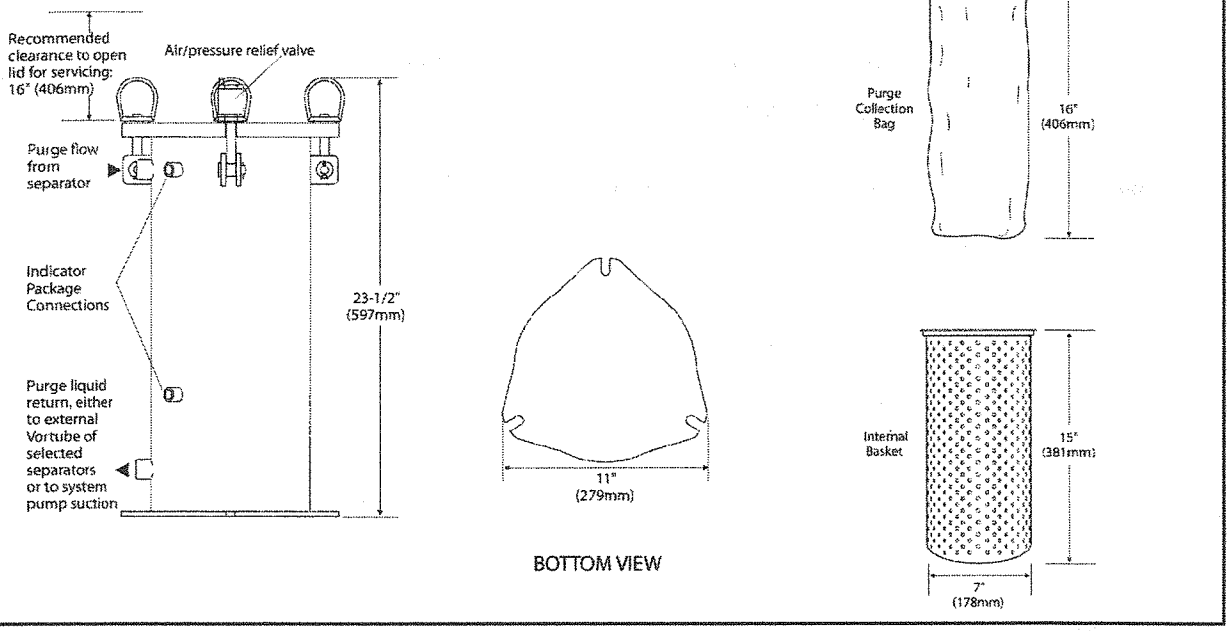
LAKOS®

General Specifications

SRV-816

Solids Collection Capacity: 360 cubic inches/6 liters
Liquid Retention Capacity: 5.0 gallons/19.0 liters
Total System weight (without liquid): 40 pounds/18 kg

Maximum Pressure: 150 psi/10.3 bar
Maximum Operating Temperature: 180°F/82°C



Maintenance Procedures

Separated solids collected in the SRV vessel must be periodically removed. The collector bag may be cleaned and re-used or discarded and replaced. This operation can be performed without interrupting system flow or the LAKOS Separator's operation (see instructions below). Recommended maximum solids load per bag is 25 lbs. (11kg).

The Indicator Package uses a pressure-differential sensor to identify when the bag should be serviced. The standard gauge will point to a red zone, indicating needed servicing. The optional dry electric contact will engage whatever indicator is connected (a light, buzzer, horn, etc.).

Follow these Steps:

1. Close the manual valve on the purge line. Wait for 30-45 seconds.
2. Close the manual valve on the liquid recovery line.
3. Open the manual pressure relief valve to release trapped air.

IMPORTANT: *Wait until all pressure has been released before proceeding.*

4. Open the lid to the SRV vessel. Remove the retainer. Grasp the stainless steel basket handle and remove the entire assembly from the SRV vessel. Remove the bag(s) and clean/replace in the basket.
5. Check o-rings on the basket lip and SRV vessel lid; replace if damaged. Replace the basket/bag assembly in the SRV vessel. Replace the retainer. Close lid and secure properly.
6. Fully open the manual valve on the purge line.
7. The air relief valve will vent air automatically.
8. Fully open the liquid recovery line valve. If the indicator Package is installed, check the sightglasses for proper flow to and from the SRV vessel. System is now back in operation.

LAKOS is a proud member of ASHRAE, BOMA and the U.S. Green Building Council

LAKOS

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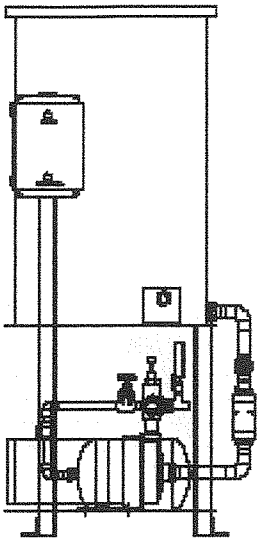
Bell & Gossett®

SUBMITTAL

D-191

JOB: St. Cloud VA Medical Center - BLDG 4 HVAC Upgrades	**REPRESENTATIVE:** Mulcahy Company	
UNIT TAG: GMU-1	**ORDER NO.**	**DATE:** 11/3/2011
ENGINEER:	**SUBMITTED BY:** Tara Syring	**DATE:**
CONTRACTOR: El-Jay Plumbing	**APPROVED BY:**	**DATE:**

Simplex Glycol Make-Up Unit (GMU)



DESCRIPTION

- The GMU automatically maintains minimum system pressure.
- Glycol addition is controlled by a pressure switch.
- Low level alarm contact.
- UL listed package.

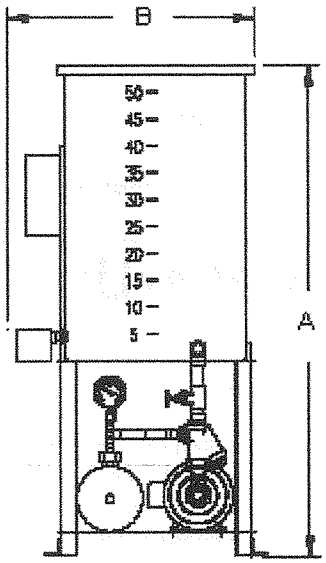
SPECIFICATION

Furnish and install as shown on the plans and specifications a packaged, automatic glycol solution make up unit model GMU as manufactured by ITT Bell & Gossett or approved equal. The package shall consist of a base, polyethylene reservoir with removable lid, visible solution level scale in gallons and liters, y-strainer, isolation valve, pump, open drip-proof motor, pump isolation, check and balance valve, expansion tank, discharge pressure gage, motor contactor and control circuit in a NEMA 4 panel, and necessary interconnecting piping.
Green light shall indicate power supplied to unit. Pump shall start based on falling pressure. System shall require a 115/1/60 single power connection and a 3/4" NPT system piping connection. GMU shall provide (10, 5) GPM and maintain a fill pressure of (30, 60) PSI. Unit includes low level cutout, with red indicator light and 110V contact for alarm indication, to stop the pump during low level condition. Contractor shall furnish application specific pressure reducing valve between GMU and connection to the system piping.

☐ GMU-30 with Steel Pipe and Fittings **OR**
☐ GMU-30P with PVC Pipe and Fittings
- Pump: Model 3530, 1 x 1¼ x 6 10GPM@70' TDH ½HP, 3600 RPM
- Tank: Rotonics, Model CT-55
- Diaphragm Tank: PT-5
- Low Water Cut Off: RB-122
- Pressure Switch/Starter: Square D, Class 9013, FSW49
- Y-Strainer: Hoffman, Model 415C
- 3D Valve: 3DX-1
- Pressure Gauge: 0 - 60 PSI, 3½" Dial
- System Outlet: ¾" NPT

☐ GMU-60 with Steel Pipe and Fittings **OR**
☐ GMU-60P with PVC Pipe and Fittings
- Pump: Model 1HM1D4C3, 5GPM@138' TDH ¾HP, 3600 RPM
- Tank: Rotonics, Model CT-55
- Diaphragm Tank: PT-5
- Low Water Cut Off: RB-122
- Pressure Switch/Starter: Square D, Class 9013, FSW49
- Y-Strainer: Hoffman, Model 415C
- 3D Valve: 3DX-1
- Pressure Gauge: 0 - 60 PSI, 3½" Dial
- System Outlet: ¾" NPT

Dimensions - Inches



Maximum Weight: 160 LBS

Model Number	Capacity (GPM@psi)	Tank Size	Dimensions - Inches		Pressure Range (psi)	System Connection
			A	B		
GMU-30	10@30	55 Gallon	58	30	3-30	¾ NPT
GMU-30P	10@30	55 Gallon	60	30	3-30	¾ NPT
GMU-60	5@60	55 Gallon	58	30	10-60	¾ NPT
GMU-60P	5@60	55 Gallon	60	30	10-60	¾ NPT

ITT
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f: 701.280.0522
www.obernel.com

SHOP DRAWING REVIEW COMMENTS

PROJECT NAME: Building 4 HVAC, VAMC

PROJECT LOCATION: St. Coud, MN

ONE PROJECT # 2009254 **SHOP DRAWING No.** M14

CONTRACTOR: McDowall Company

PRODUCT MATERIAL/PRODUCT: Automatic Temperature Controls

MANUFACTURER: Johnson Controls, Inc.

SPECIFICATION SECTION: 23 09 23 **SCHEDULE SHEET:** H13

Checking of shop drawings is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Review of the shop drawings by the Engineer or others does not relieve the contractor from his/her obligation to perform in accordance with the contract, the Drawings and Specifications, nor does it constitute an approval of any deviation from the Drawings and Specifications.

☐ NO EXCEPTIONS NOTED ☑ MAKE CORRECTIONS NOTED ☐ REVISE / RESUBMIT ☐ REJECTED

DATE 2/9/2012 **BY:** Jim Nelson

COMMENTS:

1. Sheet 1.1.1: Supplier is showing the new control devices connecting to existing freezer monitoring devices Field Bus (network wiring). Is this acceptable to the owner?

2. Sheet 1.1.1: Multiple Field Bus 2 wiring connections shown to the exisitng NAE-4 panel. Is this correct? Some of them are not even shown connecting to the panel.

3. Sheets 5.1.1, 5.2.1, 6.1.1 and 6.2.1: Supplier is showing the use of wireless thermostats. Supplier shall verify their use with the owner. Make sure the owner is aware he will have batteries in every space being controlled.

Friday, January 06, 2012

BUILDING AUTOMATION SYSTEM

SUBMITTAL

VAMC ST CLOUD - BLDG 4 UPGRADE HVAC
ST. CLOUD,MN 56303

Submitted To:

Brad Berghuis
McDowall Company
1431 Prosper Drive
PO Box 606
Waite Park, MN 56387

Submitted By:

Tyler Minke
Application Engineer

JCI Contract: 2082-0141

Johnson Controls, Inc.
2605 Frenbrook Lane N.
Plymouth, MN 55447
Tel:763-566-7650
Fax:763-566-2208

STAMPS

Bill of Materials

Tag	Type	Qty	Part	Description
NETWORK			**Metasys Extended Architecture**	

Tag	Type	Qty	Part	Description
4-C-1			**Central Heating**	
HW-DP	Field	1	DPT2302-050D	PRESS SENS,DP,0-50 PSI,VDC,0.25%
HW-P	Field	1	DPT2090-50G	PRESSURE SENSOR,GAUGE,0-50 PSI,0.5-5.5VDC,0.25% AC
HWPx-C,-S	Field	2	CSD-SA1E1-1	SLD/ADJ LED 1A W/RLY
HWR-T	Field	1	TE-6300W-102	T-WELL 6" SS DIRECT MNT
HWR-T	Field	1	TE-631AM-2	WELL INSERTION TEMPERATURE SENSOR,1K OHM NICKE
HWS-T	Field	1	TE-6300W-102	T-WELL 6" SS DIRECT MNT
HWS-T	Field	1	TE-631AM-2	WELL INSERTION TEMPERATURE SENSOR,1K OHM NICKE
HXSTM-P	Field	1	DPT2090-50G	PRESSURE SENSOR,GAUGE,0-50 PSI,0.5-5.5VDC,0.25% AC
HXSTM-P	Field	1	TBG16A-600R	STEAM TRAP ASSEMBLY
PANEL	Panel	1	PAKGJG002BH0	FEC2611/IOM2711,24X36

Tag	Type	Qty	Part	Description
4-C-2			**Central Heating**	
HW-DP	Field	1	DPT2302-050D	PRESS SENS,DP,0-50 PSI,VDC,0.25%
HW-P	Field	1	DPT2090-50G	PRESSURE SENSOR,GAUGE,0-50 PSI,0.5-5.5VDC,0.25% AC
HWPx-C,-S	Field	2	CSD-SA1E1-1	SLD/ADJ LED 1A W/RLY
HWR-T	Field	1	TE-6300W-102	T-WELL 6" SS DIRECT MNT
HWR-T	Field	1	TE-631AM-2	WELL INSERTION TEMPERATURE SENSOR,1K OHM NICKE
HWS-T	Field	1	TE-6300W-102	T-WELL 6" SS DIRECT MNT
HWS-T	Field	1	TE-631AM-2	WELL INSERTION TEMPERATURE SENSOR,1K OHM NICKE
HXSTM-P	Field	1	DPT2090-50G	PRESSURE SENSOR,GAUGE,0-50 PSI,0.5-5.5VDC,0.25% AC
HXSTM-P	Field	1	TBG16A-600R	STEAM TRAP ASSEMBLY
CONTROLLER	Panel	1	MS-FEC2611-0	FEC2611-0,FEC17
CONTROLLER	Panel	1	MS-IOM2711-0	MS-IOM2711-0 FINAL

Tag	Type	Qty	Part	Description
CHWS			**Central Cooling Plants.Central Cooling**	
CHW-DP	Field	1	DPT2302-050D	PRESS SENS,DP,0-50 PSI,VDC,0.25%
CHxCHWE-T	Field	2	TE-6300W-102	T-WELL 6" SS DIRECT MNT
CHxCHWE-T	Field	2	TE-631AM-2	WELL INSERTION TEMPERATURE SENSOR,1K OHM NICKE
CHxCHW-FS	Field	2	FS1-6	LIQ FLOW SWITCH/WATERPRF - ENCL
CHxCHWL-T	Field	2	TE-6300W-102	T-WELL 6" SS DIRECT MNT
CHxCHWL-T	Field	2	TE-631AM-2	WELL INSERTION TEMPERATURE SENSOR,1K OHM NICKE
CHx-DP	Field	2	DPT2302-050D	PRESS SENS,DP,0-50 PSI,VDC,0.25%

Tag	Type	Qty	Part	Description
CHWS			**Central Cooling Plants.Central Cooling**	
CHx-EN	Field	2	RIBU1C	120VAC
PCHWPx-C,-S	Field	2	CSD-SA1E1-1	SLD/ADJ LED 1A W/RLY
SCHWPx-C,-S	Field	2	CSD-SA1E1-1	SLD/ADJ LED 1A W/RLY
SCHWR-T	Field	1	TE-6300W-102	T-WELL 6" SS DIRECT MNT
SCHWR-T	Field	1	TE-631AM-2	WELL INSERTION TEMPERATURE SENSOR,1K OHM NICKE
SCHWS-T	Field	1	TE-6300W-102	T-WELL 6" SS DIRECT MNT
SCHWS-T	Field	1	TE-631AM-2	WELL INSERTION TEMPERATURE SENSOR,1K OHM NICKE
CONTROLLER	Panel	1	MS-IOM4711-0	17 PT IOM W/ 6 UI 2 BI 3 BO 2 AO 4 CO 24 VAC AND S
PANEL	Panel	1	PAKGJJ002BH0	FEC2611-0 AND IOM4711-0 PNL IN A 24 X 36 X 6-5/8 E
TRANSFORMER	Panel	1	Y64T15-0	120/208/240VAC PRIMARY 24VAC SECONDARY 92VA UL CU

Tag	Type	Qty	Part	Description
4-AHU-1 & 2			**Air Handling Units.Mixed Air Single Duct**	
CHWE-T	Field	2	TE-6300W-102	T-WELL 6" SS DIRECT MNT
CHWE-T	Field	2	TE-631AM-2	WELL INSERTION TEMPERATURE SENSOR,1K OHM NICKE
CHWL-T	Field	2	TE-6300W-102	T-WELL 6" SS DIRECT MNT
CHWL-T	Field	2	TE-631AM-2	WELL INSERTION TEMPERATURE SENSOR,1K OHM NICKE
DA1-P	Field	2	DPT2641-005D-1	PRESS SENS,DP,0-5"WC,MA,1%
DA1-P	Field	2	FTG18A-600R	REMOTE MTD PROBE
DAPHI-A	Field	2	AFS-460	DIF,0.4 - 12 INWC,DIF=MR,NC
DAPHI-A	Field	2	FTG18A-600R	REMOTE MTD PROBE
DAPHI-A	Field	2	RIB24P	DPDT,20A,HC=24 VAC/DC,W/LED
DA-T	Field	2	TE-6311M-1	8" 1000 OHM NI DUCT TEMP
EAD-O	Field	2	M9220-GGA-3	20 NM SR DPR ACT 0(2) TO 10 VDC 24 VAC 50/60 HZ 24
LT-A	Field	2	A70HA-1C	DUCT,MLT,SP=15-55 F (-9-13 C),STG=2
MA-T	Field	2	TE-6316M-1	NICKEL DUCT AVERAGE,17 FEET
OAD-O	Field	2	M9220-GGA-3	20 NM SR DPR ACT 0(2) TO 10 VDC 24 VAC 50/60 HZ 24
PFILT-DP	Field	2	DPT2640-2R5D-1	PRESS SENS,DP,0-2.5"WC,VDC,1%
PFILT-DP	Field	4	FTG18A-600R	REMOTE MTD PROBE
RAD-O	Field	2	M9220-GGA-3	20 NM SR DPR ACT 0(2) TO 10 VDC 24 VAC 50/60 HZ 24
RA-T	Field	2	TE-6311M-1	8" 1000 OHM NI DUCT TEMP
RF-C,-S	Field	2	CSD-SA1E1-1	SLD/ADJ LED 1A W/RLY
RHWE-T	Field	2	TE-6300W-102	T-WELL 6" SS DIRECT MNT
RHWE-T	Field	2	TE-631AM-2	WELL INSERTION TEMPERATURE SENSOR,1K OHM NICKE
RHWL-T	Field	2	TE-6300W-102	T-WELL 6" SS DIRECT MNT
RHWL-T	Field	2	TE-631AM-2	WELL INSERTION TEMPERATURE SENSOR,1K OHM NICKE
SDR-1	Field	2	RIBU1C	SPDT,10A,HC=10-30 VAC/DC,W/LED
SDR-2	Field	2	RIBU1C	SPDT,10A,HC=10-30 VAC/DC,W/LED
SF-C,-S	Field	2	CSD-SA1E1-1	SLD/ADJ LED 1A W/RLY
PANEL	Panel	2	PAKGJJ002AH0	FEC2611/IOM4711,20X24
SAFETY CIRCUIT RIB	Panel	2	RIBMNLB-4	BOARD 4 INPUTS

Tag	Type	Qty	Part	Description

Tag	Type	Qty	Part	Description
VAV RH			**VAV.Single Duct**	
DA-T	Field	5	TE-631GV-2	NICKEL DUCT PROB,4 INCHES
RECEIVER	Field	5	WRZ-7850-0	RECVR.WL.1-TO-1.SABUS.BAC
ZN-T,-SP,-TOCC	Field	5	WRZ-TTB0000-0	WIRELES ZIGBEE SENSOR, TEMP ADJUST, DISPLAY, F/C P
VMA	Panel	5	MS-VMA1620-0	VAV CTRL/ACT/DP.HTG.FAN

Tag	Type	Qty	Part	Description
VAV RH FTR			**VAV.Single Duct**	
DA-T	Field	39	TE-631GV-2	NICKEL DUCT PROB,4 INCHES
RECEIVER	Field	39	WRZ-7850-0	RECVR.WL.1-TO-1.SABUS.BAC
ZN-T,-SP,-TOCC	Field	39	WRZ-TTB0000-0	WIRELES ZIGBEE SENSOR, TEMP ADJUST, DISPLAY, F/C P
VMA	Panel	39	MS-VMA1620-0	VAV CTRL/ACT/DP.HTG.FAN

Tag	Type	Qty	Part	Description
4-FTR-1			**Terminal Units.TEC**	
ZN-T,-SP,-TOCC	Field	1	WRZ-TTB0000-0	WIRELES ZIGBEE SENSOR, TEMP ADJUST, DISPLAY, F/C P

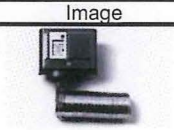
Tag	Type	Qty	Part	Description
4-FTR-2 & 3			**Terminal Units.TEC**	
ZN-T,-SP,-TOCC	Field	2	WRZ-TTB0000-0	WIRELES ZIGBEE SENSOR, TEMP ADJUST, DISPLAY, F/C P

Tag	Type	Qty	Part	Description
VAV POWER			**VAV POWER SUPPLY**	
VAV POWER SUPPLY	Field	2	PSH500A	RIB 500VA 120/24VAC PWR

Tag	Type	Qty	Part	Description
Valve Schedule				
4-AHU-1 & 2\Cooling	Field	2	VG1841FS+948GGA	2" 3W BALL VALVE 46.8CV
4-AHU-1 & 2\Heating	Field	2	VG1841CL+923GGA	1" 3W BALL VALVE 7.4CV
4-C-1\Steam	Field	1	VG7443GT+423GGA	2W 1/2" NPT 4.6CV SS TRIM
4-C-2\Steam	Field	1	VG7443LT+423GGA	2W 3/4" NPT 7.3CV SS TRIM
CONVECTORS\Exist. Co	Field	50	VG7241CT+7152G	2W1/2 NPT.73 VA7152 ELEC
VAV'S\Reheat Coil	Field	44	VG1241AD+9A4AGA	1/2" 2W BALL VALVE 1.2CV

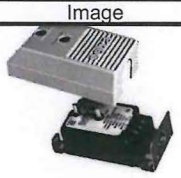
Johnson Controls
INGENUITY WELCOME

Catalog

Part Name	Image	Additional Description
A70HA-1C		The A70 and A72 series of temperature controls are heavy-duty temperature controls intended for use with refrigeration and HVAC equipment. A variety of temperature ranges are available to meet most equipment and application needs.
AFS-460		Cleveland Controls Model AFS-460 is a versatile air pressure sensing switch designed for HVAC and Energy Management applications requiring manual operator reset. The AFS-460 has an adjustable set point range of .40" to 12" WC. The AFS-460 comes standard with an electrical conduit piping bracket, suitable for 1/2" piping. Air sample connections are 1/4" male connectors with compression nuts and ferrules.
CSD-SA1E1-1		CSD-SA1E1-1 The CSD Series of digital output current switches are non-intrusive devices designed to detect current flow in cables or wires. These units are a very cost effective solution for monitoring on/off status or proof of operation, and ideal for monitoring current loads on motors driving fans, blowers, pumps, heating coils, even lighting. The CSD-SA1E1-1 is a solid core, adjustable setpoint, with an amperage range from 1.0-135A, LED status indicator, output relay, and a hole size diameter of .71 in. (18mm).
DPT2090-50G		209 Series Gauge Pressure Transducers with Conduit Adapter The DPT2090C and 2091C pressure transducer has full scale gauge pressure ranges from 5 PSIG to 1,000 PSIG. Their all stainless steel wetted parts, high accuracy NIST traceable performance (+/-0.25% FS), wide operating temperatures (0 to 250(F), NEMA 4 rated housing, excellent long term stability and guaranteed 3-5 day shipment make it a good match for any in-line pressure applications. Models are available with either voltage or current outputs, a terminal strip with conduit adapter and a 1/4" NPT pressure fitting.
DPT2302-050D		230 Series Wet/Wet Differential Pressure Transducers The DPT2300, 2301 and 2302 wet/wet pressure transducers measure low differential pressures from 1 PSID to 100 PSID. The standard unit is offered with various outputs (5 VDC, 10 VDC or 4-20 mA), unidirectional and bi-directional ranges, high line pressure capabilities (250 PSIG), fast response time ((50 msec), NEMA 4 rated housing and excellent NIST traceable performance (+/-0.25% FS). With its stainless steel construction, the 230 series is compatible with the media encountered in wet/wet HVAC applications.
DPT2640-2R5D-1		264 Series Low Differential Pressure Transducers The improved DPT2640 and 2641 pressure transducer measure differential air pressure. The transducers sense differential or gage (static) pressure and convert this pressure difference to a proportional analog output. The tension diaphragm design improves overpressure capabilities up to 10 PSI, with a standard accuracy of +/-1.0% FS (NIST traceable). Units are available with voltage or current output for both unidirectional and bi-directional pressure ranges. The DPT2640/2641 series is used on a wide variety of pressure sensing applications on HVAC systems.

Johnson Controls
INGENUITY WELCOME

Catalog

Part Name	Image	Additional Description
DPT2641-005D-1		264 Series Low Differential Pressure Transducers The improved DPT2640 and 2641 pressure transducer measure differential air pressure. The transducers sense differential or gage (static) pressure and convert this pressure difference to a proportional analog output. The tension diaphragm design improves overpressure capabilities up to 10 PSI, with a standard accuracy of +/-1.0% FS (NIST traceable). Units are available with voltage or current output for both unidirectional and bi-directional pressure ranges. The DPT2640/2641 series is used on a wide variety of pressure sensing applications on HVAC systems.
FS1-6		DESCRIPTION The FS1-6 Flow Switch is designed to prove liquid flow in a wide variety of HVAC and industrial applications. The corrosion resistant flow switch is mounted in a weatherproof box for simple wiring connections. The PPS plastic vane is field trimmable for 1" and larger pipes and is magnetically coupled to the SPDT switch to prevent liquid from entering the switch housing.
FTG18A-600R		FTG18A-600R is a remote mounting kit for use with the P32 Series Sensitive Pressure Switch. The remote mounting kit consists of a four inch flanged sensing tube, two barbed fittings, two No. 10 screws, and a gasket.
M9220-GGA-3		20 NM SPRING RETURN DIRECT COUPLED DAMPER ACTUATOR, DC 0...10 V OR DC 2...10 V PROPORTIONAL CONTROL, FIELD SELECTABLE, AC/DC 24 V 50/60 HZ, -5 TO 90 DEGREE ROTATION, OPTIONAL M9220-603 ROTATION LIMITER AVAILABLE TO LIMIT THE ACTUATOR STROKE BETWEEN 30 AND 90 DEGREES, 150 SECONDS OPENING TIME, 20 SECONDS SPRING RETURN TIME AT ROOM TEMPERATURE, -40 TO 55C (-40 TO 131F) AMBIENT TEMPERATURE RATING, ONE HANDED LOCKING MANUAL OVERRIDE, STANDARD CLAMP ACCEPTS 1/2 TO 3/4 INCH ROUND (12 to 19 MM) / 3/8 OR 1/2 INCH (10,12 and 14 MM) SQUARE DAMPER SHAFT, OPTIONAL M9220-600 CLAMP ACCEPTS 3/4 TO 1-1/16 INCH (19 to 27 MM) ROUND / 5/8 OR 3/4 INCH (16, 18 and 19 MM) SQUARE DAMPER SHAFT, ONE 48 INCH (1.2 METER) HALOGEN FREE APPLIANCE CABLE WITH CONNECTOR FOR 3/8 INCH FLEXIBLE METAL CONDUIT, NEMA 2 (IP54) ENCLOSURE RATING, FIVE YEAR WARRANTY
MS-FEC2611-0		The Metasys® system family of Field Equipment Controllers comprise a group of versatile BACnet®, Master-Slave/Token-Passing (MS/TP) network compliant field controllers designed to monitor, control, and integrate a wide variety Heating, Ventilating, and Air Conditioning (HVAC) and other building equipment. This family of controllers includes the Field Equipment Controller (FEC) , Input/Output Module (IOM), and the Variable Air Volume (VAV) Modular Assembly (VMA) 16 controller. The FEC and IOM Series Controllers feature an advanced design that provides optimum performance and easy access to power, network, and field terminations. These controllers come with 32-bit microprocessors to meet and exceed ever demanding industry standards.
MS-IOM2711-0		The Metasys® system family of Field Equipment Controllers comprise a group of versatile BACnet®, Master-Slave/Token-Passing (MS/TP) network compliant field controllers designed to monitor, control, and integrate a wide variety Heating, Ventilating, and Air Conditioning (HVAC) and other building equipment. This family of controllers includes the Field Equipment Controller (FEC) , Input/Output Module (IOM), and the Variable Air Volume (VAV) Modular Assembly (VMA) 16 controller. The FEC and IOM Series Controllers feature an advanced design that provides optimum performance and easy access to power, network, and field terminations. These controllers come with 32-bit microprocessors to meet and exceed ever demanding industry standards.

Johnson Controls
INGENUITY WELCOME

Catalog

Part Name	Image	Additional Description
MS-IOM4711-0		The Metasys® system family of Field Equipment Controllers comprise a group of versatile BACnet®, Master-Slave/Token-Passing (MS/TP) network compliant field controllers designed to monitor, control, and integrate a wide variety Heating, Ventilating, and Air Conditioning (HVAC) and other building equipment. This family of controllers includes the Field Equipment Controller (FEC) , Input/Output Module (IOM), and the Variable Air Volume (VAV) Modular Assembly (VMA) 16 controller. The FEC and IOM Series Controllers feature an advanced design that provides optimum performance and easy access to power, network, and field terminations. These controllers come with 32-bit microprocessors to meet and exceed ever demanding industry standards.
MS-VMA1620-0	Johnson Controls INGENUITY WELCOME	VAV CTRL/ACT/DP.HTG.FAN
PAKGJG002BH0	Johnson Controls INGENUITY WELCOME	The PAKGJG002BH0 Control Panel is shipped complete, mounted in a 24 in. W x 36 in. W x 6-5/8 in. D steel enclosure. In addition to the MS-FEC2611-0 and IOM2711-0 controller(s), the assembly also contains a power supply incorporating a 5 A circuit breaker, a 96 VA 120/24 VAC transformer, and two 120 VAC outlets and a second 96 VA 120/24 VAC transformer
PAKGJJ002AH0	Johnson Controls INGENUITY WELCOME	The PAKGJJ002AH0 Control Panel is shipped complete, mounted in a 20 in. W x 24 in. W x 6-5/8 in. D steel enclosure. In addition to the MS-FEC2611-0 controller(s), the assembly also contains a power supply incorporating a 5 A circuit breaker, a 96 VA 120/24 VAC transformer, and two 120 VAC outlets and a second 96 VA 120/24 VAC transformer
PAKGJJ002BH0	Johnson Controls INGENUITY WELCOME	The PAKGJJ002BH0 Control Panel is shipped complete, mounted in a 24 in. W x 36 in. W x 6-5/8 in. D steel enclosure. In addition to the MS-FEC2611-0 and IOM4711-0 controller(s), the assembly also contains a power supply incorporating a 5 A circuit breaker, a 96 VA 120/24 VAC transformer, and two 120 VAC outlets and a second 96 VA 120/24 VAC transformer
PSH500A	Johnson Controls INGENUITY WELCOME	RIB 500VA 120/24VAC PWR
RIB24P		Enclosed Relay 20Amp DPDT 24Vac/dc
RIBMNLB-4		RIB logic board, 4-inputs, 2.75 Track-Mount

Johnson Controls
INGENUITY WELCOME

Catalog

Part Name	Image	Additional Description
RIBU1C		Enclosed Relay 10Amp SPDT 10-30Vac/dc/120Vac
TBG16A-600R		STEAM TRAP FOR P47 SERIES STEAM PRESSURE CONTROL
TE-6300W-102		TE-6300W-102 Thermowells are used in conjunction with remote temperature controls where thermowell insertion into a vessel or container to sense temperature is required. The TE-6300W-102 is a 6-in (152.4-mm) thermowell made of 304 stainless steel and marked with the Canadian Registration Number (CRN) for pressure vessel compliance.
TE-6311M-1		TE-6311M-1 The TE-6300 Temperature Sensor line offers economical solutions for a variety of temperature sensing applications including, strap-on, wall mount, outdoor air, duct, well, duct averaging, and Variable Air Volume (VAV) applications. The TE-6311M-1 is an 8-in. (203.2-mm), 1k-ohm, nickel sensor probe with a metal enclosure.
TE-6316M-1		TE-6316M-1 IS A 1,000 OHM NICKEL SENSOR, DUCT MOUNT AVERAGING TEMPERATURE SENSOR 17 FEET IN LENGTH WITH A METAL ENCLOSURE. ORDER THE TE-6001-8 TEMPERATURE ELEMENT HOLDER SEPARATELY.
TE-631AM-2		TE-631AM-2 The TE-6300 Temperature Sensor line offers economical solutions for a variety of temperature sensing applications including, strap-mount, wall mount, outdoor air, duct, well, duct averaging, and Variable Air Volume (VAV) applications. The TE-631AM-2 is a 6-in. (152.4-mm), 1 k-ohm, nickel sensor probe with a metal enclosure. This unit is used with the TE-6300W-101 and TE-6300W-102 6-in. direct mount (adapterless) thermowells.
TE-631GV-2		TE-631GV-2 The TE-6300 Temperature Sensor line offers economical solution for a variety of temperature sensing applications including, strap-on, wall mount, outdoor air, duct, well, duct averaging, and Variable Air Volume (VAV) applications. The TE-631GV-2 is a 4-in. (101.6-mm), 1 k-ohm nickel sensor probe with a flange mounting bracket (no enclosure). This model comes with 10 ft (2.524 m) of plenum rated cable terminated with spade connectors.
VG1241AD+9A4AGA		1/2" Two-Way Ball Valve, 1.2 Cv, Brass Trim, 200 psig closeoff, NPT end connections, with VA9104-AGA-2S, Non-Spring Return Electric Actuator, 48 inch 18 AWG plenum rated cable electrical connection, 24 VAC Floating Control, no end switches

Johnson Controls
INGENUITY WELCOME

Catalog

Part Name	Image	Additional Description
VG1841CL+923GGA		1 in. three-way ball valve, 7.4 Cv, NPT end connections, plated brass trim, 23 to 203°F fluid temperature rating, not rated for steam service,VA9203-GGA-2Z spring return coil open, 0(2) - 10 VDC proportional control, 24 VAC 50/60 Hz or 24 VDC power required, no end switches, 0(2) to 10 VDC feedback, with 120 in. plenum rated cable
VG1841FS+948GGA		2 in. three-way ball valve, 46.8 Cv (Port A) / 29.2 Cv (Port B), NPT end connections, plated brass trim, 23 to 203°F fluid temperature rating, not rated for steam service,VA9208-GGA-2 spring return coil closed, 0(2) - 10 VDC proportional control, 24 VAC 50/60 Hz or 24 VDC power required, no end switches, 0(2) to 10 VDC feedback, with 120 in. plenum rated cable
VG7241CT+7152G		The VG7000 Series Bronze Valves accurately regulate the flow of water or steam in response to the demand of a controller in heating, ventilating and air conditioning systems. These valves are available in normally open, normally closed, and three-way mixing configurations with a variety of end connections including, NPT, union globe, union angle and union sweat. Both electric and pneumatic actuators are available. Standard bonnet and stem design allow interchange of actuators for easy field retrofit or mounting of actuators using standardized mounting kits.
VG7443GT+423GGA		The VG7000 Series Bronze Valves accurately regulate the flow of water or steam in response to the demand of a controller in heating, ventilating and air conditioning systems. These valves are available in normally open, normally closed, and three-way mixing configurations with a variety of end connections including, NPT, union globe, union angle and union sweat. Both electric and pneumatic actuators are available. Standard bonnet and stem design allow interchange of actuators for easy field retrofit or mounting of actuators using standardized mounting kits.
VG7443LT+423GGA		The VG7000 Series Bronze Valves accurately regulate the flow of water or steam in response to the demand of a controller in heating, ventilating and air conditioning systems. These valves are available in normally open, normally closed, and three-way mixing configurations with a variety of end connections including, NPT, union globe, union angle and union sweat. Both electric and pneumatic actuators are available. Standard bonnet and stem design allow interchange of actuators for easy field retrofit or mounting of actuators using standardized mounting kits.

Johnson Controls
INGENUITY WELCOME

Catalog

Part Name	Image	Additional Description
WRZ-7850-0		The WRZ-7850-0 Receiver with BACnet interface, functions with a WRZ-TTX wireless sensor; and a FEC Series or VMA1600 Series field controller. The WRZ-7850-0 is a component of the One-to-One Wireless Room Temperature and Relative Humidity Sensing Systems, in which a single WRZ-TTx Series Wireless Sensor communicates wirelessly to a WRZ-7850-0 receiver that is wired to a BACnet field controller via the SA Bus. Up to five WRZ-TTx sensors may be used per WRX-7850-0 receiver for averaging temperature or relative Humidity in a zone. The One-to One Wireless Room Temperature & Relative Humidity Sensing System is designed for systems that need few sensors and may not have a NAE; and contain FEC or VMA1600 field controllers. A wireless system replaces hardwired temperature sensors, in applications where hardwired temperature sensors are impractical or costly to install.
WRZ-TTB0000-0		The WRZ-TTB0000-0 Wireless Room Temperature Sensor offers a LCD display of the temperature set point, zone temperature, occupancy status, as well as a low battery indicator. The set point can be either warmer/cooler (+/-) with a + 5°F or + 3°C, or the absolute value between 55° and 85° F or between 12° and 28° C. Includes a F/C button to toggle between Celsius and Fahrenheit This wireless sensor uses Zigbee technology to transmit temperature data to a Metasys BACnet field controller. The sensor is battery-powered, and features a 5 year battery life and advance low-battery indication.
Y64T15-0		These transformers are designed for use on digital controllers, gas controls, ignition systems, motor actuators, staging controls, and other 24 VAC control systems. The entire line meets all the requirements of UL 1585, UL 506, and C22.2 No. 66. This assures acceptance in both the United States and Canada. Provides best primary/secondary isolation and reduces stocking requirements and offers application flexibility. The Y64T15-0 is a 92 VA capacity transformer with circuit breaker. Its specifications are 120/208/240, 24, male fitting 8 in. primary leads, female fitting 30 in. sec. leads, foot UL, cUL Class 2.

MIDWEST MECHANICAL SOLUTIONS

5831 Cedar Lake Road
Minneapolis, MN 55416

Product Description:	*Yaskawa* Variable Frequency Drives (Serving: "4-P1 thru 4-P8; 4-SF1, 4-RF1, 4-SF2, 4-RF2")
Spec. Section	26.29.11
Date:	December 29, 2011
Project:	VAMC St. Cloud / Bldg 4 HVAC
Engineer:	ONE, Inc.
Contractor:	McDowall Company
Project Manager:	Mark Dingmann
Sales Engineer:	Dan Mueller – 952-525-2063
MMS Job#:	9065-J10487

Submittals for Approval. Please Advise on Release

APPROVAL STAMPS

Equipment will not be released for production until approved shop drawings are received by Midwest Mechanical Solutions. Production timing and shipping information cannot be determined until approved drawings are received. Performance, openings and dimensions may vary from contract documents. Receipt of approved drawings constitutes acceptance of these variances. Contractor to notify Midwest Mechanical Solutions of required shipping dates.

YASKAWA

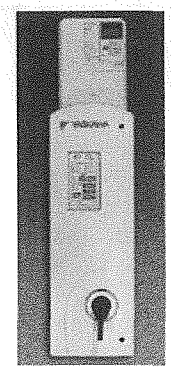
E7N Drive/Bypass

Model: E7N

Description

1/2-20HP
E7 Narrow Bypass

E7N



The E7N Bypass package is a 2-contactor style bypass with HOA touchpad control, allowing motor operation from either the drive or across the line. This allows continued operation even if the E7 drive is disabled, by fault or intention. Drive maintenance must be delayed until line power can be removed. The E7 and E7N Bypass have been designed for flexibility in providing the features and options commonly specified by facility designers.

The E7 Drive is a variable torque AC drive, designed specifically for HVAC applications in building automation. A new benchmark for size, cost, performance, benefits, and quality, the E7 includes numerous built-in features such as Network Communications, PI control and energy savings functions.

The E7 has embedded communications for the popular building automation protocols, Johnson Controls Metasys N2 and Siemens APOGEE, as well as Modbus. An optional LonWorks or BACnet interface card is available.

Performance Features

- VT Ratings: 1/2-10 HP, 208 VAC
  1/2-20 HP, 480 VAC
- Overload capacity: 110% for 60 sec (150% peak)
- Starting torque: 100% at 3 Hz
- DC injection braking: at start or stop, adjustable, current limited (anti-windmilling)
- Motor preheat function
- Adjustable accel/decel: 0.1 to 6000 sec.
- Controlled speed range: 40:1
- Critical frequency rejection: 3 selectable, adjustable bands
- Current limiting: 30-180%
- Energy $aving control
- Torque boost: full range, automatic
- Power loss ride-thru: 2 seconds
- Inertia ride-thru
- Auto restart after power loss or resettable fault, selectable, programmable
- Feedback signal loss detection
- Serial communication loss detection
- "Up/Down" floating point control capability
- Stationary motor auto-tuning
- Customizable monitor display
- Sleep function
- Run permissive input
- Ramp-to-stop or coast-to-stop selection
- Runtime changes in control and display
- Project-specific parameter reinitialization
- Copy keypad

Protective Features

- Current limited stall prevention
- Heat sink over-temperature, speed fold-back
- Cooling fan operating hours recorded
- Bi-directional start into rotating motor at synchronized speed
- DC bus charge indicator
- Current limiting DC bus fuse
- Optically-Isolated controls
- Short circuit protection: Phase-phase and phase-neutral
- Ground fault protection
- Electronic motor overload: UL
- Current and torque limit
- Fault display: last 10 faults
- Fault trace capabilities
- Over torque and under torque protection
- Program security code
- "Hunting" prevention logic
- Input source protection (MOVs)
- Input/output phase loss protection

Design Features

- 32-bit microprocessor logic
- Flash upgradeable firmware
- Non-volatile memory, program retention
- Surface-mount devices
- Displacement power factor: 0.98
- Output frequency: 0.1 to 120 Hz
- Frequency resolution: 0.06 Hz
- Frequency regulation: 0.1%
- Carrier frequency: selectable to 15 kHz
- 3% DC bus reactor: 40-60 HP, 480 VAC (optional on lower ratings)
- LED display
- 24 VDC control logic
- Transmitter/Option power supply
- Input/output terminal status
- Timer function: Elapsed time, Delay on start, Delay on stop
- Embedded Metasys N2, APOGEE FLN, and Modbus
- Volts/hertz ratio: Preset and programmable V/Hz patterns
- Remote speed command: 0-10 VDC or 4-20 mA, direct or reverse-acting
- Setpoint (PI) control with inverse or square root input, differential control via two feedback capability
- Feedback signal: low pass filter
- Speed command: bias and gain
- Meter Functions: Volt, amp, kilowatt, elapsed run time, speed command
- Output Current Transformers: qty 3
- UL, cUL listed and CE marked; IEC 146;
- MTBF: exceeds 28 years

Service Conditions

- Ambient Temperature: -10°C to 40°C (14° F to 104° F)
- Humidity: 95% RH, non-condensing
- Altitude: 3300 ft; higher by derate
- Input voltage: +10%/-15%
- Input frequency: 50/60 Hz ± 5%
- 3-phase, 3-wire, phase sequence insensitive

Options

- Circuit breaker (MCP) disconnect
-
-
-
-
- 3% impedance
- LCD "Alpha" drive keypad
-
-
-
- 3 Contactor Bypass

Bypass Features

- Bypass and Drive are factory assembled, utilizing 2 contactors with Electronic Control System
- NEMA 1 metal enclosure standard
- Input disconnect switch with a lockable, through-the-door operating mechanism
- Sealed Bypass Control Keypad mounted on front door
- Integrated Drive touchpad control
- Drive Output and Bypass contactors
- Bi-metallic thermal overload relay, provides motor protection in both the "drive" and "bypass" modes
- 120 VAC control power transformer
- Control and safety circuit terminal strip (Selectable for 120 VAC or 24 VDC input)
- Indicator LED's for Control Power, Drive Ready, Drive Run, Drive Selected, Drive Fault, Drive Test, Bypass Selected, Bypass Run, Motor OL, Safety Open, Damper/BAS, Auto Run, Auto/Rem Transfer, Smoke Purge, Hand Mode, Off Mode, and Auto Mode
- 3 programmable Form C contacts (250 VAC, 1 Amp) for: Motor Run, Damper/BAS, Drive Run, Hand Mode, Auto Mode, Bypass Run, Fault or 1 selectable from the drive menu
- Remote Run/Stop via contact closure or serial communication
- Input speed command via 0-10 VDC, 4-20 mA or serial communication
- 2 Programmable analog outputs (0-10 VDC or 4-20 mA)
- Damper control circuit
- Programmable auto transfer to bypass on drive fault
- Remote transfer to bypass via contact closure
- Smoke purge function via contact closure
- Safety (freezestat, firestat, duct pressure, etc.) interlock
- Building Automation System (BAS) interlock

◆ Dimensions and Weights

Table 1.5 Bypass Dimensions and Weights

Rated Input Voltage	Continuous Output Current (Amps)	Nominal HP[1]	Bypass E7N-	NEMA 1 Dimensions inches (mm) Height[2]	Width	Depth	Wall Mounting Dimensions H x W	Drawing Number	Weight (lbs)[3]
208V	2.4	1/2	D002	41.43 (1052.3)	8.38 (212.9)	11.5 (292.1)	40.29" H 7.14" W	DD.E7N.203.01	70 lbs
	3.5	3/4	D003						
	4.6	1	D004						
	7.5	2	D007						
	10.6	3	D010						
	16.7	5	D016						
	24.2	7.5	D024						
	30.8	10	D030						
	46.2	15	D046	52.38 (1330.4)	15.43 (391.9)	14.25 (361.9)	51.27" H 12.39" W	DD.E7N.255.01	150 lbs
	59.4	20	D059						
	74.8	25	D074						
480V	1.1	1/2	B001	41.43 (1052.3)	8.38 (212.9)	11.5 (292.1)	40.29" H 7.14" W	DD.E7N.203.01	70 lbs
	1.6	3/4							
	2.1	1	B002						
	3.4	2	B003						
	4.8	3	B004						
	7.6	5	B007						
	11	7.5	B011						
	14	10	B014						
	21	15	B021						
	27	20	B027						
	34	25	B034	52.38 (1330.4)	15.43 (391.9)	14.25 (361.9)	51.27" H 12.39" W	DD.E7N.255.01	150 lbs
	40	30	B040						
	52	40	B052						
	65	50	B065						

4-P1, P2, P5 THRU P8

4-RF1, RF2

4-P3, P4

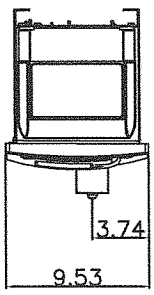
4-SF1, SF2

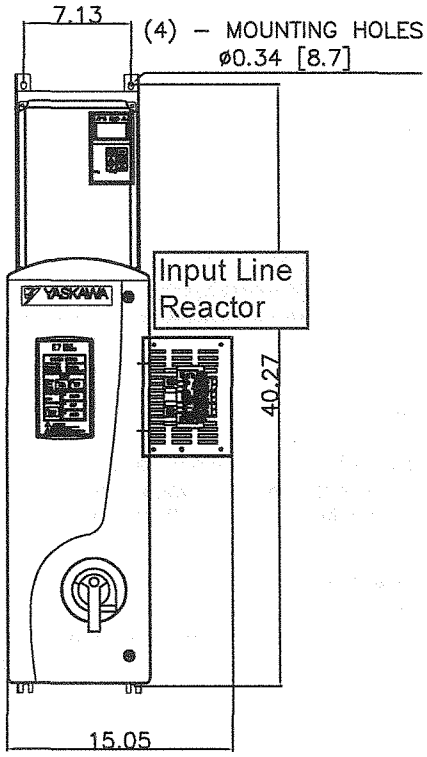
(1) Horsepower rating is based on standard NEMA B 4-pole motor design

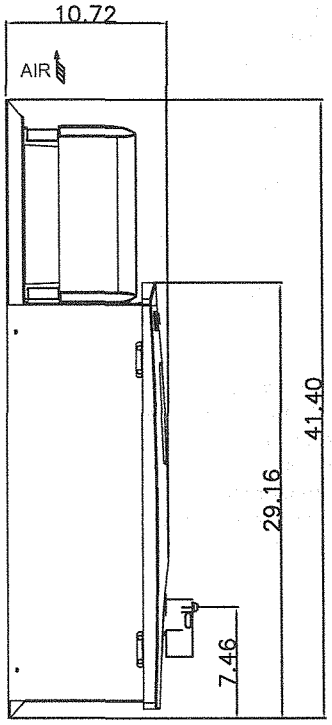
(2) Height dimension includes the mounting screw tabs.

(3) Data represents the total weight of the drive with all possible standard options, not shipping weight.

FOR REFERENCE ONLY UNLESS PROPERLY ENDORSED



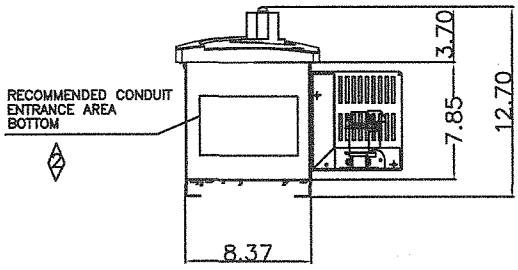




NOTES:

1. LED OPERATOR SHOWN
2. MAXIMUM DIMENSIONS SHOWN WHEN APPLICABLE
3. DIMENSIONS ARE IN inch [mm].

FOR ADDITIONAL DETAILS AND SPECIFICATIONS, CONSULT MANUAL



PROJECT NAME: _____
SYSTEM/TAG #: _____
MODEL #: _____
HP: _____
AMPS: _____
VOLTS: _____
WEIGHT: _____

YASKAWA

DRAWN BY: JJS	DATE: 5/28/08	TITLE: E7N DIMENSION DRAWING	
CHECKED: DC	DATE: 5/28/08		
TECH:	DATE		
APPROVED: J.ZUEHLKE	DATE: 5/28/08	SIZE: C	REVISION: R02 / PAGE: 1 of 1
ORIGINAL DESIGN: J.MATTAS	DATE: 5-15-07	DRAWING #: DD.E7N.203.01	

YASKAWA
The Drive for Quality™

Date	Customer	Job Name	P.O. / S.O.
12-29-2011	McDowall Co.	VAMC St. Cloud Bldg 4	TBD

Variable Frequency Drive (VFD)

E7N Mechanical Specifications Submittal

GENERAL

The E7 is a high performance PWM (pulse-width-modulated) AC drive. Three-phase input line power is converted to a sine-coded, variable frequency output, which provides optimum speed control of any conventional squirrel cage induction motor. The use of IGBTs (Insulated Gate Bipolar Transistors), with a carrier frequency range of 0.4 kHz to 15 kHz, permits quiet motor operation.

This drive has one control logic board for all horsepower ratings. Printed circuit boards employ surface mount technology, providing both high reliability, and small physical size of the printed circuit assemblies. The 32-bit microprocessor delivers the computing power necessary for complete three phase motor control in building automation systems.

Operating Principle: Input three phase AC line voltage is first rectified to a fixed DC voltage. Using pulse width modulation (PWM) inverter technology, the DC voltage is processed, to produce an output waveform in a series of variable-width pulses. Unique firmware algorithms optimize motor magnetization through control of voltage, current and frequency applied to generate a nearly sinusoidal output waveform.

DRIVE STANDARDS

UL 508A (Industrial Control Panel)

CSA 22.2 No. 14-95 (Industrial Control Equipment)

UL 1995 (Plenum)

EN 50178 (LVD)

EN 61800-3

IEC 529

IEEE C62.41

ENVIRONMENTAL & SERVICE CONDITIONS

Ambient service temperature:

NEMA 1 (IP20): -10°C to 40°C (14°F to 104°F)

Ambient storage temperature: -20°C to 60°C (-4°F to 140°F)

Humidity: 0 % to 95 %, non-condensing

Altitude: to 1000 meters (3300 feet), higher by de-rating

Service factor: 1.0

Vibration: 9.81m/s^2 (1 G) maximum at 10 to 20 Hz, 2.0 m/s^2 (0.2 G) at 20 Hz to 50 Hz.

Plenum mounting capable

QUALITY ASSURANCE

In circuit testing of all printed circuit boards is conducted, to ensure proper manufacturing.

Final printed circuit board assemblies are functionally tested, via computerized test equipment.

All fully assembled drives are burned in for 4 hours, at 60°C (140°F).

All fully assembled controls are computer tested with induction motor loads to assure unit specifications are met.

The average MTBF (Mean Time Between Failure) is 28 years

CONSTRUCTION

Input Section - VFD power input stage converts three phase AC line power into a fixed DC voltage, via a solid-state full wave diode rectifier, with MOV (Metal Oxide Varistor) surge protection.

Intermediate Section - DC bus maintains a fixed DC voltage, with filtering and short circuit protection, as a DC supply to the VFD output section. It is interfaced with the VFD diagnostic logic circuit, to continuously monitor and protect the power components.

Output Section - Insulated Gate Bipolar Transistors (IGBTs) convert DC bus voltage to a variable frequency and voltage, utilizing a PWM sine-coded output to the motor. IGBT output, allows motor noise, at 60 Hz., to measure less than 2 dB (@ 1 meter) above that resulting from across the line operation.

Power and control electronics housings:

NEMA 1 (IP20) wall-mounted enclosure:

208 V, 0.5 thru 10 HP

480 V, 0.75 thru 20 HP

Microprocessor based control circuit

Non-Volatile memory (NV RAM); all programming memory is saved when the VFD is disconnected from power.

Three current transformers detect the output current for motor control and protective functions

Surface mount technology, with protective coating

Digital operator keypad and display, with copy function, provides local control and readout capability:

- Speed Reference command
- Reset command
- Programming command

Easy to remove heat sink cooling fan with programmable on/off control

PRODUCT FEATURES

Displacement power factor of .98 throughout the motor speed range

Input phase insensitive; sequencing of the three phase input is unnecessary

Volt meter, ammeter, kilowatt meter elapsed run time meter and heat sink temperature monitoring functions

Setpoint (PI) control – closed loop control

Differential PI feedback feature

Sleep function in both closed loop and open loop control

Feedback signal low pass filter

Feedback signal loss detection and selectable response strategy

Feedback signal inverse and square root capability

Transmitter power supply

Input and output terminal status indication

Diagnostic fault indication

VFD efficiency: 96% at half-speed; 98% at full-speed

"S-curve" soft start

Serial communication loss detection and selectable response strategy

"Up/Down" floating point control capability

Controlled speed range of 40:1

Critical frequency rejection capability: 3 selectable, adjustable bandwidths

100% starting torque capability, available from 3 Hz to 60 Hz

Remote speed reference (speed command) signal:

- 0 to 10 VDC (20 kΩ)
- 4 to 20 mADC (250 Ω)

Adjustable carrier frequency, from 0.4 kHz to 15 kHz

Programmable security code

Adjustable current limit capability: 30 to 180 %

Built-in building automation protocols (Metasys N2 and Siemens FLN) along with Modbus/Memobus. Protocols are accessible via RS-422/485 communication, which is standard.

Stationary motor auto-tuning

"High Slip Braking" (HSB) function stops the drive in up to half the time it would take without this function.

Motor preheat function

Flash upgradeable firmware

Heat sink over temperature speed fold-back feature

Run permissive input

"Bumpless" transfer between Hand and Auto modes

Fan failure detection and selectable drive action

OPERATION

Power loss ride-thru of 2 seconds

Time delay on start, peak avoidance

VFD accepts either a direct-acting or a reverse acting speed command signal

Bi-directional "Speed Search" capability in order to start into a rotating load. Two types: current detection and residual voltage detection

DC injection braking capability, to prevent fan "wind milling"

LED display provides readout functions that include: output frequency, output voltage, output current, output power, DC bus voltage, interface terminal status, PI feedback and fault status.

Over 100 programmable functions, re-settable to factory HVAC presets

User parameter initialization, re-establish project specific parameters

Ramp-to-stop or coast-to-stop selection

Auto restart capability: 0 to 10 attempts with adjustable delay time between attempts

One custom selectable Volts/Hertz pattern and multiple preset Volts/Hertz patterns

Auto speed reference input signal, adjustable for bias and gain

While the VFD is running, operational changes in control and display functions are possible, including:

- Acceleration time (0 to 6000 seconds)
- Deceleration time (0 to 6000 seconds)
- Frequency reference command
- Hand/Off/Auto commands
- Monitor display

Automatic energy saving, reduced voltage operation

PROTECTION

Output current overload rating of 110% of drive's continuous current rating for 60 seconds

Short circuit protection

Current limited stall prevention (overload trip prevention) during acceleration, deceleration, and run conditions

Optically isolated operator controls

Drive Fault display and last 10 faults storage

"Hunting" prevention logic

Electronic ground fault protection

Electronic thermal motor overload protection (UL approved)

Current limiting DC bus fuse

DC bus charge indication

Heat sink over temperature protection

Cooling fan operating hours recorded

Input/Output phase loss protection

Reverse prohibit (selectable)

Drive short circuit withstand rating of 100K amps RMS

BYPASS FEATURES

Bypass and drive are factory assembled, and electrically interlocked, utilizing 2 contactors with Electronic Control System.

NEMA 1 enclosure

Input disconnect switch with a lockable, through-the-door operating mechanism

Sealed Bypass Control Keypad mounted on front door

Drive Output, and Bypass contactors

Thermal overload relay, which provides motor protection in both the "drive" and "bypass" modes

120 VAC fused control power transformer

Control and safety circuit terminal strip (Selectable for 24vdc)

"Bypass Select" Pushbutton

"Hand/Off/Auto" Pushbuttons

"Drive Select/Drive Test" Pushbuttons

Indicator LED's for "Control Power", "Drive Ready", "Drive Run", "Drive Selected", "Drive Fault", "Drive Test", "Bypass Selected", "Bypass Run", "Motor OL", "Safety Open" "Damper Closed", "Auto Run", Auto Transfer", "Smoke Purge", "Hand Mode", "Off Mode", and "Auto Mode".

3 Programmable Form C Contacts (250vac, 1 Amp) for: "Bypass Run", "Damper Actuator Power", "Auto Transfer Enabled", "Drive Run", "Serial Comm. Run", "Hand Mode", "Auto Mode", "System Fault"

Remote Run/Stop via contact closure or serial communication

Input Speed Command via 0-10vdc, 4-20mADC or serial communication

2 Programmable analog outputs (0-10vdc or 4-20 mADC)

Damper Control Circuit

Switch selectable auto transfer to bypass on drive fault

Remote transfer to bypass via contact closure

Switch selectable smoke purge function via contact closure

Safety (Freezestat, Firestat, etc) Interlock

Building Automation System (BAS) Interlock

YASKAWA
The Drive for Quality™

E7N Bypass Options

Variable Frequency Drive (VFD) E7N Mechanical Specification
Products and Options Submitted

[E7N]

ENCLOSURE TYPE

[V] NEMA 1 Enclosure

VOLTAGE

[B] 480 volt model for nominal, 380, 400, 415, 440, 460 or 480 VAC (+10/-15 %); 60 or 50 Hz (+/-5%) systems

MAIN INPUT DISCONNECT

[C] Circuit Breaker Disconnect (Replaces Standard Input Disconnect)

DRIVE INPUT CIRCUIT

[B] 3 Contactor Bypass (Replaces Standard

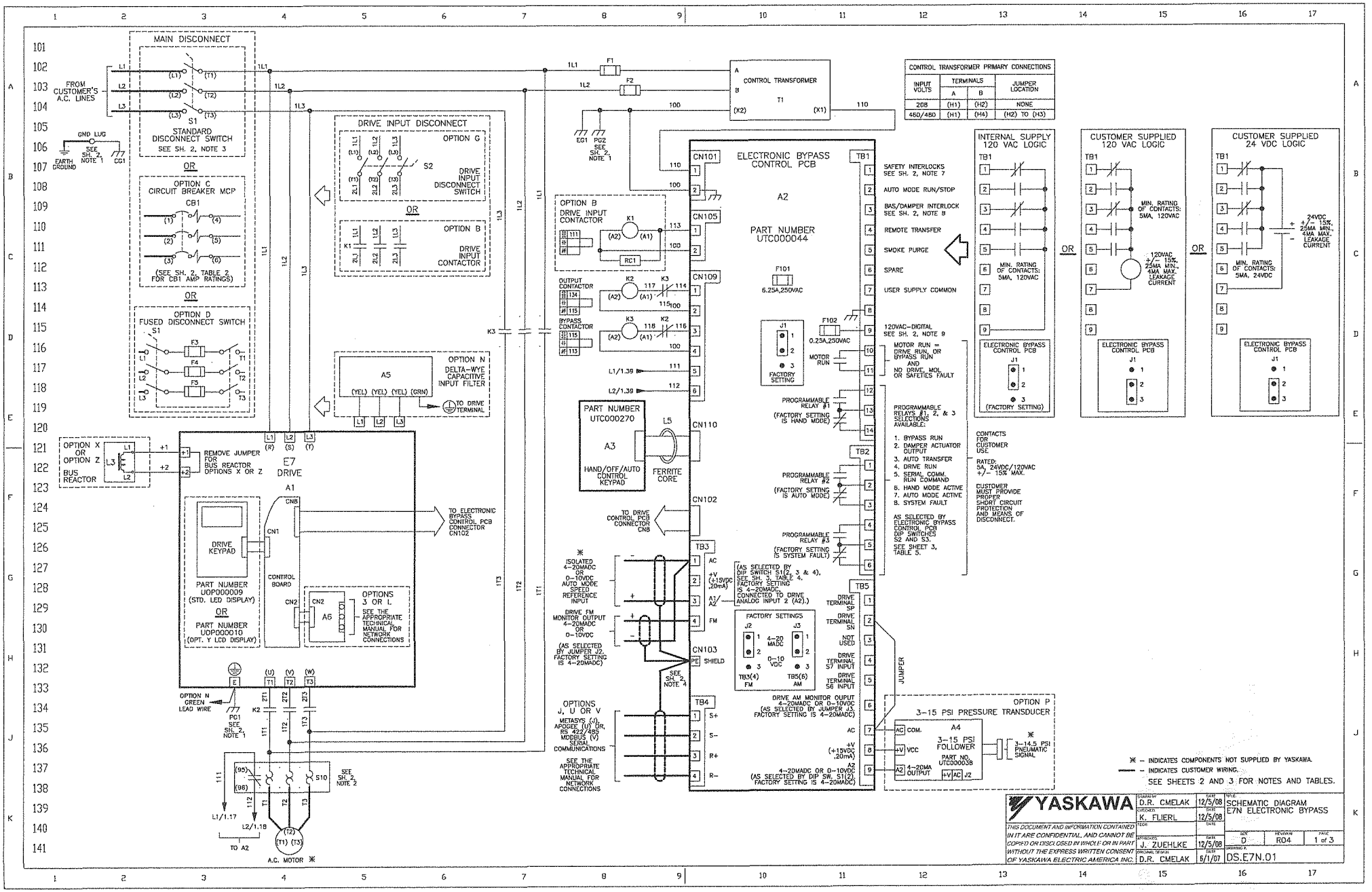
2 Contactor Bypass)

INPUT IMPEDANCE

[X] 3% Input Line Reactor

DRIVE KEYPAD

[Y] LCD Display (Replaces Standard LED Display)



CONTROL TRANSFORMER PRIMARY CONNECTIONS			
INPUT VOLTS	TERMINALS A	TERMINALS B	JUMPER LOCATION
208	(H1)	(H2)	NONE
460/480	(H1)	(H4)	(H2) TO (H3)

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DRAWN BY	D.R. CMELAK	12/5/08
CHECKED	K. FLIERL	12/5/08
TECH		DATE
APPROVED	J. ZUEHLKE	12/5/08
ORIGINAL RELEASE	D.R. CMELAK	6/1/07

TITLE: SCHEMATIC DIAGRAM E7N ELECTRONIC BYPASS

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NOTES:

1. CONNECTED TO THE CABINET. CUSTOMER TO CONNECT THE CABINET GROUND LUG TO EARTH GROUND.
2. THE MOTOR OVERLOAD RELAY IS FACTORY SET FOR MANUAL RESET. CUSTOMER TO ADJUST THE MOTOR OVERLOAD RELAY TRIP SETTING FOR THE ACTUAL AC MOTOR'S FULL LOAD AMPS.
3. WITHOUT THE INPUT CIRCUIT BREAKER MCP OPTION C OR FUSED DISCONNECT SWITCH OPTION D, BRANCH CIRCUIT FUSES MUST BE SUPPLIED BY THE INSTALLER.
4. INSULATED TWISTED SHIELDED WIRE IS REQUIRED. SHIELD TO CONNECT TO PROPER TERMINAL AS SHOWN. CONNECT THE SHIELD ONLY AT THIS END. STUB AND ISOLATE THE OTHER END. DO NOT RUN THESE WIRES IN THE SAME CONDUIT AS THE AC POWER AND THE AC CONTROL WIRES.
5. SERIAL COMMUNICATIONS OPTIONS 3, J, U, V, AND L (SEE TABLE 6 ON SHEET 3):
   OPTION 3 = BACNET, OPTION J = EMBEDDED METASYS N2, OPTION U = EMBEDDED APOGEE FLN, OPTION V = EMBEDDED MODBUS AND OPTION L = LONWORKS
   THE HAND/OFF/AUTO CONTROL KEYPAD MUST BE IN "AUTO" MODE, IF SERIAL COMMUNICATIONS IS TO BE USED TO CONTROL THE DRIVE.
6. THERE MUST BE JUMPERS ADDED TO THE BYPASS CONTROL PCB A2, FROM TERMINAL TB1(12) TO TERMINAL TB5(5), AND FROM TB1(13) TO TB5(2).
7. ON POWER-UP, THIS DRIVE SYSTEM WILL DISPLAY A RED "SAFETY OPEN" LED IN THE "SYSTEM STATUS" AREA OF THE FRONT CONTROL PANEL, IF A NORMALLY CLOSED "SAFETY INTERLOCK" HAS NOT BEEN INSTALLED BETWEEN TB1-1 AND TB1-9 ON THE BYPASS CONTROL PCB A2. THIS CONDITION WILL PREVENT DRIVE OR BYPASS OPERATION.
   ONE OF THE FOLLOWING THREE ITEMS NEEDS TO BE DONE PRIOR TO START-UP:
   A. INSTALL A NORMALLY CLOSED SAFETY CONTACT BETWEEN TB1-1 AND TB1-9 ON PCB A2,
   B. INSTALL A JUMPER BETWEEN TB1-1 AND TB1-9 ON PCB A2, ONLY IF A SAFETY CONTACT WILL BE ADDED LATER IN THE INSTALLATION, OR
   C. DE-ACTIVATE THESE TERMINALS BY MOVING DIP SWITCH S2-7 ON PCB A2 TO THE "ON" POSITION (TOWARDS THE CABINET DOOR). THIS IS TO BE DONE ONLY IF A "SAFETY INTERLOCK" WILL NEVER BE APPLIED TO THIS DRIVE SYSTEM.
8. WHEN A RUN COMMAND IS RECEIVED IN THE HAND OR AUTO MODE, THIS DRIVE SYSTEM WILL DISPLAY A RED "DAMPER/BAS" LED IN THE "SYSTEM STATUS" AREA OF THE FRONT CONTROL PANEL. THIS CONDITION WILL PREVENT DRIVE OR BYPASS OPERATION.
   ONE OF THE FOLLOWING THREE ITEMS NEEDS TO BE DONE PRIOR TO START-UP:
   A. INSTALL A NORMALLY OPEN BAS (BUILDING AUTOMATION SYSTEM) INTERLOCK, OR NORMALLY OPEN DAMPER END SWITCH, BETWEEN TB1-3 AND TB1-9 ON THE BYPASS CONTROL PCB A2,
   B. INSTALL A JUMPER BETWEEN TB1-3 AND TB1-9 ON PCB A2, ONLY IF A BAS INTERLOCK, OR DAMPER END SWITCH, WILL BE ADDED LATER IN THE INSTALLATION, OR
   C. DE-ACTIVATE THESE TERMINALS BY MOVING DIP SWITCH S2-8 ON PCB A2 TO THE "ON" POSITION (TOWARDS THE CABINET DOOR). THIS IS TO BE DONE ONLY IF A "BAS INTERLOCK", OR DAMPER END SWITCH, WILL NEVER BE APPLIED TO THIS DRIVE SYSTEM.
9. TERMINAL TB1(9) OF THE ELECTRONIC BYPASS CONTROL PCB IS ONLY FOR USE IN THE "INTERNAL SUPPLY 120VAC LOGIC" CONNECTION DIAGRAM SHOWN ON SHEET 1.

TABLE 1 FACTORY SET DRIVE PARAMETERS

PARAMETER	DATA	UNIT	DESCRIPTION/REMARKS
b1-01	SEE TABLE 6	N/A	FREQUENCY REFERENCE SELECTION
b1-08	1	N/A	RUN COMMAND SELECTION DURING PROGRAMMING - ENABLED
b2-03	0.0	SEC.	DC INJECTION BRAKING TIME AT START
b5-01	SEE TABLE 6	N/A	PI MODE SETTING
d1-01	10.0	HZ.	FREQUENCY REFERENCE 1 - SEE TABLE 6
d1-02	6.0	HZ.	FREQUENCY REFERENCE 2 - SEE TABLE 6
E1-01	480	VOLTS	STANDARD INPUT VOLTAGE SETTING
	208		INPUT VOLTAGE SETTING FOR BASE NUMBER "D___"
E1-05	460	VOLTS	STANDARD MAXIMUM OUTPUT VOLTAGE SETTING
	208		MAXIMUM OUTPUT VOLTAGE SETTING FOR BASE NUMBER "D___"
F6-02	SEE TABLE 6	N/A	SERIAL COMMUNICATIONS EXTERNAL FAULT DETECTION SELECTION
F6-03	SEE TABLE 6	N/A	SERIAL COMMUNICATIONS EXTERNAL FAULT STOPPING METHOD SELECTION
H1-01	70	N/A	TERMINAL S3 SET FOR BYPASS DRIVE ENABLE
H1-02	SEE TABLE 6	N/A	TERMINAL S4 SELECTION
H1-03	SEE TABLE 6	N/A	TERMINAL S5 SELECTION
H1-04	SEE TABLE 6	N/A	TERMINAL S6 SELECTION
H2-02	3B	N/A	TERMINALS M3-M4 SET FOR SERIAL COMM. RUN COMMAND
H3-08	SEE TABLE 6	N/A	TERMINAL A2 SIGNAL SELECTION
H3-09	SEE TABLE 6	N/A	TERMINAL A2 FUNCTION SELECTION
H5-02	SEE TABLE 6	N/A	SERIAL COMMUNICATIONS SPEED SELECTION BAUD RATE
H5-07	SEE TABLE 6	N/A	REQUEST TO SEND (RTS) CONTROL SELECTION
H5-08	SEE TABLE 6	N/A	SERIAL COMMUNICATIONS PROTOCOL SELECTION
H5-09	10.0	SEC.	SERIAL COMMUNICATIONS ERROR DETECTION TIME
L4-05	0	N/A	FREQUENCY REFERENCE LOSS DETECTION DISABLED
L5-01	10	N/A	NUMBER OF AUTO RESTART ATTEMPTS
L5-03	10.0	SEC.	MAXIMUM RESTART TIME AFTER FAULT
o2-01	0	N/A	DRIVE DIGITAL OPERATOR KEYPAD "LOCAL/REMOTE" KEY DISABLED, WITH STD. LED STYLE KEYPAD
o2-02	0	N/A	DRIVE DIGITAL OPERATOR KEYPAD "OFF", OR "STOP", KEY DISABLED
o2-03	1	N/A	USER INITIALIZATION FACTORY SET PARAMETER DEFAULT VALUES (FOUND IN A1-03="1110") (PROGRAM LAST)
o2-15	0	N/A	DRIVE DIGITAL OPERATOR KEYPAD "HAND" KEY DISABLED, WITH OPTION Y LCD STYLE KEYPAD
o3-02	1	N/A	DRIVE DIGITAL OPERATOR KEYPAD READ ALLOWED ENABLED

CUSTOMER WIRING REQUIREMENTS

- FOR 0 TO 100 AMPS, USE A MINIMUM OF 60°-75°C COPPER WIRE.
- FOR ABOVE 100 AMPS, USE A MINIMUM OF 75°C COPPER WIRE.

TABLE 2 A.C. LINE WIRING

E7 BYPASS MODEL NO. BASE NUMBER E7NVXXXX		OPTION C INPUT CIRCUIT BREAKER MCP				OPTION D FUSED INPUT DISCONNECT SWITCH			STANDARD NON-FUSED INPUT DISCONNECT SWITCH		
208V	480V	MFG. PART NUMBER	CURRENT RATING (AMPS)	WIRE SIZE RANGE (AWG)	TIGHTENING TORQUE (LB.-IN.)	MFG. PART NUMBER	WIRE SIZE RANGE (AWG)	TIGHTENING TORQUE (LB.-IN.)	MFG. PART NUMBER	WIRE SIZE RANGE (AWG)	TIGHTENING TORQUE (LB.-IN.)
	B001	FAL36003	3	14 - 4	35	CFD30J3	18 - 8	17	V0	14 - 8	19
D002	B002	FAL36007	7								
D003	B003										
D004	B004										
D007	B007	FAL36015	15								
D010	B011										
	B014	FAL36030	30								
D016		FAL36030	30	14 - 4	35	CFD30J3	18 - 8	17	V3	12 - 6	40
	B021	FAL36030	30	14 - 4	35	CFD60J3	14 - 4	30			
D024	B027	FAL36050	50	14 - 1/0	80						
D030									V4	6 - 2	50
	B034	FAL36050	50			GS1GU3	10 - 3	58			
	B040	FAL36100	100			GS1JU3	14 - 2/0	120			
D046	B052								V5	8 - 2/0	200
D059											
	B065					GS1MU3	6 - 3/0	200			
D074		KAL36150	150	4 - 350 kcmil	250				V6		

TABLE 3

E7 BYPASS MODEL NO. BASE NUMBER E7NVXXXX		A.C. MOTOR WIRING MOTOR OVERLOAD RELAY			EARTH GND. WIRING GROUND LUG		CONTROL WIRING TERMINAL BLOCKS TB1 - TB5	
208V	480V	MFG. PART NUMBER	WIRE SIZE RANGE (AWG)	TIGHTENING TORQUE (LB.-IN.)	WIRE SIZE RANGE (AWG)	TIGHTENING TORQUE (LB.-IN.)	WIRE SIZE RANGE (AWG)	TIGHTENING TORQUE (LB.-IN.)
	B001	LRD06	18 - 8	15	14 - 10	35	22 - 14	4.4
D002	B002	LRD07						
D003	B003	LRD15						
D004	B004				OR	OR		
D007	B007							
D010	B011							
D016	B014				8	40		
D024	B021							
D030	B027							
D046	B034	LR2 D35	10 - 1/0	100	OR	OR		
D059	B040							
D074	B052							
	B065				6 - 4	45		

SEE SHEET 3 FOR TABLES 4, 5 AND 6.

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DRAWN BY	D.R. CMELAK	12/5/08
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TECH		DATE
APPROVED	J. ZUEHLKE	12/5/08
ORIGINAL RELEASE	D.R. CMELAK	5/1/07

TITLE: SCHEMATIC DIAGRAM E7N ELECTRONIC BYPASS

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ELECTRONIC BYPASS CONTROL PCB DIP SWITCH SETTINGS

TABLE 4

DIP SWITCH	POS.	DESCRIPTION	SETTINGS ON	SETTINGS OFF	FACTORY SETTING
S1	1	SERIAL COMMUNICATIONS TERMINATING RESISTANCE	IN	OUT	SEE TABLE 6
	2	DRIVE ANALOG INPUT 2 (A2) SIGNAL (H3-08="0", FOR 0-10VDC)	4-20MADC	0-10VDC	ON
	3	TB3(3) CONNECTED TO DRIVE ANALOG INPUT 2 (A2)	YES		ON
	4			YES	OFF
	3	TB3(3) CONNECTED TO DRIVE ANALOG INPUT 1 (A1)		YES	
	4		YES		
S2	1	AUTO TRANSFER TO BYPASS UPON A DRIVE FAULT	ACTIVE	INACTIVE	OFF
	2	POWER UP IN THE "OFF" OR "AUTO" MODE	AUTO	OFF	OFF
	3	POWER UP IN THE MAINTENANCE MODE	ACTIVE	INACTIVE	OFF
	4-6	SEE TABLE 5			
	7	SAFETY INTERLOCKS AT TB1(1) SEE SHEET 2, NOTE 7	INACTIVE	ACTIVE	OFF
	8	BAS/DAMPER INTERLOCKS AT TB1(3) SEE SHEET 2, NOTE 8	INACTIVE	ACTIVE	OFF
S3	1-6	SEE TABLE 5			
S4	1	RESERVED FOR FUTURE EXPANSION MUST BE AT FACTORY SETTING	ACTIVE	INACTIVE	OFF
	2	SPEED COMMAND FROM DRIVE TERMINAL A2, WITH SERIAL COMM.	YES	NO	SEE TABLE 6
	3	RESERVED FOR FUTURE EXPANSION MUST BE AT FACTORY SETTING	ACTIVE	INACTIVE	OFF
	4	RESERVED FOR FUTURE EXPANSION MUST BE AT FACTORY SETTING	ACTIVE	INACTIVE	OFF
	5	RESERVED FOR FUTURE EXPANSION MUST BE AT FACTORY SETTING	ACTIVE	INACTIVE	OFF
	6	RESERVED FOR FUTURE EXPANSION MUST BE AT FACTORY SETTING	ACTIVE	INACTIVE	OFF

TABLE 5

NO.	FUNCTION	PROGRAMMABLE RELAY 1 S2(6)	S2(5)	S2(4)	PROGRAMMABLE RELAY 2 S3(3)	S3(2)	S3(1)	PROGRAMMABLE RELAY 3 S3(6)	S3(5)	S3(4)	ACTIVE	DESCRIPTION
1	BYPASS RUN	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	HIGH	RUNNING IN BYPASS MODE
2	DAMPER COIL	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	ON	HIGH	DAMPER COIL ACTIVATION
3	AUTO TRANSFER	OFF	ON	OFF	OFF	ON	OFF	OFF	ON	OFF	HIGH	AUTO-TRANSFER IS ACTIVE
4	DRIVE RUN	OFF	ON	ON	OFF	ON	ON	OFF	ON	ON	HIGH	DRIVE IS IN THE RUN MODE
5	SERIAL COMM. RUN	ON	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF	HIGH	SERIAL COMM. RUN COMMAND
6	HAND MODE	ON	OFF	ON	ON	OFF	ON	ON	OFF	ON	HIGH	MANUAL MODE OPERATION
7	AUTO MODE	ON	ON	OFF	ON	ON	OFF	ON	ON	OFF	HIGH	AUTO MODE OPERATION
8	SYSTEM FAULT	ON	ON	ON	ON	ON	ON	ON	ON	ON	LOW	DRIVE, MOTOR OR CONTROL FAULT
FACTORY SETTINGS		ON	OFF	ON	ON	ON	OFF	ON	ON	ON		

TABLE 6 DRIVE OPERATION MODE SELECTION

OPTION PRESENT	FACTORY SET E7N BYPASS DRIVE PARAMETERS b1-01	b5-01	F6-02	F6-03	H1-02 (S4)	H1-03 (S5)	H1-04 (S6)	H3-08	H3-09	H5-02	H5-07	H5-08	BYPASS CONTROL PCB DIP SWITCH SETTINGS S1 1	S1 2	S4 2	DRIVE MODE SPEED COMMAND HAND MODE DRIVE KEYPAD d1-01	d1-02	AUTO MODE DRIVE TERMINAL A2 SIGNAL LEVEL VIA TB3(3) OR TB5(9) 4-20 MADC	0-10 VDC	LEVEL VIA TB5(9) 3-15 PSI	SERIAL COMM.	SEE SH. 2, NOTE	DRIVE MODE PI CONTROL HAND MODE SPEED CMD. DRIVE KEYPAD d1-01	AUTO MODE SETPOINT DRIVE KEYPAD d1-01	SERIAL COMM.	FEEDBACK DRIVE TERMINAL A2 SIGNAL LEVEL VIA TB3(3) OR TB5(9) 4-20 MADC	0-10 VDC	RUN/STOP CONTROL (SEE SHEET 2, NOTE 8) HAND MODE DRIVE	BYPASS	AUTO MODE DRIVE	BYPASS
NONE +	1 *	0 *	0 *	1 *	14 *	3 *	4 *	2 *	0	3 *	1 *	0 *	OFF *	ON *	OFF *		YES	YES														AUTO MODE RUN/STOP CONTACT AT TB1(2) AND BAS/DAMPER INTERLOCK AT TB1(3)
NONE	1 *	0 *	0 *	1 *	14 *	3 *	4 *	0	0	3 *	1 *	0 *	OFF *	OFF	OFF *		YES		YES												
P	1 *	0 *	0 *	1 *	14 *	3 *	4 *	2 *	0	3 *	1 *	0 *	OFF *	ON *	OFF *		YES			YES											
3 +	0	0 *	1	3	14 *	6C	4 *	2 *	2 *	3 *	1 *	0 *	OFF *	ON *	OFF *	YES					YES	5									SERIAL COMMUNICATIONS AND BAS/DAMPER INTERLOCK AT TB1(3)
3	0	0 *	1	3	3	6C	4 *	0	2 *	3 *	1 *	0 *	OFF *	OFF	ON	YES			YES			5									
3 AND P	0	0 *	1	3	3	6C	4 *	2 *	2 *	3 *	1 *	0 *	OFF *	ON *	ON	YES				YES		5									
J +	0	0 *	0 *	1 *	14 *	6C	4 *	2 *	2 *	3 *	1 *	1	OFF *	ON *	OFF *	YES					YES	5									
J	0	0 *	0 *	1 *	3	6C	4 *	0	2 *	3 *	1 *	1	OFF *	OFF	ON	YES			YES			5									
J AND P	0	0 *	0 *	1 *	3	6C	4 *	2 *	2 *	3 *	1 *	1	OFF *	ON *	ON	YES				YES		5									
U +	0	0 *	0 *	1 *	14 *	6C	4 *	2 *	2 *	2	1 *	2	OFF *	ON *	OFF *	YES					YES	5									
U	0	0 *	0 *	1 *	3	6C	4 *	2 *	2 *	2	1 *	2	OFF *	ON *	ON	YES		YES				5									
U AND P	0	0 *	0 *	1 *	3	6C	4 *	2 *	2 *	2	1 *	2	OFF *	ON *	ON	YES				YES		5									
V +	0	0 *	0 *	1 *	14 *	6C	4 *	2 *	2 *	3 *	1 *	0 *	OFF *	ON *	OFF *	YES					YES	5									
V	0	0 *	0 *	1 *	3	6C	4 *	0	2 *	3 *	1 *	0 *	OFF *	OFF	ON	YES			YES			5									
V AND P	0	0 *	0 *	1 *	3	6C	4 *	2 *	2 *	3 *	1 *	0 *	OFF *	ON *	ON	YES				YES		5									
L +	0	0 *	0 *	1 *	14 *	6C	4 *	2 *	2 *	3 *	0	0 *	ON	ON *	OFF *	YES					YES	5									
L	0	0 *	0 *	1 *	3	6C	4 *	0	2 *	3 *	0	0 *	ON	OFF	ON	YES			YES			5									
L AND P	0	0 *	0 *	1 *	3	6C	4 *	2 *	2 *	3 *	0	0 *	ON	ON *	ON	YES				YES		5									
PI CONTROL	0	1	0 *	1 *	14 *	19	4 *	2 *	B	3 *	1 *	0 *	OFF *	ON *	OFF *								YES	YES		YES					AUTO MODE RUN/STOP CONTACT AT TB1(2) AND BAS/DAMPER INTERLOCK AT TB1(3)
PI CONTROL	0	1	0 *	1 *	14 *	19	4 *	0	B	3 *	1 *	0 *	OFF *	OFF	OFF *								YES	YES			YES				
3 AND PI	0	1	1	3	14 *	6C	19	0	B	3 *	1 *	0 *	OFF *	OFF	OFF *							5,6	YES		YES		YES				SERIAL COMMUNICATIONS AND BAS/DAMPER INTERLOCK AT TB1(3)
J AND PI	0	1	0 *	1 *	14 *	6C	19	0	B	3 *	1 *	1	OFF *	OFF	OFF *							5,6	YES		YES		YES				
U AND PI	0	1	0 *	1 *	14 *	6C	19	0	B	2	1 *	2	OFF *	OFF	OFF *							5,6	YES		YES		YES				
V AND PI	0	1	0 *	1 *	14 *	6C	19	0	B	3 *	1 *	0 *	OFF *	OFF	OFF *							5,6	YES		YES		YES				
L AND PI	0	1	0 *	1 *	14 *	6C	19	0	B	3 *	0	0 *	ON	OFF	OFF *							5,6	YES		YES		YES				

HAND/OFF/AUTO CONTROL KEYPAD IN THE "HAND" MODE AND BAS/DAMPER INTERLOCK AT TB1(3)

+ = STANDARD E7N BYPASS SET UP

* = FACTORY 2-WIRE INITIALIZATION/DEFAULT SETTING

SEE SHEET 2 FOR NOTES, AND TABLES 1, 2 AND 3.

YASKAWA

DRAWN BY: D.R. CMELAK	DATE: 12/5/08	TITLE: SCHEMATIC DIAGRAM E7N ELECTRONIC BYPASS
CHECKED: K. FLIERL	DATE: 12/5/08	
TECH:	DATE:	
APPROVED: J. ZUEHLKE	DATE: 12/5/08	SIZE: D / REVISION: R04 / PAGE: 3 of 3
ORIGINAL RELEASE: D.R. CMELAK	DATE: 6/1/07	DRAWING #: DS.E7N.01

A70 Series

Four-Wire, Two-Circuit Temperature Control

Description

The A70 Series temperature control incorporates a vapor-charged sensing element. The A70G, A70H, and A70K have a 4-wire, 2-circuit contact block that contains two isolated sets of contacts.

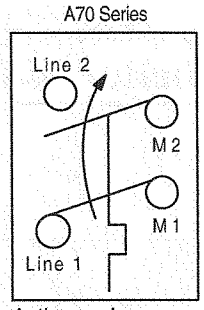
The contacts are designed so that when the main contact opens, the auxiliary contact closes.

Features

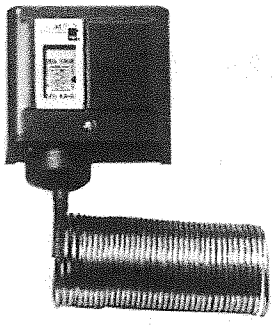
- long-life, snap-acting contacts
- automatic or manual reset models

Applications

Typical applications include energizing an indicator light after a low temperature cutout on a ventilating system.



A70 Series Action Diagram



A70GA-1

Selection Charts

A70 Series Four-Wire, Two-Circuit Temperature Control

Code Number	Switch Action		Range °F (°C)	Diff F° (C°)	Bulb and Capillary	Max Bulb Temp °F (°C)	Range Adjuster
	Main Contacts	Auxiliary Contacts					
A70GA-1C[1]	Open Low	Close Low	15 to 55 (-9.4 to 12.8)	5 (2.8)	20 ft of 1/8 in. O.D. Tubing	400 (204.4)	Screwdriver slot
A70GA-2C			35 to 80 (1.7 to 26.7)	3 to 30 (-16.1 to -1.1), factory set at 12 (-11.1)	3/8 in. x 3 in. 6 ft Cap.	250 (121)	
A70HA-1C[1]			15 to 55 (-9.4 to 12.8)	Manual reset	20 ft of 1/8 in. O.D. Tubing	400 (204.4)	
A70HA-2C			35 to 80 (1.7 to 26.7)		3/8 in. x 3 in. 6 ft Cap.	250 (121)	
A70HA-14C			15 to 55 (-9.4 to 12.8)		20 ft of 1/8 in. O.D. Tubing	400 (204.4)	
A70KA-1C	Open High	Close High	100 to 170 (37.8 to 76.7)		3/8 in. x 3 in. 6 ft Cap.	240 (116)	

1. On these models, the low cutout stop is set and sealed at 35°F (1.6°C). It cannot be set lower. The control responds only to the lowest temperature along any 14 to 16 in. section of the entire 20 ft element.

Replacement Covers

Code Number	Description
CVR17A-620R	Automatic reset cover
CVR17A-621R	Manual reset cover

Technical Specifications

Electrical Ratings

Pole Number	LINE-M2 (Main)						LINE-M1 (Auxiliary)			
Motor Ratings VAC	120	208	240	277	480[1]	600[1]	120	208	240	277
AC Full Load A	16.0	9.2	8.0	—	5.0	4.8	6.0	3.4	3.0	—
AC Locked Rotor A	96.0	55.2	48.0	—	30.0	28.8	36.0	20.4	18.0	—
AC Non-Inductive A	16.0	9.2	8.0	7.2	—	—	6.0	6.0	6.0	6.0
Pilot Duty – Both Poles	125 VA, 120 to 600 VAC and 57.5 VA, 120 to 300 VDC									

1. Not compressor motor loads.

Cleveland Controls
Division of UniControl Inc.

Model AFS–460

Air Pressure Sensing Switch with Manual Reset Feature

Application

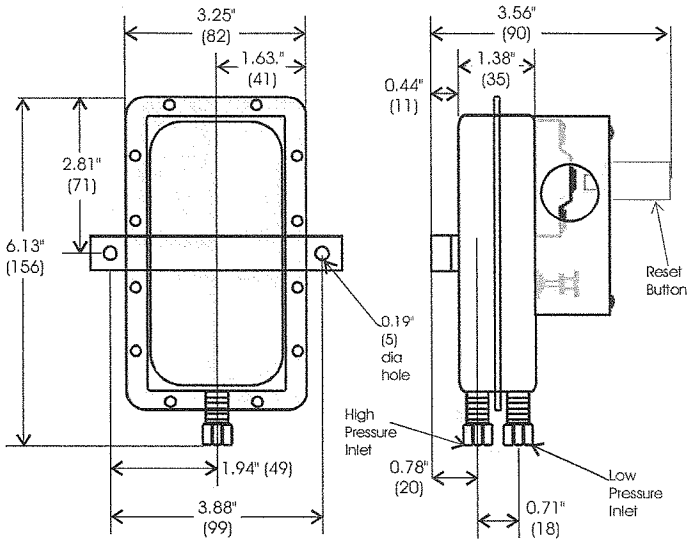
The **Model AFS-460** is a general purpose proving switch designed to require manual operator reset following actuation. It can be used to sense positive, negative, or differential air pressure in HVAC and Energy Management applications which require operator interface.

General Description & Operation

The plated housing contains a diaphragm, a calibration spring and a snap-acting SPST–NC switch with manual reset button.

The sample connections located on each side of the diaphragm accept 0.25" OD metallic tubing via the integral compression ferrule and nut.

An enclosure cover protects the operator from accidental contact with the live switch terminal screws and the set point adjusting screw. The enclosure cover accepts a 0.5" conduit connection.



Dimensions in Inches (Millimeters)

Mounting (see Figure 1)

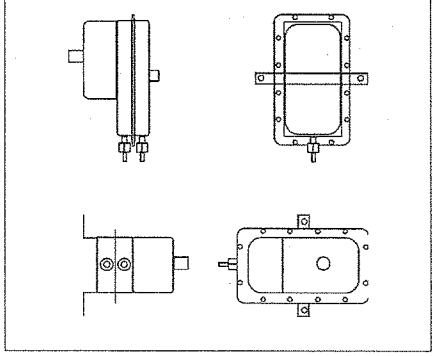
Select a mounting location which is free from vibration. The **AFS-460** must be mounted with the diaphragm in any vertical plane in order to obtain the lowest specified operating set point. Avoid mounting with the sample line connections in the "up" position. Surface mount via the two 3/16" diameter holes in the integral mounting bracket. The mounting holes are 3–7/8" apart.

Air Sampling Connection (see Figure 2)

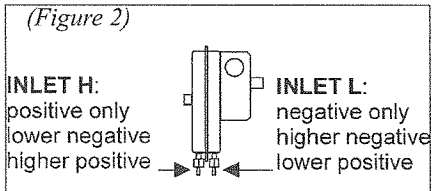
The **AFS-460** is designed to accept firm-wall sample lines of ¼" OD tubing by means of ferrule and nut compression connections. An optional ¼" adapter, suitable for slip-on flexible tubing is available: order part number 18311. For sample lines of up to 10 feet, ¼" OD tubing is acceptable. For lines up to 20 feet, use ¼" ID tubing.

For lines up to 60 feet, use ½" ID tubing. Locate the sampling probe a minimum of 1.5 duct diameters downstream from the air source. Install the sampling probe as close to the center of the airstream as possible. Refer to Figure 2 to identify the high pressure inlet (H) and the low pressure inlet (L). Select one of the five application options listed on page 2, and connect the sample lines as recommended.

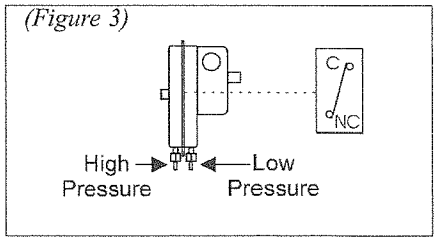
(Figure 1)



(Figure 2)

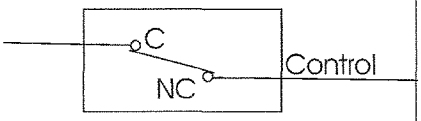


(Figure 3)



(Figure 4)

To prove excessive or insufficient air flow or pressure.



POSITIVE PRESSURE ONLY: Connect the sample line to inlet H; inlet L remains open to the atmosphere.

NEGATIVE PRESSURE ONLY: Connect the sample line to inlet L; inlet H remains open to the atmosphere.

TWO NEGATIVE SAMPLES: Connect the higher negative sample to inlet L. Connect the lower negative sample to inlet H.

TWO POSITIVE SAMPLES: Connect the higher positive sample to inlet H. Connect the lower positive sample to inlet L.

ONE POSITIVE AND ONE NEGATIVE SAMPLE: Connect the positive sample to inlet H. Connect the negative sample to inlet L.

Electrical Connections (see Figure 3)

Before pressure is applied to the diaphragm, the switch contacts will be in the normally closed (NC) position.

The snap switch has screw top terminals with cup washers. Wire alarm and control applications as shown in **Figure 4**.

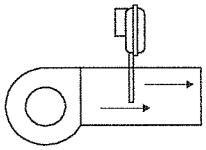
Field Adjustment

The adjustment range of an **AFS-460** Air Switch is 0.4" ± 0.02" w.c. to 12.0" w.c. To adjust the set point, turn the adjusting screw counterclockwise until motion has stopped. Next, turn the adjusting screw four complete turns in a clockwise direction to engage the spring. From this point, the next ten turns will be used for the actual calibration. **Each full turn represents approximately 1.16" w.c.**

Please note: To properly calibrate an air switch, a digital manometer or other measuring device should be used to confirm the actual set point.

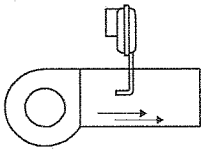
Location of Sample Lines for Typical Applications

FAN OPERATION OR TRUE AIR FLOW WITH LITTLE OR NO STATIC PRESSURE.

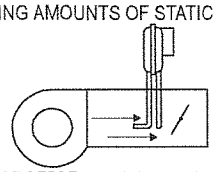


PROBE MUST BE PERPENDICULAR TO FLOW.

FAN OPERATION OR AIR FLOW WITH NO STATIC PRESSURE.

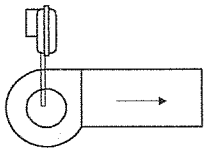


FAN OPERATION AND TRUE AIR FLOW WITH VARYING AMOUNTS OF STATIC PRESSURE.

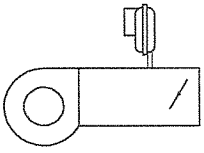


PROBE MUST BE PERPENDICULAR TO FLOW.

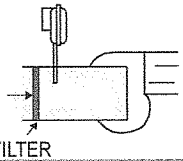
SUCTION OR FAN OPERATION.



PROVE POSITIVE STATIC PRESSURE.



NEGATIVE PRESSURE INCREASES AS FILTER GETS DIRTY.



Specifications

Model AFS-460 Air Pressure Sensing Switch with Manual Reset Feature

Sample Media: Air.
Mounting Position (in order to meet lowest operating specifications): Diaphragm in any vertical plane.
Field Adjustable Range: 0.40 ± 0.06"w.c. to 12.0"w.c.
Switch Differential: Progressive, increasing from approximately 0.06± 0.01"w.c. at minimum set point, to approximately 0.8"w.c. at maximum set point.
Maximum Pressure: 0.5 psi (0.03 bar)
Operating Temperature Range: -40 to 180F (-40.0 to 82.2C)
Life: Exceeds UL-recognized mechanical endurance test of 6,000 cycles minimum at 0.5 psi maximum pressure each cycle and at maximum electrical load.
Electrical Rating: @ 60 Hz.
15 amp 125, 250, or 277 VAC
¼ hp 125 V AC, ½Hp 250 VAC,
½ amp 125 V DC,
¼ amp 250 V DC .
Contact Arrangement: SPST–NC (manual reset).
Electrical Connections: Screw top terminals with cup washers.
Sample Line Connections: Ferrule and nut compression type connectors will accept 0.25" OD rigid tubing.
Shipping Weight: 1.2 lbs.
Approval and Recognition: **UL, CSA, CE.**

Accessories

- **P/N 18311** Slip-on ¼" OD Tubing Adapter, suitable for slipping on flexible plastic tubing.
- Sample line probes.
- Orifice plugs (pulsation dampeners).

Pressure Conversion Table

1" H_2O =0.0361 lbs./sq. in. or 0.0736 in. mercury
1" Hg. = 0.491 lbs./sq. in. or 13.6 in. water
1 psi = 27.7 in. water or 2.036 in. Hg.

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CSD Series Current Devices

Description

The Current Switch Device (CSD) Series of digital output current switches are non-intrusive devices designed to detect current flowing through a cable or wire. A cost-effective solution for monitoring on and off status or proof of operation, these units are ideal for monitoring very small current loads on motors driving fans and blowers, pumps, heating coils, and lighting.

The CSD models with command relays not only monitor the current flowing through the cable but also facilitate the start and stopping of the motor.

These units also provide a universal solid-state output and do not require a power supply. Completely self-powered, these units draw their power from current induced from the cable or line being monitored.

CSD Series Current Devices are available in the following types:

- solid core, setpoint fixed
- solid core, setpoint adjustable
- solid core with command relay, setpoint adjustable
- split core, setpoint fixed
- split core, setpoint adjustable
- split core with command relay, setpoint fixed
- split core with command relay, setpoint adjustable
- 12 VAC/VDC and 24 VAC/VDC accessory command relays

Refer to the *CSD Series Current Devices Product Bulletin (LIT-12011292)* for important product application information.

Features

- dual function — monitors current and motor start and stop
- 100% solid-state output — has no moving parts to fail
- polarity insensitive output — provides easier wiring
- snap-in mounting bracket — simplifies installation
- small size — fits in tight enclosures

Fixed Setpoint Models

CSD-SF0C0-1 (solid core)

- Setpoint fixed at 0.25 A
- Current range — 0.25 to 200 A

CSD-CF0A0-1 (split core)

- Setpoint fixed at 0.15 A
- Current range — 0.15 to 200 A

CSD-CF0J0-1 (split core)

- Setpoint fixed at 1.5 A
- Current range — 1.5 to 200 A

CSD-CF0J1-1 (split core with 24 V command relay)

- Relay Single Pole, Single Throw (SPST), Normally Open (N.O.), 10 A at 260 VAC, 5 A at 30 VDC
- Actuation coil — 20–30 VAC/DC, 40–85 mA maximum
- Setpoint fixed at 1.5 A
- Current range — 1.5 to 200 A

Adjustable Setpoint Models

CSD-SA1E0-1 (solid core)

- Multi-turn potentiometer — adjust setpoint for application
- Adjustable setpoint — wide range from 1.0 to 135 A
- Two status Light-Emitting Diodes (LEDs) — provide visual indication of off and on status

CSD-SA1E1-1 (solid core with 24 V command relay)

- Multi-turn potentiometer — adjust setpoint for application
- Adjustable setpoint — wide range from 1.00 to 135 A
- Relay SPST, N.O., 10 A at 260 VAC, 5 A at 30 VDC
- Actuation coil — 20–30 VAC/DC, 40–85 mA maximum
- Two Status LEDs — provide visual indication of off and on status

CSD-CA1G0-1 (split core)

- Multi-turn potentiometers — adjust setpoint for application
- Two status LEDs — provide visual indication of off and on status
- Adjustable setpoint — wide range from 1.25 to 135 A

CSD-CA1G1-1 (split core with 24 V command relay)

- Multi-turn potentiometers — adjust setpoint for application
- Adjustable setpoint — wide range from 1.25 to 135 A
- Relay SPST, N.O., 10 A at 260 VAC, 5 A at 30 VDC
- Actuation coil — 20–30 VAC/VDC, 40–85 mA maximum
- Two status LEDs — provide visual indication of off and on status

CSD Series Current Device

CSD-SA1E2-1 (solid core with 12 V command relay

- Multi-turn potentiometers — adjust setpoint for application
- Adjustable setpoint — wide range from 1.00 to 135 A
- Relay SPST, N.O., 10 A at 260 VAC, 5 A at 30 VDC
- Actuation coil — 10–14 VAC/VDC, 25–45 mA maximum
- Two status LEDs — provide visual indication of off and on status

Repair Information

If the CSD Series Current Device fails to operate within its specifications, replace the unit. For a replacement CSD Series Current Device, contact the nearest Johnson Controls® representative.

CSD Series Current Devices (Continued)

Selection Chart

Code Number	Core Type	Setpoint Threshold	LED Display	Low Setpoint (Amperes)	Output Relay
CSD-SF0C0-1	Solid	Fixed	No	0.25	No
CSD-SA1E0-1	Solid	Adjustable	Yes	1.00	No
CSD-SA1E1-1	Solid	Adjustable	Yes	1.00	24 V SPST, N.O. 10 A at 260 VAC, 5 A at 30 VDC
CSD-SA1E2-1	Solid	Adjustable	Yes	1.00	12 V SPST, N.O. 10 A at 260 VAC, 5 A at 30 VDC
CSD-CF0A0-1	Clamp/Split	Fixed	No	0.15	No
CSD-CF0J0-1	Clamp/Split	Fixed	No	1.5	No
CSD-CA1G0-1	Clamp/Split	Adjustable	Yes	1.25	No
CSD-CF0J1-1	Clamp/Split	Fixed	No	1.5	24 V SPST, N.O. 10 A at 260 VAC, 5 A at 30 VDC
CSD-CA1G1-1	Clamp/Split	Adjustable	Yes	1.25	24 V SPST, N.O. 10 A at 260 VAC, 5 A at 30 VDC

Accessories (Order Separately)

Product Code Number	Product Code Description
CR-01200-0[1]	12 VAC/VDC SPST, N.O. Relay
CR-02400-0[1]	24 VAC/VDC SPST, N.O. Relay

1. Refer to the *Command Relay Installation Instructions (Part No.24-10345-50)* for more information regarding the command relays.

Technical Specifications

Solid Core Models					
		CSD-SF0C0-1	CSD-SA1E0-1	CSD-SA1E1-1	CDS-SA1E2-1
Amperage Range		0.25–200 A	1.00–135 A	1.00–135 A	1.00–135 A
Switch Setpoint		Fixed	Adjustable	Adjustable	Adjustable
Output Relay		No	No	24 V SPST, N.O. 10 A at 260 VAC, 5 A at 30 VDC	12 V SPST, N.O. 10 A at 260 VAC, 5 A at 30 VDC
Actuation Coil		No	No	20–30 VAC/VDC, 40–85 mA Maximum	10–14 VAC/VDC, 25–45 mA Maximum
Switch LED Indication		No	Yes	Yes	Yes
Relay LED Indication		No	No	Yes	Yes
Trip Setpoint Value		0.25 A	1.00 A	1.00–135 A	
Current Switching Mode		Under Current Sensing	Over/Under Current Sensing	Over/Under Current Sensing	
Sensor Supply Voltage		Induced from power conductor cable.			
Wire Size		2.1–0.6 mm (12–22 AWG) Diameter			
Status Output		Switch normally open.			
Switch Load Capacity		1 A at 30 VAC/42 VDC Maximum			
Isolation Voltage		600 VAC rms			
Temperature Range		-15 to 60°C (5 to 140°F)			
Frequency Range		50/60 Hz			
Humidity Range		0–95% Noncondensing			
Screw Torque		0.5 N·m (4 lb·in.)			
Dimensions		65 x 47 x 25 mm (2-9/16 x 1-7/8 x 1 in.)		65 x 65 x 40 mm (2-9/16 x 2-9/16 x 1-19/32 in.)	
Aperture (Sensing Hole) Size		18 mm Diameter (0.71 in. Diameter)			
Compliance	United States	UL Listed, File E310692, CCN NRNT, Under UL 508, Industrial Control Equipment			
	Canada	UL Listed, File E310692, CCN NRNT7, Under CAN/CSA C22.2 No. 14-M91 Industrial Control Equipment			
CE	Europe	CE Mark – Johnson Controls, Inc., declares that this product is in compliance with the essential requirements and other relevant provisions of the EMC Directive 2004/108/EC and the Low Voltage Directive 2006/95/EC.			
Shipping Weight		0.16 kg (0.35 lb)			

CSD Series Current Devices (Continued)

Split Core Models					
		CSD-CF0A0-1/ CSD-CF0J0-1	**CSD-CA1G0-1**	**CSD-CF0J1-1**	**CSD-CA1G1-1**
Amperage Range		0.15–200 A/ 1.5–200 A	1.25–135 A	1.5–200 A	1.25–135 A
Switch Setpoint		Fixed	Adjustable	Fixed	Adjustable
Output Relay		No	No	24 V SPST, N.O. 10 A at 260 VAC, 5 A at 30 VDC	24 V SPST, N.O. 10 A at 260 VAC, 5 A at 30 VDC
Actuation Coil		No	No	20–30 VAC/VDC, 40–85 mA Maximum	20–30 VAC/VDC, 40–85 mA Maximum
Switch LED Indication		No	Yes	No	Yes
Relay LED Indication		No	No	Yes	Yes
Trip Setpoint Value		0.15 A/1.5 A	1.25–135 A	1.5 A	1.25–135 A
Current Switching Mode		Under Current Sensing	Over/Under Current Sensing	Under Current Sensing	Over/Under Current Sensing
Sensor Supply Voltage		Induced from power conductor cable.			
Wire Size		2.1–0.6 mm (12–22 AWG) Diameter Recommended			
Status Output		Switch normally open.			
Switch Load Capacity		1 A at 30 VAC/42 VDC Maximum			
Isolation Voltage		600 VAC rms			
Temperature Range		-15 to 60°C (5 to 140°F)			
Frequency Range		50/60 Hz			
Humidity Range		0–95% Noncondensing			
Screw Torque		0.5 N·m (4 lb·in.)			
Dimension		69 x 65 x 27 mm (2-23/32 x 2-9/16 x 1-1/16 in.)		69 x 65 x 44 mm (2-23/32 x 2-9/16 x 1-3/4 in.)	
Aperture (Sensing Hole) Size		18 x 20 mm Diameter (0.72 x 0.78 in. Diameter)			
Compliance	**United States**	UL Listed, File E310692, CCN NRNT, Under UL 508, Industrial Control Equipment			
	Canada	UL Listed, File E310692, CCN NRNT7, Under CAN/CSA C22.2 No. 14-M91 Industrial Control Equipment			
CE	**Europe**	CE Mark – Johnson Controls, Inc., declares that this product is in compliance with the essential requirements and other relevant provisions of the EMC Directive 2004/108/EC and the Low Voltage Directive 2006/95/EC.			
Shipping Weight		0.16 kg (0.35 lb)			

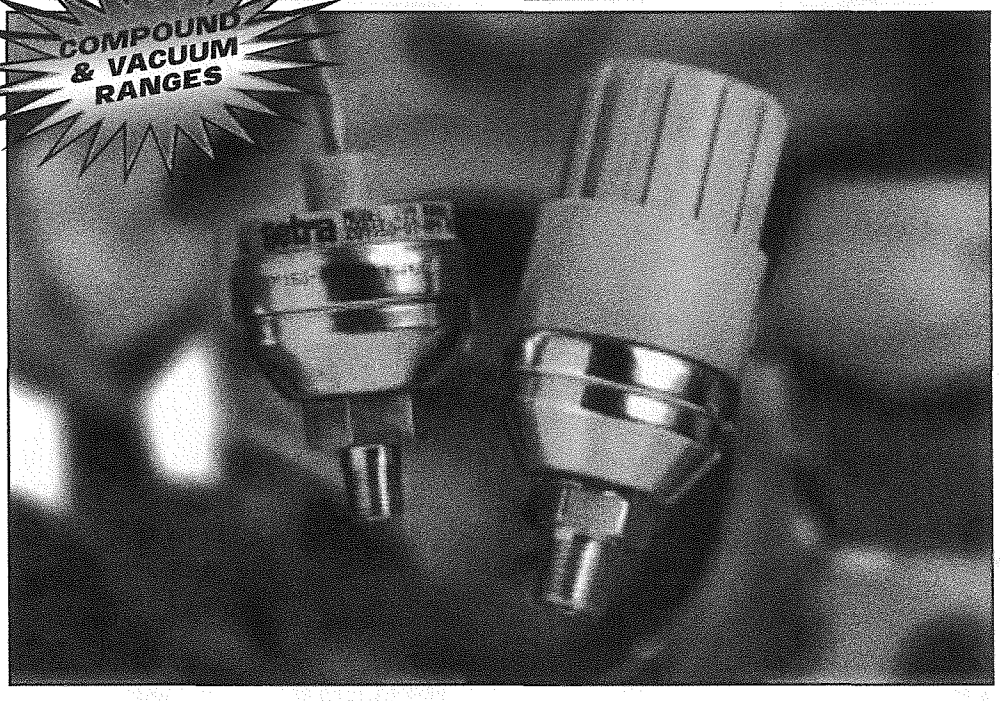
Model DPT 209 Transducer

Gauge Pressure

Range: 0 to 1 psig up to 0 to 10,000 psig

Now Available!

COMPOUND & VACUUM RANGES



Setra Systems Model 209 pressure transducers have been designed specifically for industrial applications with demanding price and performance requirements. The 209 offers exceptional reliability in typical industrial grade environments. Standard features tailor the Model 209 for applications with more extreme environmental conditions or more stringent performance needs. The Model 209 offers unparalleled performance in a configurable transducer designed specifically for the budget conscious OEM.

NOTE: Setra quality standards are based on ANSI-Z540-1. The calibration of this product is NIST traceable.

Setra's proven center mount electrode configuration is the heart of this simple, yet industrialized, design. A 17-4 PH stainless steel sensor and a rigid stainless steel electrode form the variable capacitor.

Setra 209 transducers are packaged in rugged stainless steel/Valox housings, which are small and lightweight for optimum compatibility with system designs. As a totally self - contained electronic package, the 209 stainless steel capacitance sensing element, coupled with a high level output IC-based circuit, assures excellent accuracy and long term stability.

Pressure Ranges

Full Scale Range	Proof Pressure	Burst Pressure
1	2	250
2	4	250
5	10	250
10	20	500
25	50	500
50	100	750
100	200	1000
200	400	2000
250	500	2000
500	1000	3000
1000	2000	5000
2000	3000	6500
3000	4500	7500
5000	7500	10,000
10,000	12,500	20,000

Applications

- Industrial OEM Equipment
- Hydraulic Systems
- Compressor Control
- HVAC/R Equipment
- Industrial Engines
- Process & Containerized Refrigeration Systems

Benefits

- Unparalleled Price/ Performance
- Rugged Design Survives Harsh Environments
- Operates Over a Wide Temperature Band
- Compatible with Wide Range of Gases & Liquids
- Operates on Low Cost Unregulated DC Power
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Model DPT 209 Specifications

Performance Data

Accuracy RSS* (at constant temp)	±0.25% FS
Non-Linearity (BFSL)	±0.22% FS
Hysteresis	0.10% FS
Non-Repeatability	0.05% FS
Thermal Effect	
Compensated Range °F (°C)	-4 to +176 (-20 to +80)
Zero Shift %FS/100°F (%FS/50°C)	2.0 (1.8)
Span Shift %FS/100°F (%FS/50°C)	1.5 (1.3)
Warm-up Shift	±0.1% FS total
Response Time	5 milliseconds
Stability	0.5% FS/Year

*RSS of Non-Linearity, Non-Repeatability and Hysteresis.

Environmental Data

Temperature	
Operating °F (°C)	-40 to +260 (-40 to +127)
Storage °F (°C)	-40 to +260 (-40 to +127)
Vibration*	20g
Shock**	200g
Environmental Protection	Weather Resistant

*MIL-STD 202, Method 204, Cond. C

**MIL-STD 202, Method 213B, Cond. C

Electrical Data (Voltage)

Circuit	3-Wire (Com, Out, Exc)
Excitation	9 to 30 VDC
Output*	0.5 to 5.5 VDC**
Output Impedance	10 ohms

*Calibrated into a 50K ohm load, operable into a 5000 ohm load or greater.

**Zero output factory set to within ±50mV.

**Span (Full Scale) output factory set to within ±50mV.

Note: Other outputs are available with 9 to 30 VDC excitation. An output of 0.5 to 4.5 VDC output is available with 15 VDC excitation.

Electrical Data (Current)

Circuit	2-Wire
Output*	4 to 20 mA**
External Load	0 to 800 ohms

Minimum supply voltage (VDC) = 9 + 0.02 x (Resistance of receiver plus line).

Maximum supply voltage (VDC) = 28 + 0.004 x (Resistance of receiver plus line).

*Calibrated at factory with a 24 VDC loop supply voltage and a 250 ohm load.

**Zero output factory set to within ±0.16mA.

**Span (Full Scale) output factory set to within ±0.16mA.

Physical Description

Case	Stainless Steel & Valox
Sensor	17-4 PH Stainless Steel
Electrical Connection	2 ft. multi-conductor cable
Pressure Fitting*	1/4" -18 NPT external, 17-4 PH Stainless Steel
Vent	Through cable
Weight (approx.)	2.3 ounces (65 grams)

*See ordering information for other fittings available (minimum quantities apply).

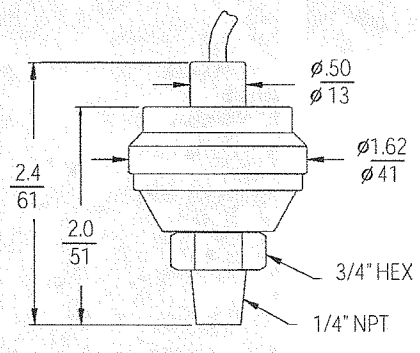
Pressure Media

Liquids or gases compatible with 17-4 PH Stainless Steel*.

*Note: Hydrogen not recommended for use with 17-4 PH Stainless Steel.

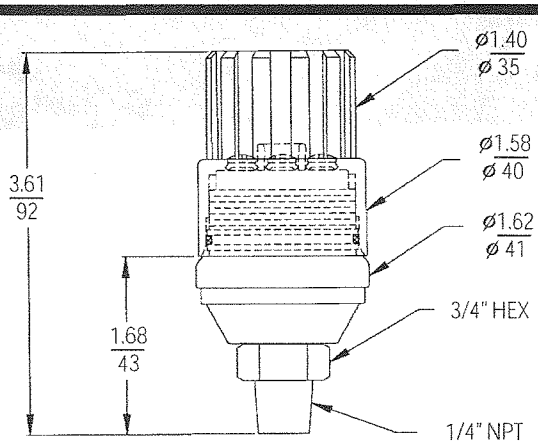
Specifications subject to change without notice.

Outline Drawings



Cable Anchor

IN
MM



Conduit Version

SSP 209/2090C-2pg Rev.D 06/13/01

Ordering Information

Input Range PSIG	Product Codes-Cable Version 0.5 to 5.5 VDC Output	Product Codes-Cable Version 4 to 20 mA Output	Input Range PSIG	Product Codes-Conduit Version 0.5 to 5.5 VDC Output	Product Codes-Conduit Version 4 to 20 mA Output
0 to 5	DPT2090-5G	DPT2091-5G	0 to 5	DPT2090C-5G	DPT2091C-5G
0 to 10	DPT2090-10G	DPT2091-10G	0 to 10	DPT2090C-10G	DPT2091C-10G
0 to 25	DPT2090-25G	DPT2091-25G	0 to 25	DPT2090C-25G	DPT2091C-25G
0 to 50	DPT2090-50G	DPT2091-50G	0 to 50	DPT2090C-50G	DPT2091C-50G
0 to 100	DPT2090-100G	DPT2091-100G	0 to 100	DPT2090C-100G	DPT2091C-100G
0 to 250	DPT2090-250G	DPT2091-250G	0 to 250	DPT2090C-250G	DPT2091C-250G
0 to 500	DPT2090-500G	DPT2091-500G	0 to 500	DPT2090C-500G	DPT2091C-500G
0 to 1000	DPT2090-1000G	DPT2091-1000G	0 to 1000	DPT2090C-1000G	DPT2091C-1000G
Compound			Compound		
-14.7 to 30	DPT2090-30C	DPT2091-30C	-14.7 to 30	DPT2090C-30C	DPT2091C-30C
-14.7 to 100	DPT2090-100C	DPT2091-100C	-14.7 to 100	DPT2090C-100C	DPT2091C-100C
Vacuum			Vacuum		
14.7 PSIV	DPT2090-14.7V	DPT2091-14.7V	14.7 PSIV	DPT2090C-14.7V	DPT2091C-14.7V

Add DPT-CAL-CERT for Calibration Certificate

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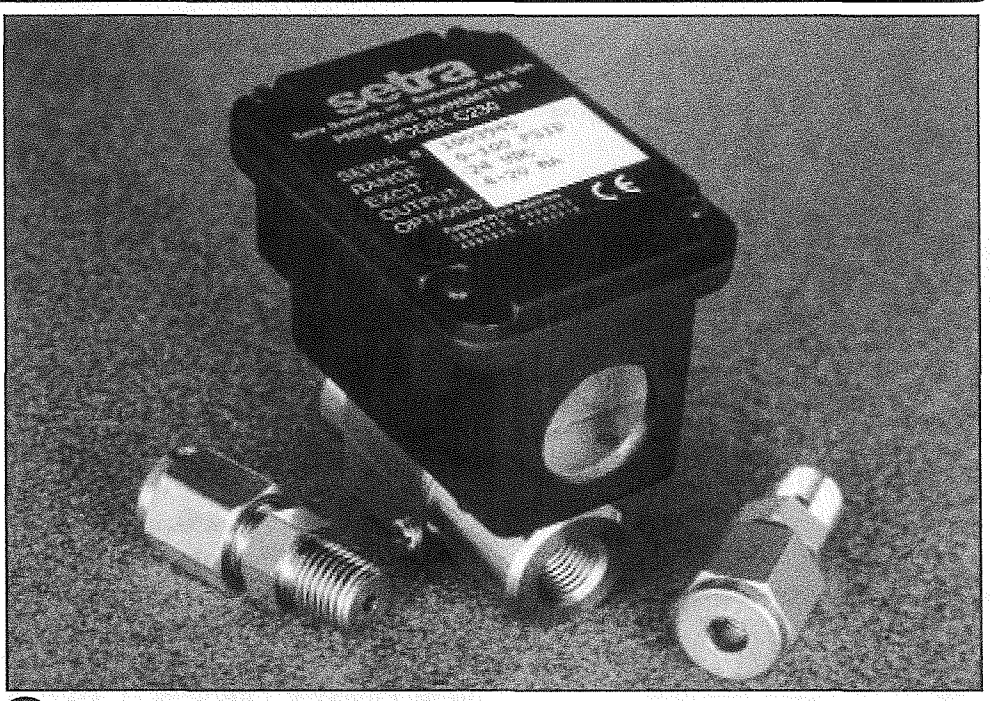
Toll Free: 800-257-3872; Fax: 978-264-0292; email: sales@setra.com

Model DPT 230

Wet/Wet Differential Pressure Transducer

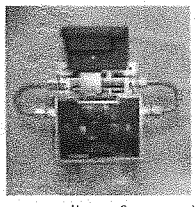
(Available with 3-Valve Manifold Assembly)

Ranges: 0 to ±0.5 psid up to 0 to 100 psid. Liquids or Gases Both Sides



Setra Systems Model 230 is a high output, low differential pressure transducer designed for wet to wet differential pressure measurements of liquids or gases. A fast-response capacitance sensor and signal conditioned electronic circuitry provide a highly accurate, linear analog output proportional to pressure. Both unidirectional and bidirectional pressure ranges are available for applications with line pressure up to 250 psig.

A unique isolation system transmits the motion of the differential pressure sensing diaphragm from the high line pressure environment (e.g. corrosive liquids) to the dry (air) enclosure where it moves one of a pair of capacitance plates proportionally to the diaphragm movement. All parts exposed to the pressure media are stainless steel and elastomer seals. The 230 has a NEMA 4/IP65 rated package to withstand environmental effects. This system responds to pressure changes approximately 20 times faster than conventional fluid-filled transducers. The electronic circuit linearizes output vs. pressure and compensates for thermal effects of the sensor.



The Model 230 can be supplied with a 3-valve manifold assembly (ordered as Pressure Fitting Code V) to protect against excessive differential overpressure, which may occur during installation, start-up or shut-down. The 230 bleed ports allow for total elimination of air in the line and pressure cavities. The manifold's rugged, yet compact, construction requires minimum space for installation. If the Model 230 is ordered with the 3-valve manifold, the system is shipped completely assembled and ready for wall or pipe mounting. If 3-Valve Manifold Assembly is ordered separately without 230 transducer, order as DPT 3-VALVE.

Pressure Ranges

UNIDIRECTIONAL		
Pressure Range PSID	Proof Pressure High Side* PSI	Proof Pressure Low Side* PSI
0 to 1	20	2.5
0 to 2	40	5
0 to 5	100	12.5
0 to 10	100	25
0 to 25	250	62.5
0 to 50	250	125
0 to 100	250	250

BIDIRECTIONAL		
Pressure Range PSID	Proof Pressure High Side* PSI	Proof Pressure Low Side* PSI
0 to ±0.5	20	1.25
0 to ±1	40	2.5
0 to ±2.5	100	6.25
0 to ±5	100	12.5
0 to ±10	200	25
0 to ±25	250	62.5
0 to ±50	250	125

NOTE: Setra quality standards including ISO 9001 are based on ANSI-Z540-1. The calibration of this product is NIST traceable.

U.S. Patent nos. 4054833

*The zero will shift slightly when high differential overpressure is applied. The shift may be as much as ±10% FS with overpressure applied to the low pressure port. Other parameters (sensitivity, linearity, etc) will not shift. If the overpressure is normally only in one direction, the user may apply this overpressure to preset the sensor. Subsequent overload of less magnitude will not cause additional shift. The unit is pre-zeroed at the factory after application of maximum overload pressure to the high pressure port.

Applications

- Process Control
- Energy Management Systems
- Flow measurement of various gases or liquids
- Liquid level measurement of pressurized vessels
- Pressure Drop Across Filters

Features

- NEMA 4/IP65 rating
- 3-Valve Manifold Assembly
- High Accuracy
- Low Cost
- Fast Response
- Gas and Liquid Compatible
- Low Differential Ranges
- Low Line Pressure Effect
- No Liquid Fill Diaphragms

ISO 9001 certified

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Model 230 Specifications

Performance Data

Accuracy RSS* (at constant temp)	±0.25% FS
Non-Linearity, BFSL	±0.20% FS
Hysteresis	0.10% FS
Non-Repeatability	0.05% FS
Thermal Effects	
Compensated Range °F (°C)	30 to 150 (-1 to 65)
Zero shift %FS/°F (%FS/°C)	2.0 (1.8)
Span Shift %FS/°F (%FS/°C)	2.0 (1.8)
Line Pressure Effect	Zero shift ±0.004% FS/psig line pressure.
Resolution	Infinite, limited only by output noise level (0.02%FS)
Static Acceleration Effect	2%FS/g (most sensitive axis)
Natural Frequency	500 Hz (gaseous media)
Warm-up Shift	±0.1% FS total
Response Time	30 to 50 milliseconds
Long Term Stability	0.5%/1 YR
Maximum Working Pressure	250 psig

*RSS of Non-Linearity, Non-Repeatability and Hysteresis.

Specifications subject to change without notice.

Environmental Data

Temperature	
Operating* °F (°C)	0 to +175 (-18 to +80)
Storage °F (°C)	-65 to +250 (-54 to +121)
Vibration	5g from 5Hz to 500Hz
Acceleration	10g
Shock	50g

*Operating temperature limits of the electronics only. Pressure media temperatures may be considerably higher or lower.

Physical Description

Case	Stainless Steel/Aluminum
Electrical Connection	Barrier strip terminal block with conduit enclosure & 0.875 DIA conduit opening.
Pressure Fittings	1/4"-18"NPT internal
Weight (approx.)	14.4oz
Sensor Cavity Volume	0.27 in³ Positive Port, 0.08 in³ Negative Port

(With 1/4"NPT external fittings installed - does not include cavity volume of 1/4"NPT external fittings.)

Electrical Data (Voltage)

Circuit	3-Wire (Exc., Out, Com)
Excitation	9 to 30 VDC for 0-5 VDC output 13 to 30 VDC for 0-10 VDC output

Electrical Data (Voltage) Cont'd.

Output*	0-5 VDC** 0-10 VDC**
Output Impedance	100 ohms

*Calibrated into a 50K ohm load, operable into a 5000 ohm load or greater.
**Zero output factory set at 50mV (±25mV) for 0-5 VDC and 50mV (±50mV) for 0-10 VDC.
***Span output factory set at 5 VDC (±25mV) or 10 VDC (±50mV).

Electrical Data (Current)

Circuit	2-Wire
Output*	4 to 20mA**
External Load	0 to 1000 ohms

Minimum loop supply voltage (VDC) = 9 + 0.02 x (Resistance of receiver plus line).
Maximum loop supply voltage (VDC) = 30 + 0.004 x (Resistance of receiver plus line).

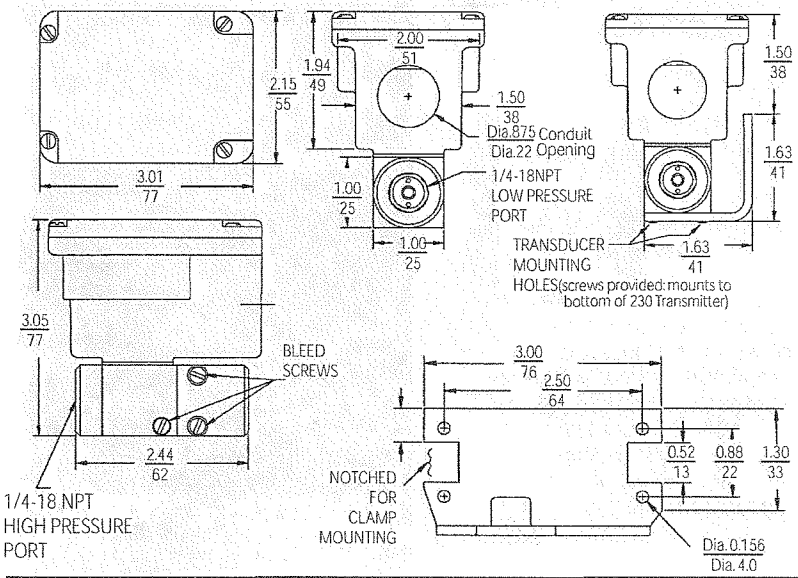
*Calibrated at factory with a 24 VDC loop supply voltage and a 250 ohm load.
**Zero output factory set at 4mA (±.08mA)
***Span output factory set at 20mA (±.08mA)

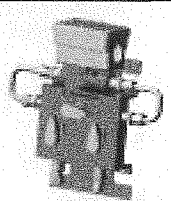
Pressure Media

Gases or liquids compatible with 17-4 PH Stainless Steel, 300 Series Stainless Steel, Viton and Silicone O-Rings.

Note: Hydrogen not recommended for use with 17-4 PH stainless steel.

Outline Drawings

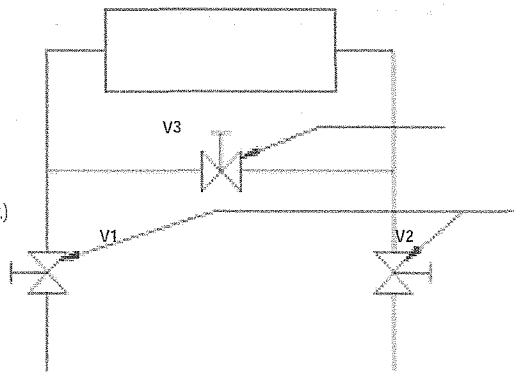




3-Valve Manifold Assembly Description

(Order by adding "-V" to standard part number. See example below.)

Manifold Block	Brass
Valves (3)	V1 for connection to +port V2 for connection to -port V3 for equalizing pressure
Valve type	90 Degree On/Off
Process Connections	1/4"-18 NPT Internal Thread



Ordering Information

Input Range PSID	Product Codes 0 to 5 VDC Output	0 to 10 VDC Output	4 to 20 mA Output
0 to 1	DPT2300-001D	DPT2302-001D	DPT2301-001D
0 to 2	DPT2300-002D	DPT2302-002D	DPT2301-002D
0 to 5	DPT2300-005D	DPT2302-005D	DPT2301-005D
0 to 10	DPT2300-010D	DPT2302-010D	DPT2301-010D
0 to 25	DPT2300-025D	DPT2302-025D	DPT2301-025D
0 to 50	DPT2300-050D	DPT2302-050D	DPT2301-050D
0 to 100	DPT2300-100D	DPT2302-100D	DPT2301-100D
-0.5 to 0.5	DPT2300-0R5B	DPT2302-0R5B	DPT2301-0R5B
-1 to 1	DPT2300-001B	DPT2302-001B	DPT2301-001B
-2.5 to 2.5	DPT2300-2R5B	DPT2302-2R5B	DPT2301-2R5B
-5 to 5	DPT2300-005B	DPT2302-005B	DPT2301-005B
-10 to 10	DPT2300-010B	DPT2302-010B	DPT2301-010B
-25 to 25	DPT2300-025B	DPT2302-025B	DPT2301-025B
-50 to 50	DPT2300-050B	DPT2302-050B	DPT2301-050B

Input Range PSID	Product Codes with 3-Valve Manifold Option 0 to 5 VDC Output	0 to 10 VDC Output	4 to 20 mA Output
0 to 1	DPT2300-001D-V	DPT2302-001D-V	DPT2301-001D-V
0 to 2	DPT2300-002D-V	DPT2302-002D-V	DPT2301-002D-V
0 to 5	DPT2300-005D-V	DPT2302-005D-V	DPT2301-005D-V
0 to 10	DPT2300-010D-V	DPT2302-010D-V	DPT2301-010D-V
0 to 25	DPT2300-025D-V	DPT2302-025D-V	DPT2301-025D-V
0 to 50	DPT2300-050D-V	DPT2302-050D-V	DPT2301-050D-V
0 to 100	DPT2300-100D-V	DPT2302-100D-V	DPT2301-100D-V
-0.5 to 0.5	DPT2300-0R5B-V	DPT2302-0R5B-V	DPT2301-0R5B-V
-1 to 1	DPT2300-001B-V	DPT2302-001B-V	DPT2301-001B-V
-2.5 to 2.5	DPT2300-2R5B-V	DPT2302-2R5B-V	DPT2301-2R5B-V
-5 to 5	DPT2300-005B-V	DPT2302-005B-V	DPT2301-005B-V
-10 to 10	DPT2300-010B-V	DPT2302-010B-V	DPT2301-010B-V
-25 to 25	DPT2300-025B-V	DPT2302-025B-V	DPT2301-025B-V
-50 to 50	DPT2300-050B-V	DPT2302-050B-V	DPT2301-050B-V

For calibration certificate, add DPT-CAL-REPORT after part number.

For separate 3-Valve Manifold order as DPT 3-VALVE

Example: Part No. 2300-005D-V for a 230 Transducer, 0 to 5 PSID. Unidirectional Range, 0 to 5 VDC Output. Assembled with the 3-Valve Manifold.

SSPC230IC Rev.C-2pg 02/22/02

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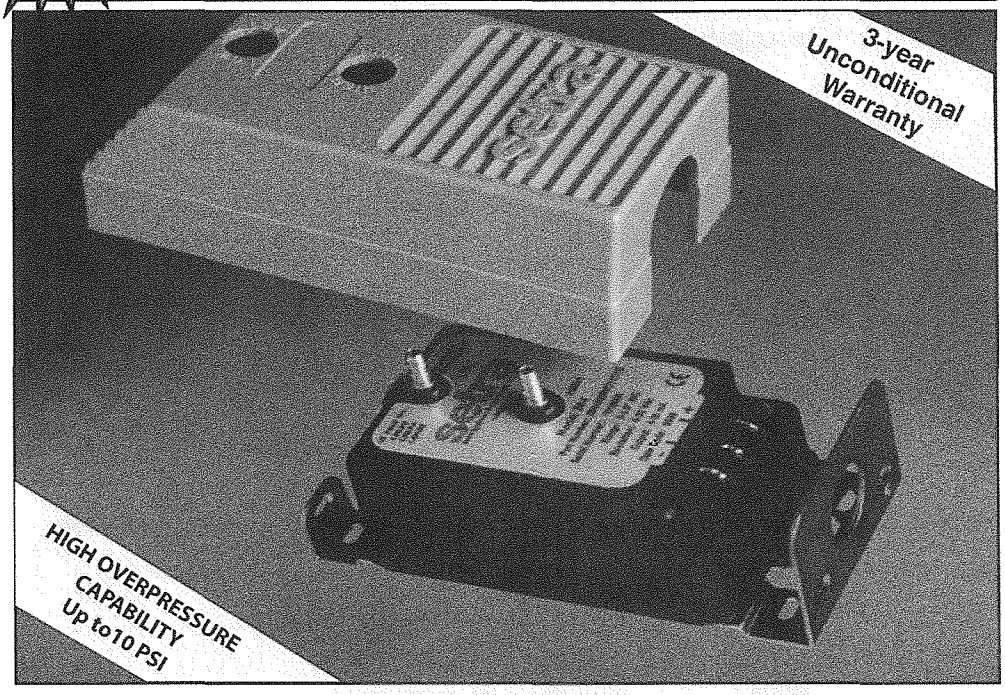
Toll Free: 800-257-3872; Fax: 978-264-0292; email: sales@setra.com

3 DAY SHIPMENT FOR STANDARD PARTS

Model DPT 264

Very Low Differential Pressure Transducer

Unidirectional Ranges: 0 - 0.1 to 0 - 100 in.W.C.
Bidirectional Ranges: 0 - ±0.5 to 0 - ±50 in.W.C.
Air or Non-Conducting Gas



Setra Systems 264 pressure transducers sense differential or gauge (static) pressure and convert this pressure difference to a proportional electrical output for either unidirectional or bidirectional pressure ranges. The 264 Series is offered with a high level analog 0 to 5 VDC or 4 to 20 mA output.

Used in Building Energy Management Systems, these transducers are capable of measuring pressures and flows with the accuracy necessary for proper building pressurization and air flow control.

The 264 Series transducers are available for air pressure ranges as low as 0.1 in. W.C. full scale to 100 in.W.C. full scale. Static standard accuracy is ±1.0% full scale in normal ambient temperature environments, but higher accuracies are available. The units are temperature compensated to 0.033% FS/°F thermal error over the temperature range of 0°F to +150°F.

The Model 264 utilizes an improved all stainless steel micro-tig welded sensor. The tensioned stainless steel diaphragm and insulated stainless steel electrode, positioned close to the diaphragm, form a variable capacitor. Positive pressure moves the diaphragm toward the electrode, increasing the capacitance. A decrease in pressure moves the diaphragm away from the electrode, decreasing the capacitance. The change in capacitance is detected and converted to a linear DC electrical signal by Setra's unique electronic circuit.

The tensioned sensor allows up to 10 PSI overpressure (range dependent) with no damage to the unit. In addition, the parts that make up the sensor have thermally matched coefficients, which promote improved temperature performance and excellent long term stability.

NOTE: Setra quality standards are based on ANSI-Z540-1. The calibration of this product is NIST traceable.

U.S. Patent nos. 6019002; 6014800

Applications

- Heating, Ventilating and Air Conditioning (HVAC)
- Energy Management Systems
- Variable Air Volume and Fan Control (VAV)
- Environmental Pollution Control
- Lab and Fume Hood Control
- Oven Pressurization and Furnace Draft Controls

Features

- Installation Time Minimized with Snap Track Mounting and Easy-To-Access Pressure Ports and Electrical Connections
- 0 to 5 VDC or 2-wire 4 to 20 mA Analog Outputs Are Compatible with Energy Management Systems
- Reverse Wiring Protection
- Internal Regulation Permits Use with Unregulated DC Power Supplies
- Fire Retardent Case (UL 94 V-0 Approved)
- Meets CE Conformance Standards

When it comes to a product to rely on - choose the Model 264. When it comes to a company to trust - choose Setra.

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Model 264 Specifications

Performance Data

	Standard	Optional	
Accuracy* RSS(at constant temp)	±1.0% FS	±0.5% FS	±0.25% FS
Non-Linearity, BFSL	±0.96% FS	±0.38% FS	±0.22% FS
Hysteresis	0.10% FS	0.10% FS	0.10% FS
Non-Repeatability	0.05% FS	0.05% FS	0.05%FS

Thermal Effects**

Compensated Range °F(°C)	0 to +150 (-18 to +65)
Zero/Span Shift %FS/°F(°C)	0.033 (0.06)
Maximum Line Pressure	10 psi
Overpressure (Range Dependant)	Up to 10 psi (Range Dependent)
Long Term Stability	0.5% FS/1 YR

Position Effect	Range	Zero Offset (%FS/G)
(Unit is factory calibrated at 0g effect in the vertical position.)	To 0.5 in. WC	0.60
	To 1.0 in.WC	0.50
	To 2.5 in.WC	0.22
	To 5 in. WC	0.14

* RSS of Non-Linearity, Hysteresis, and Non-Repeatability.
**Units calibrated at nominal 70°F. Maximum thermal error computed from this datum.

Environmental Data

Temperature	
Operating* °F (°C)	0 to +175 (-18 to +79)
Storage °F (°C)	-65 to +250 (-54 to +121)

*Operating temperature limits of the electronics only. Pressure media temperatures may be considerably higher.

Physical Description

Case	Fire-Retardant Glass Filled Polyester (UL 94 V-0 Approved)
Mounting	Four screw holes on removable zinc plated steel base (designed for 2.75" snap track)
Electrical Connection	Screw Terminal Strip
Pressure Fittings	3/16" O.D. barbed brass pressure fitting for 1/4" push-on tubing
Zero and Span Adjustments	Accessible on top of case
Weight (approx.)	10 ounces

Pressure Media

Typically air or similar non-conducting gases.

Specifications subject to change without notice.

Electrical Data (Voltage)

Circuit	3-Wire (Com, Exc, Out)
Excitation	9 to 30 VDC
Output*	0 to 5 VDC**
Bidirectional output at zero pressure:	2.5 VDC**
Output Impedance	100 ohms

*Calibrated into a 50K ohm load, operable into a 5000 ohm load or greater.
**Zero output factory set to within ±50mV (±25 mV for optional accuracies).
**Span (Full Scale) output factory set to within ±50mV. (±25 mV for optional accuracies).

Electrical Data (Current)

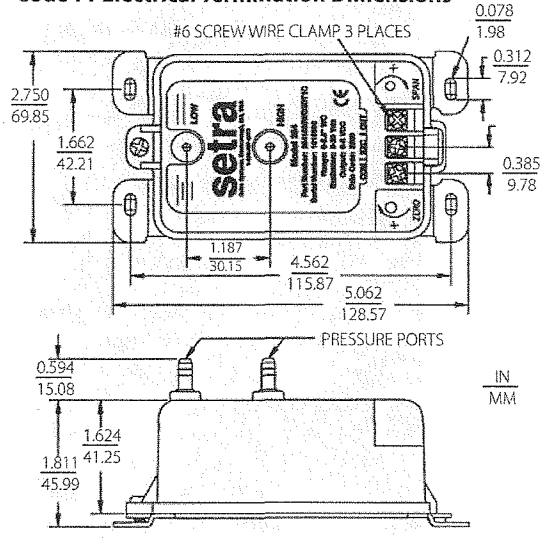
Circuit	2-Wire
Output*	4 to 20mA**
Bidirectional output at zero pressure:	12mA**
External Load	0 to 800 ohms

Minimum supply voltage (VDC) = 9+ 0.02 x (Resistance of receiver plus line).
Maximum supply voltage (VDC) = 30+ 0.004 x (Resistance of receiver plus line).

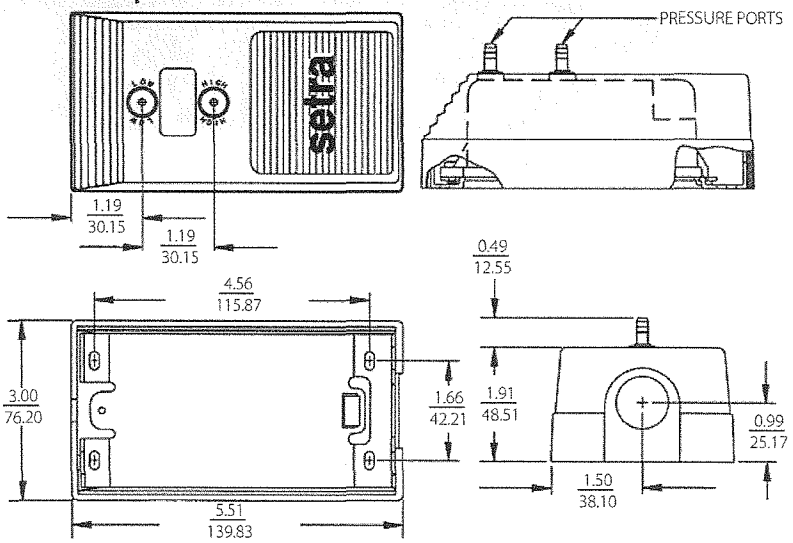
*Calibrated at factory with a 24 VDC loop supply voltage and a 250 ohm load.
**Zero output factory set to within ±0.16mA (±0.08 mA for optional accuracies).
**Span (Full Scale) output factory set to within ±0.16mA (±0.08 mA for optional accuracies).

Outline Drawings

Code T1 Electrical Termination Dimensions



Optional 1/2" Conduit Electrical Enclosure Dimensions



ORDERING INFORMATION

Input Range (Inches of WC)	Product Codes for Accuracy		Product Codes for 0.5% Accuracy		Product Codes for 0.25% Accuracy	
	0 to 5 VDC Output	4 to 20 mA	0 to 5 VDC Output	4 to 20 mA	0 to 5 VDC Output	4 to 20 mA
0 to 0.1	DPT2640-0R1D-1	DPT2641-0R1D-1	DTP2640-0R1D	DPT2641-0R1D	DPT2640-0R1D-A	DPT2640-0R1D-A
0 to 0.25	DPT2640-R25D-1	DPT2641-R25D-1	DPT2640-R25D	DPT2641-R25D	DPT2640-R25D-A	DPT2641-R25D-A
0 to 0.5	DPT2640-0R5D-1	DPT2641-0R5D-1	DPT2640-0R5D	DPT2641-0R5D	DPT2640-0R5D-A	DPT2641-0R5D-A
0 to 1	DPT2640-001D-1	DPT2641-001D-1	DPT2640-001D	DPT2641-001D	DPT2640-001D-A	DPT2641-001D-A
0 to 2.5	DPT2640-2R5D-1	DPT2641-2R5D-1	DPT2640-2R5D	DPT2641-2R5D	DPT2640-2R5D-A	DPT2641-2R5D-A
0 to 5	DPT2640-005D-1	DPT2641-005D-1	DPT2640-005D	DPT2641-005D	DPT2640-005D-A	DPT2641-005D-A
0 to 10	DPT2640-010D-1	DPT2641-010D-1	DPT2640-010D	DPT2641-010D	DPT2640-010D-A	DPT2641-010D-A
0 to 25	DPT2640-025D-1	DPT2641-025D-1	DPT2640-025D	DPT2641-025D	DPT2640-025D-A	DPT2641-025D-A
0 to 50	DPT2640-050D-1	DPT2641-050D-1	DPT2640-050D	DPT2641-050D	DPT2640-050D-A	DPT2641-050D-A
0 to 100	DPT2640-100D-1	DPT2641-100D-1	DPT2640-100D	DPT2641-100D	DPT2640-100D-A	DPT2641-100D-A
-0.1 to 0.1	DPT2640-0R1B-1	DPT2641-0R1B-1	DPT2640-0R1B	DPT2641-0R1B	DPT2640-0R1B-A	DPT2641-0R1B-A
-0.25 to 0.25	DPT2640-R25B-1	DPT2641-R25B-1	DPT2640-R25B	DPT2641-R25B	DPT2640-R25B-A	DPT2641-R25B-A
-0.5 to 0.5	DPT2640-0R5B-1	DPT2641-0R5B-1	DPT2640-0R5B	DPT2641-0R5B	DPT2640-0R5B-A	DPT2641-0R5B-A
-1 to 1	DPT2640-001B-1	DPT2641-001B-1	DPT2640-001B	DPT2641-001B	DPT2640-001B-A	DPT2641-001B-A
-2.5 to 2.5	DPT2640-2R5B-1	DPT2641-2R5B-1	DPT2640-2R5B	DPT2641-2R5B	DPT2640-2R5B-A	DPT2641-2R5B-A
-5 to 5	DPT2640-005B-1	DPT2641-005B-1	DPT2640-005B	DPT2641-005B	DPT2640-005B-A	DPT2641-005B-A

Add DPT-CAL-CERT for Calibration Certificate. Note: All units provided with Calibration Certificate

SSP264 Rev.J 04/25/2011

159 Swanson Road, Boxborough, MA 01719/Tel: 978-263-1400;
Toll Free: 800-257-3872; Fax: 978-264-0292; email: sales@setra.com

FLOW

FLOW SWITCH
MODEL FS1-6

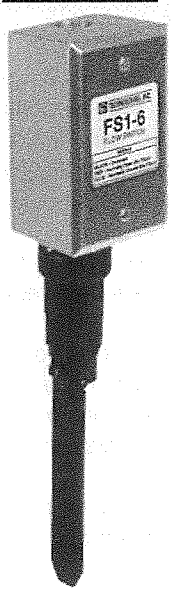
DESCRIPTION

The **FS1-6 Flow Switch** is designed to prove liquid flow in a wide variety of HVAC and industrial applications. The corrosion resistant flow switch is mounted in a weatherproof box for simple wiring connections. The PPS plastic vane is field trimmable for 1" and larger pipes and is magnetically coupled to the SPDT switch to prevent liquid from entering the switch housing.

FEATURES

- ***Waterproof construction***
- ***Simple installation***
- ***Leak proof magnetic switch operation***
- ***Field adjustable for 1" and larger pipes***
- ***SPDT snap-acting switch***
- ***Operating pressures to 150 psig***
- ***Operating temperatures to 212°F***

TECHNOLOGIES



SPECIFICATIONS

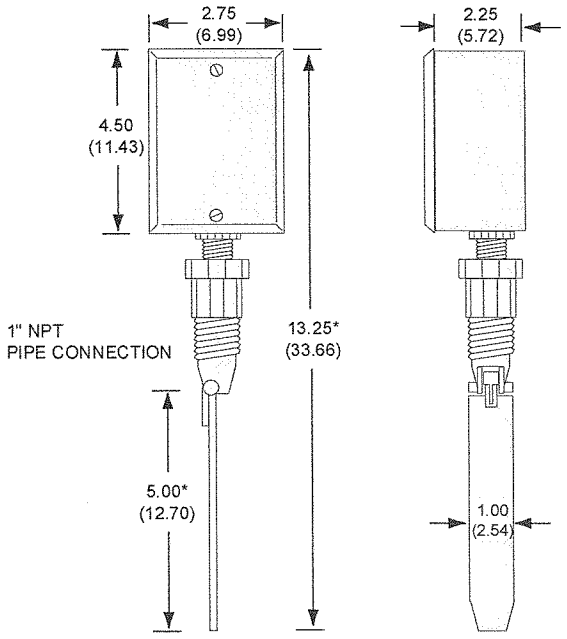
Piping connection	1" NPT
Operating pressures	150 psig (10 bar)
Operating temperature	212°F (100°C) max
Wetted materials	Polyphenylene sulfide, ceramic 8 magnet, 316SS spring and pin
Vane	Field trimmable for pipes 1" and larger
Electrical rating	SPDT snap-acting switch 5 amp, 125/250 VAC
Electrical connection	18 AWG leads, 18" (46 cm) long
Weight	1 lb. (0.45 kg)

WIRING

BLACK	–	Common
RED	–	Normally Open (No flow)
BLUE	–	Normally Closed (No flow)

DIMENSIONS

in
(cm)



*Dimension with vane full length for 6" and larger pipe installation.

KELE & ASSOCIATES • P O Box 34817 • Memphis, TN 38184

901-937-4900 • FAX 901-372-2531 • E-mail info@kele.com

FLOW

FLOW SWITCH
MODEL FS1-6

INSTALLATION

1. Carefully unpack switch, making sure to remove any packing from the lower housing. Adjust the actuation or deactuation point by trimming the vane to the length desired. If using a pipe with a weld-o-let, cond-o-let, or plastic PVC fittings, use graduations indicated on the vane. If using standard 125 lb or 250 lb bronze, iron or steel fittings, trim the vane 0.125 inch above the marking provided. Because of the great variation in fittings and process connections, it is recommended the unit be checked when installed to ensure proper operation and that there is no interference between the vane and the fittings. For pipes larger than 6", leave the vane full length.

2. This flow switch is intended to be used in clean process media where particles, scale, and debris are not present. Build up of such materials may cause inaccurate signals.

3. The switch must be indexed during installation in the line with the flow arrow on the side of the switch pointing in the direction of the flow. Pipe sealant is required at the one inch NPT thread connection. It is important to not get the sealant in the vane assembly as it may prevent proper operation and cause misleading signals. When installing the unit, be certain not to over-torque the housing. Damage may occur if excessive force is used.

4. Connect the switch wires in accordance with local electrical codes. The **FS1-6** is not intended to be a load carrying conduit connection. Loads may damage the switch and stop operation.

PERFORMANCE CHART

Pipe size	Actuation GPM (LPM)	De-actuation GPM (LPM)
1	10.7 (40.5)	9.3 (35.2)
1.25	9.5 (36.0)	7.7 (29.1)
1.5	8.1 (30.7)	6.3 (23.9)
2	9.8 (37.1)	8.5 (32.2)
3	12.4 (46.9)	8.9 (33.7)
4	20.2 (76.5)	12.7 (48.1)
6	43.0 (163)	32.8 (124)
8	74.2 (281)	56.6 (214)
10	116.7 (442)	89.0 (337)
12	167.1 (632)	127.4 (482)

When the flow increases to the actuation GPM (LPM) the switch makes.

When the flow decreases to the de-actuation GPM (LPM) the switch breaks.

Flow rates are approximate and are based on 60°F water.

ORDERING INFORMATION

FS1-6	**Waterproof Flow Switch**

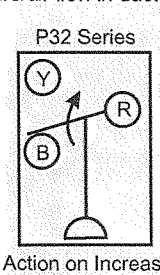
KELE & ASSOCIATES • P O Box 34817 • Memphis, TN 38184 901-937-4900 • FAX 901-372-2531 • E-mail info@kele.com

P32 Series

Sensitive Pressure Switch

Description

This differential pressure switch is used to sense pressure/air flow in ducts.



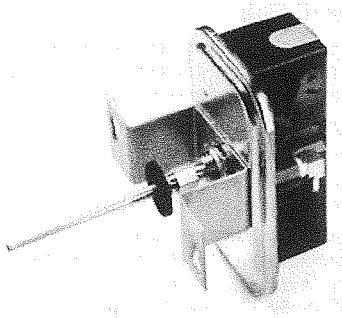
P28 Action Diagram

Features

- easy-to-read setpoint scale
- versatile mounting options

Applications

- pressure/air flow proving with electric duct heaters, humidifiers, and other equipment
- maximum pressure/air flow control for variable volume systems
- reheat duct powered systems
- clogged filter detection
- detection of icing of air conditioning coils and initiation of defrost cycle
- sensitive pressure settings
- dust-tight snap switch



P32

Selection Chart

Code Number	Ambient Temperature Min./Max.	Connector	Maximum Over-pressure psig (kPa) [1]	Contact Action	Range in. WC (kPa)	Sensitivity at Min. Set point in. WC (kPa)	Setpoint	Scale Plate	Mounting Bracket (Included)
P32AC-1C	-40°F (-40°C) min. 167°F (75°C) max.	High Pressure connectors are metal 1/8 in. female NPT inside, 1/2 in. NPSM outside for mounting Low Pressure connectors are molded, 1/8 in. female NPT	1 (6.895)	SPDT	0.15 to 12 (0.037 to 2.99)	0.07 (0.017)	Adjustable	Yes	L BKT182-1R bracket2.eps
P32AC-2C[2]					0.05 to 5 (0.012 to 1.24)	0.04 (0.01)			U BKT229-1R bracket1.eps
P32AF-1C						0.025 (0.006)			L BKT182-1R bracket2.eps
P32AF-2C[2]									U BKT229-1R bracket1.eps

1. Maximum overpressure at either connection
2. Supplied with 1/4 in. compression fitting, 4 in. extension tube, two mounting screws, and "O" gasket (angle barbed fitting installed)

Accessories

The switch can be mounted directly or with the supplied mounting bracket.

Code Number	Description
FTG18A-600R	Remote Mounting Kit: 4 in. flanged sensing tube, two barbed fittings, two No. 10 screws, and a gasket

Technical Specifications

Electrical Ratings

Motor Ratings VAC	120	208	240
Type P32AC (Standard Differential, 1/2 hp)			
AC Full Load A	9.8	5.65	4.9
AC Locked Rotor A	58.8	33.9	29.4
Non-Inductive or Resistive Load	15 amp 24 to 277 VAC		
Pilot Duty – 125 VA, 24 VAC; 360 VA, 120 to 277 VAC			
Type P32AF (Close Differential, 1/4 hp)			
AC Full Load A	5.8	3.3	2.9
AC Locked Rotor A	34.8	19.8	17.4
Non-Inductive or Resistive Load	10 amp, 24 to 277 VAC		
Pilot Duty – 125 VA, 24 VAC; 360 VA, 120 to 277 VAC			

M9220-xxx-3 Electric Spring Return Actuators

Description

The M9220-xxx-3 Actuators are direct mount, spring return electric actuators that operate with these available power options:

- AC 24 V at 50/60 Hz or DC 24 V (AGx, BGx, GGx, HGx)
- AC 120 V at 60 Hz (BAx)
- AC 230 V at 50/60 Hz (BDx)

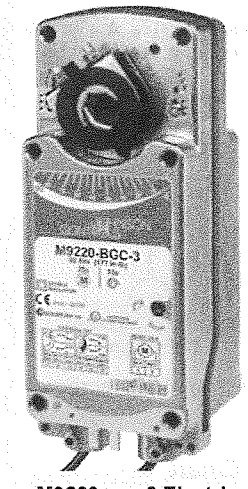
These bidirectional actuators do not require a damper linkage, and are easily installed on dampers with 1/2 to 3/4 in. or 12 to 19 mm round shafts, or 3/8 and 1/2 in. or 10, 12, and 14 mm square shafts using the standard shaft clamp included with the actuator. An optional M9220-600 Jackshaft Coupler Kit is available for 3/4 to 1-1/16 in. or 19 to 27 mm round shafts, or 5/8 and 3/4 in. or 16, 18, and 19 mm square shafts.

A single M9220-xxx-3 Electric Spring Return Actuator provides a running and spring return torque of 177 lb·in (20 N·m). Two or three models mounted in tandem deliver twice or triple the torque. Integral line voltage auxiliary switches are available on the xxC models to indicate end-stop position, or to perform switching functions within the selected rotation range.

Refer to the *M9220-xxx-3 Electric Spring Return Actuators Product Bulletin (LIT-12011057)* for important product application information.

Features

- available torques of 177 lb·in (20 N·m) for single actuators, 354 lb·in (40 N·m) for two models, and 531 lb·in (60 N·m) for three models mounted in tandem — offer a selection that is most suitable for the application
- reversible mounting design — simplifies installation and enables the actuator to spring return in either direction
- electronic stall detection throughout entire rotation range — extends the life of the actuator by deactivating the actuator motor when an overload condition is detected
- removable coupler — adapts to a shorter damper shaft
- integral 48 in. (1.2 m) halogen-free cables with colored and numbered conductors — simplify field wiring
- integral auxiliary switches (xxC Models) — provide one fixed and one adjustable switch point with line voltage capability
- NEMA 2 (IP54) rated aluminum enclosure — protects the internal components of the actuator from dirt and moisture
- easy-to-use locking manual override with auto release and crank storage — allows for manual positioning of the actuator hub
- integral connectors for 3/8 in. flexible metal conduit — simplify installation and field wiring
- microprocessor-controlled brushless DC motor (-AGx, -GGx, and -HGx types) — provides constant run-time independent of torque



M9220-xxx-3 Electric Spring Return Actuator

Applications

The M9220-xxx-3 Electric Spring Return Actuators provide reliable control of dampers and valves in Heating, Ventilating, and Air Conditioning (HVAC) systems. The M9220-xxx-3 Actuators are available for use with on/off, floating, and proportional controllers.

Repair Information

If the M9220-xxx-3 Electric Spring Return Actuators fails to operate within its specifications, refer to the *M9220-xxx-3 Electric Spring Return Actuators Product Bulletin (LIT-12011057)* for a list of repair parts available.

Selection Chart

Code Number	Control Type	Auxiliary Switches	Power Requirements
M9220-AGA-3	Floating	None	AC 24 V at 50/60 Hz or DC 24 V
M9220-AGC-3	Floating	Two	AC 24 V at 50/60 Hz or DC 24 V
M9220-BAA-3	On/Off	None	AC 120 V at 60 Hz
M9220-BAC-3	On/Off	Two	AC 120 V at 60 Hz
M9220-BDA-3	On/Off	None	AC 230 V at 50/60 Hz
M9220-BDC-3	On/Off	Two	AC 230 V at 50/60 Hz
M9220-BGA-3	On/Off	None	AC 24 V at 50/60 Hz or DC 24 V
M9220-BGC-3	On/Off	Two	AC 24 V at 50/60 Hz or DC 24 V
M9220-GGA-3	Proportional	None	AC 24 V at 50/60 Hz or DC 24 V
M9220-GGC-3	Proportional	Two	AC 24 V at 50/60 Hz or DC 24 V
M9220-HGA-3	Proportional w/Adjustable Zero and Span	None	AC 24 V at 50/60 Hz or DC 24 V
M9220-HGC-3	Proportional w/Adjustable Zero and Span	Two	AC 24 V at 50/60 Hz or DC 24 V

M9220-xxx-3 Electric Spring Return Actuators (Continued)

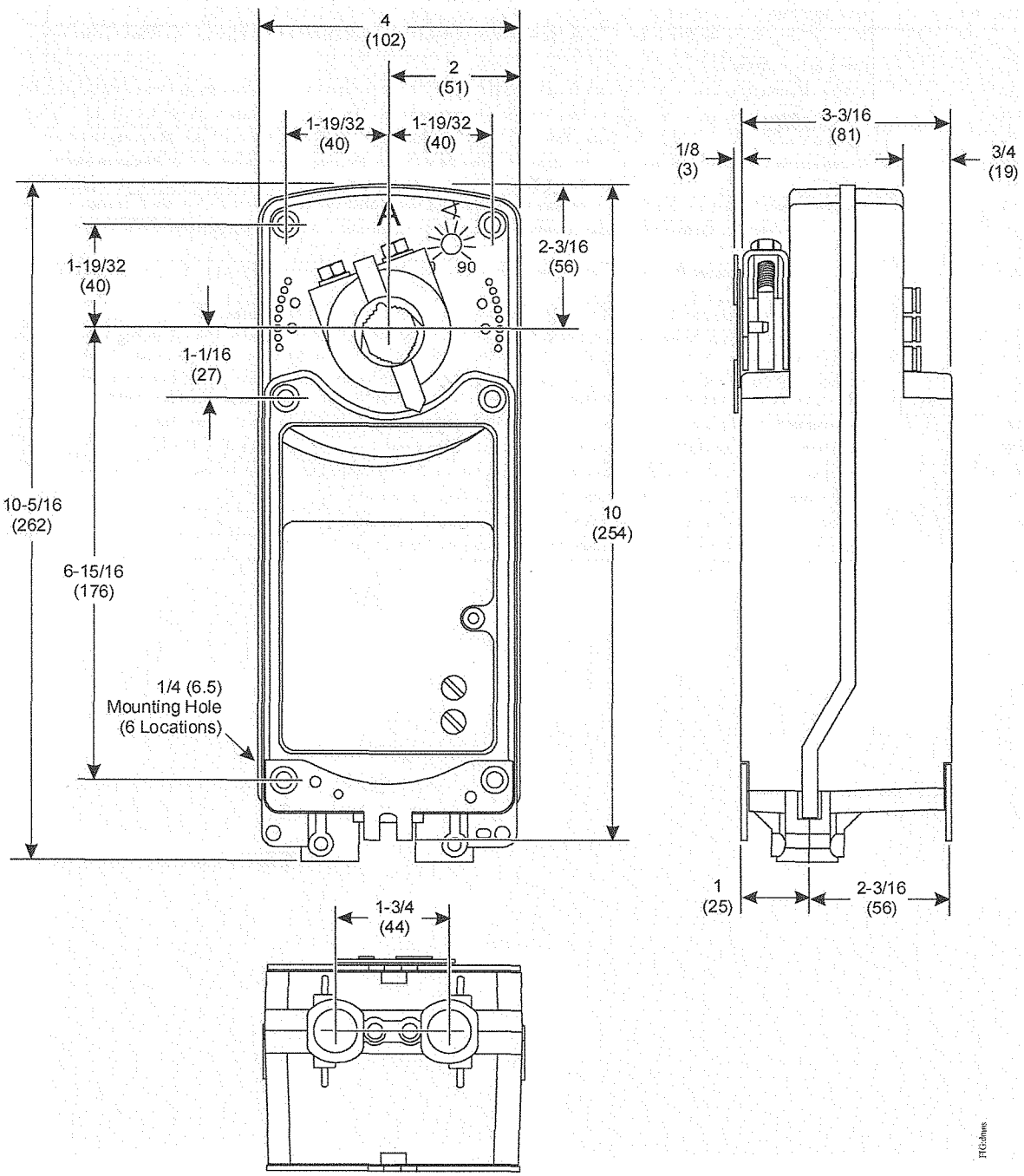
Accessories

Code Number	Description
DMPR-KC003[1]	7 in. (178 mm) Blade Pin Extension (without Bracket) for Johnson Controls® Direct-Mount Damper Applications (quantity 5)
M9000-153	Crank arm (quantity 1)
M9000-158	Tandem Mounting Kit used to Mount Two Models of M9220-xxx-3 Series Proportional Electric Spring Return Actuators (quantity 1)
M9000-170	Remote Mounting Kit, Horizontal. Kit includes Mounting Bracket, M9000-153 Crank Arm, Ball Joint, and Mounting Bolts (quantity 1)
M9000-171	Remote Mounting Kit, Vertical. Kit includes Mounting Bracket, M9000-153 Crank Arm, Ball Joint, and Mounting Bolts (quantity 1)
M9000-200	Commissioning Tool that Provides a Control Signal to Drive 24 V On/Off, Floating, Proportional, and/or Resistive Electric Actuators (quantity 1)
M9000-320	Weather Shield Enclosure - NEMA 3R enclosure for protecting a single M9210/20 actuator from rain, sleet, or snow (quantity 1)
M9000-400	Jackshaft Linkage Kit. Open-ended design enables clamping onto a jackshaft without requiring access to the ends of the jackshaft (quantity 1)
M9000-604	Replacement Anti-rotation Bracket Kit (with Screws) for M9220-xxx-3 Series Proportional Electric Spring Return Actuators (quantity 1)
M9200-100	Threaded Conduit Adapter, 1/2 NPSM, for M9210(20) and M(VA)9208 Series Actuators (quantity 5)
M9220-600	1 in. (25 mm) Jackshaft Coupler Kit (with Locking Clip) for Mounting M9220-xxx-3 Proportional Electric Spring Return Actuators on Dampers with 3/4 to 1-1/16 in. or 19 to 27 mm Round Shafts, or 5/8 and 3/4 in. or 16, 18, and 19 mm Square Shafts (quantity 1)
M9220-601	Replacement Coupler Kit (with Locking Clip) for Mounting M9220-xxx-3 Proportional Electric Spring Return Actuators on Dampers with 1/2 to 3/4 in. or 12 to 19 mm Round Shafts, or 3/8 and 1/2 in. or 10, 12, and 14 mm Square Shafts (quantity 1)
M9220-602	Replacement Locking Clips for M9220-xxx-3 Proportional Electric Spring Return Actuators (Five per Bag)
M9220-603	Adjustable Stop Kit for M9220-xxx-3 Proportional Electric Spring Return Actuators (quantity 1)
M9220-604	Replacement Manual Override Cranks for M9220-xxx-3 Proportional Electric Spring Return Actuators (Five per Bag)
M9220-610	Replacement Shaft Gripper, 10 mm Square Shaft with Locking Clip (quantity 1)
M9220-612	Replacement Shaft Gripper, 12 mm Square Shaft with Locking Clip (quantity 1)
M9220-614	Replacement Shaft Gripper, 14 mm Square Shaft with Locking Clip (quantity 1)

1. Furnished with the damper and may be ordered separately.

M9220-xxx-3 Electric Spring Return Actuators (Continued)

Dimensions



M9220-xxx-3 Electric Spring Return Actuator Dimensions, in. (mm)

M9220-xxx-3 Electric Spring Return Actuators (Continued)

Technical Specifications

M9220-xxx Electric Spring Return Actuators (Part 1 of 2)		
Product Codes		M9220-AGx-3 Models: Floating M9220-Bxx-3 Models: On/Off M9220-GGx-3 Models: Proportional M9220-HGx-3 Models: Proportional Adjustable
Power Requirements	**AGx, HGx, GGx Models**	AC 24 V (19.2 to 30 V) at 50/60 Hz: Class 2, 15.5 VA Running, 7.7 VA Holding Position; DC 24 V (21.6 to 26.4 V): Class 2, 6.7 W Running, 2.9 W Holding Position
	BAx Models	AC 120 V (AC 102 to 132 V) at 60 Hz: 0.25 A Running, 0.13 A Holding Position
	BDx Models	AC 230 V (AC 198 to 264 V) at 50/60 Hz: 0.15 A Running, 0.09 A Holding Position
	BGx Models	AC 24 V (19.2 to 30 V) at 50/60 Hz: Class 2, 24.6 VA Running, 7.7 VA Holding Position; DC 24 V (21.6 to 26.4 V): Class 2, 17.6 W Running, 2.8 W Holding Position
Transformer Sizing Requirements	**AGx, HGx, GGx Models**	20 VA Minimum per Actuator
	Bxx Models	25 VA Minimum per Actuator
Input Signal/Adjustments	**AGx Models**	DC 0 (2) to 10 V or 0 (4) to 20 mA with Field Furnished 500 ohm resistor; Switch Selectable Direct or Reverse Action with Signal Increase, 500 ms minimum pulse width
	GGx Models	Factory Set DC 0 to 10 V, CW Rotation with Signal Increase; Selectable DC 0 (2) to 10 V or 0 (4) to 20 mA with Field Furnished 500 ohm, 0.25 W minimum resistor; Switch Selectable Direct or Reverse Action with Signal Increase
	HGx Models	Factory Set DC 0 to 10 V, CW Rotation with Signal Increase; Selectable DC 0 to 10 V or 0 to 20 mA with Field Furnished 500 ohm, 0.25 W minimum resistor; Start Point Programmable DC 0 to 10 V; Span Programmable DC 2 to 10 V; Switch Selectable Direct or Reverse Action with Signal Increase
Control Input Impedance	**GGx, HGx Models**	Voltage Input: 200,000 ohms; Current Input: 500 ohms with Field Furnished 500 ohm Resistor
Feedback Signal	**GGx Models**	0 (2) to 10 VDC for Desired Rotation Range up to 90°; Corresponds to Rotation Limits, 1 mA maximum
	HGx Models	0 to 10 VDC for Desired Rotation Range up to 90°; Corresponds to Rotation Limits, 1 mA maximum
Auxiliary Switch Rating	**xxC Models**	Two Single-Pole, Double-Throw (SPDT), Double-Insulated Switches with Gold Flash Contacts: AC 24 V, 50 VA Pilot Duty; AC 120 V, 5.8 A Resistive, 1/4 hp, 275 VA Pilot Duty; AC 240 V, 5.0 A Resistive, 1/4 hp, 275 VA Pilot Duty
Spring Return		Direction is Selectable with Mounting Position of Actuator: Side A, Actuator Face Away from Damper for CCW Spring Return; Side B, Actuator Face Away from Damper for CW Spring Return
Running and Spring Return Torque		177 lb·in (20 N·m) for a Single Actuator; 354 lb·in (40 N·m) for Two Models Mounted in Tandem 531 lb·in (60 N·m) for Three Models Mounted in Tandem
Valid Tandem Combinations		Two M9220-Bxx-3 Three M9220-AGx-3 One M9220-HGx-3 master with one or two M9220-GGX-3 slaves One M9220-GGx-3 master with one or two M9220-GGX-3 slaves
Rotation Range		Adjustable from 30 to 90° CW or CCW with Optional M9220-603 Adjustable Stop Kit; Mechanically Limited to 90°
Rotation Time Power On (Running)	**AGx, HGx, GGx Models**	150 Seconds for 0 to 177 lb·in (0 to 20 N·m) at All Operating Conditions; Independent of Load
	BGx Models	24 to 57 Seconds for 0 to 177 lb·in (0 to 20 N·m) at All Operating Conditions; 35 Seconds Nominal at Full Rated Load
Rotation Time Power Off (Spring Returning)	**AGx, HGx, GGx Models**	20 Seconds for 0 to 177 lb·in (0 to 20 N·m) at Room Temperature
	BGx Models	11 to 15 Seconds for 0 to 177 lb·in (0 to 20 N·m) at Room Temperature; 35 Seconds Maximum for 0 to 177 lb·in (0 to 20 N·m) at -22°F (-30°C) 130 Seconds Maximum for 0 to 177 lb·in (0 to 20 N·m) at -40°F (-40°C)
Cycles		60,000 Full Stroke Cycles; 1,500,000 repositions
Audible Noise Rating (AGx, HGx, GGx Models)	**Power On (Running)**	<40 dBA at 39-13/32 in. (1 m)
	Power On (Holding)	<20 dBA at 39-13/32 in. (1 m)
	Power Off (Spring Returning)	<55 dBA at 39-13/32 in. (1 m)

M9220-xxx-3 Electric Spring Return Actuators (Continued)

M9220-xxx Electric Spring Return Actuators (Part 2 of 2)		
Audible Noise Rating (BGx Models)	**Power On (Running)**	<66 dBA at 39-13/32 in. (1 m)
	Power On (Holding)	<18 dBA at 39-13/32 in. (1 m)
	Power Off (Spring Returning)	<66 dBA at 39-13/32 in. (1 m)
Electrical Connections	**Actuator (All Models)**	48 in. (1.2 m) Halogen-Free Cable with 18 AWG (0.75 mm^2) Wire Leads
	Auxiliary Switches (xxC Models)	48 in. (1.2 m) Halogen-Free Cable with 18 AWG (0.75 mm^2) Wire Leads
Conduit Connections		Integral Connectors for 3/8 in. (10 mm) Flexible Metal Conduit
Mechanical Connections	**Standard Shaft Clamp Included with Actuator**	1/2 to 3/4 in. or 12 to 19 mm Diameter Round Shafts, or 3/8 and 1/2 in. or 10, 12, and 14 mm Square Shafts
	Optional M9220-600 Jackshaft Coupler Kit	3/4 to 1-1/16 in. or 19 to 27 mm Diameter Round Shafts, or 5/8 and 3/4 in. or 16, 18, and 19 mm Square Shafts
Aluminum Enclosure		NEMA 2 (IP54) for All Mounting Orientations
Ambient Conditions	**Operating**	-40 to 131°F (-40 to 55°C); 90% RH Maximum, Noncondensing
	Storage	-85 to 185°F (-65 to 85°C); 95% RH Maximum, Noncondensing
Dimensions		See *Dimensions*.
Compliance	**United States**	UL Listed, CCN XAPX, File E27734; to UL 60730-1A: 2003-08, Ed. 3.1, Automatic Electrical Controls for Household and Similar Use; and UL 60730-2-14: 2002-02, Ed. 1, Part 2, Particular Requirements for Electric Actuators. (Models: All)
	Canada	UL Listed, CCN XAPX7, File E27734; to UL 60730-1:02-CAN/CSA: July 2002, 3rd Ed., Automatic Electrical Controls for Household and Similar Use; and CSA C22.2 No. 24-93 Temperature Indicating and Regulating Equipment (Models: All).
CE	**Europe**	CE Mark – Johnson Controls, Inc., declares that this product is in compliance with the essential requirements and other relevant provisions of the EMC Directive 2004/108/EC and Low Voltage Directive 2006/95/EC.
	Australia and New Zealand	C-Tick Mark, Australia/NZ Emissions Compliant (Models: All)
Shipping Weight	**xGx Models**	6.4 lb (2.9 kg)
	BAx and BDx Models	7.6 lb (3.5 kg)

Field Equipment Controller (FEC) Series

Description

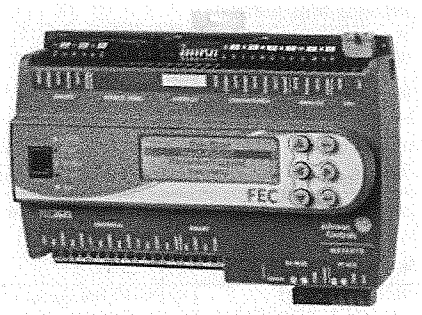
The FEC is a programmable digital controller that communicates via BACnet® Master-Slave/Token Passing (MS/TP) protocol. The FEC models include the 10-point FEC16 and the 17-point FEC26. FEC models include a 32-bit microprocessor, intuitive design, and are available with an optional built-in Liquid Crystal Display (LCD) screen local User Interface (UI).

A full range of FEC models combined with the Input/Output Module (IOM) models can be applied to a wide variety of building applications ranging from simple fan coil or heat pump control to advanced central plant management.

Refer to the *Metasys® System Field Equipment Controllers and Related Products Product Bulletin (LIT-12011042)* for important product application information.

Features

- Patented proportional adaptive control (P-Adaptive) and Pattern Recognition Adaptive Control (PRAC) technologies — provide continuous loop tuning.
- User-friendly graphic theme and clear push-button identification — facilitate easy controller use.
- Writable flash memory — allows you to download standard or customized applications from the Controller Configuration Tool (CCT) software.
- Large product family — provides a wide range of point mix to meet application requirements and allows for the addition of one or more IOMs and/or Network Sensors to provide even more application capacity.
- Network Automation Engine (NAE) and Network Control Engine (NCE) Automatic Discovery ability — allows for easy controller integration.
- Local UI display option (integral display or stand-alone display) — provides enhanced local monitoring.
- BACnet MS/TP communication — provides open system compatibility.
- 32-bit microprocessor — ensures optimum performance and meets industry specifications.
- Wireless capabilities via ZFR1800 Series Wireless Field Bus System enable wireless mesh connectivity between FECs to WRZ Series Wireless Room Temperature Sensors, and to NAE/NCE devices — facilitate easy initial location and relocation.
- Universal and configurable inputs and outputs — support multiple signal options and increase controller application flexibility.



FEC26 Controller

Repair Information

If the Field Equipment Controller fails to operate within its specifications, replace the unit. For a replacement FEC, contact the nearest Johnson Controls® representative.

Selection Charts

FEC Series Point Type Counts per Model

Point Types	Signals Accepted	FEC16	FEC26
Universal Input (UI)	Analog Input, Voltage Mode, 0–10 VDC Analog Input, Current Mode, 4–20 mA[1] Analog Input, Resistive Mode, 0–2k ohm, RTD (1k NI [Johnson Controls], 1k PT, A99B SI), NTC (10k Type L, 2.252k Type 2) Binary Input, Dry Contact Maintained Mode	2	6
Binary Input (BI)	Dry Contact Maintained Mode Pulse Counter/Accumulator Mode (High Speed), 100 Hz	1	2
Analog Output (AO)	Analog Output, Voltage Mode, 0–10 VDC Analog Output, Current Mode, 4–20 mA	0	2
Binary Output (BO)	24 VAC Triac	3	3
Configurable Output (CO)	Analog Output, Voltage Mode, 0–10 VDC Binary Output Mode, 24 VAC Triac	4	4

1. Analog Input, Current Mode is set by hardware for the FEC26, and as software for the FEC16.

Field Equipment Controller (FEC) Series (Continued)

Ordering Information

Product Code Number	Description
MS-FEC1611-0	10-Point Field Equipment Controller with 2 UI, 1 BI, 3 BO, and 4 CO; 24 VAC; SA Bus; Mounting Base
MS-FEC1621-0	10-Point Field Equipment Controller with 2 UI, 1 BI, 3 BO, and 4 CO; 24 VAC; SA Bus; Mounting Base; Integral Display
MS-FEC2611-0	17-Point Field Equipment Controller with 6 UI, 2 BI, 3 BO, 2 AO, and 4 CO; 24 VAC; SA Bus; Mounting Base
MS-FEC2621-0	17-Point Field Equipment Controller with 6 UI, 2 BI, 3 BO, 2 AO and 4 CO; 24 VAC; SA Bus; Integral Display; Mounting Base

Ordering Information for UL Listed, File S4977, UUKL 864 - 9th Edition, Smoke Control Equipment

Product Code Number[1]	Description
MS-FEU1610-0U	10-Point Field Equipment Controller with 2 UI, 1 BI, 3 BO, and 4 CO; 24 VAC; SA Bus; (includes Mounting Base and Cover)
MS-FEU1620-0U	10-Point Field Equipment Controller with 2 UI, 1 BI, 3 BO, and 4 CO; 24 VAC; SA Bus; Mounting Base; Integral Display
MS-FEU2610-0U	17-Point Field Equipment Controller with 6 UI, 2 BI, 3 BO, 2 AO, and 4 CO; 24 VAC; SA Bus; Mounting Base
MS-FEU2620-0U	17-Point Field Equipment Controller with 6 UI, 2 BI, 3 BO, 2 AO, and 4 CO; 24 VAC; SA Bus; Mounting Base; Integral Display

1. These devices are UL Listed, File S4977, UUKL 864 - 9th Edition, Smoke Control Equipment.

Accessories (Order Separately)

Product Code Number	Description
Y64T15-0	Transformer, 120/208/240 VAC Primary to 24 VAC Secondary, 92 VA, Foot Mount, 30 in. Primary Leads and 30 in. Secondary Leads, Class 2
Y65A13-0	Transformer, 120 VAC Primary to 24 VAC Secondary, 40 VA, Foot Mount (Y65AS), 8 in. Primary Leads and 30 in. Secondary Leads, Class 2
Y65T42-0	Transformer, 120/208/240 VAC Primary to 24 VAC Secondary, 40 VA, Hub Mount (Y65SP+), 8 in. Primary Leads and Secondary Screw Terminals, Class 2
Y65T31-0	Transformer, 120/208/240 VAC Primary to 24 VAC Secondary, 40 VA, Foot Mount (Y65AR+), 8 in. Primary Leads and Secondary Screw Terminals, Class 2
AP-TBK4SA-0	Replacement MS/TP SA Bus Terminal, 4-Position Connector, Brown, Bulk Pack
AP-TBK4FC-0	Replacement MS/TP FC Bus Terminal, 4-Position Connector, Blue, Bulk Pack
AP-TBK3PW-0	Replacement Power Terminal, 3-Position Connector, Gray, Bulk Pack
MS-BTCVT-1	Wireless Commissioning Converter, with Bluetooth® technology
MS-BTCVTCBL-700	Cable replacement Set for the MS-BTCVT-1 or the NS-ATV7003-0; includes one 5 ft (1.5 m) retractable cable.
MS-DIS1710-0	Local Controller Display for FEC1611 and FEC2611 models
MS-ZFR1810-0	Wireless Field Bus Coordinator, 10 mW Transmission Power. Functions with NAE35xx, NAE45xx, NAE55xx, and NCE25xx models.
MS-ZFR1811-0	Wireless Field Bus Router, 10 mW Transmission Power. Functions with Metasys BACnet FECs, VMA1600s, and WRZ-TTx Series Wireless Mesh Room Temperature Sensors.
MS-ZFRCBL-0	Wire Harness for use with ZFR1811 Router. Allows ZFR1811 Router to function with FEC1620; and with FEC1610, VMA1610, or VMA1620 controllers in conjunction with NS Series Sensors, Wireless Commissioning Converter, or DIS1710 Local Controller Display.

Field Equipment Controller (FEC) Series (Continued)

Technical Specifications

	FEC Series
Product Code Numbers	MS-FEC1611-0 – Field Equipment Controller MS-FEC2611-0 – Field Equipment Controller MS-FEC1621-0 – Field Equipment Controller with Display and Push Button User Interface MS-FEC2621-0 – Field Equipment Controller with Display and Push Button User Interface
Supply Voltage	24 VAC (nominal, 20 VAC minimum/30 VAC maximum), 50/60 Hz, power supply Class 2 (North America), Safety Extra-Low Voltage (SELV) (Europe)
Power Consumption	14 VA maximum for FEC1611 and FEC2611 (no integral display) 20 VA maximum for FEC1621 and FEC2621 (with integral display) Note: VA ratings do not include any power supplied to the peripheral devices connected to Binary Outputs (BOs) or Configurable Outputs (COs), which can consume up to 12 VA for each BO or CO; for a possible total consumption of an additional 84 VA (maximum).
Ambient Conditions	**Operating:** 0 to 50°C (32 to 122°F); 10 to 90% RH noncondensing **Storage:** -40 to 80°C (-40 to 176°F); 5 to 95% RH noncondensing
Controller Addressing	DIP switch set; valid field controller device addresses 4–127 (Device addresses 0–3 and 128–255 are reserved and not valid field controller addresses.)
Communications Bus	BACnet® MS/TP, RS-485: 3-wire FC Bus between the supervisory controller and field controllers 4-wire SA Bus between field controller, network sensors, and other sensor/actuator devices, includes a lead to source 15 VDC supply power (from field controller) to bus devices.[1]
Processor	H8SX/166xR Renesas® microcontroller
Memory	1 MB Flash Memory and 512 KB Random Access Memory (RAM)
Input and Output Capabilities	**FEC16 Models:** 2 - Universal Inputs: Defined as 0–10 VDC, 4–20 mA, 0–600k ohm, or Binary Dry Contact 1 - Binary Inputs: Defined as Dry Contact Maintained or Pulse Counter/Accumulator Mode 3 - Binary Outputs: Defined as 24 VAC Triac (selectable internal or external source power) 4 - Configurable Outputs: Defined as 0–10 VDC or 24 VAC Triac BO **FEC26 Models:** 6 - Universal Inputs: Defined as 0–10 VDC, 4–20 mA, 0–600k ohm, or Binary Dry Contact 2 - Binary Inputs: Defined as Dry Contact Maintained or Pulse Counter/Accumulator Mode 3 - Binary Outputs: Defined as 24 VAC Triac (selectable internal or external source power) 4 - Configurable Outputs: Defined as 0–10 VDC or 24 VAC Triac BO 2 - Analog Outputs: Defined as 0–10 VDC or 4–20 mA
Analog Input/Analog Output Resolution and Accuracy	Analog Input: 16-bit resolution Analog Output: 16-bit resolution and ±200 mV in 0–10 VDC applications
Terminations	Input/Output: Fixed Screw Terminal Blocks FC Bus, SA Bus, and Supply Power: 3-Wire and 4-Wire Pluggable Screw Terminal Blocks FC Bus and SA Bus: RJ-12 6-Pin Modular Jacks
Mounting	Horizontal on single 35 mm DIN rail mount (preferred), or screw mount on flat surface with three integral mounting clips on controller
Housing	Enclosure material: ABS and plycarbonate UL94 5VB; Self-extinguishing, Plenum-rated Protection Class: IP20 (IEC529)
Dimensions (Height x Width x Depth)	**FEC16 Models:** 150 x 164 x 53 mm (5-7/8 x 6-7/16 x 2-1/8 in.) including terminals and mounting clips **FEC26 Models**: 150 x 190 x 53 mm (5-7/8 x 7-1/2 x 2-1/8 in.) including terminals and mounting clips Note: Mounting space for FEC16 and FEC26 Models requires an additional 50 mm (2 in.) space on top, bottom, and front face of controller for easy cover removal, ventilation, and wire terminations.
Weight	**FEC16 Models:** 0.4 kg (0.9 lb) **FEC26 Models**: 0.5 kg (1.1 lb)
Compliance CE	**United States:** UL Listed, File E107041, CCN PAZX, UL 916, Energy Management Equipment; FCC Compliant to CFR47, Part 15, Subpart B, Class A
	Canada: UL Listed, File E107041, CCN PAZX7, CAN/CSA C22.2 No. 205, Signal Equipment Industry Canada Compliant, ICES-003
	Europe: CE Mark – Johnson Controls, Inc., declares that the FEC Series Field Equipment Controllers are in compliance with the essential requirements and other relevant provisions of the EMC Directive 2004/108/EC. Note: For **FEC26 Models**, Conducted RF Immunity within EN 61000-6-2 meets performance criteria B.
	Australia and New Zealand: C-Tick Mark, Australia/NZ Emissions Compliant
	BACnet International: BACnet Testing Laboratories™ (BTL) 135-2004 Listed BACnet Application Specific Controller (B-ASC)

1. For more information, refer to the *MS/TP Communications Bus Technical Bulletin (LIT-12011034)*.

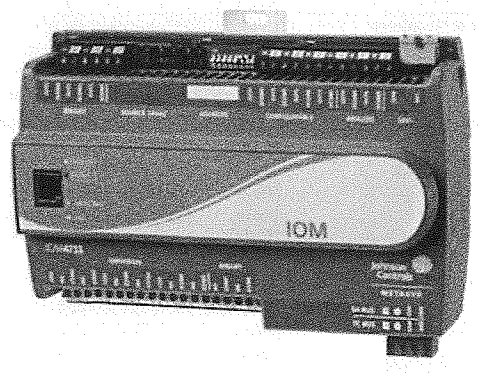
Input/Output Module (IOM) Series Controllers

Description

IOMs can serve in one of two capacities depending on where they are installed in the Metasys® system. When installed on the Sensor Actuator (SA) Bus of a Field Equipment Controller (FEC) or VAV (Variable Air Volume) Modular Assembly (VMA) controller, the IOMs expand the point count of these controllers. When installed on the Field Controller (FC) Bus as point multiplexors, IOMs allow a Network Automation Engine (NAE) or Network Controller Engine (NCE) to monitor and control supervisory points directly.

A full range of FEC models combined with the IOM models can be applied to a wide variety of building applications ranging from simple fan coil or heat pump control to advanced central plant management.

Refer to the *Metasys® System Field Equipment Controllers and Related Products Product Bulletin (LIT-12011042)* for important product application information.



IOM47 Controller

Features

- Large product family — provides a wide range of input/output point combinations to best fit the applications
- Ability to reside on the FC Bus or SA Bus — provides application flexibility
- Pluggable communications bus, Inputs/Outputs, and power terminals — expedite installation
- BACnet® Master-Slave/Token-Passing (MS/TP) communication —provides open system compatibility
- 32-bit microprocessor — ensures optimum performance and meets industry specifications
- Wireless capabilities via ZFR1800 Series Wireless Field Bus System enable wireless mesh connectivity between IOMs to WRZ Series Wireless Room Temperature Sensors, and to NAE/NCE devices — facilitate easy initial location and relocation
- Universal and configurable inputs and outputs — support multiple signal options and increase controller application flexibility

Repair Information

If the Input/Output Module fails to operate within its specifications, replace the unit. For a replacement IOM, contact the nearest Johnson Controls® representative.

Selection Charts

IOM Series Point Type Counts per Model

Point Types	Signals Accepted	IOM1711	IOM2711	IOM2721[1]	IOM3711	IOM3721[1]	IOM3731[1]	IOM4711
Universal Input (UI)	Analog Input, Voltage Mode, 0 - 10 VDC Analog Input, Current Mode, 4 - 20 mA Analog Input, Resistive Mode, 0 - 2k ohm, RTD (1k NI [Johnson Controls], 1k PT, A99B SI), NTC (10k Type L, 2.252k Type 2) Binary Input, Dry Contact Maintained Mode		2	8	4			6
Binary Input (BI)	Dry Contact Maintained Mode Pulse Counter Mode (High Speed), 100 Hz	4				16	8	2
Analog Output (AO)	Analog Output, Voltage Mode, 0 - 10 VDC Analog Output, Current Mode, 4 - 20 mA			2				2
Binary Output (BO)	24 VAC Triac						8	3
Universal Output (UO)	Analog Output, Voltage Mode, 0 - 10 VDC Binary Output Mode, 24 V AC/DC FET Analog Output, Current Mode, 4 - 20 mA		2		4			
Configurable Output (CO)	Analog Output, Voltage Mode, 0 - 10 VDC Binary Output Mode, 24 VAC Triac							4
Relay Output	120/240 VAC		2		4			

1. This model is currently available only in Asia; contact your local Johnson Controls represenative for more information.

Ordering Information

Code Number	Description
MS-IOM1711-0	4-Point IOM with 4 BI, FC Bus and SA Bus Support
MS-IOM2711-0	6-Point IOM with 2 UI, 2 AO, 2 BO, FC Bus, and SA Bus Support
MS-IOM2721-0[1]	10-Point IOM with 8 UI, 2 AO, FC Bus, and SA Bus Support
MS-IOM3711-0	12-Point IOM with 4 UI, 4 UO, 4 BO, FC Bus, and SA Bus Support
MS-IOM3721-0[1]	16-Point IOM with 16 BI, FC Bus, and SA Bus Support
MS-IOM3731-0A[1]	16-Point IOM with 8 BI, 8 BO, FC Bus, and SA Bus Support Note: Binary Outputs (BOs) on MS-IOM3731-0A controllers do not supply power for the outputs; the BOs require external low-voltage (< 30 VAC) power sources.
MS-IOM4711-0	17-Point IOM with 6 UI, 2 BI, 3 BO, 2 AO, 4 CO, 24 VAC, and SA Bus with Mounting Base

Input/Output Module (IOM) Series Controllers (Continued)

1. This model is currently available only in Asia; contact your local Johnson Controls represenative for more information.

Ordering Information for UL Listed, File S4977, UUKL 864 - 9th Edition, Smoke Control Equipment

Product Code Number[1]	Description
MS-IOM1710-0U	4-Point IOM with 4 BI, FC Bus and SA Bus Support
MS-IOM2710-0U	6-Point IOM with 2 UI, 2 UO, 2 BO, FC Bus, and SA Bus Support
MS-IOM3710-0U	12-Point IOM with 4 UI, 4 UO, 4 BO, FC Bus, and SA Bus Support
MS-IOM4710-0U	17-Point IOM with 6 UI, 2 BI, 3 BO, 2 AO, 4 CO, 24 VAC, and SA Bus with Mounting Base

1. These devices are UL Listed, File S4977, UUKL 864 - 9th Edition, Smoke Control Equipment.

Accessories

Code Number	Description
Y64T15-0	Transformer, 120/208/240 VAC Primary to 24 VAC Secondary, 92 VA, Foot Mount, 30 in. Primary Leads and 30 in. Secondary Leads, Class 2
Y65A13-0	Transformer, 120 VAC Primary to 24 VAC Secondary, 40 VA, Foot Mount (Y65AS), 8 in. Primary Leads and 30 in. Secondary Leads, Class 2
Y65T42-0	Transformer, 120/208/240 VAC Primary to 24 VAC Secondary, 40 VA, Hub Mount (Y65SP+), 8 in. Primary Leads and Secondary Screw Terminals, Class 2
Y65T31-0	Transformer, 120/208/240 VAC Primary to 24 VAC Secondary, 40 VA, Foot Mount (Y65AR+), 8 in. Primary Leads and Secondary Screw Terminals, Class 2
AP-TBK4SA-0	Replacement MS/TP SA Bus Terminal, 4-Position Connector, Brown, Bulk Pack
AP-TBK4FC-0	Replacement MS/TP FC Bus Terminal, 4-Position Connector, Blue, Bulk Pack
AP-TBK3PW-0	Replacement Power Terminal, 3-Position Connector, Gray, Bulk Pack
MS-BTCVT-1	Wireless Commissioning Converter, with Bluetooth® technology
MS-BTCVTCBL-700	Cable replacement Set for the MS-BTCVT-1 or the NS-ATV7003-0; includes one 5 ft (1.5 m) retractable cable.

Technical Specifications

	IOM Series
Product Code Numbers	MS-IOM17xx-0 – Input/Output Module MS-IOM27xx-0 – Input/Output Module MS-IOM37xx-0 – Input/Output Module MS-IOM47xx-0 – Input/Output Module
Supply Voltage	24 VAC (nominal, 20 VAC minimum/30 VAC maximum), 50/60 Hz, power supply Class 2 (North America), Safety Extra-Low Voltage (SELV) Europe
Power Consumption	14 VA maximum Note: VA rating does not include any power supplied to the peripheral devices connected to Binary Outputs (BOs) or Configurable Outputs (COs), which can consume up to 12 VA for each BO or CO; for a possible total consumption of an additional 84 VA (maximum).
Ambient Conditions	**Operating:** 0 to 50°C (32 to 122°F); 10 to 90% RH noncondensing **Storage:** -40 to 80°C (-40 to 176°F); 5 to 95% RH noncondensing
Addressing	DIP switch set; valid field controller device addresses 4–127 (Device addresses 0–3 and 128–255 are reserved and not valid IOM addresses).
Communications Bus	BACnet MS/TP, RS-485 3-wire FC Bus between the supervisory controller and field devices 4-wire SA Bus between field controller, network sensors, and other sensor/actuator devices, includes a lead source 15 VDC supply power (from field controller) to bus devices.[1]
Processor	H8SX/166xR Renesas® 32-bit microcontroller
Memory	**IOM17xx, IOM27xx, and IOM37xx Models:** 640 KB Flash Memory and 128 KB Random Access Memory (RAM) **IOM47xx Models:** 1 MB Flash Memory and 512 KB RAM

Input/Output Module (IOM) Series Controllers (Continued)

IOM Series	
Input and Output Capabilities	**IOM1711:** 4 - Binary Inputs: Defined as Dry Contact Maintained or Pulse Counter/Accumulator Mode
	IOM2711: 2 - Universal Inputs: Defined as 0–10 VDC, 4–20 mA, 0–600k ohm, or Binary Dry Contact 2 - Universal Outputs: Defined as Dry Contact Maintained or Pulse Counter/Accumulator Mode 2 - Relay Outputs (Single-Pole, Double-Throw) Rate as: 240 VAC maximum voltage 1/3 hp 125 VAC, 1/2 hp 250 VAC 400 VA Pilot Duty at 240 VAC 200 VA Pilot Duty at 120 VAC 3 A Noninductive 24–240 VAC
	IOM2721[2]**:** 8 - Universal Inputs: Defined as 0–10 VDC, 4–20 mA, 0–600k ohm, or Binary Dry Contact 2 - Analog Outputs: Defined as 0–10 VDC or 4–20 mA
	IOM3711: 4 - Universal Inputs: Defined as 0–10 VDC, 4–20 mA, 0–600k ohm, or Binary Dry Contact 4 - Universal Outputs: Defined as Dry Contact Maintained or Pulse Counter/Accumulator Mode 4 - Relay Outputs (Single-Pole, Double-Throw) Rate as: 240 VAC maximum voltage 1/3 hp 125 VAC, 1/2 hp 250 VAC 400 VA Pilot Duty at 240 VAC 200 VA Pilot Duty at 120 VAC 3 A Noninductive 24–240 VAC
	IOM3721[2]**:** 16 - Binary Inputs: Defined as Dry Contact Maintained or Pulse Counter/Accumulator Mode
	IOM3731[2]**:** 8 - Binary Inputs: Defined as Dry Contact Maintained or Pulse Counter/Accumulator Mode 8 - Binary Outputs: Defined as 24 VAC Triac Note: Note: Binary Outputs (BOs) on MS-IOM3731-0A controllers do not supply power for the outputs; the BOs require external low-voltage (< 30 VAC) power sources.
	IOM4711: 6 - Universal Inputs: Defined as 0–VDC, 4–20 mA, 0–600k ohm, or Binary Dry Contact 2 - Binary Inputs: Defined as Dry Contact Maintained or Pulse Counter/Accumulator Mode 3 - Binary Outputs: Defined as 24 VAC Triac (selectable internal or external source power) 4 - Configurable Outputs: Defined as 0–10 VDC or 24 VAC Triac BO 2 - Analog Outputs: Defined as 0–10 VDC or 4–20 mA
Analog Input/Analog Output Resolution and Accuracy	**Analog Input:** 16-bit resolution **Analog Output:** 16-bit resolution and ±200 mV in 0–10 VDC applications
Terminations	Input/Output: Fixed Screw Terminal Blocks SA/FC Bus and Supply Power: 4-Wire and 3-Wire Pluggable Screw Terminal Blocks SA/FC Bus Port: RJ-12 6-Pin Modular Jacks
Mounting	Horizontal on single 35 mm DIN rail mount (preferred), or screw mount on flat surface with three integral mounting clips on controller
Housing	Enclosure material: ABS and polycarbonate UL94 5VB; Self-extinguishing, Plenum-rated Protection Class: IP20 (IEC529)
Dimensions (Height x Width x Depth)	**IOM17xx and IOM271x Models:** 150 x 120 x 53 mm (5-7/8 x 4-3/4 x 2-1/8 in.) including terminals and mounting clips **IOM272x, IOM372x, and IOM373x Models:** 150 x 164 x 53 mm (5-7/8 x 6-1/2 x 2-1/8 in.) including terminals and mounting clips **IOM371x and IOM47xx Models:** 150 x 190 x 53 mm (5-7/8 x 7-1/2 x 2-1/8 in.) including terminals and mounting clips Note: For all models, mounting space requires an additional 50 mm (2 in.) space on top, bottom, and front face of controller for easy removal, ventilation, and wire terminations.
Weight	0.5 kg (1.1 lb) maximum
Compliance CE	**United States:** UL Listed, File E107041, CCN PAZX, UL 916, Energy Management Equipment; FCC Compliant to CFR47, Part 15, Subpart B, Class A
	Canada: UL Listed, File E107041, CCN PAZX7, CAN/CSA C22.2 No. 205, Signal Equipment; Industry Canada Compliant, ICES-003
	Europe: CE Mark – Johnson Controls, Inc., declares that this product is in compliance with the essential requirements and other relevant provisions of the EMC Directive 2004/108/EC or the Low Voltage Directive 2006/95/EC. Note: For **IOM47xx Models**, Conducted RF Immunity within EN 61000-6-2 meets performance criteria B.
	Australia and New Zealand: C-Tick Mark, Australia/NZ Emissions Compliant
	BACnet International: BACnet Testing Laboratories (BTL) 135-2004 Listed BACnet Application Specific Controller (B-ASC) (IOM2721, IOM3721, and IOM3731-0A models pending)

1. For more information, refer to the *MS/TP Communications Bus Technical Bulletin (LIT-12011034)*.
2. This model is currently available only in Asia; contact your local Johnson Controls represenative for more information.

FEC/IOM

Standard Control Panel Assembly Mounted in a 24 in. x 36 in. Enclosure

Description

The 24 in. x 36 in. Field Equipment Controller (FEC) and Input/Output Module (IOM) control panel is a pre-wired, preassembled standard control panel and enclosure that contains an FEC and/or IOM digital controller. Such a predesigned solution saves both time and money. In addition, the assembly may be tailored to a variety of common applications for additional savings.

The control panel is shipped complete, mounted in a 24 in. x 36 in. steel enclosure. In addition to the controller(s), the assembly also contains a power supply incorporating a 5 A circuit breaker, a 96 VA 120/24 VAC transformer, and two 120 VAC outlets; plus an optional second 96 VA 120/24 VAC transformer is available. Noted models are provided with an integral display on the face of the controller or a remote mounted display (MS-DIS1710-0), which is visible on the face of the panel. Space is reserved in the panel for the addition of relays and/or transducers, if desired.

The PAKxxx01xBxx contains low-voltage terminal blocks that are pre-wired and prelabeled to match every terminal on the controller, making installation, commissioning, and servicing quicker and easier. Panels without an FEC or IOM terminal block assembly are provided with a five- or ten-point 24 VAC distribution terminal block that allows for termination of additional field-mounted devices.

FEC/IOM Standard Control Panel Assembly Mounted in a 24 in. x 36 in. Enclosure

Features

- consistent layout for all standard control panel solutions simplifies installation and commissioning
- power supply with resettable circuit breaker and transformer provides high- and low-voltage protection
- space reserved for future component additions allows easy upgrading to a standard-plus control panel
- prebuilt, prewired, and pretested in an ISO-9002 manufacturing facility provides products of consistently high quality
- California Office of Statewide Health Planning and Development (OSHPD) Special Seismic Certification Preapproved control panel assembly meets standards for rigid and flexible mounting conditions to account for unit-mounted and remote-mounted application
- UL 508A rated control panel and UL 50, Canadian Standards Association (CSA) approved enclosure meets local and national code requirements for the United States and Canada (cULus listed)
- color-coded and clearly labeled terminations and wiring (if applicable) ensures easily and properly identifiable input/output points at the controller

Repair Information

If the FEC/IOM control panel assembly fails to operate within its specifications, replace the unit. For a replacement assembly, contact the nearest Johnson Controls® representative.

Components Included with the FEC/IOM Standard Control Panel Assembly

Quantity	Description
1	Enclosure: 24 in. W x 36 in. H x 6-5/8 in. D (610 mm W x 914 mm H x 168 mm D), Type 1, with slotted flush latch
1	MS-FEC1611-0, MS-FEC2611-0, MS-FEC1621-0, or MS-FEC2621-0 digital controller
1 or 2	MS-IOM1711-0, MS-IOM2711-0, MS-IOM2721-0, MS-IOM3711-0, MS-IOM3721-0, MS-IOM3731-0 and/or MS-IOM4711-0 digital controller (if applicable)
1	MS-DIS1710-0 remote mount display (if applicable)
1	96 VA 120/24 VAC power supply with 5 A primary circuit protection and two 120 VAC outlets
1	96 VA 120/24 VAC transformer with secondary protection (if applicable)
1	FEC terminal block assembly (if applicable)
1	IOM terminal block assembly (if applicable)
1	Five- or ten-point 24 VAC distribution terminal block[1]

1. Panels that have the 24 VAC distribution block and a single power supply ship with the five-point distribution block. Panels with an additional transformer ship with a ten-point distribution block.

Selection Chart

Product Code Number (Part 1 of 2)	Description
PAKF00001BH0	MS-FEC1611-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman® enclosure
PAKF00001BH4	MS-FEC1611-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with remote mount display
PAKFJF001BH0	MS-FEC1611-0 and MS-IOM1711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure
PAKFJG002BH0	MS-FEC1611-0 and MS-IOM2711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer

Standard Control Panel Assembly Mounted in a 24 in. x 36 in. Enclosure (Continued)

Product Code Number (Part 2 of 2)	Description
PAKFJH002BH0	MS-FEC1611-0 and MS-IOM3711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKFJJ002BH0	MS-FEC1611-0 and MS-IOM4711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKG00001BH0	MS-FEC2611-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure
PAKG00001BH4	MS-FEC2611-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with remote mount display
PAKGJF001BH0	MS-FEC2611-0 and MS-IOM1711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure
PAKGJG002BH0	MS-FEC2611-0 and MS-IOM2711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKGJH002BH0	MS-FEC2611-0 and MS-IOM3711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKGJJ002BH0	MS-FEC2611-0 and MS-IOM4711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKGJJ002BH4	MS-FEC2611-0 and MS-IOM4711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer and remote mount display
PAKGJK002BH0	MS-FEC2611-0, MS-IOM4711-0, and MS-IOM1711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with two 96 VA transformers
PAKGJL002BH0	MS-FEC2611-0 AND MS-IOM2721-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKGJM002BH0	MS-FEC2611-0 AND MS-IOM3721-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKGJN002BH0	MS-FEC2611-0 AND MS-IOM3731-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKH00001BH0	MS-FEC1621-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with integral display
PAKJ00001BH0	MS-FEC2621-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with integral display
PAKF00011BH0	MS-FEC1611-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with terminal blocks
PAKFJF011BH0	MS-FEC1611-0 and MS-IOM1711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with terminal blocks
PAKFJG012BH0	MS-FEC1611-0 and MS-IOM2711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer and terminal blocks
PAKFJH012BH0	MS-FEC1611-0 and MS-IOM3711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer and terminal blocks
PAKFJJ012BH0	MS-FEC1611-0 and MS-IOM4711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer and terminal blocks
PAKG00011BH0	MS-FEC2611-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with terminal blocks
PAKGJF011BH0	MS-FEC2611-0 and MS-IOM1711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with terminal blocks
PAKGJG012BH0	MS-FEC2611-0 and MS-IOM2711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer and terminal blocks
PAKGJH012BH0	MS-FEC2611-0 and MS-IOM3711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer and terminal blocks
PAKGJJ012BH0	MS-FEC2611-0 and MS-IOM4711-0 panel mounted in 24 in. W x 36 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer and terminal blocks

Technical Specifications

FEC/IOM Standard Control Panel Assembly Mounted in a 24 in. x 36 in. Enclosure	
Terminals	5/32 in. (4 mm) wire slots (if applicable)
Wiring	If applicable, all components are pre-wired to FEC and IOM terminal blocks.
Wire Size	Ground wire: 14 AWG; 24 VAC Controller wires: 18 AWG
Enclosure Rating	Type 1
Enclosure Finish	ANSI 61 gray polyester powder coating (perforated panel and enclosure)
Ambient Operating Condition	32–122°F (0–50°C) 10–90% RH
Dimensions (Width x Height x Depth)	Hoffman Standard Enclosure: 24 in. W x 36 in. H x 6-5/8 in. D (610 mm W x 914 mm H x 168 mm D)
Weight	90 lb (40.8 kg)
Ambient Storage Condition	-40–158°F (-40–70°C) 5–95% RH
Agency Compliance	Control Panel: UL 508A Rated (cULus listed); Enclosure UL 50 Rated, CSA Approved OSHPD Special Seismic Certification Preapproval: OSP-0140-10 California Building Code (CBC) - 2010, International Building Code (IBC) - 2009 Seismic Performance Characteristics: $S_{DS}(g) = 2.26$, $z/h = 1.0$, $I_p = 1.5$

FEC/IOM

Standard Control Panel Assembly Mounted in a 20 in. x 24 in. Enclosure

Description

The 20 in. x 24 in. Field Equipment Controller (FEC) and Input/Output Module (IOM) control panel is a pre-wired, preassembled standard control panel and enclosure that contains an FEC and/or IOM digital controller. This predesigned solution saves both time and money. In addition, the assembly may be tailored to a variety of common applications for additional savings.

The control panel is shipped complete, mounted in a 20 in. x 24 in. steel enclosure. In addition to the controller(s), the assembly also contains a power supply incorporating a 5 A circuit breaker, a 96 VA 120/24 VAC transformer, and two 120 VAC outlets; an optional second 96 VA 120/24 VAC transformer is also available. A five- or ten-point 24 VAC distribution terminal block that allows for termination of additional field mounted devices is also included. Noted models are provided with an integral display on the face of the controller or a remote mounted display (MS-DIS1710-0), which is visible on the face of the panel. Space is reserved in the panel along with a section of DIN rail to mount relays and/or transducers, if desired.

These control panels allow for direct wire termination to the controller, making installation, commissioning, and servicing quicker and easier.

Features

- consistent layout for all standard control panel solutions simplifies installation and commissioning
- power supply with resettable circuit breaker and transformer provides high- and low-voltage protection
- space and DIN rail reserved for future component additions allows easy upgrading to a standard-plus control panel
- prebuilt, prewired, and pretested in an ISO-9002 manufacturing facility provides products of consistently high quality

FEC/IOM Standard Control Panel Assembly Mounted in a 20 in. x 24 in. Enclosure

- UL 508A rated control panel and UL 50, Canadian Standards Association (CSA) approved enclosure meets local and national code requirements for the United States and Canada (cULus listed)
- California Office of Statewide Health Planning and Development (OSHPD) Special Seismic Certification Preapproved control panel assembly meets standards for rigid and flexible mounting conditions to account for unit-mounted and remote-mounted application
- controller with color-coded and clearly labeled screw terminals provides easily identifiable input/output points at the controller

Repair Information

If the FEC/IOM control panel assembly fails to operate within its specifications, replace the unit. For a replacement assembly, contact the nearest Johnson Controls® representative.

Components Included with the FEC/IOM Standard Control Panel Assembly

Quantity	Description
1	Enclosure: 20 in. W x 24 in. H x 6-5/8 in. D, Type 1, with slotted flush latch
1	MS-FEC1611-0, MS-FEC2611-0, or MS-FEC2621-0 digital controller
1	MS-IOM1711-0, MS-IOM1721-0, MS-IOM2721-0, MS-IOM3711-0, MS-IOM3721-0, MS-IOM3731-0, and/or MS-IOM4711-0 (if applicable)
1	MS-DIS1710-0 remote mount display (if applicable)
1	96 VA 120/24 VAC power supply with 5 A primary circuit protection and two 120 VAC outlets (standard on all panels)
1	96 VA 120/24 VAC transformer with secondary protection (if applicable)
1	Five- or ten-point 24 VAC distribution terminal block[1]

1. All panels with a single power supply ship with a five-point terminal block. Panels with an additional transformer ship with a ten-point terminal block.

Selection Chart

Product Code Number (Part 1 of 2)	Description
PAKF00001AH0	MS-FEC1611-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman® enclosure
PAKFJF001AH0	MS-FEC1611-0 and MS-IOM1711-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure
PAKFJG002AH0	MS-FEC1611-0 and MS-IOM2711-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKFJH002AH0	MS-FEC1611-0 and MS-IOM3711-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKFJJ002AH0	MS-FEC1611-0 and MS-IOM4711-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKG00001AH0	MS-FEC2611-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure
PAKG00002AH0	MS-FEC2611-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKG00001AH4	MS-FEC2611-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure with remote mount display
PAKGJF001AH0	MS-FEC2611-0 and MS-IOM1711-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure

Standard Control Panel Assembly Mounted in a 20 in. x 24 in. Enclosure (Continued)

Product Code Number (Part 2 of 2)	Description
PAKGJG002AH0	MS-FEC2611-0 and MS-IOM2711-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKGJH002AH0	MS-FEC2611-0 and MS-IOM3711-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKGJJ002AH0	MS-FEC2611-0 and MS-IOM4711-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKGJL002AH0	MS-FEC2611-0 and MS-IOM2721-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKGJM002AH0	MS-FEC2611-0 and MS-IOM3721-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKGJN002AH0	MS-FEC2611-0 and MS-IOM3731-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure with additional 96 VA transformer
PAKJ00001AH0	MS-FEC2621-0 panel mounted in a 20 in. W x 24 in. H x 6-5/8 in. D Hoffman enclosure with integral display

Technical Specifications

FEC/IOM Standard Control Panel Assembly Mounted in a 20 in. x 24 in. Enclosure	
Terminals	Controller mounted screw termination
Wire Size	Ground wire: 14 AWG; Transformer wires: 16 AWG
Enclosure Rating	Type 1
Finish	ANSI 61 gray polyester powder coating (perforated panel and enclosure)
Ambient Operating Condition	32–122°F (0–50°C) 10–90% RH
Dimensions (Width x Height x Depth)	20 in. x 24 in. x 6-5/8 in. (508 mm x 610 mm x 168 mm)
Weight	50.0 lb (22.7 kg)
Ambient Storage Condition	-40–176°F (-40–80°C) 5–95% RH
Agency Compliance	UL 508A Rated (cULus listed); Enclosure UL 50 Rated, CSA Approved OSHPD Special Seismic Certification Preapproval: OSP-0140-10 California Building Code (CBC) - 2010, International Building Code (IBC) - 2009 Seismic Performance Characteristics: $S_{DS}(g) = 2.26$, $z/h = 1.0$, $I_p = 1.5$

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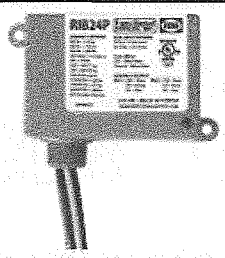
RIB24P

Enclosed Relay 20 Amp DPDT with 24 Vac/dc Coil



Functional Devices, Inc. A600D 2006

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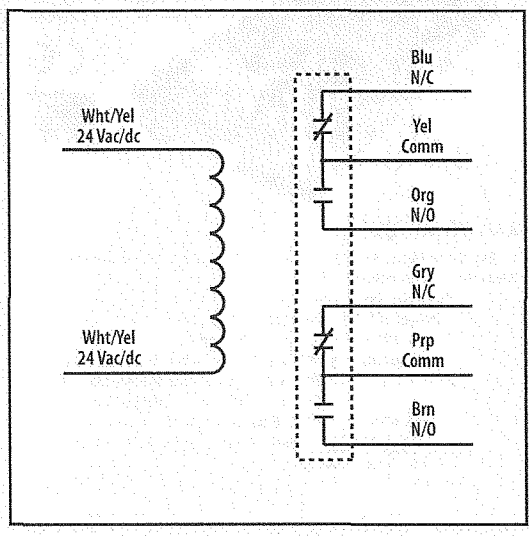
MADE IN USA

 # Relays & Contact Type: One (1) DPDT Continuous Duty Coil
Expected Relay Life: 10 million cycles minimum mechanical
Operating Temperature: -30 to 140° F
Operate Time: 18mS
Relay Status: LED On = Activated
Dimensions: 2.30" x 3.20" x 1.80" with .50" NPT Nipple
Wires: 16", 600V Rated
Approvals: UL Listed, UL916, UL864, C-UL
California State Fire Marshal, CE
Housing Rating: Plenum, NEMA 1
Gold Flash: Yes
Override Switch: No

Contact Ratings:
20 Amp Resistive @ 300 Vac
20 Amp Resistive @ 28 Vdc
20 Amp Ballast @ 277-480 Vac
15 Amp Resistive @ 600 Vac
770 VA Pilot Duty @ 120 Vac
1158 VA Pilot Duty @ 240 Vac
1110 VA Pilot Duty @ 277 Vac
1640 VA Pilot Duty @ 480 Vac
3 HP @ 480-600 Vac
2 HP @ 240-277 Vac
1 HP @ 120 Vac

Coil Current:
100 mA @ 20 Vac
125 mA @ 24 Vac
50 mA @ 20 Vdc
50 mA @ 24 Vdc
70 mA @ 30 Vdc

Coil Voltage Input:
24 Vac/dc ; 50-60 Hz
Drop Out = 3 Vac / 3.8 Vdc
Pull In = 20 Vac / 20 Vdc



NOTES

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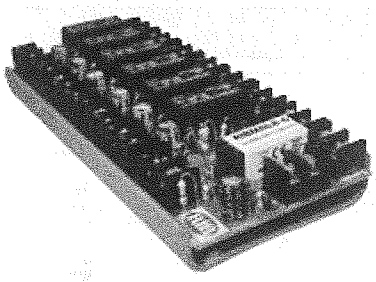
RIBMNLB-6/-4/-2

FAN SAFETY ALARM CIRCUIT

2.75˝ Track Mount AHU Fan Safety Alarm and General Purpose Logic Circuit, 24 Vac Power



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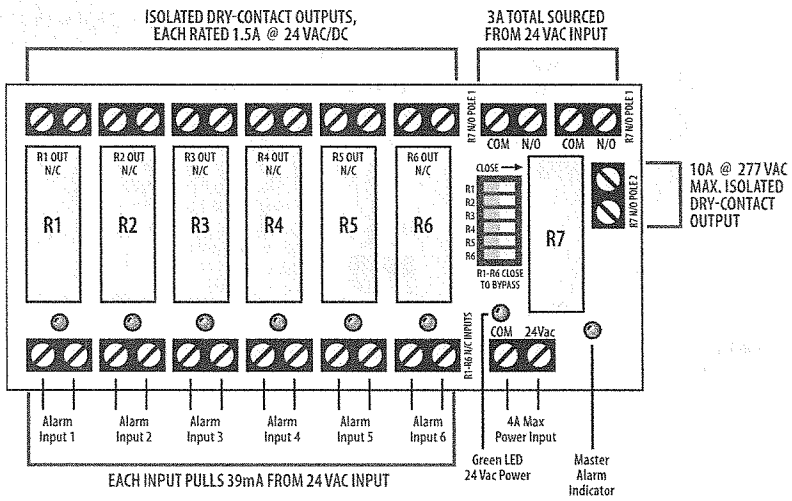
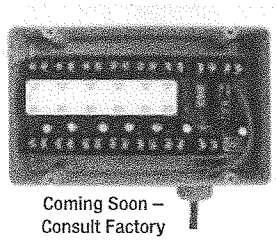


Note: RIBMNLB-4 and RIBLB-4 have four Alarm Inputs and one Master Alarm. RIBMNLB-2 and RIBLB-2 have two Alarm Inputs and one Master Alarm.

SPECIFICATIONS

Expected Relay Life:	10 million cycles minimum mechanical
Operating Temperature:	-30 to 140° F
Operate Time:	8mS
Power Input:	4 Amp @ 24 Vac ; 50-60 Hz
Alarm Status:	LED On = Activated
Dimensions:	6.000˝ x 2.750˝ x 1.750˝ (RIBMNLB-6)
	3.200˝ x 2.750˝ x 1.750˝ (RIBMNLB-4)
	4.740˝ x 2.750˝ x 1.750˝ (RIBMNLB-2)
Track Mount:	MT212-6 Mounting Track Provided
Approvals:	UL Listed, UL916, UL864, C-UL, CE
Gold Flash:	No
Override Switch:	No

RIBLB-6/-4/-2



Coming Soon – Consult Factory

SPECIFICATIONS

Dimensions:	4.28˝ x 7.00˝ x 2.00˝ with .75˝ NPT Nipple
Housing Rating:	UL Listed, Nema 1, C-UL, CE Approved, Also available NEMA 4 / 4X in Summer 2007

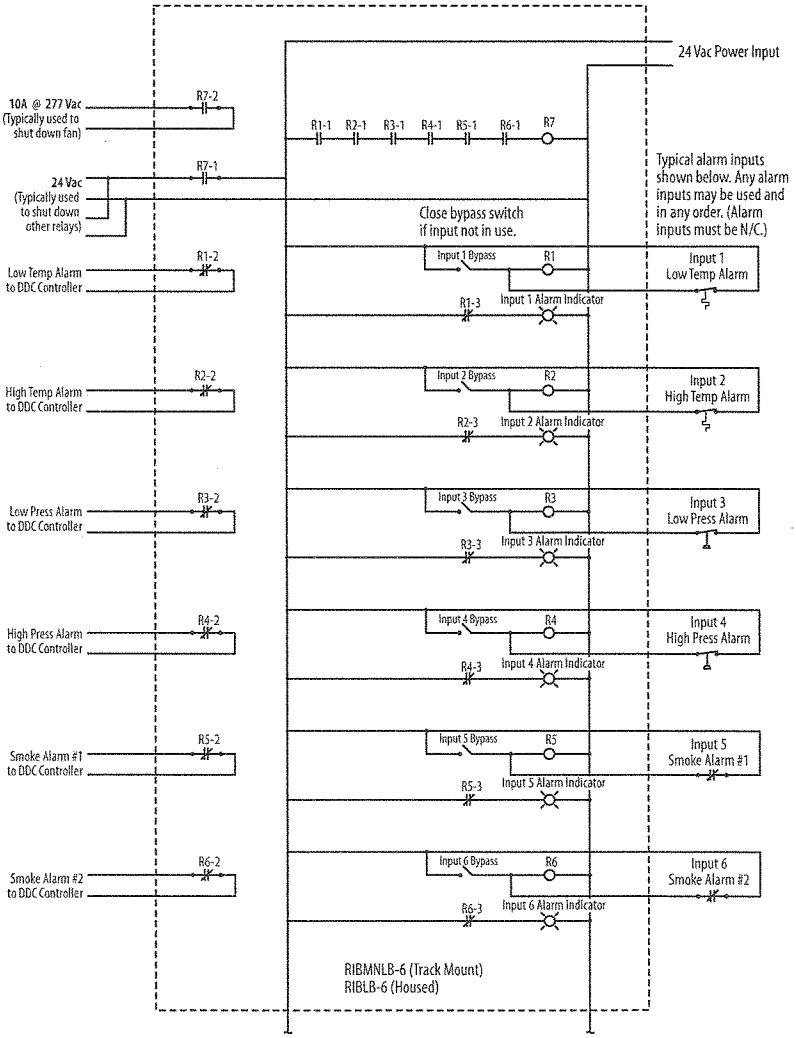
Models RIBMNLB-6, RIBMNLB-4, and RIBMNLB-2; and RIBLB-6, RIBLB-4, and RIBLB-2 are simply devices that combine a common relay-logic function into a small, easy-to-install, and less expensive form.

A master relay will open if any one of the normally-closed (N/C) inputs opens. There are six, four, or two inputs depending on the model chosen. LED status of all inputs, the master relay, and power input is provided. Bypass of un-used inputs is also provided. The RIBMNLB series is provided with mounting track for mounting in user-provided electrical enclosures. The RIBLB series is enclosed in a NEMA-1, 4˝ x 7˝ enclosure with a clear lid to allow viewing of the status LEDs. The master relay has three general-purpose outputs: two 24 Vac output terminals and one dry-contact output rated up to 10 Amp 277 Vac (terminals on RIBMNLB series, wires on RIBLB series.)

The most common application is an Air Handling Unit (AHU) fan-safety-shutdown where the master relay is used to shutdown the fan. Contact closure outputs are provided so that a DDC controller can determine the cause of a shutdown.

SELECTION GUIDE

MODEL #	INPUTS	
RIBMNLB-6	6	MT212 Mounting Track
RIBMNLB-4	4	MT212 Mounting Track
RIBMNLB-2	2	MT212 Mounting Track
RIBLB-6	6	PE6020 Enclosure
RIBLB-4	4	PE6020 Enclosure
RIBLB-2	2	PE6020 Enclosure



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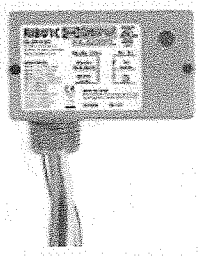
RIBU1C

Enclosed Relay 10 Amp SPDT with 10-30 Vac/dc/120 Vac Coil



Functional Devices, Inc. A600D 2006

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MADE IN USA

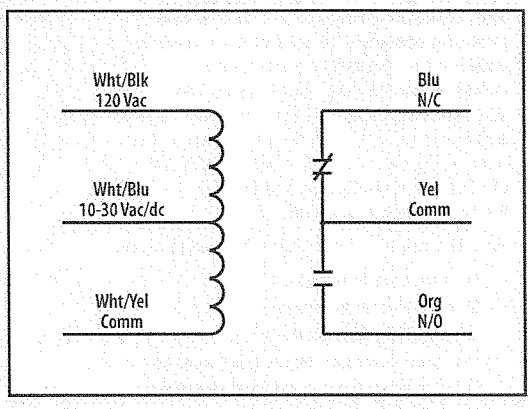
 # Relays & Contact Type: One (1) SPDT Continuous Duty Coil
Expected Relay Life: 10 million cycles minimum mechanical
Operating Temperature: -30 to 140° F
Operate Time: 20mS
Relay Status: LED On = Activated
Dimensions: 1.70" x 2.80" x 1.50" with .50" NPT nipple
Wires: 16", 600V Rated
Approvals: UL Listed, UL916, UL864, UL924, C-UL California State Fire Marshal, CE
Housing Rating: Plenum, NEMA 1
Gold Flash: Yes
Override Switch: No

Contact Ratings:
10 Amp Resistive @ 120-277 Vac
10 Amp Resistive @ 28 Vdc
480 VA Pilot Duty @ 240-277 Vac
480 VA Ballast @ 277 Vac
600 Watt Tungsten @ 120 Vac N/O
240 Watt Tungsten @ 120 Vac N/C
1/3 HP for N/O @ 120-240 Vac
1/6 HP for N/C @ 120-240 Vac
1/4 HP for N/O @ 277 Vac
1/8 HP for N/C @ 277 Vac

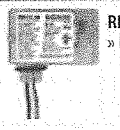
Coil Current:

30 mA @ 10 Vac	12 mA @ 10 Vdc
32 mA @ 12 Vac	14 mA @ 12 Vdc
42 mA @ 24 Vac	16 mA @ 24 Vdc
50 mA @ 30 Vac	18 mA @ 30 Vdc
25 mA @ 120 Vac	

Coil Voltage Input:
10-30 Vac/dc ; 120 Vac ; 50-60 Hz
Drop Out = 2.1 Vac / 2.8 Vdc
Pull In = 9 Vac / 10 Vdc



RIBU1C-RD
» Red housing



RIBU1C-N4
» NEMA 4X housing

NOTES

TE-6300 Series Temperature Sensors

Description

The TE-6300 Temperature Sensor line provides economical solutions for a wide variety of temperature sensing needs, including wall-mount, outdoor-air, duct, strap-mount, well-insertion, duct-averaging, and Variable Air Volume (VAV) flange-mount duct-probe applications. The TE-6300 line offers both a metal and a plastic enclosure for the most popular models.

Sensors are available in the following types:

- 1k ohm thin-film nickel
- 1k ohm nickel averaging
- 1k ohm thin-film platinum
- 100 ohm platinum equivalent averaging
- 1k ohm platinum equivalent averaging
- 2.2k (2,252) ohm thermistor
- 10k ohm thermistor, Johnson Controls® Type II

Each sensor is packaged with the necessary mounting accessories to maximize ordering and installation ease and reduce both commissioning time and cost.

Refer to the *TE-6300 Temperature Sensors Product Bulletin (LIT-216320)* for important product application information.

Features

- full line of versatile sensors — supports all your temperature sensing needs from a single supplier: wall mount, outdoor air, duct probe, duct averaging, strap-mount, well insertion, and flange mount duct probe
- single assembly ordering — simplifies ordering; provides a complete assembly in one box
- models featuring an integral NPT Adaptor — increase sensor connection strength, which eliminates the need for a special adaptor
- models with a stainless steel sensor probe — protect the sensor while increasing corrosion resistance
- metal enclosure (TE-63xxM Models only) — meets plenum requirements
- models featuring a retainer for the sensor holder — allow you to lock the sensor holder into the conduit box
- brushed stainless steel mounting plate — offers a durable, aesthetically-pleasing design
- low profile flush mount design — provides a tamper-proof installation ideally suited for schools, sporting complexes, retailers, prisons, and more

All TE-6300 series sensors are two-wire, passive, resistance output devices.

TE-63xxA Models

The TE-63xxA (adjustable length) models:

- provide a thermoplastic mounting flange and gland nut to adjust the length of the probe
- include two hex-head self-drilling screws for mounting
- come equipped with a 10 ft (3 m) plenum-rated cable with 1/4 in. (6.35 mm) female insulated quick-connect terminations on leads

TE-63xxF Models

The TE-63xxF (flush mount) models:

- provide a low profile when installed in an electrical box
- feature thermally isolated sensor from the wall with a foam pad
- offer a rugged stainless steel cover
- provide 22 AWG lead wires with low voltage installation

TE-63xxM Models

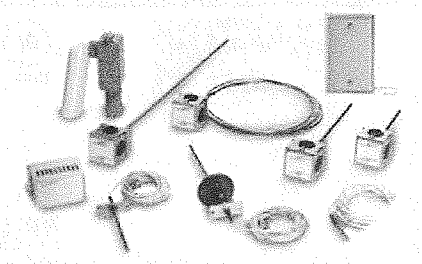
The TE-63xxM (metal enclosure) models:

- come with a corrosion-protected steel enclosure with a 0.88 in. (22 mm) hole for a 1/2 in. (12.7 mm) conduit fitting
- include two hex-head self-drilling screws for mounting the duct and duct averaging models
- offer (well models only) either a direct mount or 1/2-14 NPT threaded well sensor holder for mounting in TE-6300W Series thermal wells (Order the thermal well separately.)
- provide optional well sensor holders (order separately) to mount duct models in thermal wells.
- meet UL 1995 plenum use requirements
- offer optional accessory kit (order separately) to replace plastic hole plug and wiring bushing to meet International Mechanical Code (IMC) requirements

TE-63xxP Models

The TE-63xxP (plastic enclosure) models:

- provide a thermoplastic conduit box with 1/2-14 NPT female thread for connecting to conduit
- provide aluminum mounting plate and 1/2-14 NPT threaded hub mounting options for the duct and duct averaging models
- use the 1/2-14 NPT female thread to mount the Outdoor Air models directly to ridged conduit
- provide optional sensor holders (order separately) to mount duct models in thermal wells
- offer an optional accessory metal cover kit (order separately) to replace the plastic cover to meet UL 1995 plenum use requirements



TE-6300 Series Temperature Sensors

- include a replaceable sensing probe on duct probe, outdoor air, and well insertion models

TE-63x4P Wall Mount Models

The TE-63x4P (plastic enclosure) models:

- come with a white thermoplastic ventilated cover with a brushed aluminum face plate and a steel mounting plate for surface mounting
- include faceplates for both horizontal and vertical mounting
- offer an accessory mounting kit for mounting to a standard electrical box
- offer optional covers

TE-63xS Models

The TE-63xS (Strap-Mount) models:

- provide a 1/4 in. (6.35 mm) diameter stainless steel probe without an enclosure
- include three cable ties for mounting to pipe up to 2-5/8 in. (67 mm) diameter
- come equipped with a 10 ft (3 m) plenum rated cable
- meet UL 1995 plenum use requirements
- offer an accessory mounting kit for mounting to a pipe up to 11 in. (280 mm) diameter

TE-63xxV Models

The TE-63xxV (VAV flange mount) models:

- provide a stainless steel mounting flange with two hex-head self-drilling mounting screws
- come equipped with a 10 ft (3 m) plenum rated cable with 1/4 in. (6.35 mm) female insulated quick-connect terminations on leads
- meet UL 1995 plenum use requirements

Repair Information

If the TE-6300 Series Temperature Sensor fails to operate within its specifications, refer to the *TE-6300 Series Temperature Sensors Product Bulletin (LIT-216320)* for a list of repair parts available.

TE-6300 Series Temperature Sensors (Continued)

Selection Charts

Sensor	Mounting Style	Probe Length in. (mm)	Product Code Number
Nickel (1k ohm)	Adjustable[1]	8 ft (203)	TE-6311A-1
		8 ft (2.4 m)	TE-6315M-1
			TE-6315V-2[1]
		17 ft (5.2 m)	TE-6316M-1
			TE-6316V-2[1]
	Duct	4 (102)	TE-631GM-1
		8 (203)	TE-6311M-1
			TE-6311P-1
		18 (457)	TE-631JM-1
	Flange	4 (102)	TE-631GV-2
		8 (203)	TE-6311V-2
	Flush	N/A	TE-6310F-1
	Outdoor Air	3 (76)	TE-6313P-1
	Strap-Mount	3 (76)	TE-631S-1
	Wall[2]	N/A	TE-6314P-1
	Well	6 (152)	TE-631AM-2
		8 (203)	TE-6312M-1
Platinum (1k ohm)	Adjustable	8 (203)	TE-6351-A
	Duct	4 (102)	TE-635GM-1
		8 (203)	TE-6351M-1
			TE-6351P-1
		18 (457)	TE-635JM-1
	Flange	4 (102)	TE-635GV-2
		8 (203)	TE-6351V-2
	Flush	N/A	TE-6350F-1
	Strap-Mount	3 (76)	TE-635S-1
	Outdoor Air	3 (76)	TE-6353P-1
	Wall[2]	N/A	TE-6324P-1
	Well	6 (152)	TE-635AM-2
		8 (203)	TE-6352M-1
Platinum Equivalent	1k ohm Averaging[1]	10 ft (3 m)	TE-6327P-1
		20 ft (6.1 m)	TE-6328P-1
	100 ohm Averaging[1]	10 ft (3 m)	TE-6337P-1
		20 ft (6.1 m)	TE-6338P-1
Thermistor (2.2k ohm)	Adjustable	8 (203)	TE-6341A-1
	Duct	8 (203)	TE-6341P-1
	Flange	4 (102)	TE-634GV-2
		8 (203)	TE-6341V-2
	Outdoor Air	3 (76)	TE-6343P-1
	Wall[2]	N/A	TE-6344P-1
	Well	8 (203)	TE-6342M-1
		6 (152)	TE-634AM-2
Thermistor (10k ohm) Type II	Adjustable	8 (203)	TE-6361A-1
	Duct	4 (102)	TE-636GM-1
		8 (203)	TE-6361M-1
			TE-6361P-1
		18 (457)	TE-636JM-1
	Flange	4 (102)	TE-636GV-2
		8 (203)	TE-6361V-2
	Flush	N/A	TE-6360F-1
	Outdoor Air	3 (76)	TE-6363P-1
	Strap-Mount	3 (76)	TE-636S-1
	Well	6 (152)	TE-636AM-2
		8 (203)	TE-6362M-1

1. Two TE-6001-8 Element Holders come with the platinum equivalent averaging sensors. Order separately to use with a nickel averaging sensor.
2. Order the TE-1800-9600 Mounting Hardware separately to mount the wall unit to a wallbox.

Optional Accessories

Product Code Number	Description
F-1000-182	Thermal Conductive Grease for element wells (8 oz.)
T-4000-xxxx	Wall Mount Cover
T-4000-119	Allen Head Tool for Wall Mount Cover Screws (order in multiples of 30)
TE-1800-9600	Mounting Hardware for mounting the wall mount unit to a wall box
TE-6001-8	Element Holder for mounting an averaging sensor (order in multiples of 10)
TE-6001-13	Metal Cover and Gasket Kit (5 per package)
TE-6300-101	12 in. (305 mm) (1k ohm) Nickel Probe (cut to an appropriate length)[1]
TE-6300-105	12 in. (305 mm) (1k ohm) Platinum Class A Probe (cut to an appropriate length)[1]
TE-6300-103	1/2-14 NPT Plastic Sensor Holder without retainer (order in multiples of 10)
TE-6300-104	12 in. (305 mm) (2.2k ohm) Thermistor Probe (cut to an appropriate length)[1]
TE-6300-613	IMC Kit, Metal Knockout Plug, Metal Clamp Connector (order in multiples of 10)
TE-6300-614	Cable Tie Mounting Kit, 0.50 to 2.625 in. (12.7 to 66.7 mm) Bundle Diameter (10 per package)
TE-6300-615	Cable Tie Mounting Kit, 11 in. (280 mm) Max Bundle Diameter
TE-6300-616	8 in. (203 mm) 1k ohm Platinum Class A Probe
TE-6300-617	3 in. (76 mm) 1k ohm Platinum Class A Probe
TQ-6000-1	4 to 20 mA Output Transmitter for use with the 100 ohm platinum sensor
TE-6300W-102	6 in. (152 mm) Stainless Steel Well (direct mount)
TE-6300W-101	6 in. (152 mm) Brass Well (direct mount with thermal grease included)
TE-6300W-110	8 in. (203 mm) Stainless Steel Well

1. Cut 12 in. probes to a minimum of 3 in. (76 mm).

TE-6300 Series Temperature Sensors (Continued)

T-4000 Covers Available for the Wall Mount TE-63x4P Series

Product Code Number	Horizontal Johnson Controls Logo	Vertical Johnson Controls Logo	Thermometer, with °F/°C Scale	Faceplate/Cover Color
T-4000-2138[1]	—	—	—	Brushed Aluminum/Beige
T-4000-2139	X	—	—	
T-4000-2140	X	—	X	
T-4000-2144	—	X	—	
T-4000-2639	X	—	—	Brown and Gold/Beige
T-4000-2640	X	—	X	
T-4000-2644	—	X	—	
T-4000-3139	X	—	—	Brushed Aluminum/White
T-4000-3140	X	—	X	
T-4000-3144	—	X	—	

1. Without Johnson Controls logo

Technical Specifications

TE-6300 Series Temperature Sensors (Part 1 of 2)		
Sensor Reference Resistance	1k ohm Nickel	1k ohms at 70°F (21°C)
	1k ohm Nickel Averaging	
	1k ohm Platinum	1k ohms at 32°F (0°C)
	100 ohm Platinum Averaging	100 ohms at 32°F (0°C)
	1k ohm Platinum Averaging	1k ohms at 32°F (0°C)
	2.2k ohm Thermistor	2,252 ohms at 77°F (25°C)
	10k ohm Thermistor	10.0k ohms at 77°F (25°C)
Sensor Accuracy	1k ohm Nickel	±0.34F° at 70°F (±0.19C° at 21°C)
	1k ohm Nickel Averaging	±3.4F° at 70°F (±1.9C° at 21°C)
	1k ohm Platinum Class A	±0.35F° at 70°F (±0.19C° at 21°C), DIN Class A
	1k ohm Platinum Class B	±0.73F° at 70°F (±0.41C° at 21°C), DIN Class B
	100 ohm Platinum Averaging	±1.0F°at 70°F (± 0.58C° at 21°C)
	1k ohm Platinum Averaging	
	2.2k ohm Thermistor	±0.36F° (±0.2C°) in the range: 32 to 158°F (0 to 70°C)
	10k ohm Thermistor	±0.9F° (±0.5C°) in the range: 32 to 158°F (0 to 70°C)
Sensor Temperature Coefficient	1k ohm Nickel	Approximately 3 ohms/F° (5.4 ohms/C°)
	1k ohm Nickel Averaging	
	1k ohm Platinum	Approximately 2 ohms/F° (3.9 ohms/C°) 3850 ppm/K
	100 ohm Platinum Averaging	Approximately 0.2 ohms/F° (0.39 ohms/C°)
	1k ohm Platinum Averaging	Approximately 2 ohms/F° (3.9 ohms/C°)
	2.2k ohm Thermistor	Nonlinear, Negative Temperature Coefficient (NTC)
	10k ohm Thermistor	Nonlinear NTC, Johnson Controls Type II
Electrical Connection	TE-63xxM	22 AWG (0.6 mm diameter) x 6 in. (152 mm) long
	TE-63xxP	
	TE-63xxF-1	22 AWG (0.6 mm diameter) x 12 ft (3 m) braided-copper wires, low voltage insulation, half-stripped ends
	TE-63xxP Nickel Averaging	18 AWG (1.0 mm diameter) x 6 in. (152 mm) long
	TE-63xS	22 AWG (0.6 mm diameter) x 10 ft (3 m) long plenum-rated cable
	TE-63xxA, TE-63xxV	22 AWG (0.6 mm diameter) x 10 ft (3 m) long plenum-rated cable with 0.25 in. (6.35 mm) female quick-connect terminals

TE-6300 Series Temperature Sensors (Continued)

TE-6300 Series Temperature Sensors (Part 2 of 2)		
Materials	**Probes**	Nickel Averaging: 0.094 in. (2.4 mm) Outside Diameter (O.D.) copper tubing Nickel Averaging Adaptor: 0.25 in. (6.35 mm) O.D. Brass Platinum Averaging Probe: 0.19 in. (4.8 mm) Aluminum tubing All others (except Averaging): 0.25 in. (6.35 mm) O.D. Stainless Steel
	TE-63xxA	Mounting Adapter Plate and Gland: Thermoplastic
	TE-63xxF-1	Flush Mount: Stainless Steel
	TE-63xxM	Enclosure: Corrosion-Protected Steel Well Sensor Holder: 0.875 in. (22.2 mm) Hex Brass
	TE-63xxP	Conduit box and Shield: Rigid Thermoplastic Mounting Plate: Aluminum Sensor Holder: Rigid Thermoplastic Wall Mount Base Plate: Corrosion-Protected Steel Wall Mount Cover: Rigid Thermoplastic (White) Wall Mount Face Plate: Brushed Aluminum
	TE-63xxV	Mounting Flange: Stainless Steel
Operating Conditions	**TE-63xxA**	-50 to 140°F (-46 to 60°C)
	TE-63xxF	32 to 104°F (0 to 40°C)
	TE-63xxM	-50 to 220°F (-46 to 104°C)
	TE-63xxP	Enclosure: -50 to 122°F (-46 to 50°C) Sensor Probe: -50 to 220°F (-46 to 104°C)
	TE-63xS	Sensor Probe: -50 to 220°F (-46 to 104°C) Wire Harness: -50 to 122°F (-46 to 50°C)
	TE-63xxV	
Shipping Weight	**TE-63xxA**	0.2 lb (0.09 kg)
	TE-63xxF	0.25 lb (113.4 kg)
	TE-63xxM	Duct Averaging: 0.9 lb (0.41 kg) Duct Mount: 0.4 lb (0.18 kg) Well Insertion: 0.5 lb (0.23 kg)
	TE-63xxP	Duct Averaging: 0.5 lb (0.23 kg) Duct Mount: 0.4 lb (0.18 kg) Outdoor Air: 0.5 lb (0.23 kg) Wall Mount: 0.2 lb (0.09 kg) Well Insertion: 0.35 lb (0.16 kg)
	TE-63xS	Strap-Mount: 0.2 lb (0.09 kg)
	TE-63xxV	Duct Averaging: 0.7 lb (0.32 kg) Duct Mount: 0.2 lb (0.09 kg)
Dimensions (H x W x D)	**TE-63xxA**	2.17 in. (55 mm) diameter plus 4 or 8 in. (102 or 203 m) element
	TE-63xxF	Flush Mount: 4.50 x 2.75 in. (114.3 x 69.85 mm)
	TE-63xxM	Duct Averaging: 1.87 x 1.87 x 1.80 in. (47.5 x 47.5 x 45.8 mm) plus 8 or 17 ft (2.4 or 5.2 m) element Duct Mount: 1.87 x 1.87 x 1.80 in. (47.5 x 47.5 x 45.8 mm) plus 4, 8, or 18 in. (102, 203, or 457 mm) element Well Insertion: 1.87 x 1.87 x 1.80 in. (47.5 x 47.5 x 45.8 mm) plus 6 or 8 in. (152 or 203 mm) element
	TE-63xxP	Duct Averaging: 5.97 x 1.38 x 2.75 in. (152 x 35 x 70 mm) plus 8, 10, 17, or 20 ft (2.4, 3.0, 5.2, or 6.1 m) element Duct Mount: 5.97 x 1.38 x 2.75 in. (152 x 35 x 70 mm) plus 6 or 8 in. (152 or 203 mm) probe Outdoor Air: 5.97 x 3.47 x 4.46 in. (152 x 88 x 113 mm) Wall Mount: 2.09 x 3.12 x 1.80 in. (53 x 79 x 46 mm) Well Insertion: 5.97 x 1.38 x 2.75 in. (152 x 35 x 70 mm) plus 6 or 8 in. (152 or 203 mm) probe
	TE-63xS	Strap-Mount: 0.25 in. (6.35 mm) diameter x 3.00 in. (76 mm.) long
	TE-63xxV	Duct Averaging: 2.25 x 1.50 in. (57 x 38 mm) plus 8 or 17 ft (2.4 or 5.2 m) element Duct Mount: 2.25 x 1.50 in. (57 x 38 mm) plus 4 or 8 in. (102 or 203 m) element

VG1000 Two-Way, Plated Brass Trim, NPT End Connections Ball Valves with Non-Spring Return Electric Actuators

Description

VG1000 Series Ball Valves are designed to regulate the flow of hot or chilled water and, for some models, low pressure steam in response to the demand of a controller in Heating, Ventilating, and Air Conditioning (HVAC) systems. Available in sizes 1/2 through 2 in. (DN15 through DN50), this family of two- and three-way forged brass valves is factory or field mounted to Johnson Controls® VA9104, M9106, M9109, and M9100 Series Non-Spring Return Series Spring Return Electric Actuators for on/off, floating, or proportional control.

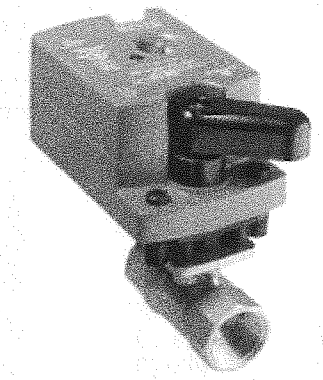
Refer to the *VG1000 Series Forged Brass Ball Valves Product Bulletin (LIT-977132)* for important product application information.

Features

- forged brass body — provides 580 psig static pressure rating
- 200 psi closeoff pressure rating — provides tight shutoff
- graphite-reinforced Polytetrafluoroethylene (PTFE) seats — include 15% graphite-reinforced ball seals, providing better wear resistance
- chrome-plated brass ball and stem assembly standard — handles both chilled and hot water applications with a fluid temperature range of 23 to 203°F (-5 to 95°C)
- 500:1 rangeability — provides accurate control under all load conditions

Repair Information

If the VG1000 Series Ball Valve fails to operate within its specifications, replace the unit. For a replacement valve, contact the nearest Johnson Controls representative.



VG1000 Series Two-Way Non-Spring Return Plated Brass Ball and Stem Ball Valve Assemblies

Selection Charts

Two-Way Plated Brass Trim Valves, Non-Spring Return, VA9104 Electric Actuators without Switches

Fluid Temperatures: 23 to 203°F (-5 to 95°C) Not Rated for Steam Service				24 VAC		
				On/Off (Floating) without Timeout[1]	On/Off (Floating) with Timeout	DC 0 to 10 V Proportional
Valve	Size, in.	Cv	Closeoff psig	Actuators with M3 Screw Terminals		
				VA9104-AGA-3S	VA9104-IGA-3S	VA9104-GGA-3S
VG1241AD	1/2	1.2[2]	200	VG1241AD+9T4AGA	VG1241AD+9T4IGA	VG1241AD+9T4GGA
VG1241AE		1.9[2]		VG1241AE+9T4AGA	VG1241AE+9T4IGA	VG1241AE+9T4GGA
VG1241AF		2.9[2]		VG1241AF+9T4AGA	VG1241AF+9T4IGA	VG1241AF+9T4GGA
VG1241AG		4.7[2]		VG1241AG+9T4AGA	VG1241AG+9T4IGA	VG1241AG+9T4GGA
VG1241AL		7.4[2]		VG1241AL+9T4AGA	VG1241AL+9T4IGA	VG1241AL+9T4GGA
VG1241AN		11.7		VG1241AN+9T4AGA	VG1241AN+9T4IGA	VG1241AN+9T4GGA
VG1241BG	3/4	4.7[2]	200	VG1241BG+9T4AGA	VG1241BG+9T4IGA	VG1241BG+9T4GGA
VG1241BL		7.4[2]		VG1241BL+9T4AGA	VG1241BL+9T4IGA	VG1241BL+9T4GGA
VG1241BN		11.7		VG1241BN+9T4AGA	VG1241BN+9T4IGA	VG1241BN+9T4GGA
VG1241CL	1	7.4[2]	200	VG1241CL+9T4AGA	VG1241CL+9T4IGA	VG1241CL+9T4GGA
VG1241CN		11.7[2]		VG1241CN+9T4AGA	VG1241CN+9T4IGA	VG1241CN+9T4GGA
VG1241CP		18.7		VG1241CP+9T4AGA	VG1241CP+9T4IGA	VG1241CP+9T4GGA
Valve	Size, in.	Cv	Closeoff psig	Actuators with 48 in. (1.2 m) 18 AWG Plenum Cable		
				VA9104-AGA-2S	VA9104-IGA-2S	VA9104-GGA-2S
VG1241AD	1/2	1.2[2]	200	VG1241AD+9A4AGA	VG1241AD+9A4IGA	VG1241AD+9A4GGA
VG1241AE		1.9[2]		VG1241AE+9A4AGA	VG1241AE+9A4IGA	VG1241AE+9A4GGA
VG1241AF		2.9[2]		VG1241AF+9A4AGA	VG1241AF+9A4IGA	VG1241AF+9A4GGA
VG1241AG		4.7[2]		VG1241AG+9A4AGA	VG1241AG+9A4IGA	VG1241AG+9A4GGA
VG1241AL		7.4[2]		VG1241AL+9A4AGA	VG1241AL+9A4IGA	VG1241AL+9A4GGA
VG1241AN		11.7		VG1241AN+9A4AGA	VG1241AN+9A4IGA	VG1241AN+9A4GGA
VG1241BG	3/4	4.7[2]	200	VG1241BG+9A4AGA	VG1241BG+9A4IGA	VG1241BG+9A4GGA
VG1241BL		7.4[2]		VG1241BL+9A4AGA	VG1241BL+9A4IGA	VG1241BL+9A4GGA
VG1241BN		11.7		VG1241BN+9A4AGA	VG1241BN+9A4IGA	VG1241BN+9A4GGA
VG1241CL	1	7.4[2]	200	VG1241CL+9A4AGA	VG1241CL+9A4IGA	VG1241CL+9A4GGA
VG1241CN		11.7[2]		VG1241CN+9A4AGA	VG1241CN+9A4IGA	VG1241CN+9A4GGA
VG1241CP		18.7		VG1241CP+9A4AGA	VG1241CP+9A4IGA	VG1241CP+9A4GGA

1. To avoid excessive wear or drive time on the motor for the AGA models, use a controller or software that provides a timeout function to remove the signal at the end of rotation (stall).
2. Cv has a characterizing disk.

VG1000 Two-Way, Plated Brass Trim, NPT End Connections Ball Valves with Non-Spring Return Electric Actuators (Continued)

Two-Way Plated Brass Trim Ball Valves, Non-Spring Return, M9106/M9109 Electric Actuators without Switches

Fluid Temperatures: 23 to 203°F (-5 to 95°C) Not Rated for Steam Service				AC 24 V		
Valve	Size, in.	Cv	Closeoff psig	On/Off (Floating) without Timeout[1]	On/Off (Floating) with Timeout	DC 0 to 10 V Proportional
				M9106-AGA-2 M9109-AGA-2	M9106-IGA-2	M9106-GGA-2 M9109-GGA-2
VG1241AD	1/2	1.2[2]	200	VG1241AD+906AGA	VG1241AD+906IGA	VG1241AD+906GGA
VG1241AE		1.9[2]		VG1241AE+906AGA	VG1241AE+906IGA	VG1241AE+906GGA
VG1241AF		2.9[2]		VG1241AF+906AGA	VG1241AF+906IGA	VG1241AF+906GGA
VG1241AG		4.7[2]		VG1241AG+906AGA	VG1241AG+906IGA	VG1241AG+906GGA
VG1241AL		7.4[2]		VG1241AL+906AGA	VG1241AL+906IGA	VG1241AL+906GGA
VG1241AN		11.7		VG1241AN+906AGA	VG1241AN+906IGA	VG1241AN+906GGA
VG1241BG	3/4	4.7[2]	200	VG1241BG+906AGA	VG1241BG+906IGA	VG1241BG+906GGA
VG1241BL		7.4[2]		VG1241BL+906AGA	VG1241BL+906IGA	VG1241BL+906GGA
VG1241BN		11.7		VG1241BN+906AGA	VG1241BN+906IGA	VG1241BN+906GGA
VG1241CL	1	7.4[2]	200	VG1241CL+906AGA	VG1241CL+906IGA	VG1241CL+906GGA
VG1241CN		11.7[2]		VG1241CN+906AGA	VG1241CN+906IGA	VG1241CN+906GGA
VG1241CP		18.7		VG1241CP+906AGA	VG1241CP+906IGA	VG1241CP+906GGA
VG1241DN	1-1/4	11.7[2]	200	VG1241DN+906AGA	VG1241DN+906IGA	VG1241DN+906GGA
VG1241DP		18.7[2]		VG1241DP+906AGA	VG1241DP+906IGA	VG1241DP+906GGA
VG1241DR		29.2		VG1241DR+906AGA	VG1241DR+906IGA	VG1241DR+906GGA
VG1241EP	1-1/2	18.7[2]	200	VG1241EP+906AGA	VG1241EP+906IGA	VG1241EP+906GGA
VG1241ER		29.2[2]		VG1241ER+906AGA	VG1241ER+906IGA	VG1241ER+906GGA
VG1241ES		46.8		VG1241ES+906AGA	VG1241ES+906IGA	VG1241ES+906GGA
VG1241FR	2	29.2[2]	200	VG1241FR+909AGA	—	VG1241FR+909GGA
VG1241FS		46.8[2]		VG1241FS+909AGA	—	VG1241FS+909GGA
VG1241FT		73.7		VG1241FT+909AGA	—	VG1241FT+909GGA

1. To avoid excessive wear or drive time on the motor for the AGA models, use a controller or software that provides a timeout function to remove the signal at the end of rotation (stall).
2. Cv has a characterizing disk.

VG1000 Two-Way, Plated Brass Trim, NPT End Connections Ball Valves with Non-Spring Return Electric Actuators (Continued)

Two-Way Plated Brass Trim Ball Valves, Non-Spring Return, M9106/M9109 Electric Actuators with Switches

Fluid Temperatures: 23 to 203°F (-5 to 95°C) Not Rated for Steam Service				AC 24 V		
Valve	Size, in.	Cv	Closeoff psig	On/Off (Floating) without Timeout[1]	On/Off (Floating) with Timeout	DC 0 to 10 V Proportional
				M9106-AGC-2 M9109-AGC-2	M9106-IGC-2	M9106-GGC-2 M9109-GGC-2
VG1241AD	1/2	1.2[2]	200	VG1241AD+906AGC	VG1241AD+906IGC	VG1241AD+906GGC
VG1241AE		1.9[2]		VG1241AE+906AGC	VG1241AE+906IGC	VG1241AE+906GGC
VG1241AF		2.9[2]		VG1241AF+906AGC	VG1241AF+906IGC	VG1241AF+906GGC
VG1241AG		4.7[2]		VG1241AG+906AGC	VG1241AG+906IGC	VG1241AG+906GGC
VG1241AL		7.4[2]		VG1241AL+906AGC	VG1241AL+906IGC	VG1241AL+906GGC
VG1241AN		11.7		VG1241AN+906AGC	VG1241AN+906IGC	VG1241AN+906GGC
VG1241BG	3/4	4.7[2]	200	VG1241BG+906AGC	VG1241BG+906IGC	VG1241BG+906GGC
VG1241BL		7.4[2]		VG1241BL+906AGC	VG1241BL+906IGC	VG1241BL+906GGC
VG1241BN		11.7		VG1241BN+906AGC	VG1241BN+906IGC	VG1241BN+906GGC
VG1241CL	1	7.4[2]	200	VG1241CL+906AGC	VG1241CL+906IGC	VG1241CL+906GGC
VG1241CN		11.7[2]		VG1241CN+906AGC	VG1241CN+906IGC	VG1241CN+906GGC
VG1241CP		18.7		VG1241CP+906AGC	VG1241CP+906IGC	VG1241CP+906GGC
VG1241DN	1-1/4	11.7[2]	200	VG1241DN+906AGC	VG1241DN+906IGC	VG1241DN+906GGC
VG1241DP		18.7[2]		VG1241DP+906AGC	VG1241DP+906IGC	VG1241DP+906GGC
VG1241DR		29.2		VG1241DR+906AGC	VG1241DR+906IGC	VG1241DR+906GGC
VG1241EP	1-1/2	18.7[2]	200	VG1241EP+906AGC	VG1241EP+906IGC	VG1241EP+906GGC
VG1241ER		29.2[2]		VG1241ER+906AGC	VG1241ER+906IGC	VG1241ER+906GGC
VG1241ES		46.8		VG1241ES+906AGC	VG1241ES+906IGC	VG1241ES+906GGC
VG1241FR	2	29.2[2]	200	VG1241FR+909AGC	—	VG1241FR+909GGC
VG1241FS		46.8[2]		VG1241FS+909AGC	—	VG1241FS+909GGC
VG1241FT		73.7		VG1241FT+909AGC	—	VG1241FT+909GGC

1. To avoid excessive wear or drive time on the motor for the AGC models, use a controller or software that provides a timeout function to remove the signal at the end of rotation (stall).
2. Cv has a characterizing disk.

VG1000 Two-Way, Plated Brass Trim, NPT End Connections Ball Valves with Non-Spring Return Electric Actuators (Continued)

Technical Specifications

VG1000 Two-Way, Plated Brass Trim Ball Valves with Non-Spring Return Electric Actuators		
Service[1]		Hot Water, Chilled Water, or 50/50 Glycol Solutions for HVAC Systems
Valve Fluid Temperature Limits	**Water**	23 to 203°F (-5 to 95°C)
	Steam	Not Rated for Steam Service
Maximum Actuator Fluid Temperature Limit	**203°F (95°C)**	VA9104 Series Non-Spring Return Actuators M9104 Series Non-Spring Return Actuators with M9000-550 Linkage M9106 or M9109 Series Non-Spring Return Actuators with M9000-520 Linkage
Valve Body Pressure Rating	**Water**	580 psig (3,999 kPa) (PN40)
	Steam	Not Rated for Steam Service
Maximum Closeoff Pressure		200 psig (1,378 kPa)
Maximum Recommended Operating Pressure Drop		50 psi Maximum Differential Pressure for Valves with Characterized Flow Control Disk and 30 psi Maximum for Quiet Service Ball Valves
Flow Characteristics	**Two-Way**	Equal Percentage
Rangeability[2]		Greater than 500:1
Minimum Ambient Operating Temperature		-4°F (-20°C)
Maximum Ambient Operating Temperature[3] **(Limited by the Actuator and Linkage)**	**140°F (60°C)**	VA9104 Series Non-Spring Return Actuators M9104 Series Non-Spring Return Actuators with M9000-550 Linkage
	125°F (52°C)	M9106 and M9109 Series Non-Spring Return Actuators with M9000-520 Linkage
Leakage		0.01% of Maximum Flow per ANSI/FCI 70-2, Class 4
End Connections		National Pipe Thread (NPT)
Materials	**Body**	Forged Brass
	Ball	Chrome Plated Brass
	Blowout-Proof Stem	Nickel Plated Brass
	Seats	Graphite-Reinforced PTFE with Ethylene Propylene Diene Monomer (EPDM) O-Ring Backing
	Stem Seals	EPDM Double O-Rings
	Characterizing Disk	Amodel® AS-1145HS Polyphthalamide Resin

1. Proper water treatment is recommended; refer to the VDI 2035 Standard.
2. Rangeability is defined as the ratio of maximum controllable flow to minimum controllable flow.
3. In steam applications, install the valve with the stem horizontal to the piping, and wrap the valve and piping with insulation.

VG1000 Series Three-Way, Plated Brass Trim, NPT End Connections, Ball Valves with Spring Return Electric Actuators without Switches

Description

VG1000 Series Ball Valves are designed to regulate the flow of hot or chilled water and, for some models, low pressure steam in response to the demand of a controller in Heating, Ventilating, and Air Conditioning (HVAC) systems. Available in sizes 1/2 through 2 in. (DN15 through DN50), this family of two- and three-way forged brass valves is factory or field mounted to Johnson Controls® VA9104, M9106, M9109, and M9100 Series Non-Spring Return and VA9203, VA9208 Series Spring Return Electric Actuators for on/off, floating, or proportional control.

Refer to the *VG1000 Series Forged Brass Ball Valves Product Bulletin (LIT-977132)* for important product application information.

Features

- forged brass body — provides 580 psig static pressure rating
- chrome-plated brass ball and stem assembly standard — handles both chilled and hot water applications with a fluid temperature range of 23 to 203°F (-5 to 95°C)
- graphite-reinforced Polytetrafluoroethylene (PTFE) seats — include 15% graphite-reinforced ball seals, providing better wear resistance
- 500:1 rangeability — provides accurate control under all load conditions
- maintenance-free design — performs without failure in excess of 200,000 full stroke cycles in iron-oxide contaminated water

Repair Information

If the VG1000 Series Ball Valve fails to operate within its specifications, replace the unit. For a replacement valve, contact the nearest Johnson Controls representative.

Three-Way, Spring Return, Plated Brass Ball and Stem Ball Valve Assemblies with End Switches

Selection Charts

Three-Way – Spring Return – without Switches (Part 1 of 2)

Fluid Temperatures: 23 to 203°F (-5 to 95°C)				AC 24 V			AC-85-264V (VA9203) AC 120 V (VA9208)
				Floating	DC 0 to 10 V Proportional	On/Off	On/Off
Valve	Size, in. (mm)	Cv	Closeoff psig	Spring Return Port A Open – Valve Spring Return Counterclockwise			
				VA9203-AGA-2Z	VA9203-GGA-2Z	VA9203-BGA-2	VA9203-BUA-2
VG1841AD	1/2	1.2/0.7[1]	200	VG1841AD+923AGA	VG1841AD+923GGA	VG1841AD+923BGA	VG1841AD+923BUA
VG1841AE		1.9/1.2[1]		VG1841AE+923AGA	VG1841AE+923GGA	VG1841AE+923BGA	VG1841AE+923BUA
VG1841AF		2.9/1.9[1]		VG1841AF+923AGA	VG1841AF+923GGA	VG1841AF+923BGA	VG1841AF+923BUA
VG1841AG		4.7/2.9[1]		VG1841AG+923AGA	VG1841AG+923GGA	VG1841AG+923BGA	VG1841AG+923BUA
VG1841AL		7.4/4.7[1]		VG1841AL+923AGA	VG1841AL+923GGA	VG1841AL+923BGA	VG1841AL+923BUA
VG1841AN		11.7/7.4		VG1841AN+923AGA	VG1841AN+923GGA	VG1841AN+923BGA	VG1841AN+923BUA
VG1841BG	3/4	4.7/2.9[1]	200	VG1841BG+923AGA	VG1841BG+923GGA	VG1841BG+923BGA	VG1841BG+923BUA
VG1841BL		7.4/4.7[1]		VG1841BL+923AGA	VG1841BL+923GGA	VG1841BL+923BGA	VG1841BL+923BUA
VG1841BN		11.7/11.7		VG1841BN+923AGA	VG1841BN+923GGA	VG1841BN+923BGA	VG1841BN+923BUA
VG1841CL	1	7.4/4.7[1]	200	VG1841CL+923AGA	VG1841CL+923GGA	VG1841CL+923BGA	VG1841CL+923BUA
VG1841CN		11.7/7.4[1]		VG1841CN+923AGA	VG1841CN+923GGA	VG1841CN+923BGA	VG1841CN+923BUA
VG1841CP		18.7/11.7		VG1841CP+923AGA	VG1841CP+923GGA	VG1841CP+923BGA	VG1841CP+923BUA
Valve	Size, in. (mm)	Cv Port A/B	Closeoff psig	Spring Return Port A Open – Valve Spring Return Counterclockwise			
				VA9208-AGA-2	VA9208-GGA-2	VA9208-BGA-3	VA9208-BAA-3
VG1841DN	1-1/4	11.7/7.4[1]	200	VG1841DN+928AGA	VG1841DN+928GGA	VG1841DN+938BGA	VG1841DN+938BAA
VG1841DP		18.7/11.7[1]		VG1841DP+928AGA	VG1841DP+928GGA	VG1841DP+938BGA	VG1841DP+938BAA
VG1841DR		29.2/18.7		VG1841DR+928AGA	VG1841DR+928GGA	VG1841DR+938BGA	VG1841DR+938BAA
VG1841EP	1-1/2	18.7/11.7[1]	200	VG1841EP+928AGA	VG1841EP+928GGA	VG1841EP+938BGA	VG1841EP+938BAA
VG1841ER		29.2/18.7[1]		VG1841ER+928AGA	VG1841ER+928GGA	VG1841ER+938BGA	VG1841ER+938BAA
VG1841ES		46.8/29.2		VG1841ES+928AGA	VG1841ES+928GGA	VG1841ES+938BGA	VG1841ES+938BAA
VG1841FR	2	29.2/18.7[1]	200	VG1841FR+928AGA	VG1841FR+928GGA	VG1841FR+938BGA	VG1841FR+938BAA
VG1841FS		46.8/29.2[1]		VG1841FS+928AGA	VG1841FS+928GGA	VG1841FS+938BGA	VG1841FS+938BAA
VG1841FT		73.7/36.8		VG1841FT+928AGA	VG1841FT+928GGA	VG1841FT+938BGA	VG1841FT+938BAA

VG1000 Series Three-Way, Plated Brass Trim, NPT End Connections, Ball Valves with Spring Return Electric Actuators without Switches (Continued)

Three-Way – Spring Return – without Switches (Part 2 of 2)

Fluid Temperatures: 23 to 203°F (-5 to 95°C)				AC 24 V			AC-85-264V (VA9203) AC 120 V (VA9208)
				Floating	DC 0 to 10 V Proportional	On/Off	On/Off
Valve	Size, in. (mm)	Cv	Closeoff psig	Spring Return Port A Closed – Valve Spring Return Clockwise			
				VA9203-AGA-2Z	VA9203-GGA-2Z	VA9203-BGA-2	VA9203-BUA-2
VG1841AD	1/2	1.2/0.7[1]	200	VG1841AD+943AGA	VG1841AD+943GGA	VG1841AD+943BGA	VG1841AD+943BUA
VG1841AE		1.91.2[1]		VG1841AE+943AGA	VG1841AE+943GGA	VG1841AE+943BGA	VG1841AE+943BUA
VG1841AF		2.9/1.9[1]		VG1841AF+943AGA	VG1841AF+943GGA	VG1841AF+943BGA	VG1841AF+943BUA
VG1841AG		4.7/2.9[1]		VG1841AG+943AGA	VG1841AG+943GGA	VG1841AG+943BGA	VG1841AG+943BUA
VG1841AL		7.4/4.7[1]		VG1841AL+943AGA	VG1841AL+943GGA	VG1841AL+943BGA	VG1841AL+943BUA
VG1841AN		11.7/7.4[1]		VG1841AN+943AGA	VG1841AN+943GGA	VG1841AN+943BGA	VG1841AN+943BUA
VG1841BG	3/4	4.7/2.9[1]	200	VG1841BG+943AGA	VG1841BG+943GGA	VG1841BG+943BGA	VG1841BG+943BUA
VG1841BL		7.4/4.7[1]		VG1841BL+943AGA	VG1841BL+943GGA	VG1841BL+943BGA	VG1841BL+943BUA
VG1841BN		11.7/7.4[1]		VG1841BN+943AGA	VG1841BN+943GGA	VG1841BN+943BGA	VG1841BN+943BUA
VG1841CL	1	7.4/4.7[1]	200	VG1841CL+943AGA	VG1841CL+943GGA	VG1841CL+943BGA	VG1841CL+943BUA
VG1841CN		11.7/7.4[1]		VG1841CN+943AGA	VG1841CN+943GGA	VG1841CN+943BGA	VG1841CN+943BUA
VG1841CP		18.7/11.7[1]		VG1841CP+943AGA	VG1841CP+943GGA	VG1841CP+943BGA	VG1841CP+943BUA
Valve	Size, in. (mm)	Cv	Closeoff psig	Spring Return Port A Closed – Valve Spring Return Clockwise			
				VA9208-AGA-2	VA9208-GGA-2	VA9208-BGA-3	VA9208-BAA-3
VG1841DN	1-1/4	11.7/7.4[1]	200	VG1841DN+948AGA	VG1841DN+948GGA	VG1841DN+958BGA	VG1841DN+958BAA
VG1841DP		18.7/11.7[1]		VG1841DP+948AGA	VG1841DP+948GGA	VG1841DP+958BGA	VG1841DP+958BAA
VG1841DR		29.2/18.7[1]		VG1841DR+948AGA	VG1841DR+948GGA	VG1841DR+958BGA	VG1841DR+958BAA
VG1841EP	1-1/2	18.7/11.7[1]	200	VG1841EP+948AGA	VG1841EP+948GGA	VG1841EP+958BGA	VG1841EP+958BAA
VG1841ER		29.2/18.7[1]		VG1841ER+948AGA	VG1841ER+948GGA	VG1841ER+958BGA	VG1841ER+958BAA
VG1841ES		46.8/29.2[1]		VG1841ES+948AGA	VG1841ES+948GGA	VG1841ES+958BGA	VG1841ES+958BAA
VG1841FR	2	29.2/18.7[1]	200	VG1841FR+948AGA	VG1841FR+948GGA	VG1841FR+958BGA	VG1841FR+958BAA
VG1841FS		46.8/29.2[1]		VG1841FS+948AGA	VG1841FS+948GGA	VG1841FS+958BGA	VG1841FS+958BAA
VG1841FT		73.7/36.8[1]		VG1841FT+948AGA	VG1841FT+948GGA	VG1841FT+958BGA	VG1841FT+958BAA

1. Cv has a characterizing disk.

VG1000 Series Three-Way, Plated Brass Trim, NPT End Connections, Ball Valves with Spring Return Electric Actuators without Switches (Continued)

Technical Specifications

VG1000 Three-Way, Plated Brass Trim Ball Valves with Spring Return Electric Actuators without Switches		
Service[1]		Hot Water, Chilled Water, 50/50 Glycol Solutions
Fluid Temperature Limits	**Water**	23 to 203°F (-5 to 95°C)
	Steam	Not Rated for Steam Service
Valve Body Pressure Rating	**Water**	580 psig (3,999 kPa) (PN40)
	Steam	Not Rated for Steam Service
Maximum Closeoff Pressure		200 psig (1,378 kPa)
Maximum Recommended Operating Pressure Drop		50 psi Maximum Differential Pressure for Valves with Characterized Flow Control Disk and 30 psi Maximum for Quiet Service Ball Valves
Flow Characteristics	**Three-Way**	Equal Percentage Flow Characteristics of In-line Port A (Coil) and Linear Flow Characteristics of Angle Port B (Bypass)
Rangeability[2]		Greater than 500:1
Minimum Ambient Operating Temperature	**-22°F (-30°C)**	VA9203 Series Spring Return Actuators
	-40°F (40°C)	VA9208 Series Spring Return Actuators
Maximum Ambient Operating Temperature[3] **(Limited by the Actuator and Linkage)**	**140°F (60°C)**	Direct Mount: VA9203 or VA9208 Series Spring Return Actuators
Leakage		0.01% of Maximum Flow per ANSI/FCI 70-2, Class 4
		1% of Maximum Flow for Three-Way Bypass Port
End Connections		National Pipe Thread (NPT)
Materials	**Body**	Forged Brass
	Ball	Chrome Plated Brass
	Blowout-Proof Stem	Nickel Plated Brass
	Seats	Graphite-Reinforced PTFE with Ethylene Propylene Diene Monomer (EPDM) O-Ring Backing
	Stem Seals	EPDM Double O-Rings
	Characterizing Disk	Amodel® AS-1145HS Polyphthalamide Resin

1. Proper water treatment is recommended; refer to the VDI 2035 Standard.
2. Rangeability is defined as the ratio of maximum controllable flow to minimum controllable flow.
3. In steam applications, install the valve with the stem horizontal to the piping and wrap the valve and piping with insulation.

VG7000 Series

Brass Trim Globe Valves with VA-715x Series Electric Actuators

Description

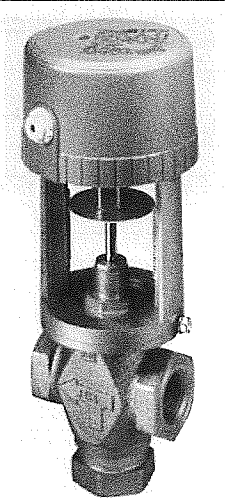
VG7000 Brass Trim Globe Valves with VA-715x Series Non-Spring Return Electric Actuator control hot or chilled water, or steam.

Features

- 90 lb force – provides tight closeoff
- direct coupled – no linkage required
- magnetic clutch – protects gearing, ensures tight closeoff
- controls – hot water, chilled water, or steam
- fits VG7000 valves 1/2 through 2 in.
- valve body static pressure rating: ANSI Class 250
- factory or field assembly
- voltage: 24 VAC, 50/60 Hz, 4.7 VA

Repair Information

If the VG7000 Brass Trim Globe Valve with VA-715x Series Non-Spring Return Electric Actuator fails to operate within its specifications, replace the unit. For a replacement valve or actuator, contact the nearest Johnson Controls® representative.



VA-715x Series Electric Actuator mounted on VG7842 Brass Globe Valve

Selection Chart

VG7000 Brass Trim Globe Valve with VA-715x Series Non-Spring Return Electric Actuator (Part 1 of 2)

Actuator Code				VA-7150-1001	VA-7153-1001	VA-7152-1001
Actuator Input				On/Off (Floating)	On/Off (Floating) with Feedback	0 to 10 VDC Proportional
Temperature Range				35 to 284°F Fluid Temperature, 38 psig Saturated Steam		
Valve	Size	Cv	Closeoff	Non-Spring Return		
Two-Way Push-Down-to-Close – NPT End Connections						
VG7241CT	1/2"	0.73	345	VG7241CT+7150G	VG7241CT+7153G	VG7241CT+7152G
VG7241ET	1/2"	1.8	345	VG7241ET+7150G	VG7241ET+7153G	VG7241ET+7152G
VG7241GT	1/2"	4.6	216	VG7241GT+7150G	VG7241GT+7153G	VG7241GT+7152G
VG7241LT	3/4"	7.3	138	VG7241LT+7150G	VG7241LT+7153G	VG7241LT+7152G
VG7241NT	1"	11.6	86	VG7241NT+7150G	VG7241NT+7153G	VG7241NT+7152G
VG7241PT	1-1/4"	18.5	52	VG7241PT+7150G	VG7241PT+7153G	VG7241PT+7152G
VG7241RT	1-1/2"	28.9	34	VG7241RT+7150G	VG7241RT+7153G	VG7241RT+7152G
VG7241ST	2"	46.2	21	VG7241ST+7150G	VG7241ST+7153G	VG7241ST+7152G
Three-Way Mixing – NPT End Connections						
VG7842CT	1/2"	0.73	345 / 345	VG7842CT+7150G	VG7842CT+7153G	VG7842CT+7152G
VG7842ET	1/2"	1.8	345 / 345	VG7842ET+7150G	VG7842ET+7153G	VG7842ET+7152G
VG7842GT	1/2"	4.6	216 / 257	VG7842GT+7150G	VG7842GT+7153G	VG7842GT+7152G
VG7842LT	3/4"	7.3	138 / 153	VG7842LT+7150G	VG7842LT+7153G	VG7842LT+7152G
VG7842NT	1"	11.6	86 / 100	VG7842NT+7150G	VG7842NT+7153G	VG7842NT+7152G
VG7842PT	1-1/4"	18.5	52 / 57	VG7842PT+7150G	VG7842PT+7153G	VG7842PT+7152G
VG7842RT	1-1/2"	28.9	34 / 36	VG7842RT+7150G	VG7842RT+7153G	VG7842RT+7152G
VG7842ST	2"	46.2	21 / 22	VG7842ST+7150G	VG7842ST+7153G	VG7842ST+7152G
Two-Way Push-Down-to-Close – Union Sweat End Connections						
VG7281CT	1/2"	0.73	345	VG7281CT+7150G	VG7281CT+7153G	VG7281CT+7152G
VG7281ET	1/2"	1.8	345	VG7281ET+7150G	VG7281ET+7153G	VG7281ET+7152G
VG7281GT	1/2"	4.6	216	VG7281GT+7150G	VG7281GT+7153G	VG7281GT+7152G
VG7281LT	3/4"	7.3	138	VG7281LT+7150G	VG7281LT+7153G	VG7281LT+7152G
VG7281NT	1"	11.6	86	VG7281NT+7150G	VG7281NT+7153G	VG7281NT+7152G
VG7281PT	1-1/4"	18.5	52	VG7281PT+7150G	VG7281PT+7153G	VG7281PT+7152G
VG7281RT	1-1/2"	28.9	34	VG7281RT+7150G	VG7281RT+7153G	VG7281RT+7152G
VG7281ST	2"	46.2	21	VG7281ST+7150G	VG7281ST+7153G	VG7281ST+7152G

Brass Trim Globe Valves with VA-715x Series Electric Actuators (Continued)

VG7000 Brass Trim Globe Valve with VA-715x Series Non-Spring Return Electric Actuator (Part 2 of 2)

Actuator Code				VA-7150-1001	VA-7153-1001	VA-7152-1001
Actuator Input				On/Off (Floating)	On/Off (Floating) with Feedback	0 to 10 VDC Proportional
Temperature Range				35 to 284°F Fluid Temperature, 38 psig Saturated Steam		
Valve	Size	Cv	Closeoff	Non-Spring Return		
Three-Way Mixing – Union Sweat End Connections						
VG7882CT	1/2"	0.73	345 / 345	VG7882CT+7150G	VG7882CT+7153G	VG7882CT+7152G
VG7882ET	1/2"	1.8	345 / 345	VG7882ET+7150G	VG7882ET+7153G	VG7882ET+7152G
VG7882GT	1/2"	4.6	216 / 257	VG7882GT+7150G	VG7882GT+7153G	VG7882GT+7152G
VG7882LT	3/4"	7.3	138 / 153	VG7882LT+7150G	VG7882LT+7153G	VG7882LT+7152G
VG7882NT	1"	11.6	86 / 100	VG7882NT+7150G	VG7882NT+7153G	VG7882NT+7152G
VG7882PT	1-1/4"	18.5	52 / 57	VG7882PT+7150G	VG7882PT+7153G	VG7882PT+7152G
VG7882RT	1-1/2"	28.9	34 / 36	VG7882RT+7150G	VG7882RT+7153G	VG7882RT+7152G
VG7882ST	2"	46.2	21 / 22	VG7882ST+7150G	VG7882ST+7153G	VG7882ST+7152G
Two-Way Push-Down-to-Close – 3/8 in. Union Sweat End Connections						
VG7271CT	1/2"	0.73	345	VG7271CT+7150G	VG7271CT+7153G	VG7271CT+7152G
VG7271ET	1/2"	1.8	345	VG7271ET+7150G	VG7271ET+7153G	VG7271ET+7152G
VG7271GT	1/2"	4.6	216	VG7271GT+7150G	VG7271GT+7153G	VG7271GT+7152G
Three-Way Mixing – 3/8 in. Union Sweat End Connections						
VG7872CT	1/2"	0.73	345 / 345	VG7872CT+7150G	VG7872CT+7153G	VG7872CT+7152G
VG7872ET	1/2"	1.8	345 / 345	VG7872ET+7150G	VG7872ET+7153G	VG7872ET+7152G
VG7872GT	1/2"	4.6	216 / 257	VG7872GT+7150G	VG7872GT+7153G	VG7872GT+7152G
Two-Way Push-Down-to-Close – 3/4 in. Union Sweat End Connections						
VG7291CT	1/2"	0.73	345	VG7291CT+7150G	VG7291CT+7153G	VG7291CT+7152G
VG7291ET	1/2"	1.8	345	VG7291ET+7150G	VG7291ET+7153G	VG7291ET+7152G
VG7291GT	1/2"	4.6	216	VG7291GT+7150G	VG7291GT+7153G	VG7291GT+7152G
Three-Way Mixing – 3/4 in. Union Sweat End Connections						
VG7892CT	1/2"	0.73	345 / 345	VG7892CT+7150G	VG7892CT+7153G	VG7892CT+7152G
VG7892ET	1/2"	1.8	345 / 345	VG7892ET+7150G	VG7892ET+7153G	VG7892ET+7152G
VG7892GT	1/2"	4.6	216 / 257	VG7892GT+7150G	VG7892GT+7153G	VG7892GT+7152G
Two-Way Push-Down-to-Close – Union Globe End Connections						
VG7251CT	1/2"	0.73	345	VG7251CT+7150G	VG7251CT+7153G	VG7251CT+7152G
VG7251ET	1/2"	1.8	345	VG7251ET+7150G	VG7251ET+7153G	VG7251ET+7152G
VG7251GT	1/2"	4.6	216	VG7251GT+7150G	VG7251GT+7153G	VG7251GT+7152G
VG7251LT	3/4"	7.3	138	VG7251LT+7150G	VG7251LT+7153G	VG7251LT+7152G
VG7251NT	1"	11.6	86	VG7251NT+7150G	VG7251NT+7153G	VG7251NT+7152G
VG7251PT	1-1/4"	18.5	52	VG7251PT+7150G	VG7251PT+7153G	VG7251PT+7152G
VG7251RT	1-1/2"	28.9	34	VG7251RT+7150G	VG7251RT+7153G	VG7251RT+7152G
Two-Way Push-Down-to-Close – Union Angle End Connections						
VG7551CT	1/2"	0.73	345	VG7551CT+7150G	VG7551CT+7153G	VG7551CT+7152G
VG7551ET	1/2"	1.8	345	VG7551ET+7150G	VG7551ET+7153G	VG7551ET+7152G
VG7551GT	1/2"	4.6	216	VG7551GT+7150G	VG7551GT+7153G	VG7551GT+7152G
VG7551LT	3/4"	7.3	138	VG7551LT+7150G	VG7551LT+7153G	VG7551LT+7152G
VG7551NT	1"	11.6	86	VG7551NT+7150G	VG7551NT+7153G	VG7551NT+7152G
VG7551PT	1-1/4"	18.5	52	VG7551PT+7150G	VG7551PT+7153G	VG7551PT+7152G
VG7551RT	1-1/2"	28.9	34	VG7551RT+7150G	VG7551RT+7153G	VG7551RT+7152G

Brass Trim Globe Valves with VA-715x Series Electric Actuators (Continued)

Technical Specifications

VG7000 Brass Trim Globe Valves with VA-715x Series Non-Spring Return Electric Actuators		
Service[1]		Hot Water, Chill Water, 50/50 Glycol Solutions and Steam for HVAC Systems
Fluid Temperature Limits	**Water**	35 to 284°F (2 to 140°C)
	Steam	38 psig (262 kPa) Saturated Steam
Maximum Allowable Pressure Temperature	**Water**	400 psig (2,756 kPa) Up to 150°F (66°C) decreasing to 365 psig (2,515 kPa) at 248°F (120°C)
	Steam	38 psig (262 kPa) Saturated Steam at 284°F (140°C)
Valve Body Pressure/ Temperature Rating		Meets Requirements of ANSI B16.15, Class 250
Maximum Recommended Operating Pressure Drop	**Water**	35 psig (241 kPa) for ½ through 1-1/4 in. valves 30 psig (207 kPa) for 1-1/2 and 2 in. valves
	Steam	15 psig (103 kPa)
Flow Characteristics	**Two-Way Valves**	Equal Percentage
	Three-Way Valves	Linear Flow Characteristics
Rangeability[2]		25:1
Leakage		0.01% of Maximum Flow per ANSI/FCI 70-2, Class 4
Actuator Ambient Operating Temperature Limits		0 to 140°F (-18 to 60°C)
Actuator Input Signal	**VA-7150-1001**	24 VAC Three-Wire Floating Control
	VA-7152-1001	0 to 10 VDC Proportional Control
	VA-7153-1001	24 VAC Three-Wire Floating Control with 0 to 2000 ohm feedback potentiometer for 25/32 in. valve stroke
Actuator Power Requirements	**VA-7150-1001**	24 VAC (20 to 30 VAC), 50/60 Hz, 2.7 VA Nominal
	VA-7152-1001	24 VAC (20 to 30 VAC), 50/60 Hz, 4.7 VA Nominal
	VA-7153-1001	24 VAC (20 to 30 VAC), 50/60 Hz, 2.7 VA Nominal
Materials	**Body**	Cast Bronze
	Bonnet	Brass
	Stem	Stainless Steel
	Plug	Brass
	Seat	Brass Against Molded Elastomeric Disk
	Packing	Self Adjusting Ethylene Propylene Rubber (EPR) Ring Pack U-Cups

1. Refer to VDI 2035 Standard for recommended proper water treatment.
2. Rangeability is defined as the ratio of maximum controllable flow to minimum controllable flow.

VG7000 Series

Stainless Steel Trim Globe Valves with VA-4233 Series Electric Actuators

Description

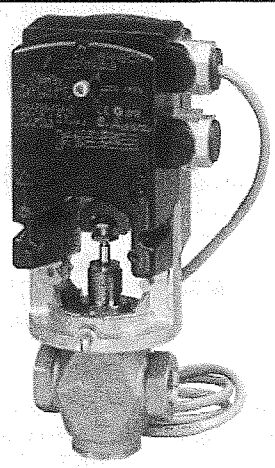
VG7000 Series Stainless Steel Trim Globe Valves with VA-4233 Series Electric Actuator control hot or chilled water, or steam.

Features

- spring return – stem up
- 61 lb force – provides tight shutoff
- packing – spring-loaded PTFE and elastomer V-rings
- manual opener
- fits VG7000 valves 1/2 through 1-1/4 in.
- valve body static pressure rating: ANSI Class 250
- optional auxiliary switches available
- factory or field assembly
- voltage: 20 to 30 VAC, 50/60 Hz, 12 VA

Repair Information

If the VG7000 Series Stainless Steel Trim Globe Valve with VA-4233 Series Electric Actuator fails to operate within its specifications, replace the unit. For a replacement valve or actuator, contact the nearest Johnson Controls® representative.



VA-4233 Electric Actuator mounted on VG7441 Brass Globe Valve

Selection Charts

VG7000 Series Valve Assemblies with VA-4233 Series Electric Actuators, Less Auxiliary Switches

Actuator Code				VA-4233-AGA-2	VA-4233-BGA-2	VA-4233-GGA-2
Actuator Input				Floating	On/Off	0 to 10 VDC - Proportional
Temperature Range				35 to 250°F (2 to 121°C), 15 psig Saturated Steam		
Valve	Size	Cv	Closeoff	Spring Return – Stem Up		
Two-Way Push-Down-to-Close – NPT End Connections						
VG7243CT	1/2"	0.73	230	VG7243CT+423AGA	VG7243CT+423BGA	VG7243CT+423GGA
VG7243ET	1/2"	1.8	230	VG7243ET+423AGA	VG7243ET+423BGA	VG7243ET+423GGA
VG7243GT	1/2"	4.6	130	VG7243GT+423AGA	VG7243GT+423BGA	VG7243GT+423GGA
VG7243LT	3/4"	7.3	82	VG7243LT+423AGA	VG7243LT+423BGA	VG7243LT+423GGA
VG7243NT	1"	11.6	39	VG7243NT+423AGA	VG7243NT+423BGA	VG7243NT+423GGA
VG7243PT	1-1/4"	18.5	24	VG7243PT+423AGA	VG7243PT+423BGA	VG7243PT+423GGA
Two-Way Push-Down-to-Open – NPT End Connections						
VG7443CT	1/2"	0.73	224	VG7443CT+423AGA	VG7443CT+423BGA	VG7443CT+423GGA
VG7443ET	1/2"	1.8	224	VG7443ET+423AGA	VG7443ET+423BGA	VG7443ET+423GGA
VG7443GT	1/2"	4.6	108	VG7443GT+423AGA	VG7443GT+423BGA	VG7443GT+423GGA
VG7443LT	3/4"	7.3	64	VG7443LT+423AGA	VG7443LT+423BGA	VG7443LT+423GGA
VG7443NT	1"	11.6	41	VG7443NT+423AGA	VG7443NT+423BGA	VG7443NT+423GGA
VG7443PT	1-1/4"	18.5	24	VG7443PT+423AGA	VG7443PT+423BGA	VG7443PT+423GGA
Three-Way Mixing – NPT End Connections						
VG7844CT	1/2"	0.73	230 / 224	VG7844CT+423AGA	VG7844CT+423BGA	VG7844CT+423GGA
VG7844ET	1/2"	1.8	230 / 224	VG7844ET+423AGA	VG7844ET+423BGA	VG7844ET+423GGA
VG7844GT	1/2"	4.6	130 / 108	VG7844GT+423AGA	VG7844GT+423BGA	VG7844GT+423GGA
VG7844LT	3/4"	7.3	82 / 64	VG7844LT+423AGA	VG7844LT+423BGA	VG7844LT+423GGA
VG7844NT	1"	11.6	39 / 41	VG7844NT+423AGA	VG7844NT+423BGA	VG7844NT+423GGA
VG7844PT	1-1/4"	18.5	24 / 24	VG7844PT+423AGA	VG7844PT+423BGA	VG7844PT+423GGA

Stainless Steel Trim Globe Valves with VA-4233 Series Electric Actuators (Continued)

VG7000 Series Valve Assemblies with VA-4233 Series Electric Actuators and Two Auxiliary Switches

Actuator Code				VA-4233-AGC-2	VA-4233-BGC-2	VA-4233-GGC-2
Actuator Input				Floating	On/Off	0 to 10 VDC - Proportional
Temperature Range				35 to 250°F (2 to 121°C), 15 psig Saturated Steam		
Actuator Code				VA-4233-AGC-2	VA-4233-BGC-2	VA-4233-GGC-2
Valve	Size	Cv	Closeoff	Spring Return – Stem Up		
Two-Way Push-Down-to-Close – NPT End Connections						
VG7243CT	1/2"	0.73	230	VG7243CT+423AGC	VG7243CT+423BGC	VG7243CT+423GGC
VG7243ET	1/2"	1.8	230	VG7243ET+423AGC	VG7243ET+423BGC	VG7243ET+423GGC
VG7243GT	1/2"	4.6	130	VG7243GT+423AGC	VG7243GT+423BGC	VG7243GT+423GGC
VG7243LT	3/4"	7.3	82	VG7243LT+423AGC	VG7243LT+423BGC	VG7243LT+423GGC
VG7243NT	1"	11.6	39	VG7243NT+423AGC	VG7243NT+423BGC	VG7243NT+423GGC
VG7243PT	1-1/4"	18.5	24	VG7243PT+423AGC	VG7243PT+423BGC	VG7243PT+423GGC
Two-Way Push-Down-to-Open – NPT End Connections						
VG7443CT	1/2"	0.73	224	VG7443CT+423AGC	VG7443CT+423BGC	VG7443CT+423GGC
VG7443ET	1/2"	1.8	224	VG7443ET+423AGC	VG7443ET+423BGC	VG7443ET+423GGC
VG7443GT	1/2"	4.6	108	VG7443GT+423AGC	VG7443GT+423BGC	VG7443GT+423GGC
VG7443LT	3/4"	7.3	64	VG7443LT+423AGC	VG7443LT+423BGC	VG7443LT+423GGC
VG7443NT	1"	11.6	41	VG7443NT+423AGC	VG7443NT+423BGC	VG7443NT+423GGC
VG7443PT	1-1/4"	18.5	24	VG7443PT+423AGC	VG7443PT+423BGC	VG7443PT+423GGC
Three-Way Mixing – NPT End Connections						
VG7844CT	1/2"	0.73	230 / 224	VG7844CT+423AGC	VG7844CT+423BGC	VG7844CT+423GGC
VG7844ET	1/2"	1.8	230 / 224	VG7844ET+423AGC	VG7844ET+423BGC	VG7844ET+423GGC
VG7844GT	1/2"	4.6	130 / 108	VG7844GT+423AGC	VG7844GT+423BGC	VG7844GT+423GGC
VG7844LT	3/4"	7.3	82 / 64	VG7844LT+423AGC	VG7844LT+423BGC	VG7844LT+423GGC
VG7844NT	1"	11.6	39 / 41	VG7844NT+423AGC	VG7844NT+423BGC	VG7844NT+423GGC
VG7844PT	1-1/4"	18.5	24 / 24	VG7844PT+423AGC	VG7844PT+423BGC	VG7844PT+423GGC

Technical Specifications

VG7000 Stainless Steel Trim Globe Valves with VA4233 Series Spring Return Electric Actuators		
Service[1]		Hot Water, Chill Water, 50/50 Glycol Solutions and Steam for HVAC Systems
Fluid Temperature Limits	Water	35 to 250°F (2 to 121°C)
	Steam	15 psig (103 kPa) Saturated Steam
Maximum Allowable Pressure Temperature	Water	400 psig (2,756 kPa) Up to 150°F (66°C) decreasing to 365 psig (2,515 kPa) at 248°F (120°C)
	Steam	15 psig (103 kPa) Saturated Steam at 250°F (121°C)
Valve Body Pressure/ Temperature Rating		Meets Requirements of ANSI B16.15, Class 250
Maximum Recommended Operating Pressure Drop	Water	35 psig (241 kPa) for ½ through 1-1/4 in. valves
	Steam	15 psig (103 kPa)
Flow Characteristics	Two-Way Valves	Equal Percentage
	Three-Way Valves	Linear Flow Characteristics
Rangeability[2]		25:1
Leakage		0.01% of Maximum Flow per ANSI/FCI 70-2, Class 4
Actuator Ambient Operating Temperature Limits		-4 to 122°F (-20 to 50°C)
Actuator Input Signal	VA-4233-AGx-2	24 VAC or 24 VDC Three-Wire Floating Control
	VA-4233-BGx-2	24 VAC or 24 VDC Two-Wire On/Off Control
	VA-4233-GGx-2	0(2) to 10 VDC Proportional Control, 0 to 10 VDC Feedback
Actuator Power Requirements		24 VAC (20 to 30 VAC), 50/60 Hz, 12 VA Nominal
Materials	Body	Cast Bronze
	Bonnet	Brass
	Stem	Stainless Steel
	Plug	Brass
	Seat	Brass Against Molded Elastomeric Disk
	Packing	Self Adjusting Ethylene Propylene Rubber (EPR) Ring Pack U-Cups

1. Refer to VDI 2035 Standard for recommended proper water treatment.
2. Rangeability is defined as the ratio of maximum controllable flow to minimum controllable flow.

WRZ-7850-0 Receiver for One-to-One Wireless Room Sensing Systems

Description

The WRZ-7850-0 Receiver for One-to-One Wireless Room Sensing Systems is designed to receive wireless Radio Frequency (RF) temperature and humidity data from WRZ Series Wireless Room Sensors, and provide single zone temperature and humidity control data to specified Metasys® system extended architecture digital controllers in building Heating, Ventilating, and Air Conditioning (HVAC) systems. The WRZ Series Wireless Room Sensor and WRZ-7850-0 Receiver combination is a functional equivalent to a network sensor, such as an NS-BTP7001-0, but eliminates communications wiring (which is usually placed inside the wall) between the room sensor and receiver.

Like a network sensor, the WRZ-7850-0 Receiver is designed to communicate over a Sensor Actuator (SA) Bus interface via Master-Slave/Token-Passing (MS/TP) BACnet® protocol with Johnson Controls® Variable Air Volume (VAV) Modular Assembly (VMA) 16 Series Controllers and Field Equipment Controllers (FECs). The receiver supplies the sensed zone temperature and humidity, temperature setpoint, and occupancy override data.

In a typical application, one WRZ Series Wireless Room Sensor reports to one WRZ-7850-0 Receiver; however, up to five WRZ Series Wireless Room Sensors can be associated with a single WRZ-7850-0 Receiver. In multi-sensor applications, the receiver passes all the room sensors' data to the controller. The VMA16 Series Controller or FEC can be configured to either average the room sensors' temperature and humidity input, or select the highest or lowest sensed temperature and humidity for control of the target zone.

The WRZ-7850-0 Receiver uses direct-sequence, spread-spectrum RF technology, and operates on the 2.4 GHz Industrial, Scientific, and Medical (ISM) band. The receiver meets the IEEE 802.15.4 standard for low power, low duty cycle RF transmitting systems. A WRZ-7850-0 Receiver operates as a transceiver, to create a bidirectional association with a WRZ Series Wireless Room Sensor.

Refer to the *WRZ-7850-0 Receiver for One-to-One Wireless Room Sensing Systems Product Bulletin (LIT-12011640)* for important product application information.

Features

- Metasys system extended architecture design — leverages the Metasys system Web-based platform to provide wireless temperature and humidity control to multiple field devices across the network
- One-to-One wireless RF design — enables quick, economical, and low-maintenance installations, which reduce installation and wiring costs
- integral wireless signal strength testing built into the receiver — provides quick and easy visual indication of the wireless RF signal strength between the receiver and its associated sensor, helps locate optimum device positions during installation, and aids in troubleshooting

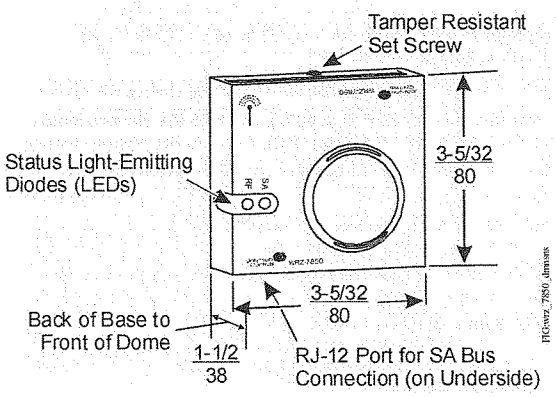
WRZ-7850-0 Receiver for One-to-One Wireless Room Sensing Systems

- multiple sensor temperature or humidity averaging or high/low selection — enhances zone temperature or humidity control by enabling up to five sensors to report to a single receiver, which allows the controller to average the sensors' temperature or humidity input, or select the highest or lowest sensed temperature or humidity for control of the target zone
- compact and easy to install design — receives the sensed zone temperature and humidity, temperature setpoint, and low battery condition from the WRZ Series Wireless Room Sensor, and interfaces directly with a Metasys field controller
- simple, field adjustable DIP switches — provide easy commissioning, with up to 4,096 unique RF addresses
- optional, battery-powered WRZ-SST-110 Wireless System Survey Tool — provides wireless mobility to check for the best RF link, and to determine the optimum receiver mounting locations
- high resistance to RF interference from other radio devices or RF noise sources — results from application-based frequency agility, which allows for automatically changing to a different channel to avoid RF interference and missed messages
- optional MS-ZFR1811-0 Wireless Field Bus Router — acts like a repeater to extend the operating range between the receiver and its associated sensor

Repair Information

If The WRZ-7850-0 Receiver fails to operate within its specifications, replace the unit. For a replacement receiver, contact the nearest Johnson Controls representative.

WRZ-7850-0 Receiver for One-to-One Wireless Room Sensing Systems (Continued)



WRZ-7850-0 Receiver Dimensions and Physical Features, in./mm

Selection Chart

Ordering Information

Code Number	Description
WRZ-7850-0	Receiver for One-to-One Wireless Room Sensing Systems
WRZ-THB0000-0	Wireless Room Temperature and Humidity Sensor with Display, Warmer/Cooler (+/-) Setpoint Adjustment or Setpoint Adjustment Scale: 55 to 85°F (13 to 27°C), F/C Button, Relative Humidity (RH) Button, and Manual Occupancy Override Button
WRZ-THN0000-0	Wireless Room Temperature and Humidity Sensor with Battery Level/Signal Strength LED and Manual Occupancy Override Button
WRZ-THP0000-0	Wireless Room Temperature and Humidity Sensor, Warmer/Cooler (+/-) Setpoint Adjustment, F/C Button, Relative Humidity (RH) Button, and Manual Occupancy Override Button
WRZ-TTB0000-0	Wireless Room Temperature Sensor with Display, F/C Button, and Manual Occupancy Override Button
WRZ-TTD0000-0	Wireless Room Temperature Sensor with Display, F/C Button, Fan Speed Control, and Manual Occupancy Override Button
WRZ-TTP0000-0	Wireless Room Temperature Sensor with Warmer/Cooler (+/-) Setpoint Adjustment, Battery Level/Signal Strength LED, and Manual Occupancy Override Button
WRZ-TTR0000-0	Wireless Room Temperature Sensor with Battery Level/Signal Strength LED, Manual Occupancy Override Button, and No Setpoint Adjustment
WRZ-TTS0000-0	Wireless Room Temperature Sensor with Setpoint Adjustment Scale: 55 to 80°F (13 to 27°C), Battery Level/Signal Strength LED, and Manual Occupancy Override Button
WRZ-SST-110	Wireless System Survey Tool
CBL-NETWORK6-0	6 ft (1.8 m) SA Bus Interface Cable to Connect WRZ-7850-0 Receiver to VMA16 Series Controller or FEC
CBL-NETWORK25-0	25 ft (7.6 m) SA Bus Interface Cable to Connect WRZ-7850-0 Receiver to VMA16 Series Controller or FEC
CBL-NETWORK50-0	50 ft (15.2 m) SA Bus Interface Cable to Connect WRZ-7850-0 Receiver to VMA16 Series Controller or FEC
CBL-NETWORK75-0	75 ft (22.9 m) SA Bus Interface Cable to Connect WRZ-7850-0 Receiver to VMA16 Series Controller or FEC
CBL-NETWORK100-0	100 ft (30.5 m) SA Bus Interface Cable to Connect WRZ-7850-0 Receiver to VMA16 Series Controller or FEC
MS-ZFR1811-0	Wireless Field Bus Router
MS-ZFRRPT-0	Power Supply for Optional MS-ZFR1811-0 Wireless Field Bus Router

WRZ-7850-0 Receiver for One-to-One Wireless Room Sensing Systems (Continued)

Technical Specifications

WRZ-7850-0 Receiver for One-to-One Wireless Room Sensing Systems	
Field Controller Interface	Power and SA Bus Interface between WRZ-7850-0 Receiver and VMA16 Series Controller or FEC
Supply Voltage	Nominal 15 VDC via the SA Bus; 6.7 to 16.5 VDC Required
Current Consumption	10 mA Maximum
Addressing	DIP Switches, Field Adjustable for up to 4,096 Unique RF Addresses
Ambient Limits	**Operating:** 32 to 122°F (0 to 50°C), 5 to 95% RH, Noncondensing **Storage:** -40 to 160°F (-40 to 71°C), 5 to 90% RH, Noncondensing
RF Band	Direct-Sequence, Spread-Spectrum, 2.4 GHz ISM Bands
Transmission Power	10 mW Maximum
Transmission Range	150 ft (45 m) Maximum Indoor Line-of-Sight; 100 ft (30 m) Practical Average Indoor
Receiver Outputs	One RJ-12 Port for SA Communication Bus Output (Sensed Zone Temperature and Humidity, Temperature Setpoint, and Occupancy Override Data)
Temperature Sensor Accuracy	**WRZ Series Wireless Room Sensor:** 1.0F° (0.6C°) over the Range of 55 to 85°F (13 to 29°C); 1.5F° (0.9C°) over the Range of 32 to 55°F (0 to 13°C) and 85 to 110°F (29 to 43°C)
Temperature Sensor Type	**WRZ Series Wireless Room Sensor:** Internal 10k ohm Negative Temperature Coefficient (NTC) Thermistor
Humidity Measurement Range	**WRZ Series Wireless Room Sensor:** Full Range 0 to 100% RH; Calibrated Range 10 to 90% RH at 74°F (23°C)
Humidity Sensor Accuracy	**WRZ Series Wireless Room Sensor:** ±3% RH across the Range of 20% to 80% RH, ±6% RH across the Range of 10% to 20% RH and 80% to 90% RH; within the Temperature Range of 55 to 85°F (13 to 29°C)
Humidity Sensor Type	**WRZ Series Wireless Room Sensor:** Planar Capacitive Polymer Sensor
Materials	NEMA 1 White Plastic Housing; UL94-5VB and V-0 Plenum Flammability Rated
Compliance	**United States:** Transmission Complies with FCC Part 15.247 Regulations for Low Power Unlicensed Transmitters; Transmitter FCC Identification: TBF-MATRIXL
	Canada: Industry Canada IC:5969A-MATRIXL
CE	**Europe:** CE Mark – Johnson Controls, Inc., declares that this product is in compliance with the essential requirements and other relevant provisions of the R&TTE Directive 1999/05/EC.
	Australia and New Zealand: Australia/NZ Emissions Compliant (C-Tick Mark)
Shipping Weight	0.2 lb (0.09 kg)

WRZ Series Wireless Room Sensors

Description

The WRZ Series Wireless Room Sensors are designed to sense room/zone temperature and transmit wireless temperature control data. Some models also sense and transmit relative humidity.

In a ZFR1800 Series Wireless Field Bus System application, the sensors communicate with FEC16 Series, FEC26 Series, and VMA16 Series Controllers by means of the ZFR1811 Router.

In wired field bus applications, the sensors communicate with a WRZ-7850 Wireless Receiver. The WRZ-7850 Receiver transfers data to the controller by means of the Sensor Actuator (SA) communication bus. In a typical application, one WRZ Series Sensor reports to one WRZ-7850 Receiver, but up to five WRZ Series Sensors can be associated with a single WRZ-7850 Receiver for multi-sensor averaging or high/low temperature selection.

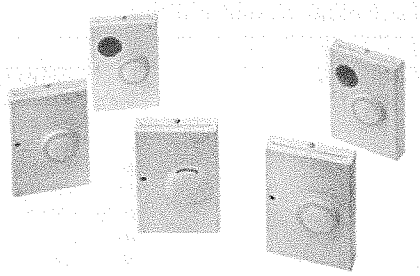
WRZ Series sensor models are available with or without a Liquid Crystal Display (LCD). Depending on the sensor model, the WRZ Series Sensor can transmit sensed temperature, setpoint temperature, sensed humidity, occupancy status, and low battery conditions to an associated router or receiver. The WRZ Series Sensors are designed for indoor, intra-building applications only.

The WRZ Sensors use direct-sequence, spread-spectrum RF technology, and operate on the 2.4 GHz Industrial, Scientific, and Medical (ISM) band. The receiver meets the IEEE 802.15.4 standard for low power, low duty cycle RF transmitting systems.

Refer to the *WRZ Series Wireless Room Sensors Product Bulletin (LIT-12011653)* for important product application information.

Features

- Wireless RF Design
- Integral Wireless Signal Strength Testing Built into the Sensor
- Easy Installation and Relocation
- Easily-Applicable Data Types
- Simple, Field Adjustable DIP Switches
- Optional, Battery-Powered WRZ-SST-110 Wireless System Survey Tool



WRZ Wireless Room Sensors

- High Resistance to RF Interference from Other Radio Devices or RF Noise Sources
- User Selectable Default Display for Humidity Models
- Display Models
- Three Temperature Setpoint Range Options

Repair Information

If the WRZ Wireless Room Sensor fails to operate within its specifications, replace the unit. For a replacement sensor, contact the nearest Johnson Controls® representative.

Selection

Selection

Product Code Number	Product Description
WRZ-THB0000-0	Wireless Room Temperature and Humidity Sensor with Display, Warmer/Cooler (+/-) Setpoint Adjustment or Setpoint Adjustment Scale: 55 to 85°F (13 to 27°C), F/C Button, Relative Humidity (RH) Button, and Manual Occupancy Override Button
WRZ-THN0000-0	Wireless Room Temperature and Humidity Sensor with Battery Level/Signal Strength LED and Manual Occupancy Override Button
WRZ-THP0000-0	Wireless Room Temperature and Humidity Sensor with Warmer/Cooler (+/-) Setpoint Adjustment and Manual Occupancy Override Button
WRZ-TTB0000-0	Wireless Room Temperature Sensor with Display, F/C Button, and Manual Occupancy Override Button
WRZ-TTD0000-0	Wireless Room Temperature Sensor with Display, F/C Button, Fan Speed Control, and Manual Occupancy Override Button
WRZ-TTP0000-0	Wireless Room Temperature Sensor with Warmer/Cooler (+/-) Setpoint Adjustment, Battery Level/Signal Strength LED, and Manual Occupancy Override Button
WRZ-TTR0000-0	Wireless Room Temperature Sensor with Battery Level/Signal Strength LED, Manual Occupancy Override Button, and No Setpoint Adjustment
WRZ-TTS0000-0	Wireless Room Temperature Sensor with Setpoint Adjustment Scale: 55 to 80°F (13 to 27°C), Battery Level/Signal Strength LED, and Manual Occupancy Override Button
WRZ-SST-110	Wireless System Survey Tool

WRZ Sensor Model Comparison

Sensor Model	Temperature	3% Humidity	Display	F/C Button	Fan Control	Occupancy Override	Setpoint Adjustment Dial[1]
WRZ-THB0000-0	x	x	x	x		x	CONFIG
WRZ-THN0000-0	x	x				x	NO DIAL
WRZ-THP0000-0	x	x				x	W/C
WRZ-TTB0000-0	x		x	x		x	CONFIG
WRZ-TTD0000-0	x		x	x	x	x	CONFIG
WRZ-TTP0000-0	x					x	W/C
WRZ-TTR0000-0	x					x	NO DIAL
WRZ-TTS0000-0	x					x	SCALED

1. Warmer/Cooler temperature offset (W/C), Single-value in 13 to 29°C (55 to 85°F) range (SCALED), CONFIG - system-configured (available on display models only)

WRZ Series Wireless Room Sensors (Continued)

Technical Specifications

WRZ Series Wireless Room Sensors	
Product Codes	WRZ-THB0000-0: Temperature/Humidity Sensor with Display, Warmer/Cooler (+/-) Setpoint Adjustment or Setpoint Adjustment Scale: 13 to 29°C/55 to 85°F, F/C Button, RH Button and Occupancy Button WRZ-THN0000-0: Temperature/Humidity Sensor with Occupancy Button WRZ-THP0000-0: Temperature/Humidity Sensor with Warmer/Cooler (+/-) Setpoint Adjustment and Occupancy Button WRZ-TTB0000-0: Temperature Sensor with Display and F/C Button WRZ-TTD0000-0: Temperature Sensor with Display, F/C Button and Fan Speed Control **WRZ-TTP0000-0:** Temperature Sensor with Warmer/Cooler (+/-) Setpoint Adjustment **WRZ-TTR0000-0:** Temperature Sensor with No Setpoint Adjustment **WRZ-TTS0000-0:** Temperature Sensor with Setpoint Adjustment Scale: 13 to 29°C (55 to 85°F)
Power Requirements	3 VDC Supplied by Two 1.5 VDC AA Alkaline Batteries (Included with Sensor); Typical Battery Life: 48 Months (36 Months Minimum)
Addressing	DIP Switches, Field Adjustable. MS/TP Address, PAN Number, and Zone Address
Ambient Conditions	**Operating:** 0 to 50°C (32 to 122°F), 5 to 95% RH, Noncondensing **Storage:** -40 to 71°C (-40 to 160°F), 5 to 95% RH, Noncondensing
Wireless Band	Direct-Sequence Spread-Spectrum, 2.4 GHz ISM Band
Transmission Power	10 mW Maximum
Transmission Range	30 m (100 ft) Maximum Line-of-Sight; 15 m (50 ft) Recommended
Transmissions	**Temperature:** Every 60 Seconds (±20 Seconds) **Humidity:** Every 3 minutes, or 1 minute intervals if temperature or humidity changes
Temperature System Accuracy	0.6C°/1.0F° Over the Range of 13 to 29°C (55 to 85°F); 0.9C°/1.5F° Over a Range of 0 to 13°C (32 to 55°F) and 29 to 43°C (85 to 110°F)
Temperature Sensor Type	Internal 10k ohm Negative Temperature Coefficient (NTC) Thermistor
Humidity Calibrated Range	10% to 90% RH at 23°C (73°F)
Humidity Accuracy	±3% RH across the Range of 20% to 80% RH, ±6% RH across the Range of 10% to 20% RH and 80% to 90% RH; within the Temperature Range of 13 to 29°C (55 to 85°F)
Materials	NEMA 1 White Plastic Housing
Mounting	Screw Mount or Double-Sided Adhesive Foam Tape Mount; Double-Sided Adhesive Foam Tape Included
Dimensions	120 x 80 x 38 mm (4.7 x 3.1 x 1.5 in.)
Shipping Weight	0.14 kg (0.3 lb)
Compliance CE	**United States:** Transmission Complies with FCC Part 15.247 Regulations for Low Power Unlicensed Transmitters Transmitter FCC Identification: TFB-MATRIXL **Canada:** Industry Canada IC: 5969A-MATRIXL **Europe:** CE Mark – Johnson Controls, Inc., declares that this product is in compliance with the essential requirements and other relevant provisions of the R&TTE Directive 1999/05/EC. **Australia and New Zealand:** C-Tick Mark, Australia/NZ Emissions Compliant

Series Y63, Y64, Y65, Y66, and Y69

Transformers

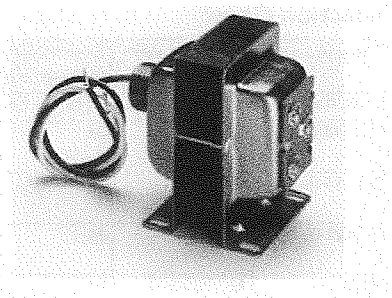
Description

The Series Y63, Y64, Y65, Y66, and Y69 Transformers provide 24 VAC power for loads of 40 VA through 300 VA. These transformers are designed for use on digital controllers, gas controls, ignition systems, motor actuators, staging controls, and most other 24 VAC Heating, Ventilation, Air Conditioning, and Refrigeration (HVACR) control systems.

The Y6x Series meets the requirements of UL 1585, UL 506, and CSA C22.2 No. 66, providing compliance in both the United States and Canada. The Y63, Y64, Y65, and Y66 transformers are listed as Class 2 transformers (UL 1585, CSA C22.2 No. 66). The Y69 is listed as a general purpose transformer (UL 506, CSA C22.2 No. 66).

Features

- split-bobbin design—provides best primary/secondary isolation
- multi-tap primaries—reduce stocking requirements and offer application flexibility
- choice of foot, plate, or conduit hub mounting—provides mounting flexibility
- choice of primary voltages—meets a wide range of power requirements from 24 VAC through 480 VAC
- color-coded lead wires—provide simplicity and standardization
- cULus listed or cURus recognized—meets US and Canadian requirements for Class 2 transformers (Y63, Y64, Y65, and Y66) and general purpose transformers (Y69)
- built-in, easy-reset circuit breakers—eliminate replacement time and cost caused by burn-out (Y63, Y64, Y66, and Y69)
- open frame Y65 models—serve as ideal models when end bells are not required



Y65 Series Transformer

Repair Information

Do not make any field repairs to transformers. For a replacement transformer, contact the nearest Johnson Controls® distributor or sales representative.

Technical Specifications

Series Y63, Y64, Y65, Y66, Y69 Transformers		
Input Power Requirements	24–480 VAC at 60 Hz	
Full Load Secondary Voltage	23.5 VAC (Nominal)	
Open Circuit Secondary Voltage (No Load)	27.0 VAC (Nominal)	
Full Load Secondary VA Rating	**Series**	**Volt-Amperes**
	Y63	50 VA
	Y64	92 VA
	Y65	40 VA
	Y66	75 VA
	Y69	300 VA
Finish	End bells, frame, feet, and mounting plates are corrosion resistant	
Ambient Operating Temperature	-40 to 104°F (-40 to 40°C)	
Ambient Storage Temperature	-40 to 140°F (-40 to 60°C)	
Shipping Weight	Y63	3.0 lb/1.4 kg
	Y64	4.0 lb/1.8 kg
	Y65	2.0 lb/0.9 kg
	Y66	3.0 lb/1.4 kg
	Y69	11.0 lb/5.0 kg
Agency Compliance	UL Listed Y63, Y64, Y65, Y66; File E95575, CCN's XOKV (US) and XOKV7 (Canada) UL Recognized Y63, Y64, Y65, Y66; File E95575, CCN's XOKV2 (US) and XOKV8 (Canada) UL Listed Y69; File E95138, CCN's XPTQ (US) and XPTQ7 (Canada) All transformers are Class 2 except the Y69 (300 VA), which is listed as a power transformer.	

Transformers (Continued)

Selection Chart

Code No.	Primary Voltage VAC	Secondary Voltage VAC	Primary Connection	Secondary Connection	Mounting	Agency Requirement
40 VA Capacity Transformers with Energy Limiting Type Overload Protection						
Y65G13-0	24	24	Male Fitting 8 in. primary leads	Male Fitting 30 in. secondary leads	Foot	cULus Class 2
Y65A13-0	120	24	Male Fitting 8 in. primary leads	Male Fitting 30 in. secondary leads	Foot	cULus Class 2
Y65A21-0	120	24	End bell holes 8 in. primary leads	Three screw terminals (one is blind)	4 in. x 4 in. plate	cULus Class 2
Y65T31-0	120/208/240	24	Male Fitting 8 in. primary leads	Three screw terminals (one is blind)	Foot 4 in. x 4 in. plate[1]	cULus Class 2
Y65T42-0	120/208/240	24	Common Male Fitting 8 in. primary leads	Common Male Fitting 8 in. secondary leads	Hub 4 in. x 4 in. plate[1]	cURus Class 2
Y65T54-0	120/208/240	24	8 in. primary leads	8 in. secondary leads	Foot-skeleton	cURus Class 2
Y65S13-0	208/240	24	Male Fitting 8 in. primary leads	Male Fittings 30 in. secondary leads	Foot	cULus Class 2
Y65F13-0	277/480	24	Male Fitting 8 in. primary leads	Male Fitting 30 in. secondary leads	Foot	cULus Class 2
Y65F42-0	277/480	24	Common Male Fitting 8 in. primary leads	Common Male Fitting 8 in. secondary leads	Hub 4 in. x 4 in. plate[1]	cURus Class 2
50 VA Capacity Transformers with Circuit Breakers						
Y63T22-0	120/208/240	24	End bell Hole 8 in. primary leads	End bell Hole 8 in. secondary leads	4 in. x 4 in. plate	cURus Class 2
Y63T31-0	120/208/240		Male Fitting 8 in. primary leads	Three screw terminals (one is blind)	Foot 4 in. x 4 in. plate[1]	cULus Class 2
Y63F22-0	277/480	24	End bell Hole 8 in. primary leads	End bell Hole 8 in. secondary leads	4 in. x 4 in. plate	cURus Class 2
75 VA Capacity Transformers with Circuit Breakers						
Y66T12-0	120/208/240	24	Common Male Fitting 8 in. primary leads	Common Male Fitting 8 in. secondary leads	Foot	cURus Class 2
Y66T13-0	120/208/240	24	Male Fitting 8 in. primary leads	Male Fitting 30 in. secondary leads	Foot	cULus Class 2
Y66F12-0	277/480	24	Common Male Fitting 8 in. primary leads	Common Male Fitting 8 in. secondary leads	Foot	cURus Class 2
Y66F13-0	277/480	24	Male Fitting 8 in. primary leads	Male Fitting 30 in. secondary leads	Foot	cULus Class 2
92 VA Capacity Transformers with Circuit Breakers						
Y64T15-0	120/208/240	24	Male Fitting 8 in. primary leads	Female Fitting 30 in. secondary leads	Foot	cULus Class 2
Y64T21-0	120/208/240	24	End bell holes 8 in. primary leads	Three screw terminals (one is blind)	Plate	cULus Class 2
Y64T22-0	120/208/240	24	End bell Hole 8 in. primary leads	End bell Hole 8 in. secondary leads	Plate	cURus Class 2
300 VA Capacity Transformers with Circuit Breakers						
Y69T15-0	120/208/240	24	Male Fitting 8 in. primary leads	Female Fitting 30 in. secondary leads	Foot	cULus Power Transformer

1. 4 in. x 4 in. plate and nut packed with transformer.

VAMC St Cloud - Bldg 4 Upgrade HVAC

2082-0141

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	2.1.2	4-C-1 Point Schedule
	2.1.3	4-C-1 Wiring Details
	2.2.1	4-C-2 Heat Exchanger Layout
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	RS.1.1	Room Schedule - ENGR
	VS.1.1	Valve Schedule - ENGR

McDOWALL COMPANY
Reviewed by BB
Date 1/9/12

REVIEWED BY
SAGINAW CONTRACTING, INC.
BY SE DATE 1-10-12
03 09 03-01

Johnson Controls

Creating a better climate for business.

- [x] Environmental Control System
- [ ] Facility Management System
- [ ] Air and Water System Balancing
- [ ] Fire Management System
- [ ] Security System
- [ ] Lighting Services
- [ ] Instrumentation System Installation
- [ ] Building Operations Management
- [ ] Energy Conservation Control
- [ ] Training Programs
- [ ] Performance Contracting
- [ ] Planned Service Agreements

Air Conditioning
Heating
Diagnostic Services
Coil Cleaning
Refrigeration
Automatic Temperature Controls
Facility Management Systems
Fire Management
Security Management
Building Operations and Management
Water Treatment
Electrical Equipment
Emergency Generator / Lighting Equipment
Industrial Controls / Recording / Indication Equipment

PROJECT TITLE
VAMC St Cloud - Bldg 4 Upgrade HVAC

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SALES ENGINEER	PROJECT MANAGER	APPLICATION ENGINEER	DATE	CONTRACT NUMBER
Shawn Klein	Josh Strommen	Tyler Minke	1/6/12	2082-0141

METASYS NETWORK LAYOUT

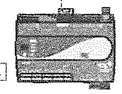
THIS DRAWING SHOWS THE OVERALL NETWORK LAYOUT. IT IS ASSUMED THAT THE ETHERNET SHOWN IS THE CUSTOMERS ETHERNET BACKBONE. NO ADDITIONAL SWITCHES, ROUTERS, FIREWALLS, ETC ARE PROVIDED.

ATTIC

FIELD BUS 2

FIELD BUS 2

EOL



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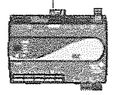

FEC2611
4-AHU-2
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2ND FLOOR

FIELD BUS 2

FIELD BUS 2

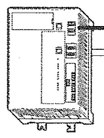
FIELD BUS 2

VMA1620
VAV RH
TYPICAL OF 5
ADD: SEE ROOM SCHEDULE

VMA1620
VAV RH FTR
TYPICAL OF 39
ADD: SEE ROOM SCHEDULE

ETHERNET FROM CUSTOMERS EXISTING LAN

EXISTING NAE-4
LOCATION: BLDG. 4 1ST FLOOR RM 120A
IP ADDRESS: 10.108.5.4



EXISTING N2 TRUNK 1

MS/TP FIELD BUS 2
(SEE INSTALLATION DETAIL FOR RECOMMENDED WIRE TYPE)

EXISTING FIELD BUS 2 FROM EXISTING FREEZER MONITORING EOL FEC CONTROLLER

FIELD BUS 2

FIELD BUS 2

FIELD BUS 2

INTEGRATION VIA BACNET MS/TP TO 4-ACRCU-1

INTEGRATION VIA BACNET MS/TP TO 4-ACRCU-2

INTEGRATION NOTE:

ONLY USE + AND – TERMINALS, WIRENUT THE REFERENCE WIRE.

1ST FLOOR

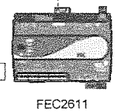
BASEMENT

FIELD BUS 2

FIELD BUS 2

FIELD BUS 2

EOL



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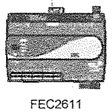

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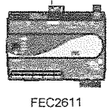

FEC2611
CHWS
ADD: 13

INSTALLED IN SAME PANEL

Drawing Title
NETWORK Network Riser

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

Sales Engineer	Project Manager	Application Engineer	DRAWN		APPROVED	
Shawn Klein	Josh Strommen	Tyler Minke	BY	DATE	BY	DATE

Project Title
VAMC St Cloud - Bldg 4 Upgrade HVAC

Johnson Controls

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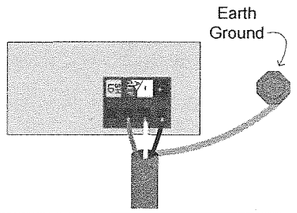
CONTRACT NUMBER
2082-0141

DRAWING NUMBER
1.1.1

METASYS MSTP NETWORK INSTALLATION DETAILS

The information in this document is not intended to replace the published Technical Product Literature for the Johnson Controls systems and products presented. The Installation Instructions that are packed with products, and the Technical Bulletins and Product Bulletins released with Johnson Controls systems and products supersede the information on this page. It is the responsibility of the product installer and product user to obtain and follow the product installation, operation, and safety procedures provided with the products or project specific information required by specification or local codes.

Category	Rules / Maximums Allowed
General	Typically daisy-chained; branch or star configuration acceptable when repeaters are used. See End of Line Switching and Repeater Guideline graphic.
Number of Devices	**When all of the devices connected on the FC Bus are Metasys FECs, VMAs, and/or IOMs, the device and bus segment limits are:** 100 devices total per FC Bus (maximum) 3 bus segments per FC Bus (maximum) 50 devices per bus segment (maximum, not to exceed 100 devices per FC Bus) **When one or more TEC26xx Series thermostat or third-party MS/TP device is connected on the FC Bus, the device and bus segment limits are:** 64 devices total per FC Bus (maximum) 3 bus segments per FC Bus (maximum) 32 devices per bus segment (maximum, not to exceed 64 devices per FC Bus) **Note:** Metasys MS/TP devices generate less data traffic than third-party MS/TP devices and TEC26xx thermostats. Connecting third-party devices or TEC26xx thermostats to the FC Bus increases data traffic, reduces bus performance, and reduces the number of devices that can be connected to the bus. Bus segments on an FC Bus are connected with repeaters (only). Up to two cascaded repeaters may be applied to an FC Bus (to connect three bus segments).
Line Length and Type	**When all of the devices connected on the FC Bus are Metasys FECs, VMAs, and/or IOMs, the cable length limits are:** Each bus segment can be up to 1520 m (5000 ft) in length (using 22 AWG 3-wire twisted, shielded cable). Each FC Bus can be up to 4750 m (15,000 ft) in length (using 22 AWG 3-wire twisted, shielded cable). **When one or more TEC26xx Series thermostat or third-party MS/TP device is connected on the FC Bus, the device and bus segment limits are:** Each bus segment can be up to 1220 m (4000 ft) in length (using 22 AWG 3-wire twisted, shielded cable) Each FC Bus can be up to 3660 m (12,000 ft) in length (using 22 AWG 3-wire twisted, shielded cable). When using fiber-optic connections: 2,010 m (6,600 ft.) between two fiber modems 22 AWG Stranded, 3-Wire Twisted, Shielded Cable
Cable	22 AWG stranded, 3-wire, twisted shielded cable
EOL Termination	End-of-Line (EOL) termination is required on the FC Bus to reduce signal reflection when data transmissions reach the end of a bus segment and bounce back. EOL termination is built into some Metasys FC devices and is enabled with a switch or jumper on the device. **EOL Termination on NAEs** An EOL switch on an NAE enables EOL termination. For those NAEs with two FC Bus connections, two EOL double-pole switches are provided. Set the EOL switch to the ON (up) position to set the controller as an EOL termination device. **EOL Termination on Switch-Terminating Devices** Some field controllers have an EOL switch or jumper. Such devices include FECs, IOMs, VMAs, ZFR1810s, and repeaters. Set the EOL termination to On for any of these devices when it is the last device on a bus segment. **EOL Termination on Devices Without EOL Provision** For the devices such as TECs and third-party controllers in which no EOL provision is provided, install the MS-BACEOL-0 RS485 End-of-Line Terminator at the device if at the end of the bus segment. **EOL Termination Across the FC Bus** The FC Bus may consist of up to three bus segments. Each bus segment on an FC Bus requires two EOL termination devices, one at each end of the bus segment. All other devices on the FC Bus should have their EOL termination disabled (EOL switches Off) . If only one device on an FC segment has an EOL termination, it must be set to On. **EOL on FC Bus Repeaters** When using repeaters in the FC Bus, set the EOL jumpers based on the position of the repeater in the run.



SHIELD GROUNDING

The shield should be earth grounded at one and only one point for the entire bus segment. (Preferably in the NAE Panel.) The shield screws on the controllers are simply a convenient way to continue the daisy chain of the bus. They are not attached to earth ground. You can use the shield terminal or twist together the shield and tape back at each controller.

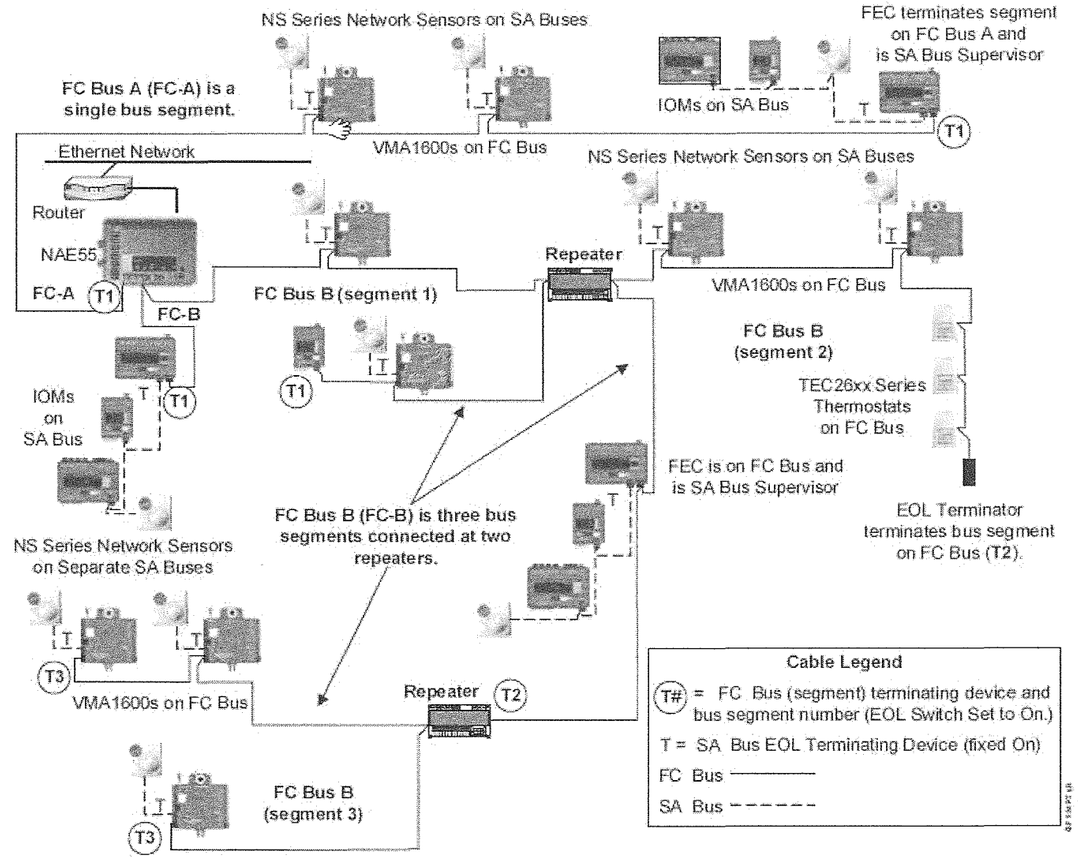
RECOMMENDED MSTP FIELD CONTROLLER BUS CABLE

Type	Typical Usage	Anixter #	Belden #	pF/ft	Area
22/3c Shielded Plenum	Open Plenum Installations. 38400+ Baud RS-485 Communication.	CBL-22/3-FC-PLN	6501FE	25	0.014
22/3c Shielded PVC	EMT (Raceway) Installations. 38400+ Baud RS-485 Communication.	CBL-22/3-FC-PVC	5501FE	31	0.015

RECOMMENDED MSTP SENSOR ACTUATOR BUS CABLE

Type	Typical Usage	Anixter #	Belden #	pF/ft	Area
22/2pr Shielded Plenum	Open Plenum Installations. 38400+ Baud RS-485 Communication.	CBL-22/2P-SA-PLN	6541FE	33	0.033
22/2pr Shielded PVC	EMT (Raceway) Installations. 38400+ Baud RS-485 Communication.	CBL-22/2P-SA-PVC	5541FE	31	0.034

END OF THE LINE SWITCHING AND REPEATER GUIDELINES



Drawing Title
NETWORK MSTP Installation Reference

Project Title
VAMC St Cloud - Bldg 4 Upgrade HVAC

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

Sales Engineer	Project Manager	Application Engineer	DRAWN		APPROVED	
Shawn Klein	Josh Strommen	Tyler Minke	BY	DATE	BY	DATE

Johnson Controls

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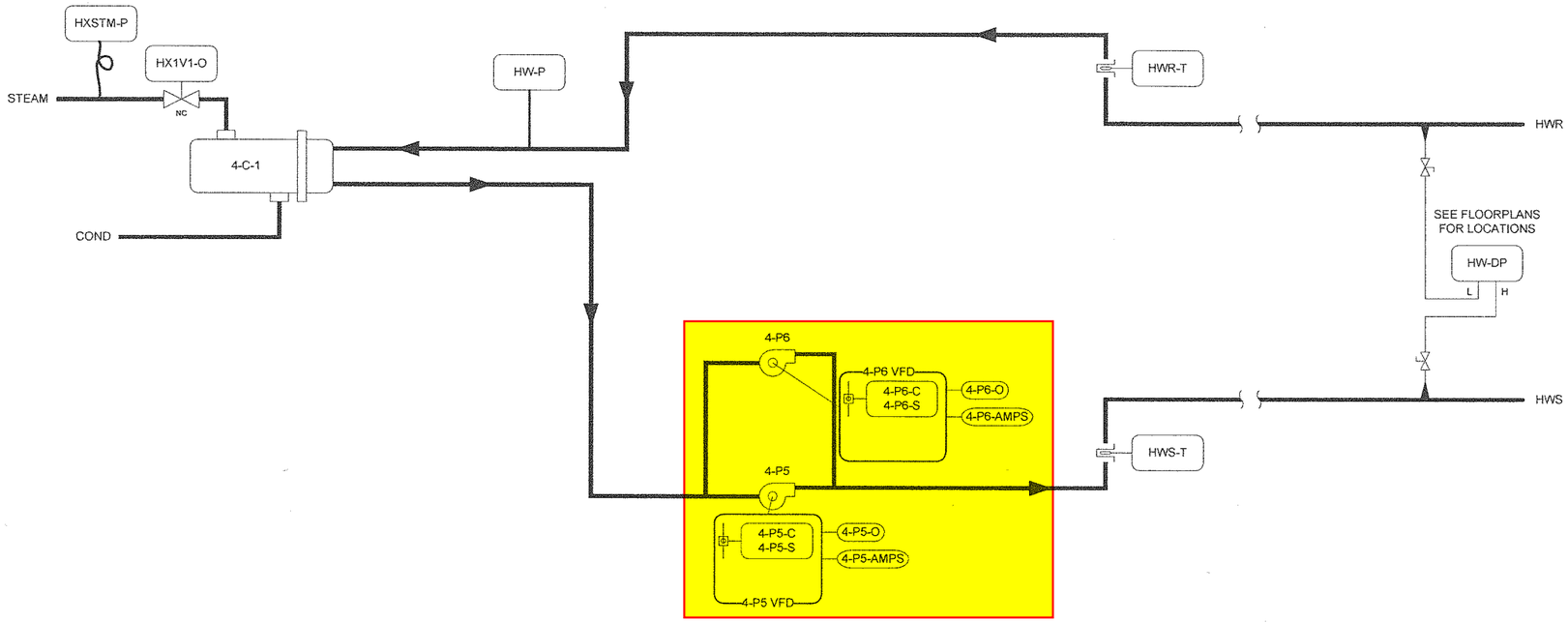
CONTRACT NUMBER
2082-0141

DRAWING NUMBER
1.1.2



SYSTEM ENABLE: THE HEATING SYSTEM WILL AUTOMATICALLY START WHEN THE OUTSIDE AIR TEMPERATURE FALLS BELOW THE SYSTEM ENABLE SETPOINT OF 70 DEGREES F (ADJ) WHILE THE SYSTEM ENABLE IS "ON". WHEN THE OUTSIDE AIR TEMPERATURE RISES ABOVE THIS SETPOINT OR THE SYSTEM ENABLE IS "OFF", THE HEATING SYSTEM WILL BE DISABLED.

HEAT EXCHANGER CONTROL: THIS SYSTEM CONSISTS OF ONE STEAM HEAT EXCHANGER. A STEAM INLET VALVE WILL MODULATE TO MAINTAIN THE DESIRED HOT WATER SUPPLY TEMPERATURE TO SETPOINT AS RESET BY THE OUTDOOR AIR TEMPERATURE. A COMMAND FROM THE FMS MAY DISABLE THE HEAT EXCHANGER. IF THE HEAT EXCHANGER IS ACTIVE AND THE SUPPLY WATER TEMPERATURE IS LESS THAN 120 DEGREES F (ADJ) OR THE RETURN WATER TEMPERATURE IS LESS THAN 90 DEGREES F (ADJ), A "LOW WATER TEMPERATURE" ALARM WILL BE DISPLAYED AT THE OPERATORS WORKSTATION.

OA RESET	HW RESET
0 DEGREES	200 DEGREES
60 DEGREES	140 DEGREES

HOT WATER PUMP CONTROL (PUMPS 4-P5 & 4-P6): WHEN ENABLED, THE PUMP WITH THE LOWEST RUNTIME TOTAL WILL BE STARTED. IF THE PUMP SPEED EXCEEDS 85% (ADJ), THE LAG PUMP WILL BE ENABLED TO RUN. IF THE SPEED OF THE PUMPS DROPS BELOW 35% (ADJ), THE LAG PUMP WILL BE DISABLED. IF THE PUMP STATUS DOES NOT MATCH THE COMMAND OR THE PUMP AMPS EXCEED NORMAL LIMITS A "PUMP FAILURE" ALARM WILL BE DISPLAYED AT THE OWS AND THE PUMP WILL BE STOPPED. UPON LOSS OF STATUS, THE PUMP WILL RESTART AFTER THE SYSTEM RESET IS ACTIVATED. PUMPS WILL BE ROTATED EVERY 1000 HOURS (ADJ) TO ENSURE EQUAL RUNTIME.

LOOP PRESSURE CONTROL: WHEN A PUMP STATUS IS VERIFIED, THE PUMP WILL BE MODULATED TO MAINTAIN THE SYSTEM DIFFERENTIAL PRESSURE OF THE PIPING SYSTEM. THE PRESSURE SENSOR WILL BE LOCATED 2/3 THE WAY DOWN THE PIPING SYSTEM.

FILL PRESSURE CONTROL: THE STATUS OF A HOT WATER PRESSURE GUAGE INSTALLED ON THE HOT WATER RETURN LINE ENTERING THE HEAT EXCHANGER WILL BE MONITORED. WHENEVER A LOW FILL PRESSURE CONDITION IS DETECTED, THE PUMPS WILL BE STOPPED AND "LOW FILL PRESSURE" ALARM WILL BE DISPLAYED AT THE OWS.

ADDITIONAL POINTS MONITORED BY THE FMS:

- STEAM PRESSURE (HXSTM-P)
- HOT WATER RETURN TEMPERATURE (HWR-T)

Drawing Title
4-C-1 Heat Exchanger Layout Steam To Water

Project Title
VAMC St Cloud - Bldg 4 Upgrade HVAC

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

Sales Engineer	Project Manager	Application Engineer	DRAWN		APPROVED	
Shawn Klein	Josh Strommen	Tyler Minke	BY	DATE	BY	DATE

Johnson Controls

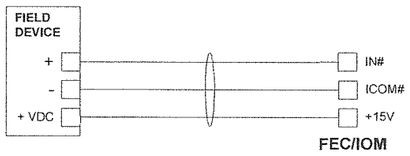
Branch Information
Johnson Controls, Inc.
2605 Frenbrook Lane N.
Plymouth, MN 55447
Phone: 763-566-7650
Fax: 763-566-2208

CONTRACT NUMBER
2082-0141

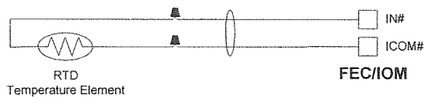
DRAWING NUMBER
2.1.1

Electrician/Fitter	Point Information				Controller Information						Panel Information					Intermediate Device					Field Device							
Tag	Point Type	System Name	Object Name	Expanded ID	Controller Details	Trunk Type	Trunk Nbr	Trunk Addr.	Cable Destination Bay/Terminal	Module Type	Termination Out	Panel	Panel Location	Slot Number	Reference Drawing	Cable Number	Wiring /Tubing	Termination In	Device	Termination Out	Location	Wiring /Tubing	Termination In	Device	Location	Ref Detail Shape	Comment	Template	
		4-C-1			FEC 26xx																						Power to Controller		
		4-C-1			FEC 26xx	MS/TP	1	11						0													BacNet FC Bus		
	UI IN-1	4-C-1	HXSTM-P	Heat Exchanger Steam Pressure	FEC 26xx	MS/TP	1	11	UI IN-1		IN1, ICOM1, +15V			0		-4-UI IN-1					3/22	OUT,COM,EXC	DPT2xxx (Vdc)		F102			
	UI IN-2	4-C-1	HW-DP	Hot Water Diff Pressure	FEC 26xx	MS/TP	1	11	UI IN-2		IN2, ICOM2, +15V			0		-4-UI IN-2					3/22	OUT,COM,EXC	DPT2xxx (Vdc)		F102			
	UI IN-3	4-C-1	HWR-T	Hot Water Return Temp	FEC 26xx	MS/TP	1	11	UI IN-3		IN3, ICOM3			0		-4-UI IN-3					2/22	2-Wire	TE		F131			
	UI IN-4	4-C-1	HWS-T	Hot Water Supply Temp	FEC 26xx	MS/TP	1	11	UI IN-4		IN4, ICOM4			0		-4-UI IN-4					2/22	2-Wire	TE		F131			
	UI IN-5	4-C-1	4-P5-AMPS	Hot Water Pump 5 Amps	FEC 26xx	MS/TP	1	11	UI IN-5		IN5, ICOM5			0		-4-UI IN-5					2/22	See wiring detail	Voltage Input (Self Powered)		F103			
	UI IN-6	4-C-1	4-P6-AMPS	Hot Water Pump 6 Amps	FEC 26xx	MS/TP	1	11	UI IN-6		IN6, ICOM6			0		-4-UI IN-6					2/22	See wiring detail	Voltage Input (Self Powered)		F103			
	BI IN-7	4-C-1	4-P5-S	Hot Water Pump 5 Status	FEC 26xx	MS/TP	1	11	BI IN-7		IN7, ICOM7			0		-4-BI IN-7	2/22	OUT, COM	Current Relay	Motor Lead		Motor Lead	See wiring detail	Motor Status (Contact)		F301			
	BI IN-8	4-C-1	4-P6-S	Hot Water Pump 6 Status	FEC 26xx	MS/TP	1	11	BI IN-8		IN8, ICOM8			0		-4-BI IN-8	2/22	OUT, COM	Current Relay	Motor Lead		Motor Lead	See wiring detail	Motor Status (Contact)		F301			
	BO OUT-1	4-C-1	4-P5-C	Hot Water Pump 5 Command	FEC 26xx	MS/TP	1	11	BO OUT-1		OUT1, 24V COM			0		-4-BO OUT-1	2/22	COIL-,COIL+	Relay	COM, NO		2/14	See wiring detail	VFD (w/o Safety w/Byp) (Sw Hi, EXT)		F1047			
	BO OUT-2	4-C-1	4-P6-C	Hot Water Pump 6 Command	FEC 26xx	MS/TP	1	11	BO OUT-2		OUT2, 24V COM			0		-4-BO OUT-2	2/22	COIL-,COIL+	Relay	COM, NO		2/14	See wiring detail	VFD (w/o Safety w/Byp) (Sw Hi, EXT)		F1047			
	BO OUT-3	4-C-1			FEC 26xx	MS/TP	1	11	BO OUT-3					0		-4-BO OUT-3													
	CO OUT-4	4-C-1	HX1V1-O	Heat Exchanger 1 Valve 1 Output	FEC 26xx	MS/TP	1	11	CO OUT-4		OUT4, OCOM4,24V HOT			0		-4-CO OUT-4					3/18	Red, White, Yellow	VA-4233 (Vdc)		F287			
	CO OUT-5	4-C-1			FEC 26xx	MS/TP	1	11	CO OUT-5					0		-4-CO OUT-5													
	CO OUT-6	4-C-1			FEC 26xx	MS/TP	1	11	CO OUT-6					0		-4-CO OUT-6													
	CO OUT-7	4-C-1			FEC 26xx	MS/TP	1	11	CO OUT-7					0		-4-CO OUT-7													
	AO OUT-8	4-C-1	4-P5-O	Hot Water Pump 5 Output	FEC 26xx	MS/TP	1	11	AO OUT-8		OUT8, OCOM8			0		-4-AO OUT-8					2/22	See VFD Detail	VFD Speed Control (Vdc)		F1047			
	AO OUT-9	4-C-1	4-P6-O	Hot Water Pump 6 Output	FEC 26xx	MS/TP	1	11	AO OUT-9		OUT9, OCOM9			0		-4-AO OUT-9					2/22	See VFD Detail	VFD Speed Control (Vdc)		F1047			
		4-C-1			IOM 2710																						Power to Controller		
		4-C-1			IOM 2710	SA Bus	1	4						0													BacNet SA Bus		1,0
	UI IN-1	4-C-1	HW-P	Hot Water Pressure	IOM 2710	SA Bus	1	4	UI IN-1		IN1, ICOM1, +15V			0		4--4-UI IN-1					3/22	OUT,COM,EXC	DPT2xxx (Vdc)		F102			
	UI IN-2	4-C-1			IOM 2710	SA Bus	1	4	UI IN-2					0		4--4-UI IN-2													
	RO OUT-1	4-C-1			IOM 2710	SA Bus	1	4	RO OUT-1					0		4--4-RO OUT-1													
	RO OUT-2	4-C-1			IOM 2710	SA Bus	1	4	RO OUT-2					0		4--4-RO OUT-2													
	UO OUT-3	4-C-1			IOM 2710	SA Bus	1	4	UO OUT-3					0		4--4-UO OUT-3													
	UO OUT-4	4-C-1			IOM 2710	SA Bus	1	4	UO OUT-4					0		4--4-UO OUT-4													

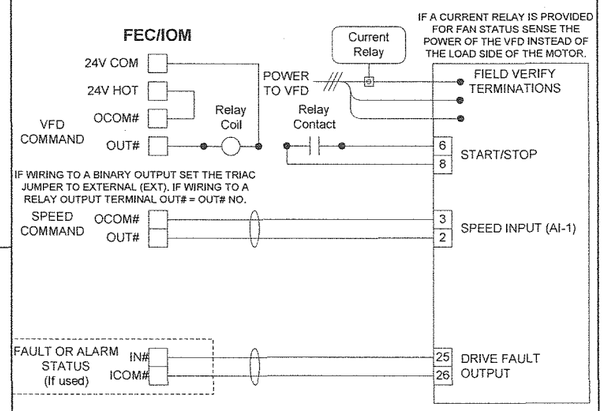
DETAIL F102 VOLTAGE INPUT - INTERNAL SOURCE



DETAIL F131 TEMPERATURE SENSOR INPUT



DETAIL F1047 VFD Bypass without Safeties Wiring

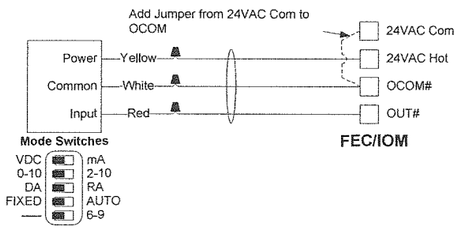


Variable Speed Enclosed IntelliPass/IntelliDisconnect Drives

DETAIL F103 VOLTAGE INPUT (Self Powered)

DETAIL F301 BINARY INPUT (DRY CONTACT)

DETAIL F287 0-10VDC OUTPUT to VA-4233



Drawing Title
4-C-1 Wiring Details

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

Sales Engineer	Project Manager	Application Engineer	DRAWN BY	DRAWN DATE	APPROVED BY	APPROVED DATE
Shawn Klein	Josh Strommen	Tyler Minke				

Project Title
VAMC St Cloud - Bldg 4 Upgrade HVAC

Johnson Controls

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Johnson Controls, Inc.
2605 Frenbrook Lane N.
Plymouth, MN 55447
Phone: 763-566-7650
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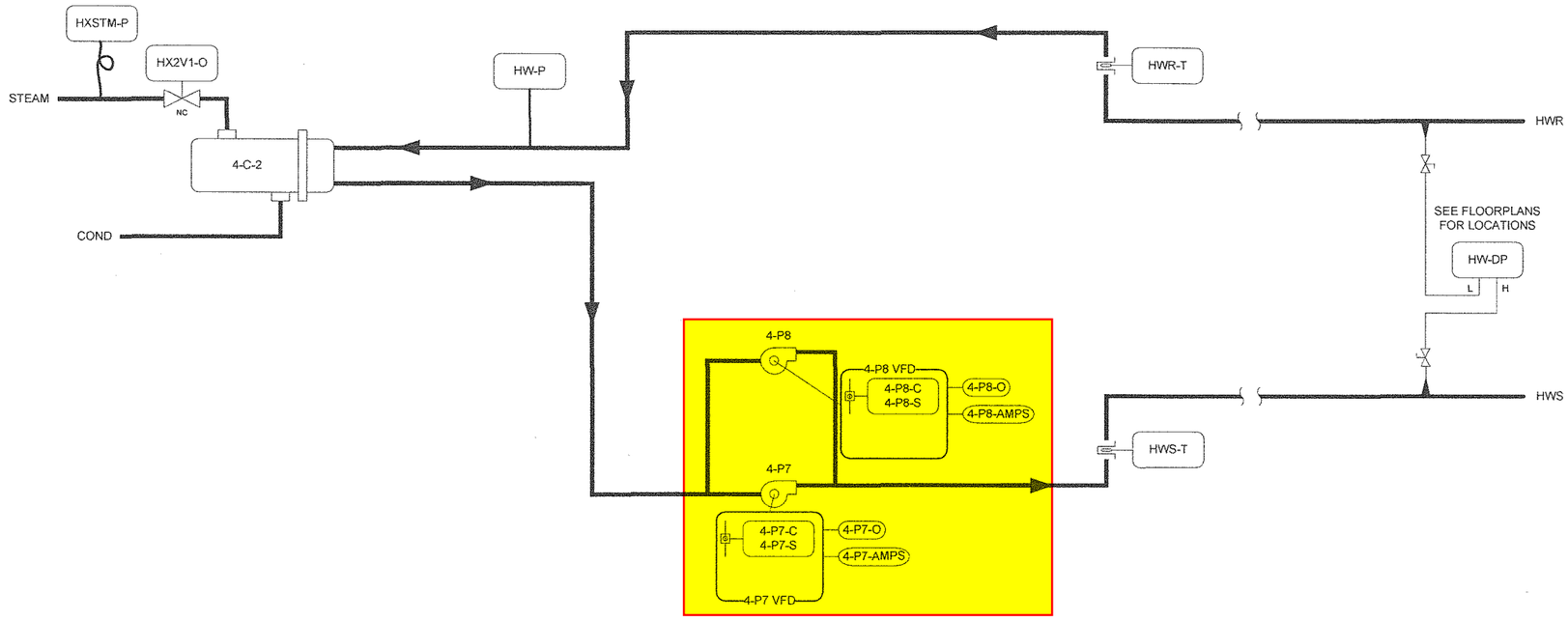
CONTRACT NUMBER
2082-0141

DRAWING NUMBER
2.1.3



SYSTEM ENABLE: THE HEATING SYSTEM WILL AUTOMATICALLY START WHEN THE OUTSIDE AIR TEMPERATURE FALLS BELOW THE SYSTEM ENABLE SETPOINT OF 70 DEGREES F (ADJ) WHILE THE SYSTEM ENABLE IS "ON". WHEN THE OUTSIDE AIR TEMPERATURE RISES ABOVE THIS SETPOINT OR THE SYSTEM ENABLE IS "OFF", THE HEATING SYSTEM WILL BE DISABLED.

HEAT EXCHANGER CONTROL: THIS SYSTEM CONSISTS OF ONE STEAM HEAT EXCHANGER. A STEAM INLET VALVE WILL MODULATE TO MAINTAIN THE DESIRED HOT WATER SUPPLY TEMPERATURE TO SETPOINT AS RESET BY THE OUTDOOR AIR TEMPERATURE. A COMMAND FROM THE FMS MAY DISABLE THE HEAT EXCHANGER. IF THE HEAT EXCHANGER IS ACTIVE AND THE SUPPLY WATER TEMPERATURE IS LESS THAN 120 DEGREES F (ADJ) OR THE RETURN WATER TEMPERATURE IS LESS THAN 90 DEGREES F (ADJ), A "LOW WATER TEMPERATURE" ALARM WILL BE DISPLAYED AT THE OWS.

OA RESET	HW RESET
0 DEGREES	200 DEGREES
60 DEGREES	140 DEGREES

HOT WATER PUMP CONTROL (PUMPS 4-P7 & 4-P8): WHEN ENABLED, THE PUMP WITH THE LOWEST RUNTIME TOTAL WILL BE STARTED. IF THE PUMP SPEED EXCEEDS 85% (ADJ), THE LAG PUMP WILL BE ENABLED TO RUN. IF THE SPEED OF THE PUMPS DROPS BELOW 35% (ADJ), THE LAG PUMP WILL BE DISABLED. IF THE PUMP STATUS DOES NOT MATCH THE COMMAND, A "PUMP FAILURE" ALARM WILL BE DISPLAYED AT THE OWS AND THE PUMP WILL BE STOPPED. UPON LOSS OF STATUS, THE PUMP WILL RESTART AFTER THE SYSTEM RESET IS ACTIVATED. PUMPS WILL BE ROTATED EVERY 1000 HOURS (ADJ) TO ENSURE EQUAL RUNTIME.

LOOP PRESSURE CONTROL: WHEN A PUMP STATUS IS VERIFIED, THE PUMP WILL BE MODULATED TO MAINTAIN THE SYSTEM DIFFERENTIAL PRESSURE OF THE PIPING SYSTEM. THE PRESSURE SENSOR WILL BE LOCATED 2/3 THE WAY DOWN THE PIPING SYSTEM.

FILL PRESSURE CONTROL: THE STATUS OF A HOT WATER PRESSURE GUAGE INSTALLED ON THE HOT WATER RETURN LINE ENTERING THE HEAT EXCHANGER WILL BE MONITORED. WHENEVER A LOW FILL PRESSURE CONDITION IS DETECTED, THE PUMPS WILL BE STOPPED AND "LOW FILL PRESSURE" ALARM WILL BE DISPLAYED AT THE OWS.

ADDITIONAL POINTS MONITORED BY THE FMS:

- STEAM PRESSURE (HXSTM-P)
- HOT WATER RETURN TEMPERATURE (HWR-T)

Drawing Title
4-C-2 Heat Exchanger Layout Steam To Glycol Water

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

Sales Engineer	Project Manager	Application Engineer	DRAWN BY	DRAWN DATE	APPROVED BY	APPROVED DATE
Shawn Klein	Josh Strommen	Tyler Minke				

Project Title
VAMC St Cloud - Bldg 4 Upgrade HVAC

Johnson Controls

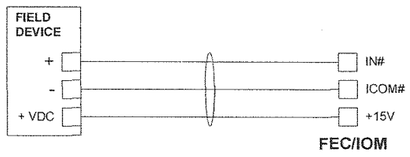
Branch Information
Johnson Controls, Inc.
2605 Frenbrook Lane N.
Plymouth, MN 55447
Phone: 763-566-7650
Fax: 763-566-2208

CONTRACT NUMBER
2082-0141

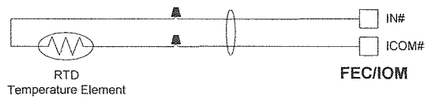
DRAWING NUMBER
2.2.1

Electrician/Fitter	Point Information				Controller Information							Panel Information					Intermediate Device					Field Device							
Tag	Point Type	System Name	Object Name	Expanded ID	Controller Details	Trunk Type	Trunk Nbr	Trunk Addr.	Cable Destination Bay/Terminal	Module Type	Termination Out	Panel	Panel Location	Slot Number	Reference Drawing	Cable Number	Wiring /Tubing	Termination In	Device	Termination Out	Location	Wiring /Tubing	Termination In	Device	Location	Ref Detail Shape	Comment	Template	
		4-C-2			FEC 26xx																						Power to Controller		
		4-C-2			FEC 26xx	MS/TP	1	12						0													BacNet FC Bus		
	UI IN-1	4-C-2	HXSTM-P	Heat Exchanger Steam Pressure	FEC 26xx	MS/TP	1	12	UI IN-1		IN1, ICOM1, +15V			0		-4-UI IN-1						3/22	OUT,COM,EXC	DPT2xxx (Vdc)		F102			
	UI IN-2	4-C-2	HW-DP	Hot Water Diff Pressure	FEC 26xx	MS/TP	1	12	UI IN-2		IN2, ICOM2, +15V			0		-4-UI IN-2						3/22	OUT,COM,EXC	DPT2xxx (Vdc)		F102			
	UI IN-3	4-C-2	HWR-T	Hot Water Return Temp	FEC 26xx	MS/TP	1	12	UI IN-3		IN3, ICOM3			0		-4-UI IN-3						2/22	2-Wire	TE		F131			
	UI IN-4	4-C-2	HWS-T	Hot Water Supply Temp	FEC 26xx	MS/TP	1	12	UI IN-4		IN4, ICOM4			0		-4-UI IN-4						2/22	2-Wire	TE		F131			
	UI IN-5	4-C-2	4-P7-AMPS	Hot Water Pump 7 Amps	FEC 26xx	MS/TP	1	12	UI IN-5		IN5, ICOM5			0		-4-UI IN-5						2/22	See wiring detail	Voltage Input (Self Powered)		F103			
	UI IN-6	4-C-2	4-P8-AMPS	Hot Water Pump 8 Amps	FEC 26xx	MS/TP	1	12	UI IN-6		IN6, ICOM6			0		-4-UI IN-6						2/22	See wiring detail	Voltage Input (Self Powered)		F103			
	BI IN-7	4-C-2	4-P7-S	Hot Water Pump 7 Status	FEC 26xx	MS/TP	1	12	BI IN-7		IN7, ICOM7			0		-4-BI IN-7	2/22	OUT, COM	Current Relay	Motor Lead		Motor Lead	See wiring detail	Motor Status (Contact)		F301			
	BI IN-8	4-C-2	4-P8-S	Hot Water Pump 8 Status	FEC 26xx	MS/TP	1	12	BI IN-8		IN8, ICOM8			0		-4-BI IN-8	2/22	OUT, COM	Current Relay	Motor Lead		Motor Lead	See wiring detail	Motor Status (Contact)		F301			
	BO OUT-1	4-C-2	4-P7-C	Hot Water Pump 7 Command	FEC 26xx	MS/TP	1	12	BO OUT-1		OUT1, 24V COM			0		-4-BO OUT-1	2/22	COIL-,COIL+	Relay	COM, NO		2/14	See wiring detail	VFD (w/o Safety w/Byp) (Sw H9, EXT)		F1047			
	BO OUT-2	4-C-2	4-P8-C	Hot Water Pump 8 Command	FEC 26xx	MS/TP	1	12	BO OUT-2		OUT2, 24V COM			0		-4-BO OUT-2	2/22	COIL-,COIL+	Relay	COM, NO		2/14	See wiring detail	VFD (w/o Safety w/Byp) (Sw H9, EXT)		F1047			
	BO OUT-3	4-C-2			FEC 26xx	MS/TP	1	12	BO OUT-3					0		-4-BO OUT-3													
	CO OUT-4	4-C-2	HX2V1-O	Heat Exchanger 2 Valve 1 Output	FEC 26xx	MS/TP	1	12	CO OUT-4		OUT4, OCOM4,24V HOT			0		-4-CO OUT-4						3/18	Red, White, Yellow	VA-4233 (Vdc)		F287			
	CO OUT-5	4-C-2			FEC 26xx	MS/TP	1	12	CO OUT-5					0		-4-CO OUT-5													
	CO OUT-6	4-C-2			FEC 26xx	MS/TP	1	12	CO OUT-6					0		-4-CO OUT-6													
	CO OUT-7	4-C-2			FEC 26xx	MS/TP	1	12	CO OUT-7					0		-4-CO OUT-7													
	AO OUT-8	4-C-2	4-P7-O	Hot Water Pump 7 Output	FEC 26xx	MS/TP	1	12	AO OUT-8		OUT8, OCOM8			0		-4-AO OUT-8						2/22	See VFD Detail	VFD Speed Control (Vdc)		F1047			
	AO OUT-9	4-C-2	4-P8-O	Hot Water Pump 8 Output	FEC 26xx	MS/TP	1	12	AO OUT-9		OUT9, OCOM9			0		-4-AO OUT-9						2/22	See VFD Detail	VFD Speed Control (Vdc)		F1047			
		4-C-2			IOM 2710																						Power to Controller		
		4-C-2			IOM 2710	SA Bus	1	4						0													BacNet SA Bus		1,0
	UI IN-1	4-C-2	HW-P	Hot Water Pressure	IOM 2710	SA Bus	1	4	UI IN-1		IN1, ICOM1, +15V			0		4--4-UI IN-1						3/22	OUT,COM,EXC	DPT2xxx (Vdc)		F102			
	UI IN-2	4-C-2			IOM 2710	SA Bus	1	4	UI IN-2					0		4--4-UI IN-2													
	RO OUT-1	4-C-2			IOM 2710	SA Bus	1	4	RO OUT-1					0		4--4-RO OUT-1													
	RO OUT-2	4-C-2			IOM 2710	SA Bus	1	4	RO OUT-2					0		4--4-RO OUT-2													
	UO OUT-3	4-C-2			IOM 2710	SA Bus	1	4	UO OUT-3					0		4--4-UO OUT-3													
	UO OUT-4	4-C-2			IOM 2710	SA Bus	1	4	UO OUT-4					0		4--4-UO OUT-4													

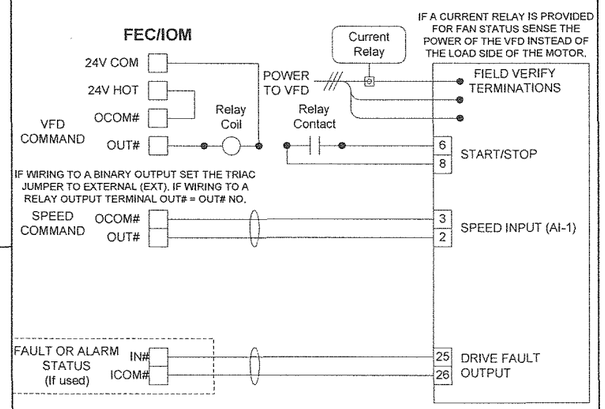
DETAIL F102 VOLTAGE INPUT - INTERNAL SOURCE



DETAIL F131 TEMPERATURE SENSOR INPUT

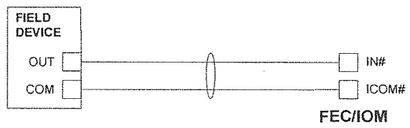


DETAIL F1047 VFD Bypass without Safeties Wiring

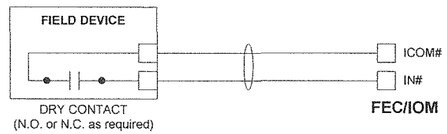


Variable Speed Enclosed IntelliPass/IntelliDisconnect Drives

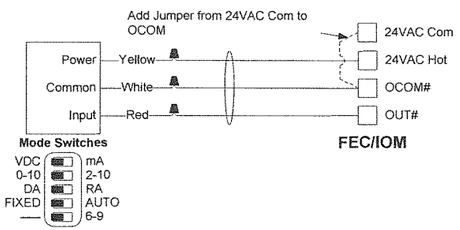
DETAIL F103 VOLTAGE INPUT (Self Powered)



DETAIL F301 BINARY INPUT (DRY CONTACT)



DETAIL F287 0-10VDC OUTPUT to VA-4233



Drawing Title
4-C-2 Wiring Details

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

Sales Engineer	Project Manager	Application Engineer	DRAWN BY	DRAWN DATE	APPROVED BY	APPROVED DATE
Shawn Klein	Josh Strommen	Tyler Minke				

Project Title
VAMC St Cloud - Bldg 4 Upgrade HVAC

Johnson Controls

Branch Information
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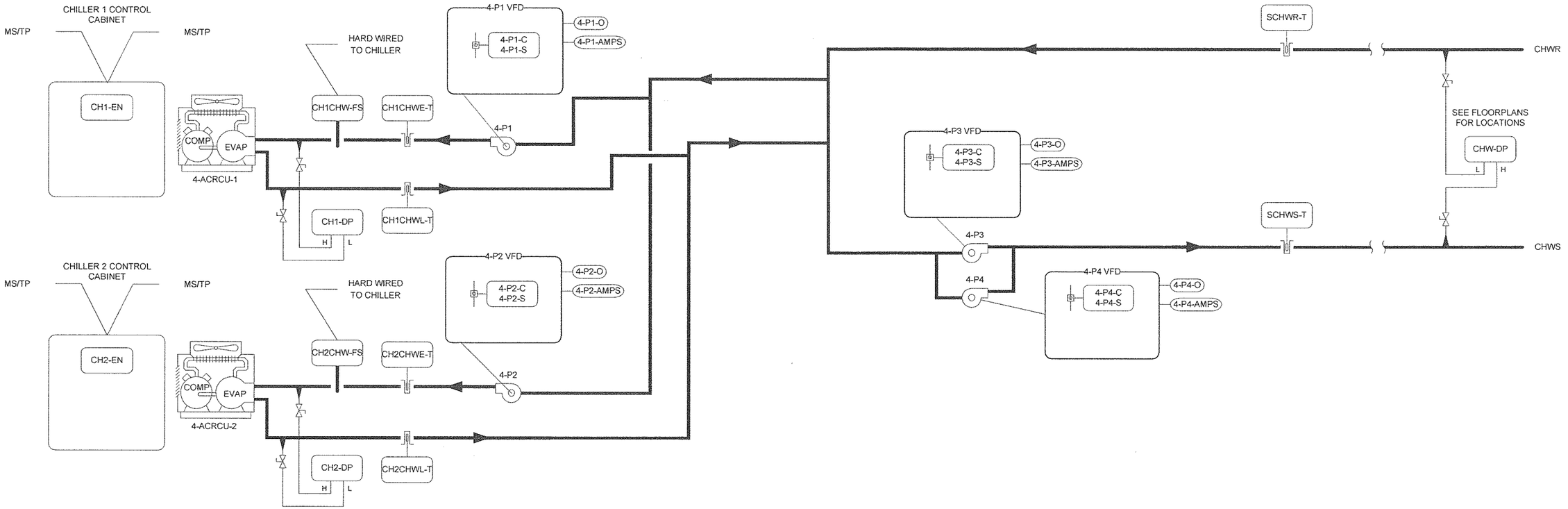
2605 Fernbrook Lane N.
Plymouth, MN 55447
Phone: 763-566-7650
Fax: 763-566-2208

CONTRACT NUMBER
2082-0141

DRAWING NUMBER
2.2.3



Drawing Title

CHWS Chiller Layout

Project Title

VAMC St Cloud - Bldg 4 Upgrade HVAC

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

Sales Engineer	Project Manager	Application Engineer	DRAWN		APPROVED	
Shawn Klein	Josh Strommen	Tyler Minke	BY	DATE	BY	DATE

Johnson Controls

Branch Information
Johnson Controls, Inc.
2605 Frenbrook Lane N.
Plymouth, MN 55447
Phone: 763-566-7650
Fax: 763-566-2208

CONTRACT NUMBER

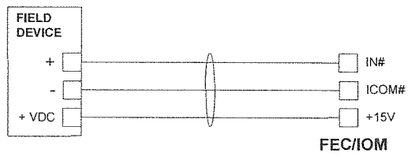
2082-0141

DRAWING NUMBER

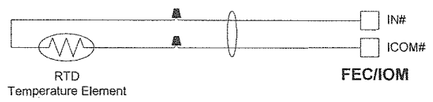
3.1.1

Electrician/Fitter	Point Information				Controller Information							Panel Information					Intermediate Device					Field Device							
Tag	Point Type	System Name	ObjectName	Expanded ID	Controller Details	Trunk Type	Trunk Nbr	Trunk Addr.	Cable Destination Bay/Terminal	Module Type	Termination Out	Panel	Panel Location	Slot Number	Reference Drawing	Cable Number	Wiring /Tubing	Termination In	Device	Termination Out	Location	Wiring /Tubing	Termination In	Device	Location	Ref Detail Shape	Comment	Template	
		CHWS			FEC 26xx									0													Power to Controller		
		CHWS			FEC 26xx	MS/TP	1	13						0													BacNet FC Bus		
	UI IN-1	CHWS	CH1-DP	Chiller 1 Differential Pressure	FEC 26xx	MS/TP	1	13	UI IN-1		IN1, ICOM1, +15V			0		-4-UI IN-1						3/22	OUT,COM,EXC	DPT2xxx (Vdc)		F102			
	UI IN-2	CHWS	CH2-DP	Chiller 2 Differential Pressure	FEC 26xx	MS/TP	1	13	UI IN-2		IN2, ICOM2, +15V			0		-4-UI IN-2						3/22	OUT,COM,EXC	DPT2xxx (Vdc)		F102			
	UI IN-3	CHWS	CHW-DP	Chilled Water Differential Pressure	FEC 26xx	MS/TP	1	13	UI IN-3		IN3, ICOM3, +15V			0		-4-UI IN-3						3/22	OUT,COM,EXC	DPT2xxx (Vdc)		F102			
	UI IN-4	CHWS	SCHWR-T	Secondary Chilled Water Return Temp	FEC 26xx	MS/TP	1	13	UI IN-4		IN4, ICOM4			0		-4-UI IN-4						2/22	2-Wire	TE		F131			
	UI IN-5	CHWS	SCHWS-T	Secondary Chilled Water Supply Temp	FEC 26xx	MS/TP	1	13	UI IN-5		IN5, ICOM5			0		-4-UI IN-5						2/22	2-Wire	TE		F131			
	UI IN-6	CHWS			FEC 26xx	MS/TP	1	13	UI IN-6					0		-4-UI IN-6													
	BI IN-7	CHWS			FEC 26xx	MS/TP	1	13	BI IN-7					0		-4-BI IN-7													
	BI IN-8	CHWS			FEC 26xx	MS/TP	1	13	BI IN-8					0		-4-BI IN-8													
	BO OUT-1	CHWS	CH1-EN	Chiller 1 Enable	FEC 26xx	MS/TP	1	13	BO OUT-1		OUT1, 24V COM			0		-4-BO OUT-1	2/22	COIL-,COIL+	Relay	COM, NO		2/14	See wiring detail	Chiller Control Panel (Sw Hi, EXT Src)		F1002			
	BO OUT-2	CHWS	CH2-EN	Chiller 2 Enable	FEC 26xx	MS/TP	1	13	BO OUT-2		OUT2, 24V COM			0		-4-BO OUT-2	2/22	COIL-,COIL+	Relay	COM, NO		2/14	See wiring detail	Chiller Control Panel (Sw Hi, EXT Src)		F1002			
	BO OUT-3	CHWS			FEC 26xx	MS/TP	1	13	BO OUT-3					0		-4-BO OUT-3													
	CO OUT-4	CHWS			FEC 26xx	MS/TP	1	13	CO OUT-4					0		-4-CO OUT-4													
	CO OUT-5	CHWS			FEC 26xx	MS/TP	1	13	CO OUT-5					0		-4-CO OUT-5													
	CO OUT-6	CHWS			FEC 26xx	MS/TP	1	13	CO OUT-6					0		-4-CO OUT-6													
	CO OUT-7	CHWS			FEC 26xx	MS/TP	1	13	CO OUT-7					0		-4-CO OUT-7													
	AO OUT-8	CHWS			FEC 26xx	MS/TP	1	13	AO OUT-8					0		-4-AO OUT-8													
	AO OUT-9	CHWS			FEC 26xx	MS/TP	1	13	AO OUT-9					0		-4-AO OUT-9													
		CHWS			IOM 4710																						Power to Controller		
		CHWS			IOM 4710	SA Bus	1	4						0													BacNet SA Bus		2,0
	UI IN-1	CHWS	4-P1-AMPS	Secondary Chilled Water Pump 1 Amps	IOM 4710	SA Bus	1	4	UI IN-1		IN1, ICOM1			0		4--4-UI IN-1						2/22	See wiring detail	Voltage Input (Self Powered)		F103			
	UI IN-2	CHWS	4-P2-AMPS	Secondary Chilled Water Pump 2 Amps	IOM 4710	SA Bus	1	4	UI IN-2		IN2, ICOM2			0		4--4-UI IN-2						2/22	See wiring detail	Voltage Input (Self Powered)		F103			
	UI IN-3	CHWS	4-P3-AMPS	Secondary Chilled Water Pump 3 Amps	IOM 4710	SA Bus	1	4	UI IN-3		IN3, ICOM3			0		4--4-UI IN-3						2/22	See wiring detail	Voltage Input (Self Powered)		F103			
	UI IN-4	CHWS	4-P4-AMPS	Secondary Chilled Water Pump 4 Amps	IOM 4710	SA Bus	1	4	UI IN-4		IN4, ICOM4			0		4--4-UI IN-4						2/22	See wiring detail	Voltage Input (Self Powered)		F103			
	UI IN-5	CHWS	4-P1-S	Secondary Chilled Water Pump 1 Status	IOM 4710	SA Bus	1	4	UI IN-5		IN5, ICOM5			0		4--4-UI IN-5	2/22	OUT, COM	Current Relay	Motor Lead		Motor Lead	See wiring detail	Motor Status (Contact)		F301			
	UI IN-6	CHWS	4-P2-S	Secondary Chilled Water Pump 2 Status	IOM 4710	SA Bus	1	4	UI IN-6		IN6, ICOM6			0		4--4-UI IN-6	2/22	OUT, COM	Current Relay	Motor Lead		Motor Lead	See wiring detail	Motor Status (Contact)		F301			
	BI IN-7	CHWS	4-P3-S	Secondary Chilled Water Pump 3 Status	IOM 4710	SA Bus	1	4	BI IN-7		IN7, ICOM7			0		4--4-BI IN-7	2/22	OUT, COM	Current Relay	Motor Lead		Motor Lead	See wiring detail	Motor Status (Contact)		F301			
	BI IN-8	CHWS	4-P4-S	Secondary Chilled Water Pump 4 Status	IOM 4710	SA Bus	1	4	BI IN-8		IN8, ICOM8			0		4--4-BI IN-8	2/22	OUT, COM	Current Relay	Motor Lead		Motor Lead	See wiring detail	Motor Status (Contact)		F301			
	BO OUT-1	CHWS	4-P1-C	Secondary Chilled Water Pump 1 Command	IOM 4710	SA Bus	1	4	BO OUT-1		OUT1, 24V COM			0		4--4-BO OUT-1	2/22	COIL-,COIL+	Relay	COM, NO		2/14	See wiring detail	VFD (w/o Safety w/Byp) (Sw Hi, EXT)		F1047			
	BO OUT-2	CHWS	4-P2-C	Secondary Chilled Water Pump 2 Command	IOM 4710	SA Bus	1	4	BO OUT-2		OUT2, 24V COM			0		4--4-BO OUT-2	2/22	COIL-,COIL+	Relay	COM, NO		2/14	See wiring detail	VFD (w/o Safety w/Byp) (Sw Hi, EXT)		F1047			
	BO OUT-3	CHWS	4-P3-C	Secondary Chilled Water Pump 3 Command	IOM 4710	SA Bus	1	4	BO OUT-3		OUT3, 24V COM			0		4--4-BO OUT-3	2/22	COIL-,COIL+	Relay	COM, NO		2/14	See wiring detail	VFD (w/o Safety w/Byp) (Sw Hi, EXT)		F1047			
	CO OUT-4	CHWS	4-P4-C	Secondary Chilled Water Pump 4 Command	IOM 4710	SA Bus	1	4	CO OUT-4		OUT4, 24V COM			0		4--4-CO OUT-4	2/22	COIL-,COIL+	Relay	COM, NO		2/14	See wiring detail	VFD (w/o Safety w/Byp) (Sw Hi, EXT)		F1047			
	CO OUT-5	CHWS			IOM 4710	SA Bus	1	4	CO OUT-5					0		4--4-CO OUT-5													
	CO OUT-6	CHWS	4-P1-O	Secondary Chilled Water Pump 1 Output	IOM 4710	SA Bus	1	4	CO OUT-6		OUT6, OCOM6			0		4--4-CO OUT-6						2/22	See VFD Detail	VFD Speed Control (Vdc)		F1047			
	CO OUT-7	CHWS	4-P2-O	Secondary Chilled Water Pump 2 Output	IOM 4710	SA Bus	1	4	CO OUT-7		OUT7, OCOM7			0		4--4-CO OUT-7						2/22	See VFD Detail	VFD Speed Control (Vdc)		F1047			
	AO OUT-8	CHWS	4-P3-O	Secondary Chilled Water Pump 3 Output	IOM 4710	SA Bus	1	4	AO OUT-8		OUT8, OCOM8			0		4--4-AO OUT-8						2/22	See VFD Detail	VFD Speed Control (Vdc)		F1047			
	AO OUT-9	CHWS	4-P4-O	Secondary Chilled Water Pump 4 Output	IOM 4710	SA Bus	1	4	AO OUT-9		OUT9, OCOM9			0		4--4-AO OUT-9						2/22	See VFD Detail	VFD Speed Control (Vdc)		F1047			
		CHWS			IOM 4710																						Power to Controller		
		CHWS			IOM 4710	SA Bus	1	5						0													BacNet SA Bus		2,0
	UI IN-1	CHWS	CH1CHWE-T	Chiller 1 Chilled Water Entering Temperature	IOM 4710	SA Bus	1	5	UI IN-1		IN1, ICOM1			0		4--5-UI IN-1						2/22	2-Wire	TE		F131			
	UI IN-2	CHWS	CH1CHWL-T	Chiller 1 Chilled Water Leaving Temperature	IOM 4710	SA Bus	1	5	UI IN-2		IN2, ICOM2			0		4--5-UI IN-2						2/22	2-Wire	TE		F131			
	UI IN-3	CHWS	CH2CHWE-T	Chiller 2 Chilled Water Entering Temperature	IOM 4710	SA Bus	1	5	UI IN-3		IN3, ICOM3			0		4--5-UI IN-3						2/22	2-Wire	TE		F131			
	UI IN-4	CHWS	CH2CHWL-T	Chiller 2 Chilled Water Leaving Temperature	IOM 4710	SA Bus	1	5	UI IN-4		IN4, ICOM4			0		4--5-UI IN-4						2/22	2-Wire	TE		F131			
	UI IN-5	CHWS			IOM 4710	SA Bus	1	5	UI IN-5					0		4--5-UI IN-5													
	UI IN-6	CHWS			IOM 4710	SA Bus	1	5	UI IN-6					0		4--5-UI IN-6													
	BI IN-7	CHWS			IOM 4710	SA Bus	1	5	BI IN-7					0		4--5-BI IN-7													
	BI IN-8	CHWS			IOM 4710	SA Bus	1	5	BI IN-8					0		4--5-BI IN-8													
	BO OUT-1	CHWS			IOM 4710	SA Bus	1	5	BO OUT-1					0		4--5-BO OUT-1													
	BO OUT-2	CHWS			IOM 4710	SA Bus	1	5	BO OUT-2					0		4--5-BO OUT-2													
	BO OUT-3	CHWS			IOM 4710	SA Bus	1	5	BO OUT-3					0		4--5-BO OUT-3													
	CO OUT-4	CHWS			IOM 4710	SA Bus	1	5	CO OUT-4					0		4--5-CO OUT-4													
	CO OUT-5	CHWS			IOM 4710	SA Bus	1	5	CO OUT-5					0		4--5-CO OUT-5													
	CO OUT-6	CHWS			IOM 4710	SA Bus	1	5	CO OUT-6					0		4--5-CO OUT-6													
	CO OUT-7	CHWS			IOM 4710	SA Bus	1	5	CO OUT-7					0		4--5-CO OUT-7													
	AO OUT-8	CHWS			IOM 4710	SA Bus	1	5	AO OUT-8					0		4--5-AO OUT-8													
	AO OUT-9	CHWS			IOM 4710	SA Bus	1	5	AO OUT-9					0		4--5-AO OUT-9													

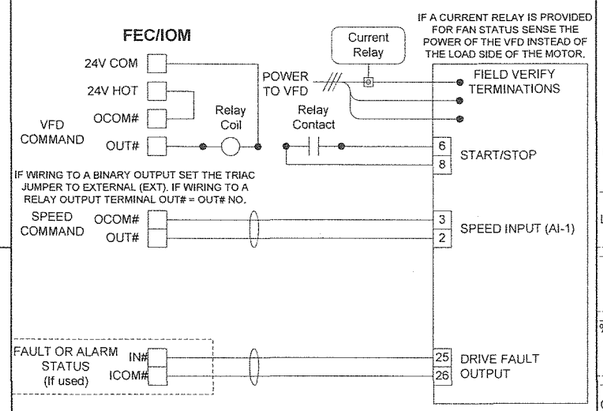
DETAIL F102 VOLTAGE INPUT - INTERNAL SOURCE



DETAIL F131 TEMPERATURE SENSOR INPUT

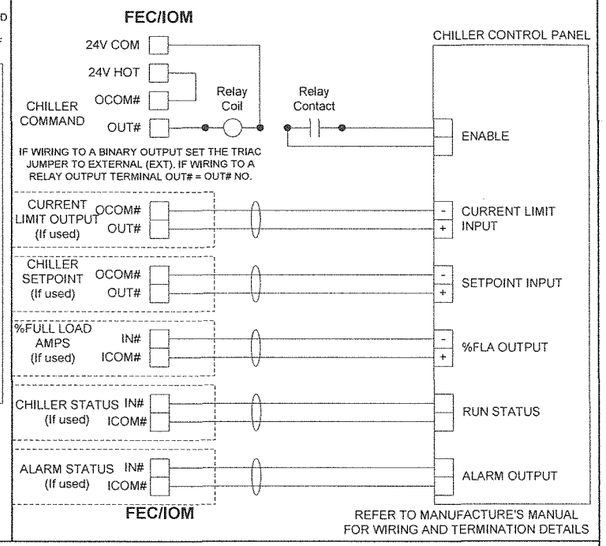


DETAIL F1047 VFD Bypass without Safeties Wiring



Variable Speed Enclosed IntelliPass/IntelliDisconnect Drives

DETAIL F1002 Chiller Control Wiring Detail



DETAIL F103 VOLTAGE INPUT (Self Powered)

DETAIL F301 BINARY INPUT (DRY CONTACT)

Drawing Title
CHWS Wiring Details

Project Title
VAMC St Cloud - Bldg 4 Upgrade HVAC

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

Sales Engineer	Project Manager	Application Engineer	DRAWN BY	DRAWN DATE	APPROVED BY	APPROVED DATE
Shawn Klein	Josh Strommen	Tyler Minke				

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Johnson Controls, Inc.
2605 Fenbrook Lane N.
Plymouth, MN 55447
Phone: 763-566-7650
Fax: 763-566-2208

CONTRACT NUMBER
2082-0141

DRAWING NUMBER
3.1.3

SYSTEM ENABLE: THE COOLING SYSTEM WILL AUTOMATICALLY START WHEN THE OUTSIDE AIR TEMPERATURE RISES ABOVE THE SYSTEM ENABLE SETPOINT OF 55 DEGREES F (ADJ) WHILE THE SYSTEM ENABLE IS "ON" DURING OCCUPIED HOURS. WHEN THE OUTSIDE AIR TEMPERATURE FALLS BELOW THIS SETPOINT OR THE SYSTEM ENABLE IS "OFF", THE COOLING SYSTEM WILL BE DISABLED.

CHILLER CONTROL: THIS SYSTEM CONSISTS OF TWO CHILLERS. THE CHILLERS WILL BE CONTROLLED VIA THEIR OWN INTERNAL CONTROLS TO MAINTAIN A CHILLED WATER SUPPLY TEMPERATURE OF 45 DEGREES F (ADJ). WHEN A CHILLER IS REQUIRED, THE CHILLER WITH THE LOWEST RUNTIME TOTAL WILL BE ENABLED TO RUN. A COMMAND FROM THE FMS MAY DISABLE EACH CHILLER.

CHILLED WATER PUMP CONTROL: WHEN ENABLED, THE PUMP ASSOCIATED WITH EACH CHILLER WILL BE STARTED. THE VARIABLE FREQUENCY DRIVE WILL BE MODULATED TO MAINTAIN A DIFFERENTIAL PRESSURE SETPOINT ACROSS THE CHILLER AS DETERMINED BY THE CHILLER MANUFACTURER. IF THE PUMP STATUS DOES NOT MATCH THE COMMAND OR THE PUMP AMPS EXCEED NORMAL LIMITS A "CHILLER PUMP FAILURE" ALARM WILL BE DISPLAYED AT THE OWS AND THE CHILLER WILL BE STOPPED. UPON LOSS OF STATUS, THE PUMP WILL RESTART AFTER THE SYSTEM RESET IS ACTIVATED. AFTER THE CHILLER IS COMMANDED OFF, THE PUMP WILL CONTINUE TO RUN FOR 5 MINUTES (ADJ) TO ALLOW THE EQUIPMENT TO COAST DOWN.

FLOW SWITCH: A FLOW SWITCH WILL BE PROVIDED AND HARD WIRED TO THE CHILLER CONTROLLER FOR ITS OWN PROOF OF FLOW SIGNAL.

SECONDARY LOOP PUMPING: WHEN THE SYSTEM IS ENABLED, THE PUMP WITH THE LOWEST RUNTIME TOTAL WILL BE STARTED. WHEN A PUMP STATUS IS VERIFIED, THE PUMP WILL BE MODULATED TO MAINTAIN THE SYSTEM DIFFERENTIAL PRESSURE OF THE PIPING SYSTEM. THE PRESSURE SENSOR WILL BE LOCATED 2/3 THE WAY DOWN THE PIPING SYSTEM. IF THE PUMP SPEED EXCEEDS 85% (ADJ), THE LAG PUMP WILL BE ENABLED TO RUN. IF THE SPEED OF THE PUMPS DROPS BELOW 35% (ADJ), THE LAG PUMP WILL BE DISABLED. IF THE PUMP STATUS DOES NOT MATCH THE COMMAND OR THE PUMP AMPS EXCEED NORMAL LIMITS A "COOLING PUMP FAILURE" ALARM WILL BE DISPLAYED AT THE OWS AND THE PUMP WILL BE STOPPED. UPON LOSS OF STATUS, THE PUMP WILL RESTART AFTER THE SYSTEM RESET IS ACTIVATED. PUMPS WILL BE ROTATED EVERY 1000 HOURS (ADJ) TO ENSURE EQUAL RUNTIME.

ADDITIONAL POINTS MONITORED BY THE FMS:

- CHILLER 1 LEAVING WATER TEMPERATURE (CH1CHWL-T)
- CHILLER 1 ENTERING WATER TEMPERATURE (CH1CHWE-T)
- CHILLER 2 LEAVING WATER TEMPERATURE (CH2CHWL-T)
- CHILLER 2 ENTERING WATER TEMPERATURE (CH2CHWE-T)
- SECONDARY SUPPLY TEMPERATURE (SCHWS-T)
- SECONDARY RETURN TEMPERATURE (SCHWR-T)

ADDITIONAL POINTS MONITORED BY THE FMS VIA BACNET MS/TP INTEGRATION:

- CHILLER ENABLE
- CHILLER STATUS
- COMPRESSOR STATUS (FOR EACH COMPRESSOR)
- CHILLED WATER SETPOINT
- CHILLED WATER SUPPLY TEMPERATURE (FOR EACH CHILLER)
- CHILLED WATER RETURN TEMPERATURE (FOR EACH CHILLER)

Drawing Title
CHWS Chiller Sequence of Operations

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

Sales Engineer	Project Manager	Application Engineer	DRAWN BY	DRAWN DATE	APPROVED BY	APPROVED DATE
Shawn Klein	Josh Strommen	Tyler Minke				

Project Title
VAMC St Cloud - Bldg 4 Upgrade HVAC

Johnson Controls

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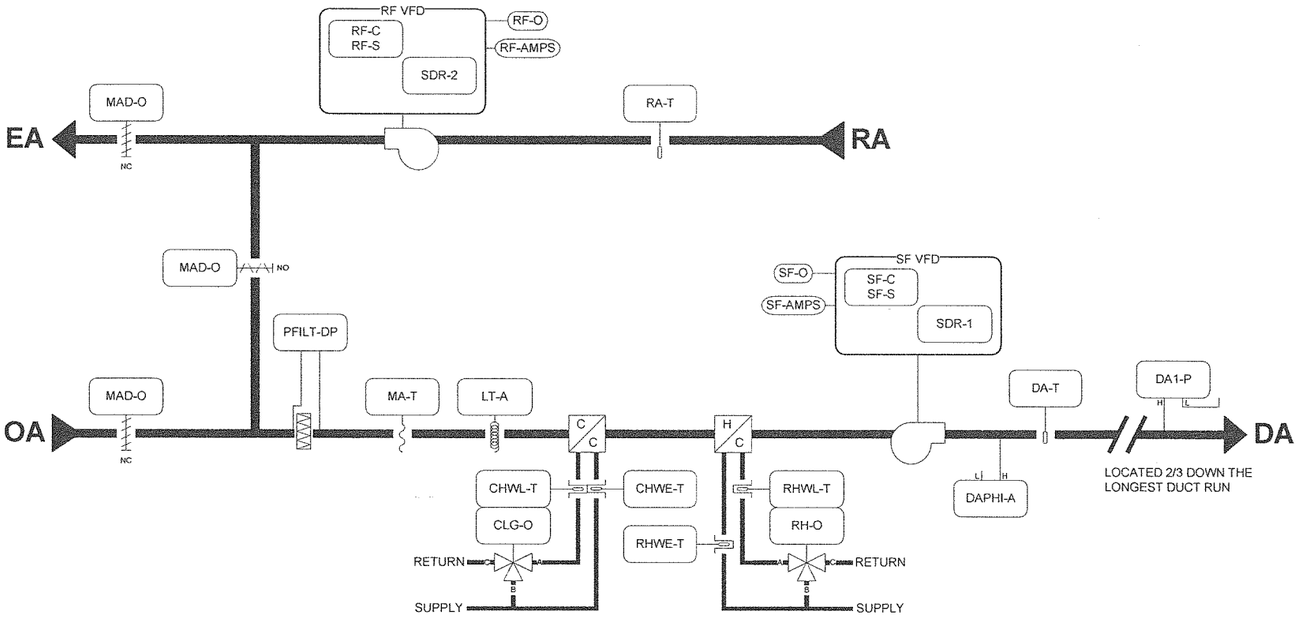
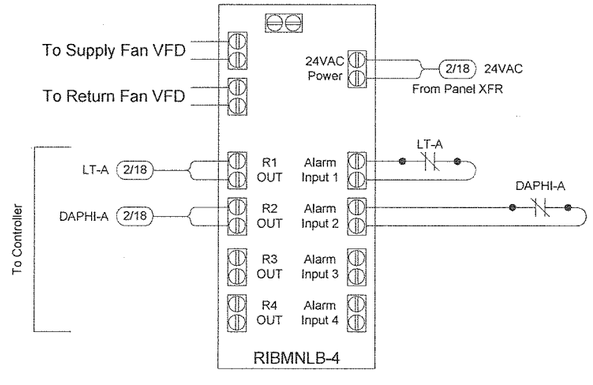
CONTRACT NUMBER
2082-0141

DRAWING NUMBER
3.1.4



Safety Shutdown Relay Coil Wiring Detail



SUPPLY FAN CONTROL: THE VARIABLE SPEED SUPPLY FAN WILL BE STARTED BASED ON OCCUPANCY SCHEDULE. WHEN THE SUPPLY FAN STATUS INDICATES THE FAN STARTED, THE CONTROL SEQUENCE WILL BE ENABLED. THE SUPPLY FAN WILL MODULATE TO MAINTAIN THE DISCHARGE STATIC PRESSURE AT SETPOINT. THE DISCHARGE AIR STATIC PRESSURE SETPOINT WILL RESET FROM 0.8 IN WC TO 1.5 IN WC BASED ON VAV DAMPER POSITION. THE DDC WILL MONITOR THE VAV DAMPER POSITIONS. IF ANY ASSOCIATED VAV BOX DAMPER IS ABOVE 95%, THE DISCHARGE STATIC SETPOINT WILL INCREASE AT A RATE OF 0.05 IN WC PER MINUTE (ADJ) UNTIL ALL VAV BOX DAMPERS ARE BELOW 95% OR THE DISCHARGE AIR STATIC SETPOINT MAXIMUM HAS BEEN REACHED. IF ALL ASSOCIATED VAV BOX DAMPERS ARE BELOW 85%, THE DISCHARGE AIR STATIC SETPOINT WILL DECREASE AT A RATE OF 0.05 IN WC PER MINUTE (ADJ) UNTIL ANY VAV BOX DAMPER IS ABOVE 85% OR THE DISCHARGE AIR STATIC SETPOINT MINIMUM HAS BEEN REACHED. UPON A LOSS OF AIRFLOW, THE SYSTEM WILL AUTOMATICALLY RESTART. IF THE FAN AMPS EXCEED NORMAL LIMITS A "SUPPLY FAN FAILURE" ALARM WILL BE DISPLAYED AT THE OWS.

RETURN FAN CONTROL: AFTER THE SUPPLY FAN HAS BEEN STARTED, THE VARIABLE SPEED RETURN FAN WILL BE STARTED. THE RETURN FAN WILL MODULATE IN CONJUNCTION WITH THE SUPPLY FAN. THE RETURN FAN WILL LAG THE SUPPLY FAN BY A PERCENTAGE DIFFERENTIAL. IF THE FAN AMPS EXCEED NORMAL LIMITS A "RETURN FAN FAILURE" ALARM WILL BE DISPLAYED AT THE OWS.

ECONOMIZER CONTROL: WHEN THE OUTDOOR AIR IS COOLER THAN THE ECONOMIZER SETPOINT OF 65 DEGREES F (ADJ), THE ECONOMIZER WILL ACT AS THE INITIAL STAGE OF COOLING, WORKING IN SEQUENCE WITH THE COOLING COIL.

MINIMUM OA CONTROL: THE FRESH AIR INTAKE OF THE UNIT WILL BE LIMITED TO PREVENT THE MIXED AIR TEMPERATURE FROM FALLING BELOW THE LOW LIMIT SETPOINT OF 45 DEGREES F (ADJ).

TEMPERATURE CONTROL: THE UNIT WILL CONTROL TO MAINTAIN A CONSTANT DISCHARGE AIR TEMPERATURE OF 55 DEGREES F (ADJ).

OCCUPIED MODE: THE OCCUPANCY MODE WILL BE CONTROLLED VIA A NETWORK INPUT. THE OCCUPANCY MODE CAN ALSO BE OVERRIDDEN BY A NETWORK INPUT.

UNOCCUPIED MODE: THE UNIT WILL CYCLE TO MAINTAIN UNOCCUPIED ZONE SETPOINTS DURING UNOCCUPIED PERIODS.

COOLING COIL: THE COOLING COIL WILL MODULATE TO MAINTAIN THE TEMPERATURE SETPOINT. WHEN THE UNIT IS SHUTDOWN, THE COOLING COIL WILL BE OFF. UPON A LOSS OF AIRFLOW, THE COOLING COIL WILL BE OFF.

REHEAT COIL: THE REHEAT COIL WILL MODULATE TO MAINTAIN THE TEMPERATURE SETPOINT. WHEN THE UNIT IS SHUTDOWN, THE REHEAT COIL WILL REMAIN IN CONTROL. UPON A LOSS OF AIRFLOW, THE REHEAT COIL WILL REMAIN IN CONTROL.

POWER FAIL RESTART: UPON POWER RESTORATION, THE UNIT RESTART SHALL BE DELAYED.

FILTER STATUS: THE DIFFERENTIAL PRESSURE ACROSS THE FILTER WILL BE MONITORED. WHENEVER A DIRTY FILTER CONDITION IS DETECTED, A "DIRTY FILTER" ALARM WILL BE DISPLAYED AT THE OWS.

HIGH STATIC PRESSURE SHUTDOWN: THE STATUS OF THE HIGH STATIC PRESSURE SWITCH INSTALLED ON THE DISCHARGE SIDE OF THE FAN WILL BE MONITORED. WHENEVER A HIGH STATIC CONDITION IS DETECTED, A "HIGH STATIC PRESSURE SHUTDOWN" ALARM WILL BE DISPLAYED AT THE OWS.

ADDITIONAL POINTS MONITORED BY THE FMS:

- CHILLED WATER ENTERING TEMPERATURE (CHEW-T)
- CHILLED WATER LEAVING TEMPERATURE (CHLW-T)
- REHEAT ENTERING WATER TEMPERATURE (RHEW-T)
- REHEAT LEAVING WATER TEMPERATURE (RHLW-T)
- RETURN FAN STATUS (RF-S)
- RETURN AIR TEMPERATURE (RA-T)
- PREFILTER DIFF PRESSURE (PFILT-DP)
- DISCHARGE AIR HIGH DUCT PRESSURE (DAPHI-A)
- LOW TEMPERATURE ALARM (LT-A)

Drawing Title
4-AHU-1 & 2 Flow Layout Typical Of 2

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

Sales Engineer	Project Manager	Application Engineer	DRAWN		APPROVED	
Shawn Klein	Josh Strommen	Tyler Minke	BY	DATE	BY	DATE

Project Title
VAMC St Cloud - Bldg 4 Upgrade HVAC

Johnson Controls

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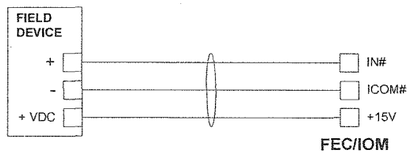
CONTRACT NUMBER
2082-0141

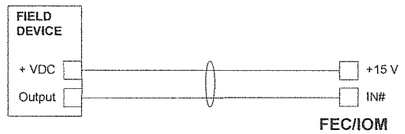
DRAWING NUMBER
4.1.1

Electrician/Fitter	Point Information				Controller Information							Panel Information					Intermediate Device					Field Device							
Tag	Point Type	System Name	Object Name	Expanded ID	Controller Details	Trunk Type	Trunk Nbr	Trunk Addr.	Cable Destination Bay/Terminal	Module Type	Termination Out	Panel	Panel Location	Slot Number	Reference Drawing	Cable Number	Wiring /Tubing	Termination In	Device	Termination Out	Location	Wiring /Tubing	Termination In	Device	Location	Ref Detail Shape	Comment	Template	
		4-AHU-1 & 2			FEC 26xx																						Power to Controller		
		4-AHU-1 & 2			FEC 26xx	MS/TP	1	14						0													BacNet FC Bus		
	UI IN-1	4-AHU-1 & 2	PFILT-DP	PreFilter Diff Pressure	FEC 26xx	MS/TP	1	14	UI IN-1		IN1, ICOM1, +15V			0		-4-UI IN-1						3/22	OUT,COM,EXC	DPT2xxx (Vdc)		F102			
	UI IN-2	4-AHU-1 & 2	DA-T	Discharge Air Temperature	FEC 26xx	MS/TP	1	14	UI IN-2		IN2, ICOM2			0		-4-UI IN-2						2/22	2-Wire	TE		F131			
	UI IN-3	4-AHU-1 & 2	CHWL-T	Chilled Water Leaving Temperature	FEC 26xx	MS/TP	1	14	UI IN-3		IN3, ICOM3			0		-4-UI IN-3						2/22	2-Wire	TE		F131			
	UI IN-4	4-AHU-1 & 2	RF-S	Return Fan Status	FEC 26xx	MS/TP	1	14	UI IN-4		IN4, ICOM4			0		-4-UI IN-4	2/22	OUT, COM	Current Relay	Motor Lead		Motor Lead	See wiring detail	Motor Status (Contact)		F301			
	UI IN-5	4-AHU-1 & 2	MA-T	Mixed Air Temperature	FEC 26xx	MS/TP	1	14	UI IN-5		IN5, ICOM5			0		-4-UI IN-5						2/22	2-Wire	TE		F131			
	UI IN-6	4-AHU-1 & 2	CHWE-T	Chilled Water Entering Temperature	FEC 26xx	MS/TP	1	14	UI IN-6		IN6, ICOM6			0		-4-UI IN-6						2/22	2-Wire	TE		F131			
	BI IN-7	4-AHU-1 & 2	LT-A	Low Temperature Alarm	FEC 26xx	MS/TP	1	14	BI IN-7		IN7, ICOM7			0		-4-BI IN-7						2/22 / 2/22 (Unit Shutdown)	LINE, M1, (LINE,M2)	A70 (NO)		F302			
	BI IN-8	4-AHU-1 & 2	SF-S	Supply Fan Status	FEC 26xx	MS/TP	1	14	BI IN-8		IN8, ICOM8			0		-4-BI IN-8	2/22	OUT, COM	Current Relay	Motor Lead		Motor Lead	See wiring detail	Motor Status (Contact)		F301			
	BO OUT-1	4-AHU-1 & 2	SF-C	Supply Fan Command	FEC 26xx	MS/TP	1	14	BO OUT-1		OUT1, 24V COM			0		-4-BO OUT-1	2/22	COIL-,COIL+	Relay	COM, NO		2/14	See wiring detail	VFD (w/ Safety w/Byp) (Sw Hi, EXT)		F1046			
	BO OUT-2	4-AHU-1 & 2	RF-C	Return Fan Command	FEC 26xx	MS/TP	1	14	BO OUT-2		OUT2, 24V COM			0		-4-BO OUT-2	2/22	COIL-,COIL+	Relay	COM, NO		2/14	See wiring detail	VFD (w/ Safety w/Byp) (Sw Hi, EXT)		F1046			
	BO OUT-3	4-AHU-1 & 2			FEC 26xx	MS/TP	1	14	BO OUT-3					0		-4-BO OUT-3													
	CO OUT-4	4-AHU-1 & 2	MAD-O	Mixed Air Damper Output	FEC 26xx	MS/TP	1	14	CO OUT-4		OUT4, OCOM4,24VAC, COM			0		-4-CO OUT-4						2/22 / 2/18	GRY, BLK/BLK, RED	M92xx-GGx-x (Vdc) (Ext Source)		F267			
	CO OUT-5	4-AHU-1 & 2	CLG-O	Cooling Output	FEC 26xx	MS/TP	1	14	CO OUT-5		OUT5, OCOM5,24VAC, COM			0		-4-CO OUT-5						2/22 / 2/18	GRY, BLK/BLK, RED	M92xx-GGx-x (Vdc) (Ext Source)		F267			
	CO OUT-6	4-AHU-1 & 2	RH-O	Reheat Output	FEC 26xx	MS/TP	1	14	CO OUT-6		OUT6, OCOM6,24VAC, COM			0		-4-CO OUT-6						2/22 / 2/18	GRY, BLK/BLK, RED	M92xx-GGx-x (Vdc) (Ext Source)		F267			
	CO OUT-7	4-AHU-1 & 2			FEC 26xx	MS/TP	1	14	CO OUT-7					0		-4-CO OUT-7													
	AO OUT-8	4-AHU-1 & 2	SF-O	Supply Fan Output	FEC 26xx	MS/TP	1	14	AO OUT-8		OUT8, OCOM8			0		-4-AO OUT-8						2/22	See VFD Detail	VFD Speed Control (Vdc)		F1046			
	AO OUT-9	4-AHU-1 & 2	RF-O	Return Fan Output	FEC 26xx	MS/TP	1	14	AO OUT-9		OUT9, OCOM9			0		-4-AO OUT-9						2/22	See VFD Detail	VFD Speed Control (Vdc)		F1046			
		4-AHU-1 & 2			IOM 4710																						Power to Controller		
		4-AHU-1 & 2			IOM 4710	SA Bus	1	4						0													BacNet SA Bus		2.1
	UI IN-1	4-AHU-1 & 2	RA-T	Return Air Temperature	IOM 4710	SA Bus	1	4	UI IN-1		IN1, ICOM1			0		4--4-UI IN-1						2/22	2-Wire	TE		F131			
	UI IN-2	4-AHU-1 & 2	RHWL-T	Reheat Leaving Water Temperature	IOM 4710	SA Bus	1	4	UI IN-2		IN2, ICOM2			0		4--4-UI IN-2						2/22	2-Wire	TE		F131			
	UI IN-3	4-AHU-1 & 2	DA1-P	Discharge Air Static Pressure 1	IOM 4710	SA Bus	1	4	UI IN-3		IN3, +15V			0		4--4-UI IN-3						2/22	-, +	DPT2xxx (mA)		F106			
	UI IN-4	4-AHU-1 & 2	RHWE-T	Reheat Entering Water Temperature	IOM 4710	SA Bus	1	4	UI IN-4		IN4, ICOM4			0		4--4-UI IN-4						2/22	2-Wire	TE		F131			
	UI IN-5	4-AHU-1 & 2			IOM 4710	SA Bus	1	4	UI IN-5					0		4--4-UI IN-5													
	UI IN-6	4-AHU-1 & 2			IOM 4710	SA Bus	1	4	UI IN-6					0		4--4-UI IN-6													
	BI IN-7	4-AHU-1 & 2			IOM 4710	SA Bus	1	4	BI IN-7					0		4--4-BI IN-7													
	BI IN-8	4-AHU-1 & 2	DAPHI-A	Discharge Air High Duct Pressure	IOM 4710	SA Bus	1	4	BI IN-8		IN8, ICOM8			0		4--4-BI IN-8						2/22 / 2/22 (Unit Shutdown)	See Detail	AFS-450 (NC)		F303			
	BO OUT-1	4-AHU-1 & 2			IOM 4710	SA Bus	1	4	BO OUT-1					0		4--4-BO OUT-1													
	BO OUT-2	4-AHU-1 & 2			IOM 4710	SA Bus	1	4	BO OUT-2					0		4--4-BO OUT-2													
	BO OUT-3	4-AHU-1 & 2			IOM 4710	SA Bus	1	4	BO OUT-3					0		4--4-BO OUT-3													
	CO OUT-4	4-AHU-1 & 2			IOM 4710	SA Bus	1	4	CO OUT-4					0		4--4-CO OUT-4													
	CO OUT-5	4-AHU-1 & 2			IOM 4710	SA Bus	1	4	CO OUT-5					0		4--4-CO OUT-5													
	CO OUT-6	4-AHU-1 & 2			IOM 4710	SA Bus	1	4	CO OUT-6					0		4--4-CO OUT-6													
	CO OUT-7	4-AHU-1 & 2			IOM 4710	SA Bus	1	4	CO OUT-7					0		4--4-CO OUT-7													
	AO OUT-8	4-AHU-1 & 2			IOM 4710	SA Bus	1	4	AO OUT-8					0		4--4-AO OUT-8													
	AO OUT-9	4-AHU-1 & 2			IOM 4710	SA Bus	1	4	AO OUT-9					0		4--4-AO OUT-9													

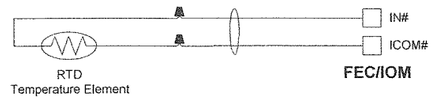
DETAIL F102 VOLTAGE INPUT - INTERNAL SOURCE



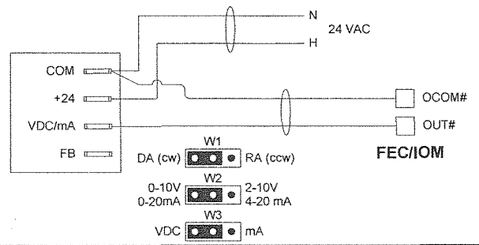
DETAIL F106 CURRENT INPUT - INTERNAL SOURCE (2 Wire)



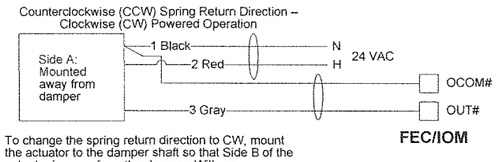
DETAIL F131 TEMPERATURE SENSOR INPUT



DETAIL F263 0-10VDC OUTPUT to M-9106, 9109

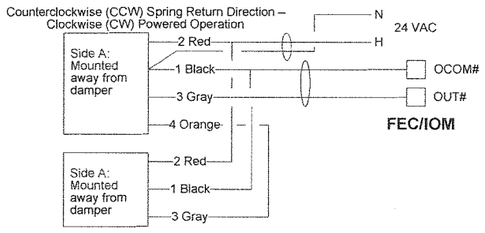


DETAIL F267 0-10VDC OUTPUT to M92xx-GGx and HGx or VA92xx-GGx and HGx

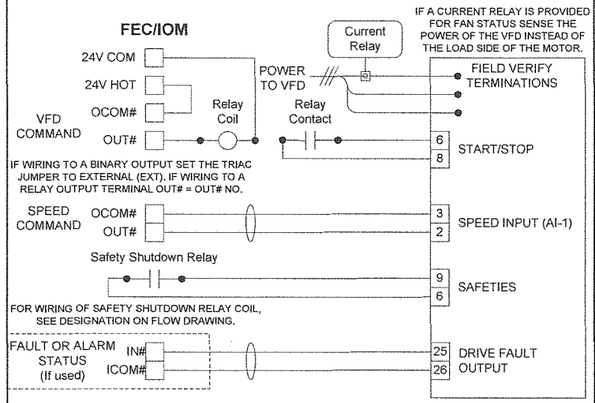


To change the spring return direction to CW, mount the actuator to the damper shaft so that Side B of the actuator is away from the damper. With power applied, the actuator now drives CCW from the 0° position, and spring returns CW.

Master-Slave Application

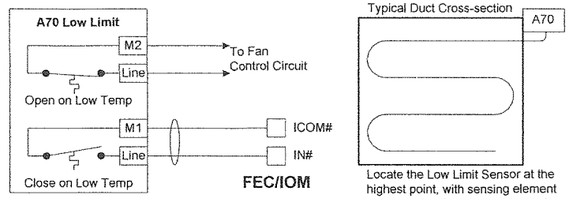


DETAIL F1046 VFD Bypass with Safeties Wiring

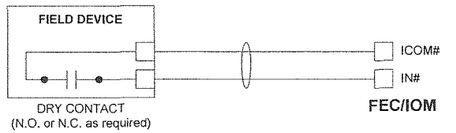


Variable Speed Enclosed IntelliPass/IntelliDisconnect Drives

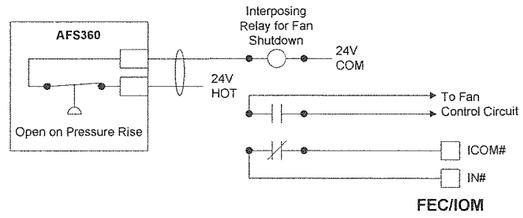
DETAIL F302 N.O. BINARY INPUT - A70



DETAIL F301 BINARY INPUT (DRY CONTACT)



DETAIL F303 N.C. BINARY INPUT – AFS360



Drawing Title
4-AHU-1 & 2 Wiring Details Typical Of 2

Project Title
VAMC St Cloud - Bldg 4 Upgrade HVAC

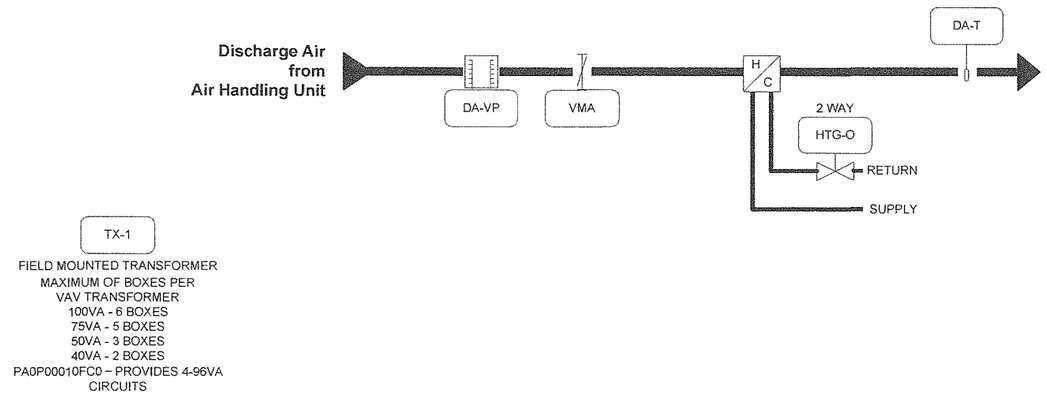
REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

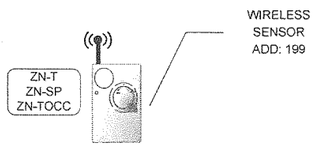
Sales Engineer	Project Manager	Application Engineer	DRAWN		APPROVED	
Shawn Klein	Josh Strommen	Tyler Minke	BY	DATE	BY	DATE

Branch Information
Johnson Controls, Inc.
2605 Frenbrook Lane N.
Plymouth, MN 55447
Phone: 763-566-7650
Fax: 763-566-2208

CONTRACT NUMBER
2082-0141

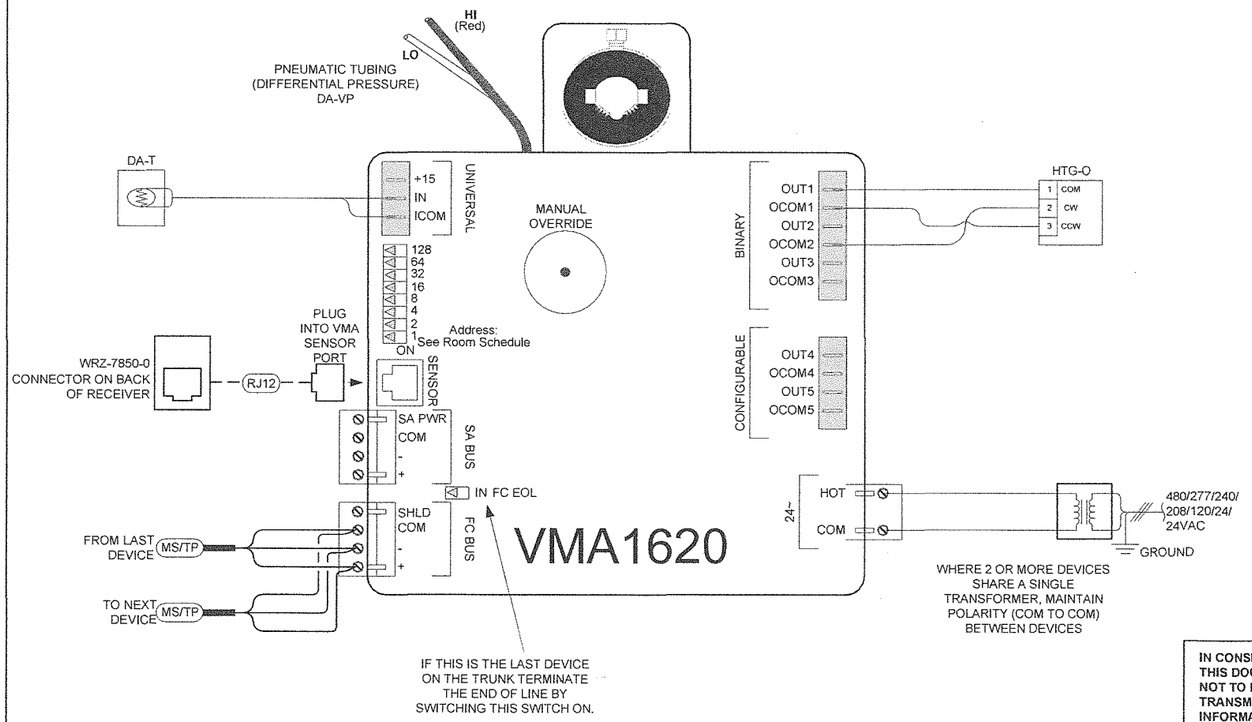
DRAWING NUMBER
4.1.3





TX-1

FIELD MOUNTED TRANSFORMER
MAXIMUM OF BOXES PER
VAV TRANSFORMER
100VA - 6 BOXES
75VA - 5 BOXES
50VA - 3 BOXES
40VA - 2 BOXES
PA0P00010FC0 – PROVIDES 4-96VA
CIRCUITS



DISCHARGE AIR TEMP SENSOR: A DISCHARGE AIR TEMP SENSOR IS PROVIDED ON EACH BOX FOR MONITORING PURPOSES.

OCCUPIED MODE: WHEN THE ZONE TEMPERATURE IS BETWEEN THE OCCUPIED HEATING AND COOLING SETPOINTS (INSIDE OF THE BIAS), THE PRIMARY AIR DAMPER WILL BE AT THE MINIMUM CFM AND THE REHEAT VALVE WILL BE FULLY CLOSED. ON A RISE IN ZONE TEMPERATURE ABOVE THE COOLING SETPOINT, THE PRIMARY AIR DAMPER WILL INCREASE THE CFM AND THE REHEAT VALVE REMAINS FULLY CLOSED. ON A DROP IN ZONE TEMPERATURE BELOW THE HEATING SETPOINT, THE REHEAT VALVE MODULATES OPEN AND THE DAMPER IS CONTROLLED TO PROVIDE A MINIMUM CFM.

UNOCCUPIED MODE: WHEN IN THIS MODE, WHILE THE ZONE TEMPERATURE IS BETWEEN THE UNOCCUPIED HEATING AND COOLING SETPOINTS (INSIDE OF THE BIAS), THE PRIMARY AIR DAMPER WILL BE CLOSED AND THERE WILL BE NO MECHANICAL HEATING. ON A RISE IN ZONE TEMPERATURE ABOVE THE UNOCCUPIED COOLING SETPOINT, THE PRIMARY AIR DAMPER WILL INCREASE THE CFM (IF AVAILABLE) AND THERE WILL BE NO MECHANICAL HEATING. ON A DROP IN ZONE TEMPERATURE BELOW THE UNOCCUPIED HEATING SETPOINT, THE REHEAT COIL WILL BE USED TO MAINTAIN THE ZONE TEMPERATURE AND THE PRIMARY AIR DAMPER WILL BE AT THE MINIMUM CFM.

OCCUPANCY CONTROL: OCCUPANCY WILL BE DETERMINED BY THE ASSOCIATED AIR HANDLING UNIT. A TEMPORARY OCCUPANCY BUTTON ON THE ZONE SENSOR WILL PLACE THE BOX IN OCCUPIED MODE FOR AN ADJUSTABLE LENGTH OF TIME.

FOR BOX PARAMETERS AND SETTINGS SEE THE ROOM SCHEDULE

Drawing Title
VAV RH Flow Layout
Typical Of 5

Project Title
VAMC St Cloud - Bldg 4 Upgrade
HVAC

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

Sales Engineer	Project Manager	Application Engineer	DRAWN BY	DRAWN DATE	APPROVED BY	APPROVED DATE
Shawn Klein	Josh Strommen	Tyler Minke				

Johnson Controls

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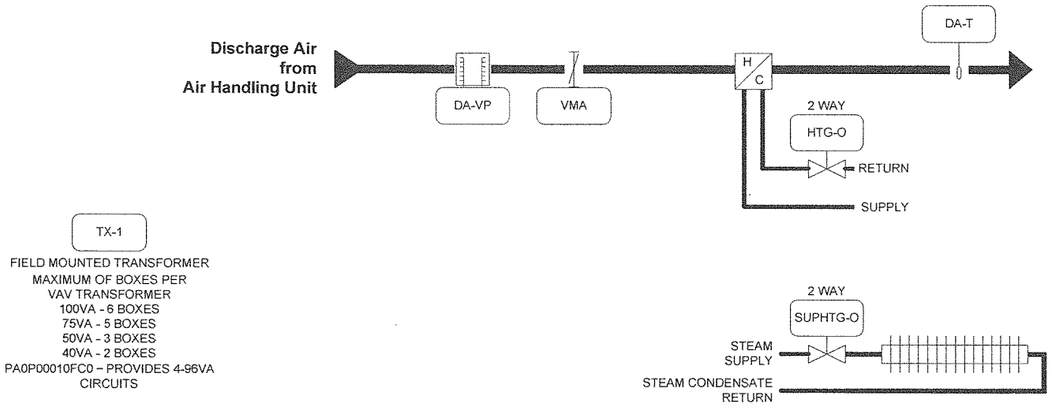
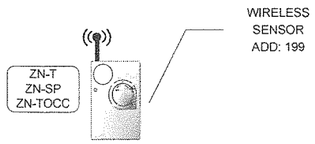
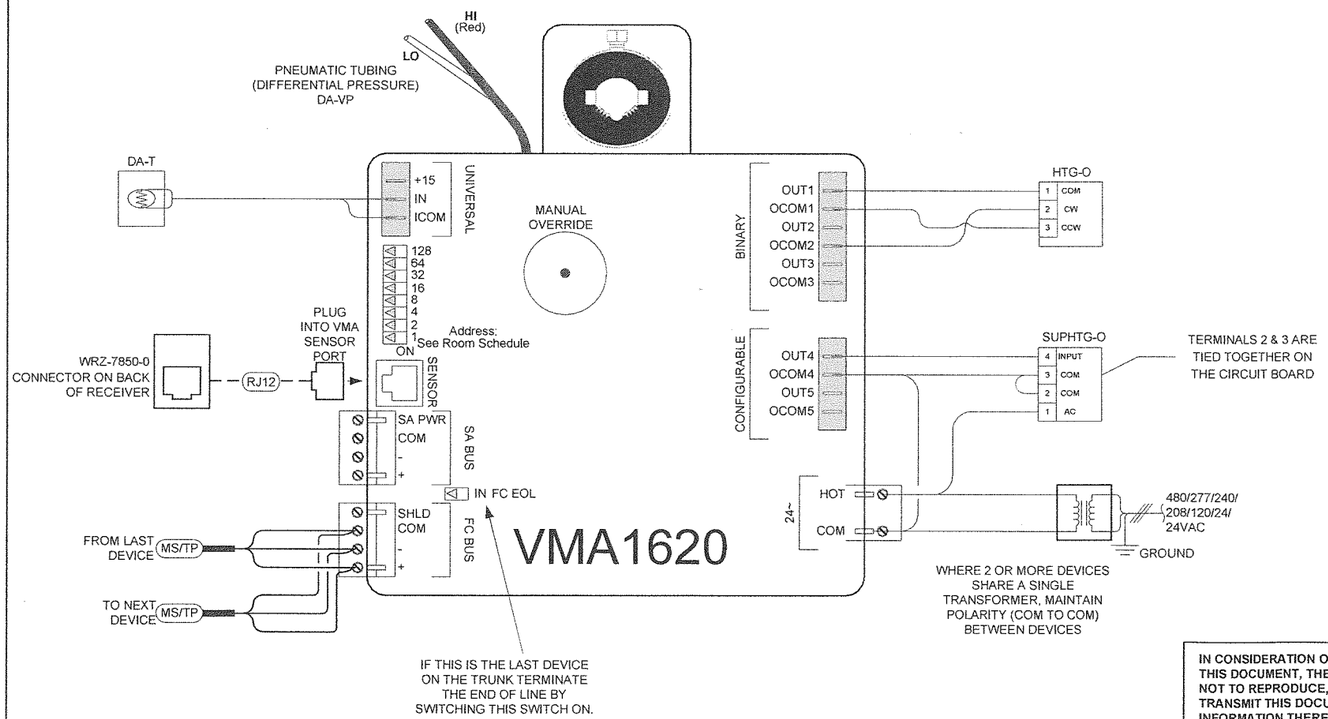
CONTRACT NUMBER
2082-0141

DRAWING NUMBER
5.1.1







DISCHARGE AIR TEMP SENSOR: A DISCHARGE AIR TEMP SENSOR IS PROVIDED ON EACH BOX FOR MONITORING PURPOSES.

OCCUPIED MODE: WHEN THE ZONE TEMPERATURE IS BETWEEN THE OCCUPIED HEATING AND COOLING SETPOINTS (INSIDE OF THE BIAS), THE PRIMARY AIR DAMPER WILL BE AT THE MINIMUM CFM, THE REHEAT VALVE WILL BE FULLY CLOSED, AND THE SUPPLEMENTARY HEAT VALVE WILL BE FULLY CLOSED. ON A RISE IN ZONE TEMPERATURE ABOVE THE COOLING SETPOINT, THE PRIMARY AIR DAMPER WILL INCREASE THE CFM, THE REHEAT VALVE REMAINS FULLY CLOSED, AND THE SUPPLEMENTARY VALVE REMAINS FULLY CLOSED. ON A DROP IN ZONE TEMPERATURE BELOW THE HEATING SETPOINT, THE REHEAT VALVE MODULATES OPEN FOLLOWED BY THE SUPPLEMENTARY HEAT VALVE, THE DAMPER IS CONTROLLED TO PROVIDE A MINIMUM CFM.

UNOCCUPIED MODE: WHEN IN THIS MODE, WHILE THE ZONE TEMPERATURE IS BETWEEN THE UNOCCUPIED HEATING AND COOLING SETPOINTS (INSIDE OF THE BIAS), THE PRIMARY AIR DAMPER WILL BE CLOSED AND THERE WILL BE NO MECHANICAL HEATING. ON A RISE IN ZONE TEMPERATURE ABOVE THE UNOCCUPIED COOLING SETPOINT, THE PRIMARY AIR DAMPER WILL INCREASE THE CFM (IF AVAILABLE) AND THERE WILL BE NO MECHANICAL HEATING. ON A DROP IN ZONE TEMPERATURE BELOW THE UNOCCUPIED HEATING SETPOINT, THE REHEAT COIL WILL BE FULLY UTILIZED BEFORE THE SUPPLEMENTARY HEAT IS ENABLED AND THE PRIMARY AIR DAMPER WILL BE AT THE MINIMUM CFM.

OCCUPANCY CONTROL: OCCUPANCY WILL BE DETERMINED BY THE ASSOCIATED AIR HANDLING UNIT. A TEMPORARY OCCUPANCY BUTTON ON THE ZONE SENSOR WILL PLACE THE BOX IN OCCUPIED MODE FOR AN ADJUSTABLE LENGTH OF TIME.

FOR BOX PARAMETERS AND SETTINGS SEE THE ROOM SCHEDULE

Drawing Title
VAV RH FTR Flow Layout
Typical Of 39

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

Sales Engineer	Project Manager	Application Engineer	DRAWN		APPROVED	
Shawn Klein	Josh Strommen	Tyler Minke	BY	DATE	BY	DATE

Project Title
VAMC St Cloud - Bldg 4 Upgrade
HVAC

Johnson Controls

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Plymouth, MN 55447
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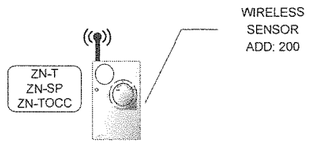
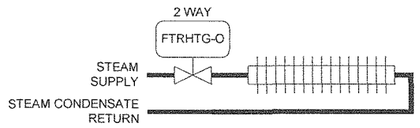
CONTRACT NUMBER
2082-0141

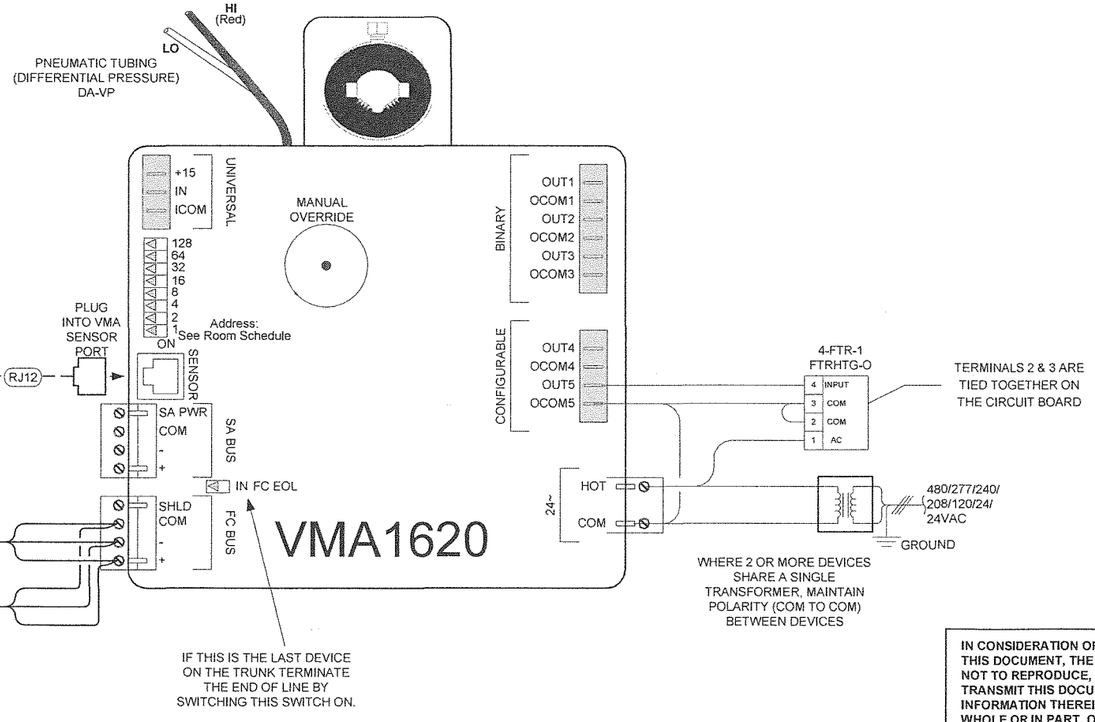
DRAWING NUMBER
5.2.1



4-FTR-1
FEMALE 213



TU-2-10



OCCUPIED MODE: THE HEATING VALVE WILL MODULATE TO MAINTAIN ZONE TEMPERATURE BETWEEN THE OCCUPIED HEATING AND COOLING SETPOINTS (INSIDE OF THE BIAS).

UNOCCUPIED MODE: THE HEATING VALVE WILL MODULATE TO MAINTAIN ZONE TEMPERATURE BETWEEN THE UNOCCUPIED HEATING AND COOLING SETPOINTS (INSIDE OF THE BIAS).

OCCUPANCY CONTROL: OCCUPANCY WILL BE DETERMINED BY THE ASSOCIATED AIR HANDLING UNIT. A TEMPORARY OCCUPANCY BUTTON ON THE ZONE SENSOR WILL PLACE THE BOX IN OCCUPIED MODE FOR AN ADJUSTABLE LENGTH OF TIME.

Drawing Title
4-FTR-1 Flow Layout

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

Sales Engineer	Project Manager	Application Engineer	DRAWN		APPROVED	
Shawn Klein	Josh Strommen	Tyler Minke	BY	DATE	BY	DATE

Project Title
VAMC St Cloud - Bldg 4 Upgrade HVAC

Johnson Controls

Branch Information
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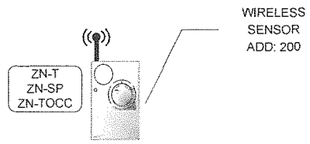
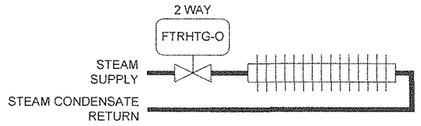
Phone: 763-566-7650
Fax: 763-566-2208

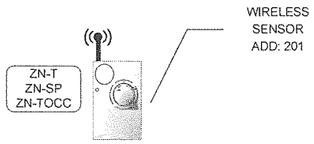
CONTRACT NUMBER
2082-0141

DRAWING NUMBER
6.1.1

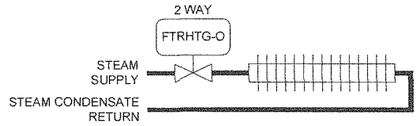


4-FTR-2
TOILET 249

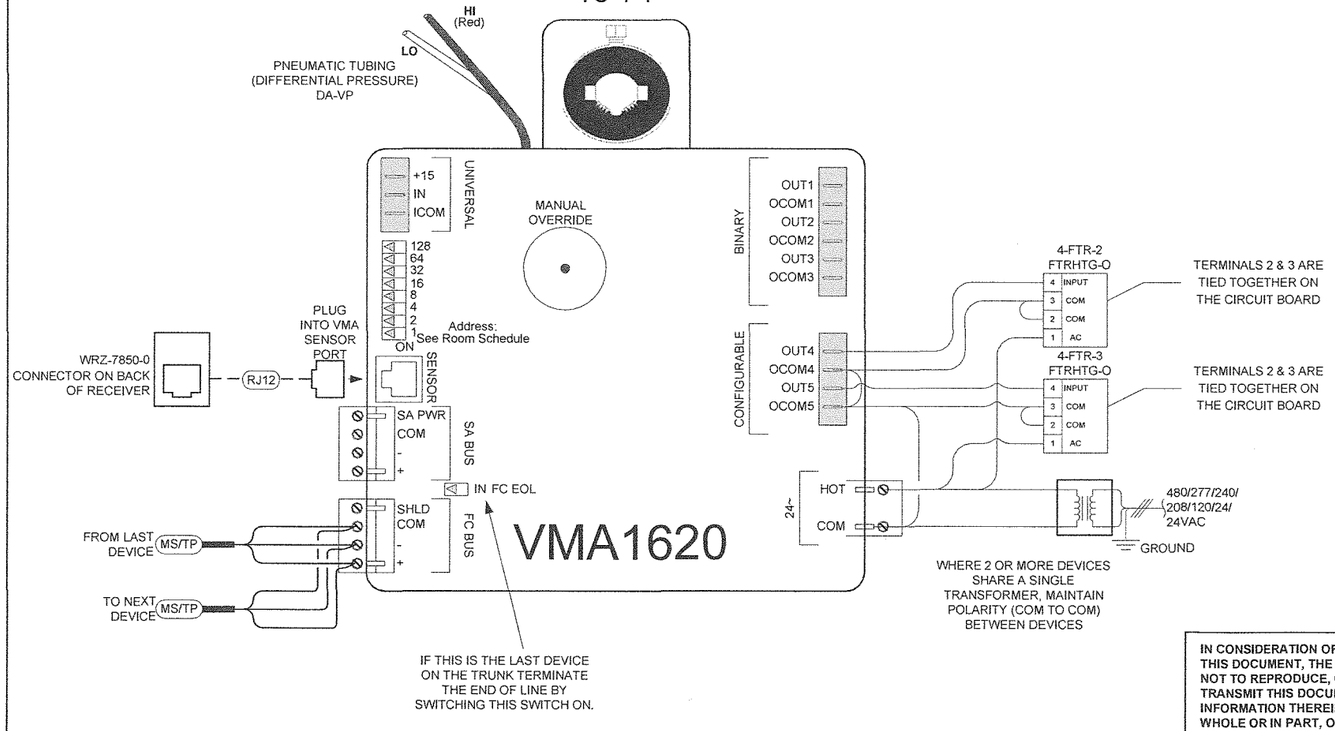




4-FTR-3
STAIR 251



TU-1-1



OCCUPIED MODE: THE HEATING VALVE WILL MODULATE TO MAINTAIN ZONE TEMPERATURE BETWEEN THE OCCUPIED HEATING AND COOLING SETPOINTS (INSIDE OF THE BIAS).

UNOCCUPIED MODE: THE HEATING VALVE WILL MODULATE TO MAINTAIN ZONE TEMPERATURE BETWEEN THE UNOCCUPIED HEATING AND COOLING SETPOINTS (INSIDE OF THE BIAS).

OCCUPANCY CONTROL: OCCUPANCY WILL BE DETERMINED BY THE ASSOCIATED AIR HANDLING UNIT. A TEMPORARY OCCUPANCY BUTTON ON THE ZONE SENSOR WILL PLACE THE BOX IN OCCUPIED MODE FOR AN ADJUSTABLE LENGTH OF TIME.

Drawing Title
4-FTR-2 & 3 Flow Layout

REFERENCE DRAWING	NO.	REVISION-LOCATION	ECN	DATE	BY

Sales Engineer	Project Manager	Application Engineer	DRAWN		APPROVED	
Shawn Klein	Josh Strommen	Tyler Minke	BY	DATE	BY	DATE

Project Title
VAMC St Cloud - Bldg 4 Upgrade HVAC

Johnson Controls

Branch Information
Johnson Controls, Inc.
2605 Fernbrook Lane N.
Plymouth, MN 55447
Phone: 763-566-7650
Fax: 763-566-2208

CONTRACT NUMBER
2082-0141

DRAWING NUMBER
6.2.1

Contract Name
Contract Number

Room Schedule

Box Location									Controller Information					Sensor	Box Information									
	Room								Controller Required								Box Config Required							
Bldg./Flr.	No.	Name	System Name	Mech. Dwg.	System Serving this Box	Box Mfgr.	Mfgr Box Type	JCI Ctrl Dwg No.	Controller Part No.	NC/ NAE Addr	Trunk ID	Device Addr	CSModel or Template	Code No.	Box Heat	Supplemental Heat	Config File Name	Inlet Size (Inches)	Inlet Area (Sq. Ft.)	K Factor	Clg Min Flow	Clg Max Flow	Comments	Generate Flag
Bldg. 4 / 2nd Floor	C2E	Corridor	TU-1-1	H8	4-AHU-1	Enviro-Tec	DESV	5.1.1	MS-VMA1620-0	NAE-4	Field Bus 2	16	VAV RH	WRZ-TTB0000-0	Yes	No	VMA-16	4	0.08	1.63	110	200	4-FTR-2 & 3	
Bldg. 4 / 2nd Floor	246	Chief of Staff	TU-1-2	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	17	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-17	10	0.53	2.41	340	1140	2 FTR Valves Wired Together	
Bldg. 4 / 2nd Floor	245	Hospital Director	TU-1-3	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	18	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-18	5	0.13	1.66	150	340	2 FTR Valves Wired Together	
Bldg. 4 / 2nd Floor	243	Secretaries	TU-1-4	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	19	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-19	9	0.42	2.4	270	900	2 FTR Valves Wired Together	
Bldg. 4 / 2nd Floor	243	Secretaries	TU-1-5	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	20	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-20	6	0.18	2.9	190	460	2 FTR Valves Wired Together	
Bldg. 4 / 2nd Floor	240	Nurse Executive	TU-1-6	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	21	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-21	7	0.25	2.55	170	580		
Bldg. 4 / 2nd Floor	239	Assistant Hospital Director	TU-1-7	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	22	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-22	4	0.08	1.63	100	165		
Bldg. 4 / 2nd Floor	238	Copy & Computer Room	TU-1-8	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	23	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-23	7	0.25	2.55	170	580		
Bldg. 4 / 2nd Floor	237	Public Relations	TU-1-9	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	24	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-24	4	0.08	1.63	100	165		
Bldg. 4 / 2nd Floor	236	Program Analyst	TU-1-10	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	25	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-25	6	0.18	2.9	110	380		
Bldg. 4 / 2nd Floor	235	Conference	TU-1-11	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	26	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-26	4	0.08	1.63	80	185		
Bldg. 4 / 2nd Floor	234	Office	TU-1-12	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	27	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-27	8	0.33	2.52	210	710		
Bldg. 4 / 2nd Floor	233	Supply Officer	TU-1-13	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	28	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-28	4	0.08	1.63	100	195		
Bldg. 4 / 2nd Floor	232	Quality Management	TU-1-14	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	29	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-29	8	0.33	2.52	220	740		
Bldg. 4 / 2nd Floor	231	Contract Specialist	TU-1-15	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	30	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-30	4	0.08	1.63	100	195		
Bldg. 4 / 2nd Floor	230	Quality Management	TU-1-16	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	31	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-31	8	0.33	2.52	220	740		
Bldg. 4 / 2nd Floor	229	Contract Specialist	TU-1-17	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	32	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-32	4	0.08	1.63	100	195		
Bldg. 4 / 2nd Floor	C2EC	Corridor	TU-1-18	H8	4-AHU-1	Enviro-Tec	DESV	5.1.1	MS-VMA1620-0	NAE-4	Field Bus 2	33	VAV RH	WRZ-TTB0000-0	Yes	No	VMA-33	5	0.13	1.66	90	250		
Bldg. 4 / 2nd Floor	226	Elevator Lobby	TU-1-19	H8	4-AHU-1	Enviro-Tec	DESV	5.1.1	MS-VMA1620-0	NAE-4	Field Bus 2	34	VAV RH	WRZ-TTB0000-0	Yes	No	VMA-34	5	0.13	1.66	100	340		
Bldg. 4 / 2nd Floor	225	Purchasing	TU-1-20	H8	4-AHU-1	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	35	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-35	7	0.25	2.55	160	500	2 FTR Valves Wired Together	
Bldg. 4 / 2nd Floor	223B	Employment Information	TU-1-21	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	36	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-36	5	0.13	1.66	120	215		
Bldg. 4 / 2nd Floor	223	Copy Room	TU-1-22	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	37	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-37	4	0.08	1.63	100	190		
Bldg. 4 / 2nd Floor	221	Fiscal Officer	TU-1-23	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	38	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-38	4	0.08	1.63	100	200		
Bldg. 4 / 2nd Floor	217	Fiscal Officer	TU-1-24	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	39	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-39	4	0.08	1.63	100	200		
Bldg. 4 / 2nd Floor	215	ADPAC Room	TU-1-25	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	40	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-40	4	0.08	1.63	100	130		
Bldg. 4 / 2nd Floor	202	Human Resources	TU-2-1	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	41	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-41	6	0.18	2.9	120	400		
Bldg. 4 / 2nd Floor	201	Human Resources	TU-2-2	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	42	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-42	6	0.18	2.9	110	355		
Bldg. 4 / 2nd Floor	204	Human Resources	TU-2-3	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	43	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-43	7	0.25	2.55	170	570		
Bldg. 4 / 2nd Floor	203	Human Resources	TU-2-4	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	44	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-44	4	0.08	1.63	100	165		
Bldg. 4 / 2nd Floor	206 & 208	Human Resources	TU-2-5	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	45	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-45	7	0.25	2.55	170	570	2 FTR Valves Wired Together	
Bldg. 4 / 2nd Floor	C2W	Corridor	TU-2-6	H8	4-AHU-2	Enviro-Tec	DESV	5.1.1	MS-VMA1620-0	NAE-4	Field Bus 2	46	VAV RH	WRZ-TTB0000-0	Yes	No	VMA-46	4	0.08	1.63	130	200		
Bldg. 4 / 2nd Floor	205	Human Resources	TU-2-7	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	47	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-47	6	0.18	2.9	140	420	2 FTR Valves Wired Together	
Bldg. 4 / 2nd Floor	210	Human Resources	TU-2-8	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	48	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-48	10	0.53	2.41	340	1140		
Bldg. 4 / 2nd Floor	209	Human Resources	TU-2-9	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	49	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-49	4	0.08	1.63	100	165		
Bldg. 4 / 2nd Floor	211	Male	TU-2-10	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	50	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-50	5	0.13	1.66	100	230	4-FTR-1	
Bldg. 4 / 2nd Floor	212	Management Specialist	TU-2-11	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	51	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-51	7	0.25	2.55	170	570		
Bldg. 4 / 2nd Floor	214	Supervisor H.R.	TU-2-12	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	52	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-52	7	0.25	2.55	180	600		
Bldg. 4 / 2nd Floor	216	Secretary H.R.	TU-2-13	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	53	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-53	6	0.18	2.9	110	370		
Bldg. 4 / 2nd Floor	218	Secretary	TU-2-14	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	54	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-54	8	0.33	2.52	230	750		
Bldg. 4 / 2nd Floor	219	Fiscal Officer	TU-2-15	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	55	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-55	4	0.08	1.63	100	200		
Bldg. 4 / 2nd Floor	220	Director	TU-2-16	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	56	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-56	10	0.53	2.41	330	1100		
Bldg. 4 / 2nd Floor	222	Accounting	TU-2-17	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	57	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-57	10	0.53	2.41	350	1180		
Bldg. 4 / 2nd Floor	C2WC	Corridor	TU-2-18	H8	4-AHU-2	Enviro-Tec	DESV	5.1.1	MS-VMA1620-0	NAE-4	Field Bus 2	58	VAV RH	WRZ-TTB0000-0	Yes	No	VMA-58	4	0.08	1.63	220	220		
Bldg. 4 / 2nd Floor	222	Accounting	TU-2-19	H8	4-AHU-2	Enviro-Tec	DESV	5.2.1	MS-VMA1620-0	NAE-4	Field Bus 2	59	VAV RH FTR	WRZ-TTB0000-0	Yes	Yes	VMA-59	10	0.53	2.41	350	1180	2 FTR Valves Wired Together	
Bldg. 4 / Attic		Serves Bldg. 4 Floor 2 East	4-AHU-1	H9				4.1.1	MS-FEC-2610-0	NAE-4	Field Bus 2	14	4-AHU-1 & 2				FEC-14							
Bldg. 4 / Attic		Serves Bldg. 4 Floor 2 West	4-AHU-2	H9				4.2.1	MS-FEC-2610-0	NAE-4	Field Bus 2	15	4-AHU-1 & 2				FEC-15							
Bldg. 4 / 2nd Floor	213	Female	4-FTR-1	H5				6.1.1						WRZ-TTB0000-0									Wire Valve to TU-2-10, CO-5	
Bldg. 4 / 2nd Floor	249	Toilet	4-FTR-2	H5				6.2.1						WRZ-TTB0000-0									Wire Valve to TU-1-1, CO-4	
Bldg. 4 / 2nd Floor	251	Stair	4-FTR-3	H5				6.2.1						WRZ-TTB0000-0									Wire Valve to TU-1-1, CO-5	
Bldg. 4 / Basement	7	Mechanical Room	4-C-1	H3				2.1.1	MS-FEC-2610-0	NAE-4	Field Bus 2	11	4-C-1				FEC-11							
Bldg. 4 / Basement	7	Mechanical Room	4-C-2	H3				2.2.1	MS-FEC-2610-0	NAE-4	Field Bus 2	12	4-C-2				FEC-12							
Bldg. 4 / Basement	7	Mechanical Room	CHWS	H3				3.1.1	MS-FEC-2610-0	NAE-4	Field Bus 2	13	CHWS				FEC-13							
Bldg. 4 / 1st Floor		Outside	4-ACRCU-1	H4				3.1.1	Integration	NAE-4	Field Bus 2	60												
Bldg. 4 / 1st Floor		Outside	4-ACRCU-2	H4				3.1.1	Integration	NAE-4	Field Bus 2	61												

Tag					Valve Information															Actuator Information					
Item	System	Service	Qty.	Ref. Dwg.	Code Number	Valve Family	Configuration	Fail Position	Inlet Pipe Size (in)	Valve Size (in)	Medium	Flow (gpm or lbs/hr)	Design Delta P (psi)	Valve Delta P (psi)	Design Coefficient (Cv)	Valve Coefficient (Cv)	Design Close Off (psi)	Valve Close Off (psi)	Trim Material	Connection	Code Number	Actuator Control	Piping Detail	Comments
1	VAV's	Reheat Coil	44		VG1241AD+9A4AGA	Ball Valve	2-Way	Last Position	3/4	1/2	Water	0.8	5.0	0.4	0.4	1.2	19.5	200.0	Brass	Threaded	VA9104-AGA-2S	24VAC INC		
2	CONVECTORS	Exist. Convectors	50		VG7241CT+7152G	Globe Valve	2-Way	Last Position	3/4	1/2	Steam	8.0	20.1	0.3	0.1	0.7	30.0	345.0	Brass	Threaded	VA-7152-1001	0-10VDC PROP		
3	4-AHU-1 & 2	Heating Coil	2		VG1841CL+923GGA	Ball Valve	3-Way	Normal Position	1-1/2	1	Water	12.0	5.0	2.6	5.4	7.4	21.7	200.0	Brass	Threaded	VA9203-GGA-2Z	0-10VDC PROP		
4	4-AHU-1 & 2	Cooling Coil	2		VG1841FS+948GGA	Ball Valve	3-Way	Normal Position	3	2	Water	88.2	5.0	3.6	39.4	46.8	23.8	200.0	Brass	Threaded	VA9208-GGA-2	0-10VDC PROP		
5	4-C-1	Steam	1		VG7443GT+423GGA	Globe Valve	2-Way	Valve Closed	2-1/2	1/2	Steam	254.0	20.1	8.5	3.2	4.6	30.0	108.0	Stainless Steel	Threaded	VA-4233-GGA-2	0-10VDC PROP		
6	4-C-2	Steam	1		VG7443LT+423GGA	Globe Valve	2-Way	Valve Closed	3	3/4	Steam	514.0	20.1	15.0	6.5	7.3	30.0	64.0	Stainless Steel	Threaded	VA-4233-GGA-2	0-10VDC PROP		

AIR SYSTEMS ENGINEERING

TEST AND BALANCE REPORT

BUILDING 4 HVAC SYSTEM UPGRADE

ST. CLOUD, MN
11/7/12

AABB

Official Member

AIR SYSTEMS ENGINEERING, INC
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PROJECT NAME

BUILDING 4 HVAC SYSTEM UPGRADE

ST. CLOUD, MN
11/7/12

TEST ENGINEER

MIKE WOZNIAK, TBE

MECHANICAL ENGINEER

ONE

MECHANICAL CONTRACTOR

McDOWALL COMPANY

AABC

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AIR SYSTEMS
ENGINEERING

AIR SYSTEMS ENGINEERING, INC. is a fully independent test and balance agency and member of the Associated Air Balance Council (AABC). The testing and balancing of this project was performed under the direct supervision of the test engineer stated below. All final test data provided in this report directly reflects the values measured for the completed systems of the referenced project. The final report has been reviewed for correctness. Air Systems Engineering, Inc. guarantees that all information and test data provided in this report is accurate. The test engineer can be contacted directly for any questions or discrepancies related to this report.

TEST & BALANCE ENGINEER:

MICHAEL S. WOZNIAK

SIGNATURE: _____

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AIR SYSTEMS ENGINEERING

TEST INSTRUMENTS

INSTRUMENT	MANUFACTURER	MODEL #	SERIAL #	CALIBRATION DATE
Hydronic Manometer	ALNOR	HM670	70524106	5/23/2012
Air Data Multimeter	SHORTRIDGE	ADM-860C	M05442	10/3/2012
Balometer (Flow Hood)	ALNOR	6463	70441003	5/23/2012
Amp Meter	FLUKE	322	N/A	N/A
Tachometer	MITCHELL	Nova-Strobe BB	2191168	N/A

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AIR SYSTEMS ENGINEERING

VARIABLE VOLUME SUPPLY FAN TEST

JOB NAME ST. CLOUD VA BUILDING 4

SYSTEM AHU-4-1

MAKE YORK

MODEL XTI-051X084

	REQUIRED	PRELIMINARY	FINAL	NOTE
VFD (Hz)	60.0 Hz MAX	60.0 Hz	55.2 Hz	
DUCT STATIC PRESSURE SETPOINT"	-	1.7"	1.7"	
CFM (OUTLETS TOTAL)	10045	-	10190	
CFM (FAN TOTAL)	10500	9884	10387	2
FAN IN/OUT/TSP"	-/-/4.52	-3.30/+1.44/4.82	-2.12/+1.54/3.66	
EXTERNAL S.P."	-/-/2.0	-1.53/+1.44/2.97	-0.57/+1.54/2.11	
FILTER S.P."	NA	-1.53/-2.29/0.76	-0.57/-0.97/0.40	
HEATING COIL S.P."	NA	-3.33/-3.38/0.05	-2.06/-2.12/0.06	
COOLING COIL S.P."	NA	-2.29/-3.33/1.04	-0.97/-2.06/1.09	
FAN RPM	NA	1421	1360	
MOTOR RPM	1765	1767	1686	
MOTOR VOLTAGE	460	480	480	
MOTOR AMPERAGE	17.7	16.7	15.2	
MOTOR HORSEPOWER	15.0	15.0	15.0	
MINIMUM OUTSIDE AIR PERCENTAGE %	10% 1050 CFM	-	10% 1096 CFM	1
MOTOR PULLEY	2B5V44 (P1 X 1 5/8)			
FAN PULLEY	2B5V54 (B X 2)			
BELT	(2)5VX810			

Notes:

1) Minimum O.A. CFM measured by pitot tube traverse at 20% damper position.
2) Fan total determined by the sum of the calibrated VAV terminals. A duct traverse could not be accurrately measured due to lack of straight duct length at discharge of the unit in attic space.

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4

SYSTEM AHU-4-1

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
	TU-1-2	K=2.768								
NA	1-1	CD	1.00	285	285	180	180	290	290	
NA	1-2	CD	1.00	285	285	240	240	285	285	
NA	1-3	CD	1.00	285	285	340	340	290	290	
NA	1-4	CD	1.00	285	285	300	300	285	285	
					1140/340		1060/350		1150/350	
	TU-1-1	K=2.266								
NA	1-5	CD	1.00	200	200	220	220	210	210	
					200/110		220/110		210/110	
	TU-1-3	K=1.967								
NA	1-6	CD	1.00	170	170	140	140	170	170	
NA	1-7	CD	1.00	170	170	120	120	180	180	
					340/150		260/150		350/150	
	TU-1-5		K=2.9							
NA	1-8	CD	1.00	230	230	230	230	230	230	
NA	1-9	CD	1.00	230	230	240	240	240	240	
					460/190		470/200		470/200	

Notes:

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4

SYSTEM AHU-4-1

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
	TU-1-7	K=1.943								
NA	1-10	CD	1.00	165	165	160	160	165	165	
					165/100		160/100		165/100	
	TU-1-9	K=1.959								
NA	1-11	CD	1.00	165	165	150	150	170	170	
					165/100		150/105		170/105	
	TU-1-11	K=1.831								
NA	1-12	CD	1.00	195	195	190	190	200	200	
					195/100		190/105		200/105	
	TU-1-13	K=1.943								
NA	1-13	CD	1.00	195	195	180	180	200	200	
					195/100		180/100		200/100	
	TU-1-15	K=1.928								
NA	1-14	CD	1.00	195	195	180	180	200	200	
					195/100		180/100		200/100	

Notes:

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4

SYSTEM AHU-4-1

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
	TU-1-17		K=1.986							
NA	1-15	CD	1.00	195	195	160	160	200	200	
					195/100		160/100		200/100	
	TU-1-18		K=2.117							
NA	1-16	CD	1.00	250	250	225	225	250	250	
					250/90		225/90		250/90	
	TU-1-20		K=1.547							
NA	1-17	CD	1.00	250	250	370	370	260	260	
NA	1-18	CD	1.00	250	250	350	350	250	250	
					500/160		720/165		510/165	
	TU-1-21		K=2.101							
NA	1-19	CD	1.00	215	215	200	200	225	225	
					215/120		200/125		225/125	
	TU-1-22		K=1.630							
NA	1-20	CD	1.00	190	190	220	220	155	155	
NA	1-21	CD	1.00	190	190	90	90	150	150	
					380/100		310/100		305/100	1

Notes: 1) VAV is designed to be a 4" box at 190 CFM. Maximum CFM attainable.

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4

SYSTEM AHU-4-1

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
	TU-1-23		K=2.091							
NA	1-22	CD	1.00	200	200	180	180	205	205	
					200/100		180/100		205/100	
	TU-1-24		K=2.125							
NA	1-23	CD	1.00	200	200	180	180	205	205	
					200/100		180/105		205/105	
	TU-1-25		K=2.027							
NA	1-24	CD	1.00	130	130	115	115	130	130	
					130/100		115/100		130/100	
	TU-1-4		K=1.773							
NA	1-25	CD	1.00	225	225	210	210	225	225	
NA	1-26	CD	1.00	225	225	250	250	225	225	
NA	1-27	CD	1.00	225	225	310	310	235	235	
NA	1-28	CD	1.00	225	225	290	290	235	235	
					900/270		1060/280		920/280	

Notes:

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4

SYSTEM AHU-4-1

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
	TU-1-6	K=1.508								
NA	1-29	CD	1.00	290	290	230	230	300	300	
NA	1-30	CD	1.00	290	290	460	460	290	290	
					580/170		690/175		590/175	
	TU-1-8	K=1.432								
NA	1-31	CD	1.00	290	290	360	360	300	300	
NA	1-32	CD	1.00	290	290	430	430	290	290	
					580/170		790/170		590/170	
	TU-1-10	K=2.474								
NA	1-33	CD	1.00	190	190	210	210	195	195	
NA	1-34	CD	1.00	190	190	210	210	200	200	
					380/110		420/110		395/110	
	TU-1-12	K=2.296								
NA	1-35	CD	1.00	355	355	290	290	355	355	
NA	1-36	CD	1.00	355	355	450	450	360	360	
					710/210		740/220		715/220	

Notes:

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4

SYSTEM AHU-4-1

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
TU-1-14			K=2.644							
NA	1-37	CD	1.00	370	370	400	400	370	370	
NA	1-38	CD	1.00	370	370	380	380	370	370	
					740/220		780/230		740/230	
TU-1-16			K=2.475							
NA	1-39	CD	1.00	370	370	440	440	370	370	
NA	1-40	CD	1.00	370	370	320	320	380	380	
					740/220		760/230		750/230	
TU-1-19			K=1.842							
NA	1-41	CD	1.00	340	340	320	320	345	345	
					340/100		320/105		345/105	
SYSTEM TOTAL					10045		-		10190	

Notes:

VARIABLE VOLUME RETURN FAN TEST

JOB NAME ST. CLOUD VA BUILDING 4

SYSTEM AHU-4-1

MAKE YORK

MODEL STI-051X084

	REQUIRED	PRELIMINARY	FINAL	NOTE
VFD (Hz)	60.0 Hz Max	53.7 Hz	60.0 Hz	2
CFM	9500	6914	9828	1
EXTERNAL S.P." (ESP)	-/-/1.06	-0.32/+0.38/0.70	-1.08/-0.44/0.64	
FAN RPM	NA	694	1039	
MOTOR RPM	1755	1599	1768	
MOTOR VOLTAGE	460	480	480	
MOTOR AMPERAGE	9.55	5.1	9.4	
MOTOR HORSEPOWER	7.5	7.5	7.5	
MOTOR PULLEY	2VP62 X 1 3/8			
FAN PULLEY	2TB90 (Q1 X 1)			
BELT	(2) AX48			

Notes:

1) CFM measured by velocity grid traverse at 100% relief air. Return fan speed lag set to 0%.
2) Maximum fan speed set to 54.0 Hz to prevent return fan from running over the rated motor amps when supply fan is at maximum cooling speed.

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4

SYSTEM AHU-4-1 (Return Air)

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
RETURN AIR										
NA	1-1	CD	1.20	1133	1360	-	-	1150	1380	
NA	1-2	CD	1.20	138	165	-	-	140	168	
NA	1-3	CD	1.20	138	165	-	-	140	168	
NA	1-4	CD	1.20	163	195	-	-	170	204	
NA	1-5	CD	1.20	163	195	-	-	170	204	
NA	1-6	CD	1.20	163	195	-	-	170	204	
NA	1-7	CD	1.20	163	195	-	-	170	204	
NA	1-8	CD	1.20	163	195	-	-	170	204	
NA	1-9	CD	1.20	179	215	-	-	180	216	
NA	1-10	CD	1.20	167	200	-	-	170	204	
NA	1-11	CD	1.20	167	200	-	-	170	204	
NA	1-12	CD	1.20	167	200	-	-	170	204	
NA	1-13	CD	1.20	167	200	-	-	170	204	
NA	1-14	CD	1.20	108	130	-	-	110	132	
NA	1-15	CD	1.20	567	680	-	-	570	684	
NA	1-16	CD	1.20	283	340	-	-	285	342	
NA	1-17	CD	1.20	567	680	-	-	570	684	
NA	1-18	CD	1.20	483	580	-	-	500	600	
NA	1-19	CD	1.20	483	580	-	-	490	588	
NA	1-20	CD	1.20	317	380	-	-	320	384	

Notes:

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4

SYSTEM AHU-4-1 (Return Air)

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
RETURN AIR (CONT.)										
NA	1-21	CD	1.20	592	710	-	-	600	720	
NA	1-22	CD	1.20	617	740	-	-	620	744	
NA	1-23	CD	1.20	617	740	-	-	630	756	
NA	1-24	CD	1.20	283	340	-	-	290	348	
					9580		-		9750	

Notes:

VARIABLE VOLUME SUPPLY FAN TEST

JOB NAME ST. CLOUD VA BUILDING 4 2ND FLOOR RENOVATIONS

SYSTEM 4-AHU-2

MAKE YORK

MODEL XTI-051X084

	REQUIRED	PRELIMINARY	FINAL	NOTE
VFD (Hz)	60.0 Hz Max	55.4 Hz	55.4 Hz	
DUCT STATIC PRESSURE SETPOINT"	-	1.2"	1.2"	
CFM (OUTLETS TOTAL)	10365	10517	10517	
FAN IN/OUT/TSP"	NA	-1.98/+1.81/3.79	-1.98/+1.81/3.79	
EXTERNAL S.P."	NA	-0.24/+1.81/2.05	-0.24/+1.81/2.05	
FILTER S.P."	NA	-0.24/-0.73/0.49	-0.24/-0.73/0.49	
HEATING COIL S.P."	NA	-0.73/-1.92/1.19	-0.73/-1.92/1.19	
COOLING COIL S.P."	NA	-1.92/-1.98/0.06	-1.92/-1.98/0.06	
FAN RPM	NA	1304	1304	
MOTOR RPM		1640	1640	
MOTOR VOLTAGE	460	480	480	
MOTOR AMPERAGE	17.7	14.8	14.8	
MOTOR HORSEPOWER	1.5	1.5	1.5	
MINIMUM OUTSIDE AIR PERCENTAGE %	10% 1050 CFM	10% 1068 CFM	10% 1068 CFM	1
MOTOR PULLEY	2B5V44 (P1 X 1 5/8)			
FAN PULLEY	2B5V54 (B X 2)			
BELT	5VX810			

Notes:

1) Minimum O.A. CFM measured by pitot tube traverse at 18% damper position.
2) Fan total determined by the sum of the calibrated VAV terminals. A duct traverse could not be accurrately measured due to lack of straight duct length at discharge of the unit in attic space.

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4 2ND FLOOR RENOVATIONS

SYSTEM AHU-4-2

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
	TU-2-1	K=2.730								
NA	2-1	CD	1.0	200	200	380	380	205	205	
NA	2-2	CD	1.0	200	200	40	40	205	205	
					400/120		420/120		410/120	
	TU-2-2	K=2.506								
NA	2-3	CD	1.0	355	355	380	380	355	355	
					355/110		380/110		355/110	
	TU-2-3	K=1.253								
NA	2-4	CD	1.0	285	285	400	400	285	285	
NA	2-5	CD	1.0	285	285	420	420	290	290	
					570/170		820/175		575/175	
	TU-2-4	K=2.012								
NA	2-6	CD	1.0	165	165	150	150	170	170	
					165/100		150/105		170/105	

Notes:

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4 2ND FLOOR RENOVATIONS

SYSTEM AHU-4-2

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
	TU-2-5	K=1.268								
NA	2-7	CD	1.0	285	285	415	415	290	290	
NA	2-8	CD	1.0	285	285	410	410	285	285	
					570/170		825/170		575/170	
	TU-2-6	K=2.161								
NA	2-9	CD	1.0	200	200	175	175	205	205	
					200/130		175/130		205/130	
	TU-2-7	K=3.093								
NA	2-10	CD	1.0	210	210	215	215	220	220	
NA	2-11	CD	1.0	210	210	200	200	210	210	
					420/140		415/140		430/140	
	TU-2-8	K=2.338								
NA	2-12	CD	1.0	285	285	340	340	285	285	
NA	2-13	CD	1.0	285	285	240	240	290	290	
NA	2-14	CD	1.0	285	285	310	310	295	295	
NA	2-15	CD	1.0	285	285	280	280	290	290	
					1140/340		1170/350		1160/350	

Notes:

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4 2ND FLOOR RENOVATIONS

SYSTEM AHU-4-2

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
	TU-2-9	K=1.843								
NA	2-16	CD	1.0	165	165	155	155	165	165	
					165/100		155/100		165/100	
	TU-2-10	K=1.502								
NA	2-17	CD	1.0	115	115	120	120	120	120	
NA	2-18	CD	1.0	115	115	120	120	120	120	
					230/100		240/100		240/100	
	TU-2-11	K=1.392								
NA	2-19	CD	1.0	285	285	350	350	285	285	
NA	2-20	CD	1.0	285	285	430	430	290	290	
					570/170		780/		575/175	
	TU-2-12	K=1.283								
NA	2-21	CD	1.0	300	300	370	370	300	300	
NA	2-22	CD	1.0	300	300	470	470	300	300	
					600/180		840/250		600/180	

Notes:

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4 2ND FLOOR RENOVATIONS

SYSTEM AHU-4-2

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
	TU-2-13		K=2.473							
NA	2-23	CD	1.0	185	185	200	200	185	185	
NA	2-24	CD	1.0	185	185	200	200	190	190	
					370/110		400/130		375/110	
	TU-2-14		K=2.310							
NA	2-25	CD	1.0	375	375	360	360	375	375	
NA	2-26	CD	1.0	375	375	430	430	375	375	
					750/230		790/235		750/235	
	TU-2-15		K=1.796							
NA	2-27	4"	.09	2222	200	2213	199	2249	202	
					200/100		199/104		202/104	
	TU-2-16		K=2.408							
NA	2-28	CD	1.0	275	275	250	250	275	275	
NA	2-29	CD	1.0	275	275	310	310	285	285	
NA	2-30	CD	1.0	275	275	250	250	275	275	
NA	2-31	CD	1.0	275	275	300	300	280	280	
					1100/330		1110/345		1115/345	

Notes:

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4 2ND FLOOR RENOVATIONS

SYSTEM AHU-2-4

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
	TU-2-17		K=2.226							
NA	2-32	CD	1.0	295	295	280	280	295	295	
NA	2-33	CD	1.0	295	295	315	315	305	305	
NA	2-34	CD	1.0	295	295	310	310	305	305	
NA	2-35	CD	1.0	295	295	325	325	305	305	
					1180/350		1230/360		1210/360	
	TU-2-18		K=1.634							
NA	2-36	CD	1.0	200	200	200	200	200	200	
					200/100		200/100		200/100	
	TU-2-19		K=2.158							
NA	2-37	CD	1.0	295	295	335	335	310	310	
NA	2-38	CD	1.0	295	295	305	305	295	295	
NA	2-39	CD	1.0	295	295	305	305	295	295	
NA	2-40	CD	1.0	295	295	320	320	305	305	
					1180/350		1265/365		1205/365	
SYSTEM TOTAL					10,365		-		10,517	

Notes:

VARIABLE VOLUME RETURN FAN TEST

JOB NAME ST. CLOUD VA BUILDING 4 2ND FLOOR RENOVATIONS

SYSTEM 4-AHU-2

MAKE YORK

MODEL XTI-051X084

	REQUIRED	PRELIMINARY	FINAL	NOTE
VFD (Hz)	60.0 Hz Max	49.9 Hz	55.4 Hz	
CFM	9500	8641	9826	1
FAN IN/OUT/TSP"	NA	-	-0.74/-0.13/0.61	
FAN RPM	NA	-	1445	
MOTOR RPM	1755	-	1638	
MOTOR VOLTAGE	460	480	480	
MOTOR AMPERAGE	9.55	6.5	7.0	
MOTOR HORSEPOWER	7.5	7.5	7.5	
MOTOR PULLEY	2BK47 X 1 1/8			
FAN PULLEY	2TB90 (Q1 X 1)			
BELT	(2) AX48			

Notes: 1) CFM measured by velocity grid traverse. Return fan lag speed set to 0%.

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4 2ND FLOOR RENOVATIONS

SYSTEM AHU-4-2 (Return Air)

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
RETURN AIR										
NA	2-1	CD	1.2	304	365	390	468	310	372	
NA	2-2	CD	1.2	138	165	210	252	140	168	
NA	2-3	CD	1.2	350	420	200	240	350	420	
NA	2-4	CD	1.2	138	165	90	108	140	168	
NA	2-5	CD	1.2	333	400	950	1140	340	408	
NA	2-6	CD	1.2	475	570	650	780	490	588	
NA	2-7	CD	1.2	713	855	920	1104	720	864	
NA	2-8	CD	1.2	713	855	920	1104	720	864	
NA	2-9	CD	1.2	475	570	400	480	480	576	
NA	2-10	CD	1.2	500	600	460	552	520	624	
NA	2-11	CD	1.2	308	370	410	492	310	372	
NA	2-12	CD	1.2	625	750	400	480	630	756	
NA	2-13	CD	1.2	917	1100	600	720	880	1056	
NA	2-14	CD	1.4	1687	2360	1820	2548	1700	2380	
					9545		-		9616	

Notes:

AIR SYSTEMS ENGINEERING

EXHAUST FAN TEST

JOB NAME ST. CLOUD VA BUILDING 4

FAN NO.	4EF-1	4EF-2			
MANUFACTURER	TWIN CITY FAN	TWIN CITY FAN			
MODEL NO.	DSI-100AE	DSI-080AE			
MOTOR HP	1/2	1/4			
VOLTAGE	115	115			
RATED AMPS	8.3	3.9			
ACTUAL AMPS	6.6	3.0			
REQUIRED FAN RPM	NA	NA			
ACTUAL FAN RPM	DIRECT DRIVE	DIRECT DRIVE			
REQUIRED CFM	540	330			
ACTUAL CFM	553	338			
LOCATION	ATTIC	ATTIC			
MOTOR PULLEY	-	-			
FAN PULLEY	-	-			
BELT SIZE	-	-			
NOTE					

NOTES:

AIR SYSTEMS ENGINEERING

DIFFUSER AND GRILL TEST

JOB NAME ST. CLOUD VA BUILDING 4

SYSTEM EXHAUST

ROOM	OUTLET NO.	OUTLET SIZE	"K"	REQUIRED		PRELIMINARY		FINAL		NOTE
				VEL	CFM	VEL	CFM	VEL	CFM	
	4EF-1									
211	1	CD	1.10	245	270	320	352	250	275	
213	2	CD	1.10	223	245	300	330	230	253	
213A	3	6X4	0.20	125	25	178	36	127	25	
					540		718		553	
	4EF-2									
249	1	CD	1.10	255	280	0	0	260	286	
248	2	6X4	0.20	250	50	231	46	259	52	
					330		46		338	

Notes:

AIR SYSTEMS ENGINEERING

CIRCULATING PUMP TEST

JOB NAME: ST. CLOUD VA BUILDING 4

Pump No.	4-P1	4-P2	4-P3	4-P4
Manufacturer	TACO	TACO	TACO	TACO
Model No.	NA	NA	NA	NA
Pump service	CHILLER	CHILLER	COOLING	COOLING

	Specified	**Actual**	Specified	**Actual**	Specified	**Actual**	Specified	**Actual**
GPM	200	183 (2)	200	183 (2)	425	180 (1)	425	180 (1)
Total Head	15	18	15	18	55	72	55	72
Pressure In	-	13	-	14	-	12	-	12
Pressure Out	-	21	-	22	-	43	-	43
Shut-off Head	-	21	-	21	-	78	-	78
Shut-off In	-	14	-	14	-	13	-	14
Shut-off Out	-	23	-	23	-	47	-	48
Discharge Valve Pos.	-	100%	-	100%	-	100%	-	100%
VFD	-	60 Hz	-	60 Hz	-	60 Hz		60 Hz
Horsepower	2	2	2	2	10	10	10	10
Voltage	460	481	460	481	460	480	460	480
Amperage	3.5	2.8	3.5	2.9	12.5	10.0	12.5	9.8
Pump RPM	1170	1176	1170	1187	1770	1780	1770	1792
Diff. Pres Setpt.	-	5.0	-	5.0	-	16.0	-	16.0

NOTES: 1) Pumps tested at full speed, future piping system not complete at time of testing.

2) Flow measured using pressure gauges at pump by comparing actual pump head to design head.

Maximum gpm attainable with pump operating at full speed.

* The check valve for pump 4-P3 did not funtion properly at the time of testing.

AIR SYSTEMS ENGINEERING

CIRCULATING PUMP TEST

JOB NAME: ST. CLOUD VA BUILDING 4

Pump No.	4-P5		4-P6		4-P7		4-P8	
Manufacturer	TACO		TACO		TACO		TACO	
Model No.	191C1E1 6.8				1919C1E1 7.2		1919C1E1 7.2	
Pump service	VAV HEAT		VAV HEAT		AHU HEAT		AHU HEAT	
	Specified	**Actual**	Specified	**Actual**	Specified	**Actual**	Specified	**Actual**
GPM	25	27	25	27	35	31 (1)	35	29 (1)
Total Head	45	46	45	46	50	53	50	55
Pressure In	-	12	-	12	-	13	-	13
Pressure Out	-	32	-	32	-	36	-	37
Shut-off Head	-	48	-	48	-	55	-	55
Shut-off In	-	12	-	12	-	14	-	14
Shut-off Out	-	33	-	33	-	38	-	38
Discharge Valve Pos.	-	100	-	100%	-	100%	-	100%
VFD	60 Hz MAX	60 Hz	60 Hz MAX	60 Hz	60 Hz MAX	60 Hz	60 Hz MAX	60 Hz
Horsepower	2	2	2	2	2	2	2	2
Voltage	460	480	460	480	460	480	460	480
Amperage	2.7	1.6	2.7	1.5	2.7	1.7	2.7	1.75
Pump RPM	1725	1778	1725	1765	1725	1768	1725	1772
Diff. Pres Setpt.	-	6.0	-	6.0	-	10.0	-	10.0

NOTES: 1) Maximum gpm attainable with pump operating at full speed.

WATER ELEMENT TEST

JOB NAME: ST. CLOUD VA BUILDING 4

Element	Element Type	Flow Fitting Size (Inches)	Specified GPM	Preliminary GPM	Final GPM	Final Valve Position	NOTES
4-CC1	CHILLED	3"	88.2	90.0	90.0	8.0	
4-CC2	CHILLED	3"	88.2	60.0	90.0	8.0	
4-HC1	HEAT	1 1/2"	17.5	14.5	14.5	4.0	1
4-HC2	HEAT	1 1/2"	17.5	8.5	15.0	4.0	1

NOTES:

1) Maximum gpm attainable with pump operating at 60 Hz and system in maximum heating flow condition.

* Entering and leaving air temperatures could not be measured at maximum heating load conditions to prevent occupant discomfort in fully occupied spaces.

** Entering and leaving air temperatures could not be measured at maximum cooling load conditions due to seasonal conditions.

WATER ELEMENT TEST

JOB NAME: ST. CLOUD VA BUILDING 4

Element	Element Type	Flow Fitting Size (Inches)	Specified GPM	Preliminary GPM	Final GPM	Final Valve Position	NOTES
TU-1-1	HEAT	3/4"	0.5	0.8	0.5	1.0	
TU-1-2	HEAT	3/4"	0.8	0.8	0.8	1.0	
TU-1-3	HEAT	3/4"	0.5	0.8	0.8	1.0	1
TU-1-4	HEAT	3/4"	0.6	0.9	0.9	1.0	1
TU-1-5	HEAT	3/4"	0.5	0.7	0.7	1.0	1
TU-1-6	HEAT	3/4"	0.5	0.0	1.0	1.0	1
TU-1-7	HEAT	3/4"	0.5	1.1	1.1	1.0	1
TU-1-8	HEAT	3/4"	0.5	1.1	1.1	1.0	1
TU-1-9	HEAT	3/4"	0.5	1.3	1.3	1.0	1
TU-1-10	HEAT	3/4"	0.5	1.2	1.2	1.0	1
TU-1-11	HEAT	3/4"	0.5	1.4	1.4	1.0	1
TU-1-12	HEAT	3/4"	0.5	1.3	1.3	1.0	1
TU-1-13	HEAT	3/4"	0.5	1.4	1.4	1.0	1
TU-1-14	HEAT	3/4"	0.5	1.4	1.4	1.0	1
TU-1-15	HEAT	3/4"	0.5	1.5	1.5	1.0	1
TU-1-16	HEAT	3/4"	0.5	1.4	1.4	1.0	1

NOTES:

1) Minimum GPM attainable with 3/4" balance valve 75% closed. Balance valve closed to a maximum of 75% to prevent possible clogging of valve orifice.

* EAT and LAT could not be tested to prevent occupant discomfort in fully occupied space.

WATER ELEMENT TEST

JOB NAME: ST. CLOUD VA BUILDING 4

Element	Element Type	Flow Fitting Size (Inches)	Specified GPM	Preliminary GPM	Final GPM	Final Valve Position	NOTES
TU-1-17	HEAT	3/4"	0.5	1.5	1.5	1.0	1
TU-1-18	HEAT	3/4"	0.5	1.6	1.6	1.0	1
TU-1-19	HEAT	3/4"	0.5	1.3	1.3	1.0	1
TU-1-20	HEAT	3/4"	0.5	1.6	1.6	1.0	1
TU-1-21	HEAT	3/4"	0.5	2.6	1.6	1.0	1
TU-1-22	HEAT	3/4"	0.5	2.4	1.5	1.0	1
TU-1-23	HEAT	3/4"	0.5	2.6	1.5	1.0	1
TU-1-24	HEAT	3/4"	0.5	2.4	1.5	1.0	1
TU-1-25	HEAT	3/4"	0.5	2.2	1.4	1.0	1
TU-2-1	HEAT	3/4"	0.5	0.3	0.5	1.0	
TU-2-2	HEAT	3/4"	0.5	0.5	0.5	4.0	
TU-2-3	HEAT	3/4"	0.5	0.7	0.7	1.0	1
TU-2-4	HEAT	3/4"	0.5	0.6	0.6	1.0	1
TU-2-5	HEAT	3/4"	0.5	0.7	0.7	1.0	1
TU-2-6	HEAT	3/4"	0.5	0.8	0.8	1.0	1
TU-2-7	HEAT	3/4"	0.5	0.0	0.9	1.0	1

NOTES:

1) Minimum GPM attainable with 3/4" balance valve 75% closed. Balance valve closed to a maximum of 75% to prevent possible clogging of valve orifice.

* EAT and LAT could not be tested to prevent occupant discomfort in fully occupied space.

WATER ELEMENT TEST

JOB NAME: ST. CLOUD VA BUILDING 4

Element	Element Type	Flow Fitting Size (Inches)	Specified GPM	Preliminary GPM	Final GPM	Final Valve Position	NOTES
TU-2-8	HEAT	3/4"	0.8	1.8	1.0	1.0	1
TU-2-9	HEAT	3/4"	0.5	1.9	1.0	1.0	1
TU-2-10	HEAT	3/4"	0.5	2.0	1.2	1.0	1
TU-2-11	HEAT	3/4"	0.5	2.0	1.1	1.0	1
TU-2-12	HEAT	3/4"	0.5	2.2	1.3	1.0	1
TU-2-13	HEAT	3/4"	0.5	2.3	1.4	1.0	1
TU-2-14	HEAT	3/4"	0.6	2.5	1.6	1.0	1
TU-2-15	HEAT	3/4"	0.5	2.4	1.5	1.0	1
TU-2-16	HEAT	3/4"	0.8	2.5	1.5	1.0	1
TU-2-17	HEAT	3/4"	0.8	2.6	1.6	1.0	1
TU-2-18	HEAT	3/4"	0.5	2.4	1.5	1.0	1
TU-2-19	HEAT	3/4"	0.8	2.5	1.6	1.0	1

NOTES:

1) Minimum GPM attainable with 3/4" balance valve 75% closed. Balance valve closed to a maximum of 75% to prevent possible clogging of valve orifice.

* EAT and LAT could not be tested to prevent occupant discomfort in fully occupied space.

SECTION 01 00 00
GENERAL REQUIREMENTS

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SECTION 01 00 00
GENERAL REQUIREMENTS

1.1 SAFETY REQUIREMENTS

Refer to section 01 35 26, SAFETY REQUIREMENTS for safety and infection control requirements. Throughout the campus there is existing hazardous material (lead paint, asbestos, etc); not all areas are shown on the drawings. Contractor shall maintain awareness, have safety plans, PPE and comply with OSHA, EPA and other related regulations when working near assemblies.

In addition to the requirements of the safety section, the contractor shall submit Safety Data Sheets per OSHA, for all products, chemicals, etc to be used on site within 15 business days of contract award. Any changes to the material, products, chemicals planned for use during the project shall be submitted and approved 15 business days prior to bringing the material onsite.

1.2 GENERAL INTENTION

A. Contractor shall completely prepare site for building operations, including demolition and removal of existing structures, and furnish labor and materials and perform work for th Repair Structural Foundations project as required by drawings and specifications.

1. The contract duration shall include all work, inspections and punch list corrections. Beneficial occupancy and final acceptance shall be achieved within the contract duration.

2. Contract working hours are 8 am to 4:30 pm Monday through Friday, excluding Federal Holidays.

B. Visits to the site by Bidders may be made only by appointment with the Contracting Officer.

C. Offices of LHB, as Architect-Engineers, will render certain technical services during construction. Such services shall be considered as advisory to the Government and shall not be construed as expressing or implying a contractual act of the Government without affirmations by Contracting Officer or his duly authorized representative.

D. Before placement and installation of work subject to tests by testing laboratory retained by the Contractor. The Contractor shall notify the COR not less than two work days in advance of the tests/inspection.

E. All employees of general contractor and subcontractors shall comply with VA security management program and obtain permission of the VA police, be identified by project and employer, and restricted from unauthorized access.

F. Prior to commencing work, the general contractor shall provide proof that the project supervisor assigned to the project is an OSHA 30 certified “competent person” (CP) (29 CFR 1926.20(b)(2). The CP will maintain a presence at the work site whenever the employees of the general contractor or subcontractors are present.

G. Training:

1. **The Contractor’s project supervisor is required to attend GEMS and Safety training provided by VA St. Cloud. Training must be attended prior to being designated as a job supervisor on any VA St. Cloud construction project.**

2. **All employees of general contractor and subcontractors shall have, at a minimum, the 10-hour OSHA certified Construction Safety course and other relevant competency training, as determined by VA CP with input from the Infection Control Risk Assessment (ICRA) team.**

3. **Submit training records of all such employees for approval before the start of work.**

4. **Notice to proceed will be issued not less than 2 weeks after receipt of bonds; time extensions will not be granted because of the need for training.**

H. Identification Badge:

All contractor employees working on this project will be required to obtain and wear while on VA property, a VA picture identification badge. The badge will only be issued to those employees having the appropriate OSHA Construction Safety Cards. All completed badge request forms, proof of OSHA training and any other required certificates shall be submitted electronically 60 business days in advance of working on site. Contractors will then be issued a badge free of charge by the VA. A separate site visit prior to performing work by each contractor employee shall be expected to obtain a badge. Contractors shall not perform work without a VA issued badge. **All ID badges must be returned upon contract completion. There will be a $200 charge for each PIV/Flash ID badge not returned at the end of the contract. There will be a $25 charge for “facility” badges and “contractor” or consultant badges. Reference security procedures for additional information. Payments to invoices will be withheld for badging noncompliance.**

Contractor and subcontractor employees that will work on VA property shall submit the following information to the Contracting Officer’s Representative (COR) when requesting a badge:

First, middle and last name (Legal name, as shown on picture ID)

Date of Birth (DOB)

Social Security Number (SSN)

Height

Eye Color

Hair Color

Name of Firm or Company

Place of Birth: Town/State

VA Contract Number

VA Project Name

Name of COR

I. Project Acceptance (Substantial Completion):

1. The acceptance of a project for substantial completion is to include the following:

a. The completion of all items to meet the criteria of the contract drawings and specifications to the satisfaction of the Contracting Officer (CO). Items for correction may be considered to be punch list items, as determined by the CO, if the COR finds them to be minor in correction. Value for the corrections will be held by the VA, as determined by the CO, until all corrections are completed to the satisfaction of the CO.

b. The VA will not accept a project, or phase of a project as determined by contract documents, as substantially complete until a complete passing test and balance report of the HVAC system **has been submitted and accepted as complete and passing by the CO. It is recommended that the HVAC system be completed with sufficient time to make corrections to submit a passing report. A time extension to the contract will not be considered for corrections to the HVAC system that are determined by the CO to be installation or design errors if within the contract.**

c. Occupancy and/or use of contractor provided/installed items does not require acceptance by the government. Contractor is to coordinate with the COR and the Contracting Officer when this condition exists.

d. In addition to the above items, the following conditions included in the contract shall be satisfied prior to requesting a final inspection to consider a substantial completion date.

1. All items completed within Division 1.
a. Occupied flushing of the building or similar commissioning activities identified prior to request of the final inspection may be considered punch list items subject to the discretion of the COR and Contracting Officer.

2. All items completed within Division 2 thru 8.

3. All items completed within Division 9.

a. No more than 1 patch and paint repair within 100 linear feet of wall shall be accepted as a punch list condition per project/phase. Unfinished painting conditions shall not be accepted as punch list items (i.e. cuts, blemishes, flashing etc).

b. No more than 1 flooring repair per 200 square feet shall be accepted as a punch list condition. Flooring repair is defined as gaps between tiles, grout damage, grout stains, grout gaps, broken tiles/flooring, scratches in tile/grout/flooring, gaps between wall base and flooring, incomplete transitions, poor adhesion, discoloration, etc.

c. No more than 1 ceiling repair per 200 square feet shall be accepted as a punch list condition.

4. All contractor furnished and/or contractor installed items completed within Division 10 and 11.

5. All items completed within Division 12 thru 22.

6. All items completed within Division 23.
a. Occupied flushing of the building or similar commissioning activities identified prior to request of the final inspection may be considered punch list items subject to the discretion of the COR and Contracting Officer.

7. All items completed within Division 25 thru 48.

E. General contractor to have dedicated site superintendent that is assigned to this project only. Contractor to include project management, site supervision and related expenses for the entire period of performance.

1.3 STATEMENT OF BID ITEM(S)

A. Work will include but not limited to: repair and or replacement of specific deteriorated sections or whole areas of concrete walls, foundations, beams, columns and ceilings as identified. Structural support measures will be in place prior to any demolition, excavation, repair or replacement. Steam, power, data, water and any other utility lines running through the work area will be protected and supported prior to starting work. Contractor shall incorporate all utility modifications, both temporary and permanent due to structure modification. Other types of work may include: welding/ torching/cutting metal, drilling/coring, demo removal, fill, compaction and concrete and all items necessary for the Repair Structural Foundations at Buildings 4, 7 and 59 at

the St. Cloud V.A. Health Care System Site. It shall be the responsibility of the contractor to coordinate all demolition and construction activities through VA personnel (COR).

1.4 SPECIFICATIONS AND DRAWINGS FOR CONTRACTOR

A. AFTER AWARD OF CONTRACT, Contractor is to provide his/her own drawings and specifications as downloaded from WWW.FBO.gov

B. The Contractor has the Duty of Coordination. By executing the contract the contractor agrees the contract package has been reviewed (prior to bid) to ensure that each trade included all work required to construct functional systems.

C. There is no requirement that the construction documents be completely accurate. Minor clarifications and coordination of details are not changes due to defective specifications.

D. Omissions from the drawings or specifications or the misdescription of details of work which are manifestly necessary to carry out the intent of the drawings and specifications, or which are customarily performed, shall not relieve the contractor from performing such omitted or misdescribed details of the work, but they shall be performed as if fully and correctly set forth and described in the drawings and specifications. The contractor shall furnish and install complete and functional systems.

1.5 CONSTRUCTION SECURITY REQUIREMENTS

A. Security Plan: A. Security Plan:

1. The security plan defines both physical and administrative security procedures that will remain effective for the entire duration of the project.

2. The General Contractor is responsible for assuring that all sub-contractors working on the project and their employees also comply with these regulations.

B. Security Procedures:

1. General Contractor’s employees shall not enter the project site without appropriate badge. They may also be subject to inspection of their personal effects when entering or leaving the project site.

2. All contractor and subcontractor employees working on this project are subject to a background investigation. VA has the right to refuse to badge any employee that does not pass the background investigation. It is expected that the contractor will have the employee scheduled for the issuance of a badge well in advance of starting work. Due to the badge process, the employee will not be able come to the VA, receive badge, and conduct work on same day. There will be a $**200** fine for badges issued and not returned upon completion of project.

3. Before starting work the General Contractor shall give 15 business days' notice to the COR so that security arrangements can be provided for the employees. This notice is separate from any notices required for utility shutdown described later in this section.

4. For working outside the "regular hours" as defined in the contract, the General Contractor shall give 15 business days' notice to the Contracting Officer and the COR so that arrangements can be made. This notice is separate from any notices required for utility shutdown described later in this section.

5. No photography of VA premises is allowed without written permission of the Contracting Officer.

6. VA reserves the right to close down or shut down the project site and order General Contractor's employees off the premises in the event of a national emergency. The General Contractor may return to the site only with the written approval of the Contracting Officer.

7. The prime contractor shall secure the entire construction operation (interior and exterior, staging, work area(s), etc) to prevent unauthorized access and to maintain appropriate (1 or 2 hour fire rating) fire separation between construction activities and VA space. It is the contractor's responsibility to furnish and install temporary walls/ceiling, chain link 8' fences, doors, gates, hardware for doors and/or gates as needed for their activities. Not all temporary provisions are illustrated on the construction documents. The contractor shall include 64 square feet of sheetrock assembly patching to patch existing walls used as construction barriers to a 1 hour fire barrier rating in each project phase. The contractor shall include 20 linear feet of red in color, fire caulk patching to existing walls used as construction barriers in each project phase. The contractor shall include UL listed fire barrier assemblies for temporary fire barrier protection thru construction barriers and other permanent fire barriers.

   Prior to installing temporary walls, the contractor and the COR shall inspect the existing conditions to determine if existing penetrations exist in existing fire barriers. The contractor shall ensure all fire barriers around the construction site are compliant prior to commencing with other non-fire barrier related construction activities.

   Temporary construction walls/ceilings shall be constructed of noncombustible material (metal framing with gypsum sheathing), per a UL rated 1hr fire rated assembly minimum (match existing rating if more than 1 hr), sound insulated with mineral wool batts and to a level 2 finish on the public side of the wall/ceiling. If the temporary construction wall/ceiling will remain in place for more than 5 business days, it shall be painted to cover, the color of the adjacent wall. Wood shall not be used in the temporary wall/ceiling assemblies. Corner guards or similar protective furnishing shall be at the contractors discretion. It is the contractors responsibility to repair/maintain the temporary assemblies due to wear and tear

caused by operations of the VA, contractor shall include costs for upkeep of the temporary barriers. Not all temporary wall/ceiling locations are illustrated on the plans. The contractor shall include material and labor as needed to separate VA occupied space and the construction activity. Temporary walls/ceilings shall be assembled in a manner to control dust per ICRA and remain compliant with below fire resistant poly duration limitations.

Temporary construction doors (interior and exterior) shall be an UL rated assembly with a minimum rating to be installed into a 1 hr fire rated wall or match increased rating of wall. Not all construction ingress and egress doors are illustrated on the plans. The contractor shall include material and labor for temporary doors and hardware to separate VA occupied space and the construction site. Repairing existing doors with wood filler due to temporary door hardware is not allowed. If the contractor alters an existing door for use as a temporary construction door, it shall be replaced with a new like and kind door assembly.

Fire resistant poly products per NFPA 241 shall only be used as dust control. It shall be used for up to (1) 8 hour work shift in a single location.

8. Contractor shall comply with VHA St. Cloud influenza policy (VHA Directive 1192.01 and VHA Directive 1013). Contractor shall direct all subcontractors working on site to also comply with VHA St. Cloud influenza policy. To comply with this policy, all contractors must complete a Health Care Personnel Influenza Vaccination Form during the influenza season which is generally from December 1 through March 31; however, it can vary from one season or geographic location to another. For security reasons, these forms are to be submitted directly to the St. Cloud VA Infection Prevention Nurse, whom will document and track influenza vaccination status. Starting at the end of December until the end of March, Contractor shall provide monthly a list of all contractors working on site. This list will be provided to the St. Cloud VA Infection Prevention Nurse whom can check against their documentation to confirm forms have been received for all contractors working on site during the influenza season. A copy of Directive 1192.01 and Directive 1013 and Health Care Personnel Influenza Vaccination Forms are available upon request.

C. Key Control:

1. Door hardware installed in construction doors is to be self-closing and storage function lock, able to receive a BEST 7 pin core and only operable with a key. The VA will install the construction core and issue keys to the contractor’s personnel. All construction fences are to be locked with a VA lock in series so VA engineering and police personnel have emergency access at all times. Construction fences are to be kept locked at all times to prevent access by patients and VA unauthorized staff. Contractor is to provide means of egress from the site that keeps the site secure from the exterior. Keys to necessary construction areas can be

checked out with the approval of the COR. The contractor is to give a minimum of 15 business days' notice for security approval for areas that need to be entered for construction purposes.

2. The General Contractor shall turn over all permanent lock cylinders to the VA locksmith for permanent installation. See Section 08 71 00, DOOR HARDWARE and coordinate.

3. VA construction core keys will be issued to the contractor as deemed necessary by the COR. All keys must be returned when no longer needed or upon completion of the contract. **There will be a $25 charge for each key not returned at the end of the contract. Should VA security be compromised as a result of failure to return a key(s), there will be an additional charge to the contractor of $25 for each door re-cored. There will be a $75 charge for any VA padlocks not returned by the contractor.**

D. Document Control:

1. Before starting any work, the General Contractor/Subcontractors shall submit an electronic security memorandum describing the approach to following goals and maintaining confidentiality of "sensitive information".

2. The General Contractor is responsible for safekeeping of all drawings, project manual and other project information. This information shall be shared only with those with a specific need to accomplish the project.

3. Certain documents, sketches, videos or photographs and drawings may be marked "Law Enforcement Sensitive" or "Sensitive Unclassified". Secure such information in separate containers and limit the access to only those who will need it for the project. Return the information to the Contracting Officer upon request.

4. These security documents shall not be removed or transmitted from the project site without the written approval of Contracting Officer.

5. All paper waste or electronic media such as CD's and diskettes shall be shredded and destroyed in a manner acceptable to the VA.

6. Notify Contracting Officer and Site Security Officer immediately when there is a loss or compromise of "sensitive information".

7. All electronic information shall be stored in specified location following VA standards and procedures using an Engineering Document Management Software (EDMS).

   a. Security, access and maintenance of all project drawings, both scanned and electronic shall be performed and tracked through the EDMS system.

b. “Sensitive information” including drawings and other documents may be attached to e-mail provided all VA encryption procedures are followed.

E. Motor Vehicle Restrictions

1. Vehicle authorization request shall be required for any vehicle entering the site and such request shall be submitted 5 business days before the date and time of access. Contractor shall maintain a list of vehicles of all employees (general contractor and subcontractors) working on their site. List shall include employee name, vehicle make, model, color and license plate number.

2. Ten parking permits shall be issued for General Contractor and subcontractor for parking in the east contractor lot. This lot is gravel, with minimum maintenance. No overnight parking of contractor vehicles allowed in this lot. No equipment and/or materials are allowed in this lot.

1.6 OPERATIONS AND STORAGE AREAS

A. The Contractor shall confine all operations (including storage of materials) on Government premises to areas authorized or approved by the Contracting Officer. The Contractor shall hold and save the Government, its officers and agents, free and harmless from liability of any nature occasioned by the Contractor's performance.

B. Temporary buildings (e.g., storage sheds, shops, offices) and utilities may be erected by the Contractor only with the approval of the Contracting Officer and shall be built with labor and materials furnished by the Contractor without expense to the Government. The temporary buildings and utilities shall remain the property of the Contractor and shall be removed by the Contractor at its expense upon completion of the work. With the written consent of the Contracting Officer, the buildings and utilities may be abandoned and need not be removed.

C. The Contractor shall, under regulations prescribed by the Contracting Officer, use only established roadways, or use temporary roadways constructed by the Contractor when and as authorized by the Contracting Officer. When materials are transported in prosecuting the work, vehicles shall not be loaded beyond the loading capacity recommended by the manufacturer of the vehicle or prescribed by any Federal, State, or local law or regulation. When it is necessary to cross curbs or sidewalks, the Contractor shall protect them from damage. This includes crossing curbs and other features when temporary roads and pedestrian walk ways are used. The Contractor shall repair or pay for the repair of any damaged curbs, sidewalks, or roads.

(FAR 52.236-10)

D. Working space and space available for storing materials shall be as shown on the drawings.

E. Works are subject to rules of Health Care System applicable to their conduct.

F. Execute work in such a manner as to interfere as little as possible with work being done by others. Keep roads clear of construction materials, debris, standing construction equipment and vehicles at all times.

G. Execute work so as to interfere as little as possible with the normal functioning of the Health Care System as a whole, including operations of utility services, fire protection systems and any existing equipment, and with work being done by others. The Contractor shall notify the COR prior to the use of equipment and tools that transmit vibrations and noises that can be either felt or heard outside the work site (core drilling, chipping hammer, jack hammer etc.). COR approval to use such equipment and tools shall be obtained in advance, not less than 10 business days prior to the use of such tools, in order to allow advance coordination with health care staff. Contractor to include pricing in the offer for executing this work off hours, before 8am and/or after 4:30 pm or as indicated in the construction documents. This applies to all VA occupied space and any occupied space adjacent to construction activities where noise above 80 decibel or vibration can be felt or heard.

1. Do not store materials and equipment in other than assigned areas.

2. Contractor shall coordinate and utilize just in time material and equipment delivery system. Long term storage of material is not allowed. Storage of common construction material beyond 5 business days is not allowed. Schedule delivery of materials and equipment to construction working areas in quantities sufficient for not more than 5 work days as the staging/storage areas as indicated on the plans allow. Provide unobstructed access to Health Care System areas required to remain in operation.

3. Contractor shall provide unobstructed access to VA Health Care System area required to remain in operation.

H. Utilities Services: Where necessary to cut existing pipes, electrical wires, conduits, cables, etc., of utility services, or of fire protection systems or communications systems (except telephone), they shall be cut and capped at suitable places where shown; or, in absence of such indication, where directed by the COR. All such actions shall be coordinated with the COR or Utility Company involved.

1. Whenever it is required that a connection fee be paid to a public utility provider for a new permanent service to the construction project, for such items as water, sewer, electricity, gas or steam, payment of such fee shall be the responsibility of the Government and no the Contractor.

J. Phasing:

The Health Care System must maintain its operation 24 hours a day 7 days a week. Therefore, any interruption in service must be scheduled 15 business days in advance and coordinated with the COR to ensure that no lapses in operation occur. It is the CONTRACTOR'S responsibility to develop a work plan and schedule detailing, at a minimum, the procedures to be employed, the equipment and materials to be used, the interim life safety measure to be used during the work, and a schedule defining the duration of the work with milestone subtasks.

To insure such executions, Contractor shall furnish the COR with a schedule of approximate phasing dates on which the Contractor intends to accomplish work in each specific area of site, building or portion thereof. In addition, Contractor shall notify the COR 20 business days in advance of the proposed date of starting work in each specific area of site, building or portion thereof. All phasing dates shall be arranged to insure accomplishment of this work in successive phases as detailed in the Construction Drawings for phasing. Unless noted otherwise, 15 business days between each phase is required for VA activations and move relocates. The contractor shall include this coordination time in their schedule.

K. not used.

L. Building(s) 4, 7 and 59 will be occupied during performance of work but immediate areas of alterations will be vacated.

1. Certain areas of Building(s) 4, 7 and 59 will be occupied by Health Care System personnel during construction activities.

   Contractor shall take all measures and provide all material necessary for protecting existing equipment and property in affected areas of construction against dust and debris, so that equipment and affected areas to be used in the Health Care System’s operations will not be hindered. Contractor shall permit access to Department of Veterans Affairs personnel through construction areas which serve as routes of access to such affected areas and equipment. These routes whether access or egress shall be isolated from the construction area by temporary partitions and have walking surfaces, lighting etc to facilitate staff access. Coordinate alteration work in areas occupied by Department of Veterans Affairs so that Health Care System operations will continue during the construction period.

M. Construction Fence: Before construction operations begin, Contractor shall provide a chain link construction fence, (eight feet) minimum height, around the construction area(s) indicated on the drawings or as required confining all construction activities and staged materials, equipment etc. All fences designed and inteneded to run parallel to sidewalks and roadways shall be atleast 5’ away from the edge/shoulder of sidewalks and/or roadways. Provide vehicle and “personnel gate” (s) for access with necessary hardware, including hasps and padlocks. The “personnel gate”(s) shall have panic hardware installed on the gate to allow emergency egress from the construction

staging area(s) and construction work zone(s) to the public way. Contractor must provide hardware on the gate to provide egress of contractor's staff and not allow access to unauthorized persons at the facility. An exterior grade metal door and frame (with appropriate hardware per ingress & egress requirements) professionally and securely installed into the fence assembly can be an alternative to "personnel gate (s)". VA engineering staff must have the ability to access this gate at any time. Fasten fence fabric to terminal posts with tension bands and to line posts and top and bottom rails with tie wires spaced at maximum 375mm (15 inches). Bottom of fences shall extend to 25mm (one inch) above grade. Access to the contractors' staging area and/or work site shall remain secure at all times. Secure is defined as locked to prevent unauthorized entrance to the construction site or during times of entrance or delivery, a construction representative shall be within 10 yards of the gate, monitoring the gate to prevent unauthorized access. Removal of construction fence shall be coordinated in advance with the COR.

N. When a building or part of a building and/or construction site is turned over to Contractor, Contractor shall accept entire responsibility including upkeep and maintenance therefore:

1. Contractor shall maintain a minimum temperature of 4 degrees C (40 degrees F) at all times, except as otherwise specified.

2. Contractor shall maintain in code compliant operating condition and provide any temporary material and equipment for existing fire protection and alarm equipment until the final systems are operational. During renovation the contractor shall alter the existing and/or install a temporary fire sprinkler system, compliant with NFPA to be used until the final system is opporational. In connection with fire alarm equipment, Contractor shall make arrangements for pre-inspection of site with VA's Fire Protection System Representative whichever will be required to respond to an alarm from Contractor's employee or watchman.

O. Utilities Services: Maintain existing utility services for Health Care System at all times. Not all details will be shown on the construction plan. Contractor shall request any additional information prior to bid if needed, contractor shall field verify electrical, HVAC, water, sewer and life systems in project area to provide material and equipment to maintain existing utilities for construction, life safety and operations of adjacent/impacted patients and/or staff. Provide temporary facilities, labor, materials, equipment, connections, and utilities to assure uninterrupted services. Where necessary to cut existing water, steam, gases, sewer or air pipes, or conduits, wires, cables, etc. of utility services or of fire protection systems and communications systems (including telephone), they shall be cut and capped at suitable places where shown; or, in absence of such indication, the Contractor shall coordinate in advance with the COR and receive COR approval to proceed prior to any such cuts or caps. The Contractor shall coordinate with the COR and the Utility Company when applicable. Utility pathways no longer used shall be removed back to the common source (main, branch, panel, junction box, etc).

1. No utility service such as water, gas, steam, sewers or electricity, or fire protection systems and communications systems may be interrupted without 15 business day notice and prior approval of the COR. No “HOT TAPPING” of any utility service other than storm or sanitary utilities is allowed unless under extreme circumstances. If these circumstances are determined appropriate and approved by the Chief Engineer, all work must follow Facilities Management Memorandum 23 “Hot Tapping Procedures”. All services under work shall be isolated and all energy released before work begins. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished, work on any energized circuits or equipment shall not commence without a detailed work plan, the Health Care System Director’s prior knowledge and written approval. Refer to specification Sections 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, 27 05 11 REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS and 28 05 11, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS for additional requirements.

2. Contractor shall submit a request to interrupt any such services to the COR, in writing, 15 business days in advance of proposed interruption. Request shall state reason, date, exact time of, and approximate duration of such interruption. The contractor will identify the detailed work activity plan related including a contingency plan with this request. The request shall be submitted to the COR via the RFI process.

3. Contractor will be advised (in writing) of approval of request, or of which other date and/or time such interruption will cause least inconvenience to operations of Health Care System. Interruption time approved by Health Care System may occur at other than Contractor's normal working hours.

4. Major interruptions (any utility systems affecting operations of the Health Care System, i.e. power, water, steam, heating, cooling etc outside of the immediate construction work site) of any system must be requested, in writing, at least 15 business days prior to the desired time and shall be performed as directed by the COR.

5. In case of a contract construction emergency, service will be interrupted on approval of the COR. Such approval will be confirmed in writing as soon as practical.

6. Whenever it is required that a connection fee be paid to a public utility provider for new permanent service to the construction project, for such items as water, sewer, electricity, gas or steam, payment of such fee shall be the responsibility of the Government and not the Contractor.

P. Abandoned Lines: All service lines such as wires, cables, conduits, ducts, pipes and the like (including hangers and all supports) shall be removed back to the common source (panels, main lines, branch lines, etc).

Q. To minimize interference of construction activities with flow of Health Care System traffic, comply with the following:

1. Keep roads, walks and entrances to grounds/parking/occupied areas of buildings clear of construction materials, debris and standing construction equipment and vehicles. Wherever excavation for new utility lines cross existing roads, at least one lane must be open to traffic at all times with approval.

2. The Contractor shall submit proposed methods and scheduling of required cutting, altering and removal of existing roads, walks and entrances to the COR not less than 15 work days in advance of any such work. Plans for such work must be approved in advance by the COR.

R. Coordinate the work for this contract with other construction operations and notify the COR in advance of scheduling of traffic and the use of roadways, as specified in Article, USE OF ROADWAYS.

1.7 ALTERATIONS

A. Survey: Before any work is started, the Contractor shall make a thorough survey with the COR in which alterations occur and areas which are anticipated routes of access, and furnish a report, signed by both, to the Contracting Officer. This report shall list by rooms and spaces:

1. Existing condition and types of resilient flooring, doors, windows, walls and other surfaces not required to be altered throughout affected areas of buildings.

2. Existence and conditions of items such as plumbing fixtures and accessories, electrical fixtures, equipment, venetian blinds, shades, etc., required by drawings to be either reused or relocated, or both.

3. Shall note any discrepancies between drawings and existing conditions at site.

4. Shall designate areas for working space, materials storage and routes of access to areas within buildings where alterations occur and which have been agreed upon by Contractor and the COR.

B. Any items required by drawings to be either reused or relocated or both, found during this survey to be nonexistent, or in opinion of the COR, to be in such condition that their use is impossible or impractical, shall be furnished and/or replaced by Contractor with new items in accordance with specifications which will be furnished by Government. Provided the contract work is changed by reason of this subparagraph B, the contract will be modified accordingly, under provisions of

clause entitled "DIFFERING SITE CONDITIONS" (FAR 52.236-2) and "CHANGES" (FAR 52.243-4 and VAAR 852.236-88).

C. Re-Survey: Thirty days before expected partial or final inspection date, the Contractor and the COR together shall make a thorough re-survey of the areas of buildings involved. They shall furnish a report on conditions then existing, of resilient flooring, doors, windows, walls and other surfaces as compared with conditions of same as noted in first condition survey report:

1. Re-survey report shall also list any damage caused by Contractor to such flooring and other surfaces, despite protection measures; and, will form basis for determining extent of repair work required of Contractor to restore damage caused by Contractor's workmen in executing work of this contract.

D. Protection: Provide the following protective measures:

1. Wherever existing roof surfaces are disturbed they shall be protected against water infiltration. In case of leaks, they shall be repaired immediately upon discovery.

2. Temporary protection against damage for portions of existing structures and grounds where work is to be done, materials handled and equipment moved and/or relocated.

3. Protection of interior of existing structures at all times, from damage, dust and weather inclemency. Wherever work is performed, floor surfaces that are to remain in place shall be adequately protected prior to starting work, and this protection shall be maintained intact until all work in the area is completed.

1.8 DISPOSAL AND RETENTION

A. Materials and equipment accruing from work removed and from demolition of buildings or structures, or parts thereof, shall be disposed of as follows:

1. Reserved items which are to remain property of the Government are identified by attached tags or noted on drawings or in specifications as items to be stored. Items that remain property of the Government shall be removed or dislodged from present locations in such a manner as to prevent damage which would be detrimental to re-installation and reuse. Store such items where directed by the COR.

2. Items not reserved shall become property of the Contractor and be removed by Contractor from Health Care System.

3. Items of portable equipment and furnishings located in rooms and spaces in which work is to be done under this contract shall remain the property of the Government. When rooms and spaces are vacated by the Department of Veterans Affairs during the alteration period, such items which are NOT required by drawings and specifications to be either relocated or reused

will be removed by the Government in advance of work to avoid interfering with Contractor's operation.

1.9 PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS

A. The Contractor shall preserve and protect all surfaces including but not limited to asphalt, sidewalks, curbs, structures, equipment, and vegetation (such as trees, shrubs, and grass) on or adjacent to the work site, which are not to be removed and which do not unreasonably interfere with the work required under this contract. The Contractor shall only remove trees when specifically authorized to do so, and shall avoid damaging vegetation that will remain in place. If any limbs or branches of trees are broken during contract performance, or by the careless operation of equipment, or by workmen, the Contractor shall trim those limbs or branches with a clean cut and paint the cut with a tree-pruning compound. Any grass that is damaged during construction will have the pre-existing grade restored, be sodded and maintained until the sod is firmly rooted as determined by the COR. Sod will be watered by contractor and may not exceed 4 inches while the contractor is responsible for the sod. Any trees/shrubs not identified for demolition shall remain. The contractor shall protect the existing trees/shrubs from damage by enclosing the dripline area with plastic fence. No material, vehicles and/or equipment shall be stored within this protected area. Tree trimming is not allowed as the trees are considered “historic”. Contractors shall make all reasonable efforts to use other methods to not conflict with trees (i.e. shorter/smaller equipment).

B. The Contractor shall protect from damage all existing improvements and utilities at or near the work site and on adjacent property of a third party, the locations of which are made known to or should be known by the Contractor. The Contractor shall repair any damage to those facilities, including those that are the property of a third party, resulting from failure to comply with the requirements of this contract or failure to exercise reasonable care in performing the work. If the Contractor fails or refuses to repair the damage promptly, the Contracting Officer may have the necessary work performed and charge the cost to the Contractor.

(FAR 52.236-9)

C. Refer to Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS, for additional requirements on protecting vegetation, soils and the environment. Refer to Articles, "Alterations", "Restoration", and "Operations and Storage Areas" for additional instructions concerning repair of damage to structures and site improvements. At a minimum, the contractor is to comply with all EPA regulations for protection from storm water pollution that would be caused by construction and implement all required safeties to maintain compliance. Also, all wash downs for concrete trucks is to be conducted off site. No containment areas are allowed on site.

D. Refer to FAR clause 52.236-7, "Permits and Responsibilities," which is included in General Conditions. A National Pollutant Discharge Elimination System (NPDES)and/or Storm Water pollution Prevention Plan (SWPPP) permit is required for this project. The Contractor is considered an "operator" under the permit and has extensive responsibility for compliance with permit requirements. VA will provide the permit application upon request available at the (appropriate Health Care System) office. The Contractor and affected subcontractors shall furnish all information and certifications that are required to comply with the permit process and permit requirements. Many of the permit requirements will be satisfied by completing construction as shown and specified. Some requirements involve the Contractor's method of operations and operations planning and the Contractor is responsible for employing best management practices. The affected activities often include, but are not limited to the following:

- Designating areas for equipment maintenance and repair;
- Providing waste receptacles at convenient locations and provide regular collection of wastes;
- Locating equipment wash down areas on site, and provide appropriate control of wash-waters; concrete truck wash down is not allowed on site.
- Providing protected storage areas for chemicals, paints, solvents, fertilizers, and other potentially toxic materials; and
- Providing adequately maintained sanitary facilities.

E. Contractor shall maintain grounds in and around their construction site including all staging, storage and parking areas assigned to this contract (referred to as construction area). Contractor shall remove debris promptly within construction areas. Contractor shall mow and weed whip the construction areas and weed whip on the public side of their construction fences. Mowing and whipping shall occur on regular basis at all times throughout the active contract to prevent vegetation from exceeding 4” in height. Weed control shall be maintained throughout the construction contract period with a plan approved by the COR to return construction site to the preexisting condition unless stated otherwise.

Contractor shall make all reasonable attempts to prevent tracking or other type of unintentional debris transferring of material. Should this occur, the contractor shall complete clean up the affected areas within 2 hours of the discovery.

Inlet protection bags shall be clear of debris after each rain event. Any erosion control blankets or spikes used shall be biodegradable.

Contractor shall not use a “restricted use” herbicide.

1.10 RESTORATION

A. Remove, cut, alter, replace, patch and repair existing work as necessary to install new work. Except as shown in the drawings or specified, do not cut, alter or remove any structural work, and do not disturb any ducts, plumbing, steam, gas, or electric work without prior written approval of the CO. Existing work to be altered or extended and that is found to be defective in any way, shall be reported to the COR before it is disturbed. Materials and workmanship used in restoring work, shall conform in type and quality to that of original existing construction, except as otherwise shown or specified.

B. Upon completion of contract, deliver work complete and undamaged. Existing work (walls, ceilings, partitions, floors, mechanical and electrical work, lawns, paving, roads, walks, etc.) disturbed or removed as a result of performing required new work, shall be patched, repaired, reinstalled, or replaced with new work, and refinished and left in as good condition as existed before commencing work.

C. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workmen to existing piping and conduits, wires, cables, etc., of utility services or of fire protection systems and communications systems (including telephone) which are not scheduled for discontinuance or abandonment.

D. Expense of repairs to such utilities and systems not shown on drawings or locations of which are unknown will be covered by adjustment to contract time and price in accordance with clause entitled "CHANGES" (FAR 52.243-4 and VAAR 852.236-88) and "DIFFERING SITE CONDITIONS" (FAR 52.236-2).

1.11 PHYSICAL DATA

A. Data and information furnished or referred to below is for the Contractor's information. The Government shall not be responsible for any interpretation of or conclusion drawn from the data or information by the Contractor.

(FAR 52.236-4)

B. Subsurface conditions have been developed by core borings and test pits. Logs of subsurface exploration are shown diagrammatically on drawings.

C. Government does not guarantee that other materials will not be encountered nor that proportions, conditions or character of several materials will not vary from those indicated by explorations. Bidders are expected to examine site of work and logs of borings; and, after investigation, decide for themselves character of materials and make their bids accordingly. Upon proper application to Department of Veterans Affairs, bidders will be permitted to make subsurface explorations of their own at site.

1.12 PROFESSIONAL SURVEYING SERVICES

A registered professional land surveyor or registered civil engineer whose services are retained and paid for by the Contractor shall perform services specified herein and in other specification sections. The Contractor shall certify that the land surveyor or civil engineer is not one who is a regular employee of the Contractor, and that the land surveyor or civil engineer has no financial interest in this contract.

1.13 LAYOUT OF WORK

A. The Contractor shall lay out the work from Government established base lines and bench marks, indicated on the drawings, and shall be responsible for all measurements in connection with the layout. The Contractor shall furnish, at Contractor's own expense, all stakes, templates, platforms, equipment, tools, materials, and labor required to lay out any part of the work. The Contractor shall be responsible for executing the work to the lines and grades that may be established or indicated by the Contracting Officer. The Contractor shall also be responsible for maintaining and preserving all stakes and other marks established by the Contracting Officer until authorized to remove them. If such marks are destroyed by the Contractor or through Contractor's negligence before their removal is authorized, the Contracting Officer may replace them and deduct the expense of the replacement from any amounts due or to become due to the Contractor.

(FAR 52.236-17)

B. Establish and plainly mark center lines for each building and corner of column lines and/or addition to each existing building, and such other lines and grades that are reasonably necessary to properly assure that location, orientation, and elevations established for each such structure and/or addition, are in accordance with lines and elevations shown on contract drawings.

C. Following completion of general mass excavation and before any other permanent work is performed, establish and plainly mark (through use of appropriate batter boards or other means) sufficient additional survey control points or system of points as may be necessary to assure proper alignment, orientation, and grade of all major features of work. Survey shall include, but not be limited to, location of lines and grades of footings, exterior walls, center lines of columns in both directions, major utilities and elevations of floor slabs:

1. Such additional survey control points or system of points thus established shall be checked and certified by a registered land surveyor or registered civil engineer. Furnish such certification to the COR before any work (such as footings, floor slabs, columns, walls, utilities and other major controlling features) is placed.

D. During progress of work, and particularly as work progresses from floor to floor, Contractor shall have line grades and plumbness of all major form work checked and certified by a registered land surveyor or registered civil engineer as meeting requirements of contract drawings. Furnish such certification to the COR before any major items of concrete work are placed. In addition, Contractor shall furnish to the COR certificates from a registered land surveyor or registered civil engineer that the following work is complete in every respect as required by contract drawings.

1. Lines of each building and/or addition.

2. Elevations of bottoms of footings and tops of floors of each building and/or addition.

3. Lines and elevations of sewers and of all outside distribution systems.

E. Whenever changes from contract drawings are made in line or grading requiring certificates, record such changes on a reproducible drawing bearing the registered land surveyor or registered civil engineer seal, and forward these drawings upon completion of work to the COR.

F. The Contractor shall perform the surveying and layout work of this and other articles and specifications in accordance with the provisions of Article "Professional Surveying Services".

1.14 AS-BUILT DRAWINGS

A. The contractor shall maintain two full size sets of as-built drawings which will be kept current during construction of the project, to include all contract changes, modifications and clarifications (Field coordination, Request For Information, Architectural Supplemental Info, PR’s etc). These drawings shall be maintained and protected in a professional manner. All information shall be legiable to a reasonable person.

B. All variations shall be shown in the same general detail as used in the contract drawings. To insure compliance, as-built drawings shall be made available for COR review, as often as requested.

C. Contractor shall deliver two approved completed sets of as-built drawings in the electronic version (scanned PDF) to the COR within 15 calendar days after each completed phase and after the acceptance of the project by the COR.

D. Paragraphs A, B, & C shall also apply to all shop drawings.

1.15 USE OF ROADWAYS

A. For hauling, use only established public roads and roads on Health Care System property and, when authorized by the COR, such temporary roads which are necessary in the performance of contract work. Temporary roads shall be constructed and restoration performed by the Contractor at Contractor's expense. When necessary to cross curbing, sidewalks, or similar construction, they must be protected by well-constructed bridges.

B. When new permanent roads are to be a part of this contract, Contractor may construct them immediately for use to facilitate building operations. These roads may be used by all who have business thereon within zone of building operations.

C. When certain buildings (or parts of certain buildings) are required to be completed in advance of general date of completion, all roads leading thereto must be completed and available for use at time set for completion of such buildings or parts thereof.

1.16 NOT USED

1.17 TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT

A. Use of new installed mechanical and electrical equipment to provide heat, ventilation, plumbing, light and power will be permitted subject to written approval and compliance with the following provisions:

1. Permission to use each unit or system must be given by the Contracting Officer in writing. Any such equipment shall be installed and maintained in accordance with the written agreement and following provisions

2. Electrical installations used by the equipment shall be completed in accordance with the drawings and specifications to prevent damage to the equipment and the electrical systems, i.e. transformers, relays, circuit breakers, fuses, conductors, motor controllers and their overload elements shall be properly sized, coordinated and adjusted. Installation of temporary electrical equipment or devices shall be in accordance with NFPA 70, National Electrical Code, (2017 Edition), Article 590, *Temporary Installations.* Voltage supplied to each item of equipment shall be verified to be correct. Motors shall not be overloaded. The electrical equipment shall be thoroughly cleaned before using it and again immediately before final inspection including vacuum cleaning and wiping clean interior and exterior surfaces.

3. Units shall be properly lubricated, balanced, and aligned. Vibrations must be reduced to contract specifications or, in the absence of contracting specifications, to at or below manufacturer’s specifications for typical installations.

4. Automatic temperature control systems for preheat coils shall function properly and all safety controls shall function to prevent coil freeze-up damage.

5. The air filtering system utilized shall be that which is designed for the system when complete, and all filter elements shall be replaced at completion of construction and prior to testing and balancing of system.

6. All components of heat production and distribution system, metering equipment, condensate returns, and other auxiliary facilities used in temporary service shall be cleaned prior to use;

maintained to prevent corrosion internally and externally during use; and cleaned, maintained and inspected prior to acceptance by the Government.

B. Prior to final inspection, the equipment or parts used which show wear and tear beyond normal, shall be replaced with identical replacements, at no additional cost to the Government.

C. This paragraph shall not reduce the requirements of the mechanical and electrical specifications sections.

D. Any damage to the equipment or excessive wear due to prolonged use will be repaired replaced by the contractor at the contractor’s expense.

1.18 TEMPORARY USE OF EXISTING ELEVATORS

A. Use of existing elevators for handling building materials and Contractor's personnel will be permitted subject to following provisions:

1. Contractor makes advance arrangements with the COR for use of elevators. The COR will ascertain that elevators are in proper condition. Contractor may use elevators for daily use and for special nonrecurring time intervals once permission is granted by the COR. Personnel for operating elevators will not be provided by the Department of Veterans Affairs.

2. Contractor covers and provides maximum protection of following elevator components:

a. Entrance jambs, heads soffits and threshold plates.

b. Entrance columns, canopy, return panels and inside surfaces of car enclosure walls.

c. Finish flooring.

1.19 NOT USED

1.20 TEMPORARY TOILETS

A. Provide where directed, (for use of all Contractor's workmen) ample temporary sanitary toilet accommodations with suitable sewer and water connections; or, when approved by the COR , provide suitable dry closets where directed. Keep such places clean and free from flies, and all connections and appliances connected therewith are to be removed prior to completion of contract, and premises left perfectly clean.

1.21 AVAILABILITY AND USE OF UTILITY SERVICES

A. The Government shall make all reasonably required amounts of utilities available to the Contractor from existing outlets and supplies, as specified in the contract. The Contractor shall carefully conserve all utilities furnished.

B. The Contractor, at Contractor's expense and in a workmanlike manner, in compliance with code and as satisfactory to the Contracting Officer, shall install and maintain all necessary temporary

connections and distribution lines. Before final acceptance of the work by the Government, the Contractor shall remove all the temporary connections, distribution lines, meters, and associated paraphernalia and repair restore the infrastructure as required.

C. Contractor shall furnish and install temporary utility meters at Contractor's expense and furnish the Health Care System a monthly record of the Contractor's usage of all furnished utilities including but not limited to electricity, water and steam.

D. Heat: Furnish temporary heat necessary to prevent injury to work and materials through dampness and cold. Use of open flame devices including but not limited to ‘salamander’ is not permitted on St Cloud VA property. Use only indirect heat exchanger heaters. Maintain minimum temperatures as specified for various materials:

1. Obtain heat by connecting to Health Care System heating distribution system.

   a. Steam is available at no cost to Contractor. Building must be dried in (weather tight), perimtere completely insulated per design and deemed not wasteful (by Chief Engineer) of VA utilities prior to heating with steam.

   b. Electric Resistance heat is not allowed.

2. If the contractor elects not to connect to the nearest available steam supply, gas/fuel heaters will be allowed with a submitted plan that is approved by the COR and facility Safety Officer.

   a. Gas/fuel heaters must be an indirect heat unit with a heat exchanger. The unit must utilize a fresh air intake and exhaust outdoors.

   b. All gas/fuel is to be supplied by the contractor at contractor’s expense.

E. Electricity (for Construction and Testing): Furnish all temporary electric services.

1. Obtain electricity by connecting to the Health Care System electrical distribution system. The Contractor shall meter and pay for electricity required for electric cranes and hoisting devices, electrical welding devices and any electrical heating devices providing temporary heat. Electricity for all other uses is available at no cost to the Contractor.

F. Water (for Construction and Testing): Furnish temporary water service.

1. Obtain water by connecting to the Health Care System water distribution system. Provide reduced pressure backflow preventer at each connection as per code. Water is available at no cost to the Contractor.

2. Maintain connections, pipe, fittings and fixtures and conserve water-use so none is wasted. Failure to stop leakage or other wastes may be cause for revocation (at Contracting Officer's discretion) of use of water from Health Care System's system.

3. Water from the potable water system may not be used for irrigation. Irrigation water is available on campus near the Sauk River pump from Monday through Friday, June through the end of September between the hours of 1pm to 4pm. Contractor shall arrange for transportation of water, and source of water outside of those times.

4. **Contractor Water Activities** - any action in which water is used on a construction site that creates an aerosolized risk (landscape watering, compaction watering, moisture content adjustments, dust mitigation, cleaning, surface preparation, dewatering pumps etc)shall be conducted offhours when patients are not traversing the grounds to prevent risk of legionella impacts. Contractors shall not utilize a method of watering that aerosolizes to create a legionella risk to adjacent patients. The contractors watering activities shall be completed under supervision of an employee of the prime contractor.

G. Fuel: Natural and LP gas and burner fuel oil required for boiler cleaning, normal initial boiler-burner setup and adjusting, and for performing the specified boiler tests will be furnished by the Government. Fuel required for prolonged boiler-burner setup, adjustments, or modifications due to improper design or operation of boiler, burner, or control devices shall be furnished and paid by the Contractor at Contractor's expense.

1.22 NEW TELEPHONE EQUIPMENT

The contractor shall coordinate with the work of installation of telephone equipment by others. This work shall be completed before the building is turned over to VA.

1.23 TESTS

A. Pre-test mechanical and electrical equipment and systems and make corrections required for proper operation of such systems before requesting final tests. Final test will not be conducted unless pre-tested.

B. Conduct final tests required in various sections of specifications in presence of an authorized representative of the Contracting Officer. Contractor shall furnish all labor, materials, equipment, instruments, and forms, to conduct and record such tests.

C. Mechanical and electrical systems shall be balanced, controlled and coordinated. A system is defined as the entire system which must be coordinated to work together during normal operation to produce results for which the system is designed. For example, air conditioning supply air is only one part of entire system which provides comfort conditions for a building. Other related components are return air, exhaust air, steam, chilled water, refrigerant, hot water, controls and

electricity, etc. Another example of a system which involves several components of different disciplines is a boiler installation. Efficient and acceptable boiler operation depends upon the coordination and proper operation of fuel, combustion air, controls, steam, feedwater, condensate and other related components.

D. All related components as defined above shall be functioning when any system component is tested. Tests shall be completed within a reasonable period of time during which operating and environmental conditions remain reasonably constant and are typical of the design conditions.

E. Individual test result of any component, where required, will only be accepted when submitted with the test results of related components and of the entire system.

1.24 INSTRUCTIONS

A. Contractor will be provided an electronic copy of the VA equipment log spreadsheet. During the initial start-up, the contractor shall submit the populated spreadsheet to include the following information for each piece of equipment:

- Equipment installed
- Manufacturer of equipment
- Model # of equipment
- Serial # of equipment
- Location of equipment
- Market value of equipment
- Purchase date of equipment
- Manufacturer warranty end date of equipment

Contractor shall also furnish Maintenance and Operating manuals (hard copies and electronic), completed start-up check lists and verbal instructions when the equipment is activated and as required by the various sections of the specifications and as hereinafter specified.

B. Manuals: Maintenance and operating manuals and one compact disc (four hard copies and one electronic copy each) for each separate piece of equipment shall be delivered to the COR coincidental with the delivery of the equipment to the job site. Manuals shall be complete, detailed guides for the maintenance and operation of equipment. They shall include complete information necessary for starting, adjusting, maintaining in continuous operation for long periods of time and dismantling and reassembling of the complete units and sub-assembly components. Manuals shall include an index covering all component parts clearly cross-referenced to diagrams and illustrations. Illustrations shall include "exploded" views showing and identifying each separate item. Emphasis shall be placed on the use of special tools and instruments. The function of each piece of equipment, component, accessory and control shall be clearly and thoroughly explained. All necessary precautions for the operation of the equipment and the reason for each precaution shall be clearly set forth. Manuals must reference the exact model, style and size of the piece of equipment and system being furnished. Manuals referencing equipment similar to but of a different model, style, and size than that furnished will not be accepted.

C. Instructions: Contractor shall provide qualified, factory-trained manufacturers' representatives to give detailed training to assigned Department of Veterans Affairs personnel in the operation and complete maintenance for each piece of equipment. All such training will be at the job site. These requirements are more specifically detailed in the various technical sections. Training for different items of equipment that are component parts of a complete system, shall be given in an integrated, progressive manner. All instructors for every piece of component equipment in a system shall be available until training for all items included in the system have been completed. This is to assure proper instruction in the operation of inter-related systems. The Contractor shall coordinate and schedule all training in advance with the COR. Training shall be considered concluded only when the COR is satisfied in regard to complete and thorough coverage. The contractor shall submit a course outline with associated material to the COR for review and approval prior to scheduling training to ensure the subject matter covers the expectations of the VA and the contractual requirements. The Department of Veterans Affairs reserves the right to request the removal of, and substitution for, any instructor who, in the opinion of the COR, does not demonstrate sufficient qualifications.

1.25 NOT USED

1.26 RELOCATED EQUIPMENT

A. Contractor shall disconnect, dismantle as necessary, remove and reinstall in new location, all existing equipment and items indicated or otherwise shown to be relocated by the Contractor.

B. Perform relocation of such equipment or items at such times and in such a manner as directed by the COR.

C. Suitably cap existing service lines, such as steam, condensate return, water, drain, gas, air, vacuum and/or electrical, at the main whenever such lines are disconnected from equipment to be relocated. Remove abandoned lines in finished areas and cap as specified herein before under paragraph "Abandoned Lines".

D. Provide all mechanical and electrical service connections, fittings, fastenings and any other materials necessary for assembly and installation of relocated equipment; and leave such equipment in proper operating condition.

F. All service lines such as noted above for relocated equipment shall be in place at point of relocation ready for use before any existing equipment is disconnected. Make relocated existing equipment ready for operation or use immediately after reinstallation.

1.27 NOT USED

1.28 NOT USED

1.29 SAFETY SIGN

A. Provide a Safety Sign where directed by the COR. Face of sign shall be 19 mm (3/4 inch) thick exterior grade plywood. Provide two 100 mm by 100 mm (four by four inch) posts extending full height of sign and 900 mm (three feet) into ground. Set bottom of sign level at 1200 mm (four feet) above ground.

B. Paint all surfaces of Safety Sign and posts with one prime coat and two coats of white gloss paint. Letters and design shall be painted with gloss paint of colors noted.

C. Maintain sign and remove it when directed by the COR.

D. Standard Detail Drawing Number SD10000-02(Found on VA TIL) of safety sign showing required legend and other characteristics of sign is attached hereto and is made a part of this specification.

1.30 PHOTOGRAPHIC DOCUMENTATION

A. During the construction period through completion, provide photographic documentation of construction progress and at selected milestones including electronic indexing, navigation, storage and remote access to the documentation, as per these specifications. A minimum of 50 photos per month (for NRM) and 75 photos per month (for Minor) are to be delivered monthly on 2 CD’s to the COR. The commercial photographer or the subcontractor used for this work shall meet the following qualifications:

1. Demonstrable minimum experience of three (3) years in operation providing documentation and advanced indexing/navigation systems including a representative portfolio of construction projects of similar type, size, duration and complexity as the Project.

2. Demonstrable ability to service projects throughout North America, which shall be demonstrated by a representative portfolio of active projects of similar type, size, duration and complexity as the Project.

B. Photographic documentation elements:

1. Each digital image shall be taken with a professional grade camera with minimum size of 6 megapixels (MP) capable of producing 200x250mm (8 x 10 inch) prints with a minimum of 2272 x 1704 pixels and 400x500mm (16 x 20 inch) prints with a minimum 2592 x 1944 pixels.

2. Indexing and navigation system shall utilize actual AUTOCAD construction drawings, making such drawings interactive on an on-line interface. For all documentation referenced herein, indexing and navigation must be organized by both time (date-stamped) and location throughout the project.

3. Documentation shall combine indexing and navigation system with inspection-grade digital photography designed to capture actual conditions throughout construction and at critical

milestones. Documentation shall be accessible on-line through use of an internet connection. Documentation shall allow for secure multiple-user access, simultaneously, on-line.

4. Before construction, the building pad, adjacent streets, roadways, parkways, driveways, curbs, sidewalks, landscaping, adjacent utilities and adjacent structures surrounding the building pad and site shall be documented. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive architectural drawings. If site work or pad preparation is extensive, this documentation may be required immediately before construction and at several pre-determined intervals before building work commences.

5. Construction progress for all trades shall be tracked at pre-determined intervals, but not less than once every thirty (30) calendar days (“Progressions”). Progression documentation shall track both the exterior and interior construction of the building. Exterior Progressions shall track 360 degrees around the site and each building. Interior Progressions shall track interior improvements beginning prior to demolition commencing and continuing until Project completion.

6. As-built condition of pre-foundation utilities and site utilities shall be documented prior to pouring footers, placing concrete and/or backfilling. This process shall include all underground and in-slab utilities within the building(s) envelope(s) and utility runs in the immediate vicinity of the building(s) envelope(s). This may also include utilities enclosed in slab-on-deck in multi-story buildings. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive site utility plans.

7. As-built conditions of mechanical, electrical, plumbing and all other systems shall be documented post-inspection and pre-insulation, sheet rock or dry wall installation. This process shall include all finished systems located in the walls and ceilings of all buildings at the Project. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive architectural drawings.

8. As-built conditions of exterior skin and elevations shall be documented with an increased concentration of digital photographs as directed by the COR in order to capture pre-determined focal points, such as waterproofing, window flashing, radiused steel work, architectural or Exterior Insulation and Finish Systems (EIFS) detailing. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive elevations or elevation details.

9. As-built finished conditions of the interior of each building including floors, ceilings and walls shall be documented at certificate of occupancy or equivalent, or just prior to occupancy, or

both, as directed by the COR. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive architectural drawings.

10. Miscellaneous events that occur during any Contractor site visit, or events captured by the Department of Veterans Affairs independently, shall be dated, labeled and inserted into a Section in the navigation structure entitled “Slideshows,” allowing this information to be stored in the same “place” as the formal scope.

11. Customizable project-specific digital photographic documentation of other details or milestones. Indexing and navigation accomplished through interactive architectural plans.

12. Monthly (29 max) exterior progressions (360 degrees around the project) and slideshows (all elevations and building envelope). The slideshows allow for the inclusion of Department of Veterans Affairs pictures, aerial photographs, and timely images which do not fit into any regular monthly photopath.

13. Weekly (21 Max) Site Progressions - Photographic documentation capturing the project at different stages of construction. These progressions shall capture underground utilities, excavation, grading, backfill, landscaping and road construction throughout the duration of the project.

14. Regular (8 max) interior progressions of all walls of the entire project to begin at time of substantial framed or as directed by the COR through to completion.

15. Detailed Exact-Built of all Slabs for all project slab pours just prior to placing concrete or as directed by the COR.

16. Detailed Interior exact built overlapping photos of the entire building to include documentation of all mechanical, electrical and plumbing systems in every wall and ceiling, to be conducted after rough-ins are complete, just prior to insulation and or drywall, or as directed by the COR.

17. Finished detailed Interior exact built overlapping photos of all walls, ceilings, and floors to be scheduled by the COR prior to occupancy.

18. In event a greater or lesser number of images than specified above are required by the COR, adjustment in contract price will be made in accordance with clause entitled "CHANGES" (FAR 52.243-4 and VAAR 852.236-88).

C. Images shall be taken by a commercial photographer and must show distinctly, at as large a scale as possible, all parts of work embraced in the picture.

D. Coordination of photo shoots is accomplished through the COR. Contractor shall also attend construction team meetings as necessary. Contractor's operations team shall provide regular updates regarding the status of the documentation, including photo shoots concluded, the availability of new Progressions or Exact-Builts viewable on-line and anticipated future shoot dates.

E. Contractor shall provide all on-line domain/web hosting, security measures, and redundant server back-up of the documentation.

F. Contractor shall provide technical support related to using the system or service.

G. Upon completion of the project, final copies of the documentation (the "Permanent Record") with the indexing and navigation system embedded (and active) shall be provided in an electronic media format, typically a DVD or external hard-drive. Permanent Record shall have Building Information Modeling (BIM) interface capabilities. On-line access terminates upon delivery of the Permanent Record.

1.31 NOT USED

1.32 HISTORIC PRESERVATION

Where the Contractor or any of the Contractor's employees, prior to, or during the construction work, are advised of or discover any possible archeological, historical and/or cultural resources, the Contractor shall immediately notify the COR verbally, and then with a written follow up. The Contractor shall cease work at the point of discovery in order to protect the find from damage, pending direction from the Contracting Officer as to how to proceed.

1.33 REBATE DOCUMENTATION

A. As the VA is involved in rebate programs for installed materials and equipment, the contractor is to provide information to the COR including invoices, information sheets, etc. as required for the government to successfully receive rebates.

1.34 SITE INSPECTIONS

A. The Government reserves the right to inspect the project site during contractor performance. Inspections shall conform to FAR 52.246-12 and herein described.

B. Inspections shall be conducted randomly on a daily basis by the assigned COR and/or other Facilities Management (FM) staff members. Once per week project sites may be inspected by Facilities Management team. Work shall continue during these inspections as usual, as these are routine compliance inspections.

C. Throughout the duration of the project the contractor shall schedule critical milestone inspections and obtain approval from the Contracting Officer and COR in order to proceed with the work.

1. At minimum the Contractor shall schedule inspections for any underground, in floor, in wall, above ceiling, concrete, concrete reinforcement, partial final and final inspection work. If any work is covered without inspection, it is the Contractor's responsibility to uncover the work at the Contractors expense for inspection. These is inspections are for the benefit of the Government. It is the contractors responsibility (regardless of an inspection and/or results of an inspection) to comply with the terms of the contract.

    a. Above ceiling inspections are treated as final inspections for items above the ceiling. All items shall be installed into the ceiling with exception of the acoustical tile or finished surface (sheetrock etc.). Ceiling tile or finished surface required for items to be mounted to (such as speakers) are allowed to be installed prior to inspection. One M&O clearance pre-inspection with appropriate contractor coordination drawings is allowed prior to above ceiling inspection

2. Contractor shall request inspection date 15 business days prior to the proposed inspection date. The Government will make all reasonable attempts to schedule inspection within 5 business days of the proposed inspection date. However, an alternate date may be scheduled by the COR. This shall not constitute a delay to the schedule, if within a reasonable time period.

3. Written inspection reports will be furnished to the contractor by the Government. In the event there are discrepancies that effect follow on tasks, the Contractor shall not proceed with work without written approval from the Contracting Officer. This inspection log is generic; the specific project may require additional or less inspections depending upon the construction, site location and impacts. Coordinate with COR and Contracting Officer throughout the project for more information. Contracting Officers have the final authority on all punch lists. If the COR chooses to send an informal punch list to the contractor, that punch list is for reference only. If the COR chooses to send this information they have at least 5 business days to format and submit to the contractor.

4. Inspections by VA and or A/E personnel do not release the contractor from following the contract documents. The contractor shall have all work completed and ready for the requested inspection. The VA reserves the right to deny an inspection due to incomplete, unacceptable work. The contractor cannot claim delays for failure to prepare for requested inspection. All inspection requests must be submitted 15 business days prior to the requested date. Reasonable attempts will be made to accommodate the Contractor's request.

5. Should VA personnel identify items that do not meet or exceed the requirements for maintenance and safety clearances it is the contractor's responsibility to remove and reinstall the item(s) at no additional cost to the Government.

6. At the start of any Contractor requested inspection, the Contractor shall submit to the COR 3 copies of the Contractor's inspection records. The Contractor shall develop, maintain and document an inspection system acceptable to the Government to ensure that all work performed under the contract conforms to the contract requirements. The Contractor shall maintain complete inspection records documenting deficiencies and corrective actions. The Superintendent shall sign off on each deficiency listed upon completion.

1.35 PROJECT/PHASE OCCUPANCY

A. Prior to VA occupancy of any portion of the project the contractor shall provide all training (maintenance of equipment, operation of equipment, lockout/tag out training of equipment), operation manuals, maintenance manuals, safety manuals (including lockout/tag out and permit required confine space forms completed by contractors on the VA format used during construction), as built documents, the VA inspection packet and inspection records kept by the contractors which demonstrate contract compliance. The contractor will not be granted a time extension and will not be allowed to proceed due to not providing proper documents for the VA to occupy the space.

1.36 CONTRACTING OFFICER REPRESENTATIVE COORDINATION

A Contracting Officer Representative (COR) will be onsite while the contract is active. CORs will be available at all times for emergencies. Contractors are to coordinate with the CORs schedule for inspections, coordination, etc. It is the responsibility of the contractor to submit Requests For Information (RFI) within a reasonable time frame. Typical RFI processing duration is 15 – 20 calendar days per RFI, subject to complexity. Contractor has a duty to coordinate upcoming work and seek clarifications in a timely manner to prevent contract delays and diligenty pursue the contract. Contractor shall provide submittals for COR's and/or A/E's review within a reasonable time frame. Typical submittal review process duration is 25 calendar days per submittal, subject to complexity of the submittal.

A. For working outside the "regular hours" as defined in the contract, the General Contractor shall give 15 business days' notice to the Contracting Officer and the COR so that arrangements can be made. This notice is separate from any notices required for utility shutdown described in other sections.

1.37 REQUIRED PERMITS

The contractor shall request and coordinate information to obtain the following permits.

A. Storm Water Polution Prevention Plan

B. Infectious Control Risk Assessment

C. Excavation/Trenching

D. Hot Work

E. Lock Out/Tag Out

F. Confinded Space

G. Energized Work

- Including removing electrical panel covers

H. Demolition Permit

- Will be approved after NFPA 241, ICRA, security, other temporary safety/security measures including approved GEMS measures are installed by the contractor per contract.

1.38 GC SUPERVISION

The contractor shall request and coordinate information to comply with superivision requirements

A. The GC shall employee a superinitentant either via contract or via direct employee.

B. Each superintendent shall be assigned to only 1 contract/projet for the duration of the period of performance of the contract.

C. Each superintendent shall have construction management experience in a healthcare setting.

D. Each superintendent shall have ICRA, SWPPP and OSHA 30 certification.

E. Each superintendent shall assume reasonability of the construction site under this contract and the safety of those whom enter it.

1.39 LOCATES

A. The GC shall contract/employ a locate crew for locating public and private utilities on VA grounds. Any locate paint, flags or other locate markers on the VA grounds, not contained in an approved construction fence after 10 business days is consider abandoned. VA will remove locate markers to maintain grounds. It will be the contractors responsibility to relocate the utilities if needed. Damage to existing utilities is subject to repair by the contractor.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

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SECTION 01 32 16.15
PROJECT SCHEDULES
(SMALL PROJECTS – DESIGN/BID/BUILD)

PART 1- GENERAL

1.1 DESCRIPTION

A. The Contractor shall develop a Critical Path Method (CPM) plan and schedule demonstrating fulfillment of the contract requirements (Project Schedule) and shall keep the Project Schedule up-to-date in accordance with the requirements of this section and shall utilize the plan for scheduling, coordinating and monitoring work under this contract (including all activities of subcontractors, equipment vendors and suppliers). Conventional Critical Path Method (CPM) technique shall be utilized to satisfy both time and cost applications.

1.2 CONTRACTOR'S REPRESENTATIVE

A. The Contractor shall designate an authorized representative responsible for the Project Schedule including preparation, review, and progress reporting with and to the Contracting Officer's Representative (COR).

B. The Contractor's representative shall have direct project control and complete authority to act on behalf of the Contractor in fulfilling the requirements of this specification section.

C. The Contractor’s representative shall have the option of developing the project schedule within their organization or to engage the services of an outside consultant. If an outside scheduling consultant is utilized, Section 1.3 of this specification will apply.

1.3 CONTRACTOR'S CONSULTANT

A. The Contractor shall submit a qualification proposal to the COR, within 10 days of bid acceptance. The qualification proposal shall include:

1. The name and address of the proposed consultant.
2. Information to show that the proposed consultant has the qualifications to meet the requirements specified in the preceding paragraph.
3. A representative sample of prior construction projects, which the proposed consultant has performed complete project scheduling services. These representative samples shall be of similar size and scope.

B. The Contracting Officer has the right to approve or disapprove the proposed consultant, and will notify the Contractor of the VA decision within seven calendar days from receipt of the qualification proposal. In case of disapproval, the Contractor shall resubmit another consultant within 10 calendar days for renewed consideration. The Contractor shall have their scheduling consultant approved prior to submitting any schedule for approval.

1.4 COMPUTER PRODUCED SCHEDULES

A. The contractor shall provide monthly, to the Department of Veterans Affairs (VA), all computer-produced time/cost schedules and reports generated from monthly project updates. This monthly computer service will include: three copies of up to five different reports (inclusive of all pages) available within the user defined reports of the scheduling software approved by the Contracting Officer; a hard copy listing of all project schedule changes, and associated data, made at the update and an electronic file of this data; and the resulting monthly updated schedule in PDM format. These must be submitted with and substantively support the contractor's monthly payment request and the signed look ahead report. The COR shall identify the five different report formats that the contractor shall provide.

B. The contractor shall be responsible for the correctness and timeliness of the computer-produced reports. The Contractor shall also be responsible for the accurate and timely submittal of the updated project schedule and all CPM data necessary to produce the computer reports and payment request that is specified.

C. The VA will report errors in computer-produced reports to the Contractor's representative within ten calendar days from receipt of reports. The Contractor shall reprocess the computer-produced reports and associated diskette(s), when requested by the Contracting Officer's representative, to correct errors which affect the payment and schedule for the project.

1.5 THE COMPLETE PROJECT SCHEDULE SUBMITTAL

A. Within 45 calendar days after receipt of Notice to Proceed, the Contractor shall submit for the Contracting Officer's review; three blue line copies of the interim schedule on sheets of paper 765 x 1070 mm (30 x 42 inches) and an electronic file in the previously approved CPM schedule program. The submittal shall also include three copies of a computer-produced activity/event ID schedule showing project duration; phase completion dates; and other data, including event cost. Each activity/event on the computer-produced schedule shall contain as a minimum, but not limited to, activity/event ID, activity/event description, duration, budget amount, early start date, early finish date, late start date, late finish date and total float. Work activity/event relationships shall be restricted to finish-to-start or start-to-start without lead or lag constraints. Activity/event date constraints, not required by the contract, will not be accepted unless submitted to and approved by the Contracting Officer. The contractor shall make a separate written detailed request to the Contracting Officer identifying these date constraints and secure the Contracting Officer's written approval before incorporating them into the network diagram. The Contracting Officer's separate approval of the Project Schedule shall not excuse the contractor of this requirement. Logic events (non-work) will be permitted where necessary to reflect proper logic among work events, but must have zero duration. The complete working schedule shall reflect the Contractor's approach to

scheduling the complete project. **The final Project Schedule in its original form shall contain no contract changes or delays which may have been incurred during the final network diagram development period and shall reflect the entire contract duration as defined in the bid documents.** These changes/delays shall be entered at the first update after the final Project Schedule has been approved. The Contractor should provide their requests for time and supporting time extension analysis for contract time as a result of contract changes/delays, after this update, and in accordance with Article, ADJUSTMENT OF CONTRACT COMPLETION.

B. Within 30 calendar days after receipt of the complete project interim Project Schedule and the complete final Project Schedule, the Contracting Officer or his representative, will do one or both of the following:
   1. Notify the Contractor concerning his actions, opinions, and objections.
   2. A meeting with the Contractor at or near the job site for joint review, correction or adjustment of the proposed plan will be scheduled if required. Within 14 calendar days after the joint review, the Contractor shall revise and shall submit three blue line copies of the revised Project Schedule, three copies of the revised computer-produced activity/event ID schedule and a revised electronic file as specified by the Contracting Officer. The revised submission will be reviewed by the Contracting Officer and, if found to be as previously agreed upon, will be approved.

C. The approved baseline schedule and the computer-produced schedule(s) generated there from shall constitute the approved baseline schedule until subsequently revised in accordance with the requirements of this section.

D. The Complete Project Schedule shall contain approximately fifty work activities/events.

1.6 WORK ACTIVITY/EVENT COST DATA

A. The Contractor shall cost load all work activities/events except procurement activities. The cumulative amount of all cost loaded work activities/events (including alternates) shall equal the total contract price. Prorate overhead, profit and general conditions on all work activities/events for the entire project length. The contractor shall generate from this information cash flow curves indicating graphically the total percentage of work activity/event dollar value scheduled to be in place on early finish, late finish. These cash flow curves will be used by the Contracting Officer to assist him in determining approval or disapproval of the cost loading. Negative work activity/event cost data will not be acceptable, except on VA issued contract changes.

B. The Contractor shall cost load work activities/events for guarantee period services, test, balance and adjust various systems in accordance with the provisions in Article, FAR 52.232 – 5 (PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS) and VAAR 852.232

– Article 70 Without NAS-CPM, Article 71 Including NAS-CPM for (PAYMENTS UNDER FIXED PRICE CONSTRUCTION).

C. In accordance with FAR 52.236 – 1 (PERFORMANCE OF WORK BY THE CONTRACTOR) and VAAR 852.236 – 72 (PERFORMANCE OF WORK BY THE CONTRACTOR), the Contractor shall submit, simultaneously with the cost per work activity/event of the construction schedule required by this Section, a responsibility code for all activities/events of the project for which the Contractor's forces will perform the work.

D. The Contractor shall cost load work activities/events for all BID ITEMS including ASBESTOS ABATEMENT. The sum of each BID ITEM work shall equal the value of the bid item in the Contractors' bid.

1.7 PROJECT SCHEDULE REQUIREMENTS

A. Show on the project schedule the sequence of work activities/events required for complete performance of all items of work. The Contractor Shall:

1. Show activities/events as:
   a. Contractor's time required for submittal of shop drawings, templates, fabrication, delivery and similar pre-construction work.
   b. Contracting Officer's and Architect-Engineer's review and approval of shop drawings, equipment schedules, samples, template, or similar items.
   c. Interruption of VA Facilities utilities, delivery of Government furnished equipment, and rough-in drawings, project phasing and any other specification requirements.
   d. Test, balance and adjust various systems and pieces of equipment, maintenance and operation manuals, instructions and preventive maintenance tasks.
   e. VA inspection and acceptance activity/event with a minimum duration of five work days at the end of each phase and immediately preceding any VA move activity/event required by the contract phasing for that phase.
2. Show not only the activities/events for actual construction work for each trade category of the project, but also trade relationships to indicate the movement of trades from one area, floor, or building, to another area, floor, or building, for at least five trades who are performing major work under this contract.
3. Break up the work into activities/events of a duration no longer than 20 work days each or one reporting period, except as to non-construction activities/events (i.e., procurement of materials, delivery of equipment, concrete and asphalt curing) and any other activities/events for which the COR may approve the showing of a longer duration. The duration for VA approval of any required submittal, shop drawing, or other submittals will not be less than 20 work days.

4. Describe work activities/events clearly, so the work is readily identifiable for assessment of completion. Activities/events labeled "start," "continue," or "completion," are not specific and will not be allowed. Lead and lag time activities will not be acceptable.
5. The schedule shall be generally numbered in such a way to reflect either discipline, phase or location of the work.

B. The Contractor shall submit the following supporting data in addition to the project schedule. Failure of the Contractor to include this data shall delay the review of the submittal until the Contracting Officer is in receipt of the missing data.
1. The appropriate project calendar including working days and holidays.
2. The planned number of shifts per day.
3. The number of hours per shift.

C. To the extent that the Project Schedule or any revised Project Schedule shows anything not jointly agreed upon, it shall not be deemed to have been approved by the COR. Failure to include any element of work required for the performance of this contract shall not excuse the Contractor from completing all work required within any applicable completion date of each phase regardless of the COR's approval of the Project Schedule.

D. Compact Disk Requirements and CPM Activity/Event Record Specifications: Submit to the VA an electronic file(s) containing one file of the data required to produce a schedule, reflecting all the activities/events of the complete project schedule being submitted.

1.8 PAYMENT TO THE CONTRACTOR:

A. Monthly, the contractor shall submit an application and certificate for payment using the AIA application and certificate for payment documents G702 & G703 reflecting updated schedule activities and cost data in accordance with the provisions of the following Article, PAYMENT AND PROGRESS REPORTING, as the basis upon which progress payments will be made pursuant to Article, FAR 52.232 – 5 (PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS) and VAAR 852.232 – Article 70 Without NAS-CPM for (PAYMENTS UNDER FIXED PRICE CONSTRUCTION). The Contractor shall be entitled to a monthly progress payment upon approval of estimates as determined from the currently approved updated project schedule. Monthly payment requests shall include: a listing of all agreed upon project schedule changes and associated data; and an electronic file (s) of the resulting monthly updated schedule.

B. Approval of the Contractor's monthly Application for Payment shall be contingent, among other factors, on the submittal of a satisfactory monthly update of the project schedule.

1.9 PAYMENT AND PROGRESS REPORTING

A. Monthly schedule update meetings will be held on dates mutually agreed to by the COR and the Contractor. Contractor and their CPM consultant (if applicable) shall attend all monthly schedule update meetings. The Contractor shall accurately update the Project Schedule and

all other data required and provide this information to the COR three work days in advance of the schedule update meeting. Job progress will be reviewed to verify:

1. Actual start and/or finish dates for updated/completed activities/events.
2. Remaining duration for each activity/event started, or scheduled to start, but not completed.
3. Logic, time and cost data for change orders, and supplemental agreements that are to be incorporated into the Project Schedule.
4. Changes in activity/event sequence and/or duration which have been made, pursuant to the provisions of following Article, ADJUSTMENT OF CONTRACT COMPLETION.
5. Completion percentage for all completed and partially completed activities/events.
6. Logic and duration revisions required by this section of the specifications.
7. Activity/event duration and percent complete shall be updated independently.

B. After completion of the joint review, the contractor shall generate an updated computer-produced calendar-dated schedule and supply the Contracting Officer's representative with reports in accordance with the Article, COMPUTER PRODUCED SCHEDULES, specified.

C. After completing the monthly schedule update, the contractor's representative or scheduling consultant shall rerun all current period contract change(s) against the prior approved monthly project schedule. The analysis shall only include original workday durations and schedule logic agreed upon by the contractor and COR for the contract change(s). When there is a disagreement on logic and/or durations, the Contractor shall use the schedule logic and/or durations provided and approved by the COR. After each rerun update, the resulting electronic project schedule data file shall be appropriately identified and submitted to the VA in accordance to the requirements listed in articles 1.4 and 1.7. This electronic submission is separate from the regular monthly project schedule update requirements and shall be submitted to the COR within fourteen (14) calendar days of completing the regular schedule update. Before inserting the contract changes durations, care must be taken to ensure that only the original durations will be used for the analysis, not the reported durations after progress. In addition, once the final network diagram is approved, the contractor must recreate all manual progress payment updates on this approved network diagram and associated reruns for contract changes in each of these update periods as outlined above for regular update periods. This will require detailed record keeping for each of the manual progress payment updates.

D. Following approval of the CPM schedule, the VA, the General Contractor, its approved CPM Consultant, RE office representatives, and all subcontractors needed, as determined by the SRE, shall meet to discuss the monthly updated schedule. The main emphasis shall be to address work activities to avoid slippage of project schedule and to identify any necessary actions required to maintain project schedule during the reporting period. The Government

representatives and the Contractor should conclude the meeting with a clear understanding of those work and administrative actions necessary to maintain project schedule status during the reporting period. This schedule coordination meeting will occur after each monthly project schedule update meeting utilizing the resulting schedule reports from that schedule update. If the project is behind schedule, discussions should include ways to prevent further slippage as well as ways to improve the project schedule status, when appropriate.

1.10 RESPONSIBILITY FOR COMPLETION

A. If it becomes apparent from the current revised monthly progress schedule that phasing or contract completion dates will not be met, the Contractor shall execute some or all of the following remedial actions:
   1. Increase construction manpower in such quantities and crafts as necessary to eliminate the backlog of work.
   2. Increase the number of working hours per shift, shifts per working day, working days per week, the amount of construction equipment, or any combination of the foregoing to eliminate the backlog of work.
   3. Reschedule the work in conformance with the specification requirements.

B. Prior to proceeding with any of the above actions, the Contractor shall notify and obtain approval from the COTR for the proposed schedule changes. If such actions are approved, the representative schedule revisions shall be incorporated by the Contractor into the Project Schedule before the next update, at no additional cost to the Government.

1.11 CHANGES TO THE SCHEDULE

A. Within 30 calendar days after VA acceptance and approval of any updated project schedule, the Contractor shall submit a revised electronic file (s) and a list of any activity/event changes including predecessors and successors for any of the following reasons:
   1. Delay in completion of any activity/event or group of activities/events, which may be involved with contract changes, strikes, unusual weather, and other delays will not relieve the Contractor from the requirements specified unless the conditions are shown on the CPM as the direct cause for delaying the project beyond the acceptable limits.
   2. Delays in submittals, or deliveries, or work stoppage are encountered which make rescheduling of the work necessary.
   3. The schedule does not represent the actual prosecution and progress of the project.
   4. When there is, or has been, a substantial revision to the activity/event costs regardless of the cause for these revisions.

B. CPM revisions made under this paragraph which affect the previously approved computer-produced schedules for Government furnished equipment, vacating of areas by the VA Facility, contract phase(s) and sub phase(s), utilities furnished by the Government to the

Contractor, or any other previously contracted item, shall be furnished in writing to the Contracting Officer for approval.

C. Contracting Officer's approval for the revised project schedule and all relevant data is contingent upon compliance with all other paragraphs of this section and any other previous agreements by the Contracting Officer or the VA representative.

D. The cost of revisions to the project schedule resulting from contract changes will be included in the proposal for changes in work as specified in FAR 52.243 – 4 (Changes, and will be based on the complexity of the revision or contract change, man hours expended in analyzing the change, and the total cost of the change.

E. The cost of revisions to the Project Schedule not resulting from contract changes is the responsibility of the Contractor.

1.12 ADJUSTMENT OF CONTRACT COMPLETION

A. The contract completion time will be adjusted only for causes specified in this contract. Request for an extension of the contract completion date by the Contractor shall be supported with a justification, CPM data and supporting evidence as the COR may deem necessary for determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract. Submission of proof based on revised activity/event logic, durations (in work days) and costs is obligatory to any approvals. The schedule must clearly display that the Contractor has used, in full, all the float time available for the work involved in this request. The Contracting Officer's determination as to the total number of days of contract extension will be based upon the current computer-produced calendar-dated schedule for the time period in question and all other relevant information.

B. Actual delays in activities/events which, according to the computer- produced calendar-dated schedule, do not affect the extended and predicted contract completion dates shown by the critical path in the network, will not be the basis for a change to the contract completion date. The Contracting Officer will within a reasonable time after receipt of such justification and supporting evidence, review the facts and advise the Contractor in writing of the Contracting Officer's decision.

C. The Contractor shall submit each request for a change in the contract completion date to the Contracting Officer in accordance with the provisions specified under FAR 52.243 – 4 (Changes). The Contractor shall include, as a part of each change order proposal, a sketch showing all CPM logic revisions, duration (in work days) changes, and cost changes, for work in question and its relationship to other activities on the approved network diagram.

D. All delays due to non-work activities/events such as RFI’s, WEATHER, STRIKES, and similar non-work activities/events shall be analyzed on a month by month basis.

PART 2 - PRODUCTS (NOT USED)
PART 3 – EXECUTION (NOT USED)

- - - E N D - - -

SECTION 01 33 23
SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

PART 1 – GENERAL

1.1 DESCRIPTION

A. This specification defines the general requirements and procedures for submittals. A submittal is information submitted for VA review to establish compliance with the contract documents.

B. Detailed submittal requirements are found in the technical sections of the contract specifications. The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective technical specifications at no additional cost to the government.

C. VA approval of a submittal does not relieve the Contractor of the responsibility for any error which may exist. The Contractor is responsible for fully complying with all contract requirements and the satisfactory construction of all work, including the need to check, confirm, and coordinate the work of all subcontractors for the project. Non-compliant material incorporated in the work will be removed and replaced at the Contractor’s expense.

1.2 DEFINITIONS

A. Preconstruction Submittals: Submittals which are required prior to issuing contract notice to proceed or starting construction. For example, Certificates of insurance; Surety bonds; Site-specific safety plan; Construction progress schedule; Schedule of values; Submittal register; List of proposed subcontractors.

B. Shop Drawings: Drawings, diagrams, and schedules specifically prepared to illustrate some portion of the work. Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be integrated and coordinated.

C. Product Data: Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions, and brochures, which describe and illustrate size, physical appearance, and other characteristics of materials, systems, or equipment for some portion of the work. Samples of warranty language when the contract requires extended product warranties.

D. Samples: Physical examples of materials, equipment, or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged. Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project. Field samples and mock-ups constructed to establish standards by which the ensuing work can be judged.

E. Design Data: Calculations, mix designs, analyses, or other data pertaining to a part of work.

F. Test Reports: Report which includes findings of a test required to be performed by the Contractor on an actual portion of the work. Report which includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

G. Certificates: Document required of Contractor, or of a manufacturer, supplier, installer, or subcontractor through Contractor. The purpose is to document procedures, acceptability of methods, or personnel qualifications for a portion of the work.

H. Manufacturer's Instructions: Pre-printed material describing installation of a product, system, or material, including special notices and MSDS concerning impedances, hazards, and safety precautions.

I. Manufacturer's Field Reports: Documentation of the testing and verification actions taken by manufacturer's representative at the job site on a portion of the work, during or after installation, to confirm compliance with manufacturer's standards or instructions. The documentation must indicate whether the material, product, or system has passed or failed the test.

J. Operation and Maintenance Data: Manufacturer data that is required to operate, maintain, troubleshoot, and repair equipment, including manufacturer's help, parts list, and product line documentation. This data shall be incorporated in an operations and maintenance manual.

K. Closeout Submittals: Documentation necessary to properly close out a construction contract. For example, Record Drawings and as-built drawings. Also, submittal requirements necessary to properly close out a phase of construction on a multi-phase contract.

1.3 SUBMITTAL REGISTER

A. The submittal register will list items of equipment and materials for which submittals are required by the specifications. This list may not be all inclusive and additional submittals may be required by the specifications. The Contractor is not relieved from supplying submittals required by the contract documents, but which have been omitted from the submittal register.

B. The submittal register will serve as a scheduling document for submittals and will be used to control submittal actions throughout the contract period.

C. The VA will provide the initial submittal register in electronic format. Thereafter, the Contractor shall track all submittals by maintaining a complete list, including completion of all data columns, including dates on which submittals are received and returned by the VA.

D. The Contractor shall update the submittal register as submittal actions occur and maintain the submittal register at the project site until final acceptance of all work by Contracting Officer.

E. The Contractor shall submit formal monthly updates to the submittal register in electronic format. Each monthly update shall document actual submission and approval dates for each submittal.

1.4 SUBMITTAL SCHEDULING

A. Submittals are to be scheduled, submitted, reviewed, and approved prior to the acquisition of the material or equipment.

B. Coordinate scheduling, sequencing, preparing, and processing of submittals with performance of work so that work will not be delayed by submittal processing. Allow time for potential resubmittal.

C. No delay costs or time extensions will be allowed for time lost in late submittals or resubmittals.

D. All submittals are required to be approved prior to the start of the specified work activity.

1.5 SUBMITTAL PREPARATION

A. Each submittal is to be complete and in sufficient detail to allow ready determination of compliance with contract requirements.

B. Collect required data for each specific material, product, unit of work, or system into a single submittal. Prominently mark choices, options, and portions applicable to the submittal. Partial submittals will not be accepted for expedition of construction effort. Submittal will be returned without review if incomplete.

C. If available product data is incomplete, provide Contractor-prepared documentation to supplement product data and satisfy submittal requirements.

D. All irrelevant or unnecessary data shall be removed from the submittal to facilitate accuracy and timely processing. Submittals that contain the excessive amount of irrelevant or unnecessary data will be returned without review.

E. Provide a transmittal form for each submittal with the following information:

1. Project title, location, and number.
2. Construction contract number.
3. Date of the drawings and revisions.
4. Name, address, and telephone number of subcontractor, supplier, manufacturer, and any other subcontractor associated with the submittal.
5. List paragraph number of the specification section and sheet number of the contract drawings by which the submittal is required.
6. When a resubmission, add alphabetic suffix on submittal description. For example, submittal 18 would become 18A, to indicate resubmission.
7. Product identification and location in project.

F. The Contractor is responsible for reviewing and certifying that all submittals are in compliance with contract requirements before submitting for VA review. Proposed deviations from the contract requirements are to be clearly identified. All deviations submitted must include a side by side comparison of item being proposed against item specified. Failure to point out

deviations will result in the VA requiring removal and replacement of such work at the Contractor's expense.

G. Stamp, sign, and date each submittal transmittal form indicating action taken.

H. Stamp used by the Contractor on the submittal transmittal form to certify that the submittal meets contract requirements is to be similar to the following:

CONTRACTOR	
(Firm Name)	
	Approved
	Approved with corrections as noted on submittal data and/or attached sheets.
Signature	
Title	
Date	

1.6 SUBMITTAL FORMAT AND TRANSMISSION

A. Provide submittals in electronic format, with the exception of material samples. Use PDF as the electronic format, unless otherwise specified or directed by the Contracting Officer.

B. Compile the electronic submittal file as a single, complete document. Name the electronic submittal file specifically according to its contents.

C. Electronic files must be of sufficient quality that all information is legible. Generate PDF files from original documents so that the text included in the PDF file is both searchable and can be copied. If documents are scanned, Optical Character Resolution (OCR) routines are required.

D. E-mail electronic submittal documents smaller than 5MB in size to e-mail addresses as directed by the Contracting Officer.

E. Provide electronic documents over 5MB through an electronic FTP file sharing system. Confirm that the electronic FTP file sharing system can be accessed from the VA computer network. The Contractor is responsible for setting up, providing, and maintaining the electronic FTP file sharing system for the construction contract period of performance.

F. Provide hard copies of submittals when requested by the Contracting Officer. Up to 3 additional hard copies of any submittal may be requested at the discretion of the Contracting Officer, at no additional cost to the VA.

1.7 SAMPLES

A. Submit two sets of physical samples showing range of variation, for each required item.

B. Where samples are specified for selection of color, finish, pattern, or texture, submit the full set of available choices for the material or product specified.

C. When color, texture, or pattern is specified by naming a particular manufacturer and style, include one sample of that manufacturer and style, for comparison.

D. Before submitting samples, the Contractor is to ensure that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.

E. The VA reserves the right to disapprove any material or equipment which previously has proven unsatisfactory in service.

F. Physical samples supplied maybe requested back for use in the project after reviewed and approved.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit data specified for a given item within 30 calendar days after the item is delivered to the contract site.

B. In the event the Contractor fails to deliver O&M Data within the time limits specified, the Contracting Officer may withhold from progress payments 50 percent of the price of the item with which such O&M Data are applicable.

1.9 TEST REPORTS

A. COR may require specific test after work has been installed or completed which could require contractor to repair test area at no additional cost to contract.

1.10 VA REVIEW OF SUBMITTALS AND RFIS

A. The VA will review all submittals for compliance with the technical requirements of the contract documents. The Architect-Engineer for this project will assist the VA in reviewing all submittals and determining contractual compliance. Review will be only for conformance with the applicable codes, standards, and contract requirements.

B. Period of review for submittals begins when the VA COR receives submittal from the Contractor.

C. Period of review for each resubmittal is the same as for initial submittal.

D. VA review period is 15 business days for submittals.

E. VA review period is 10 business days for RFIs.

F. The VA will return submittals to the Contractor with the following notations:

1. "Approved": authorizes the Contractor to proceed with the work covered.
2. "Approved as noted": authorizes the Contractor to proceed with the work covered provided the Contractor incorporates the noted comments and makes the noted corrections.
3. "Disapproved, revise and resubmit": indicates noncompliance with the contract requirements or that submittal is incomplete. Resubmit with appropriate changes and corrections. No work shall proceed for this item until resubmittal is approved.

4. "Not reviewed": indicates submittal does not have evidence of being reviewed and approved by Contractor or is not complete. A submittal marked "not reviewed" will be returned with an explanation of the reason it is not reviewed. Resubmit submittals after taking appropriate action.

1.11 APPROVED SUBMITTALS

A. The VA approval of submittals is not to be construed as a complete check, and indicates only that the general method of construction, materials, detailing, and other information are satisfactory.

B. VA approval of a submittal does not relieve the Contractor of the responsibility for any error which may exist. The Contractor is responsible for fully complying with all contract requirements and the satisfactory construction of all work, including the need to check, confirm, and coordinate the work of all subcontractors for the project. Non-compliant material incorporated in the work will be removed and replaced at the Contractor's expense.

C. After submittals have been approved, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

D. Retain a copy of all approved submittals at project site, including approved samples.

1.12 WITHHOLDING OF PAYMENT

A. Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

- - - E N D - - -

SECTION 01 33 23.01
SUBMITTAL REGISTER

ITEM NO.	SPEC. NO.	SPEC PARA NO.	DESCRIPTION OF ITEM SUBMITTED	TYPE OF SUBMITTAL									Planned Transmittal Date	Actual Transmittal Date	Planned Return Date	Acutal Return Date	Rvw Code: (R)ejected, (A)pproved, Approved as (N)oted	Remarks
				Data	Drawings	Instructions	Schedules	Statements	Reports	Certifications	Samples	Records						
1	01 00 00	1.2 F	30 Hour OSHA SSHO and CP Certificates							X								
2	01 10 00	1.2 G.1	SSHO GEMS and Safety Training Certificates							X								
3	01 00 00	1.2 G.2	10 Hour OSHA Employee Certificates							X								
4	01 00 00	1.5 A	Security Plan						X									
5	01 00 00	1.6 K	Construction Phasing Schedule				X											
6	01 00 00	1.6 O.2	Service Interruption				X											
7	01 00 00	1.7 C	Existing Condition Report						X									
8	01 00 00	1.14	As-Built Drawings									X						
9	01 00 00	1.15	Warranty Management Plan						X									
10	01 00 00	1.21 A	Testing Plan				X		X									
11	01 00 00	1.22 A	O&M Manuals			X						X						
12	01 00 00	1.25 A	Photographic Documentation						X			X						
13	01 00 00	1.27 A	Rebate Information						X									
14	01 32 16.15	1.5	Project Schedule				X											
15	01 32 16.15	1.11	Project Schedule Changes				X											
16	01 33 23	1.3 E	Monthly Submittal Register Updates						X									
17	01 35 26	1.4 C	Accident Prevention Plans (APPs)					X	X									
18	01 35 26	1.5 C	Activity Hazard Analysis (AHA)					X	X									
19	01 35 26	1.9 A	Weekly Safety Inspection Report						X									
20	01 35 26	1.9 B	Monthly Safety Inspection Report						X									
21	01 35 26	1.10	Accident Report (when applicable)						X									
22	01 35 26	1.12 F	Infection Prevention (Dust Protection) Plan						X									
23	01 35 26	1.13 A	Tuberculosis Screening Documentation						X									
24	01 35 26	1.14 A	Fire Safety Plan						X									
25	01 35 26	1.19 C	Lift Plan						X									
26	01 35 26	1.21 B	Confined Space Entry Plan						X									

ITEM NO.	SPEC. NO.	SPEC PARA NO.	DESCRIPTION OF ITEM SUBMITTED	TYPE OF SUBMITTAL									Planned Transmittal Date	Actual Transmittal Date	Planned Return Date	Acutal Return Date	Rvw Code: (R)ejected, (A)pproved, Approved as (N)oted	Remarks
				Data	Drawings	Instructions	Schedules	Statements	Reports	Certifications	Samples	Records						
27	01 45 29	3.1 B	Earthwork Compaction Testing Report						X									
28	01 45 29	3.1 C	Earthwork Gradation Test Report						X									
29	01 45 29	3.1 D	Earthwork Load Bearing Capacity Test Report						X									
30	01 45 29	3.2 C	Helical Pile Load Test Report						X									
31	01 45 29	3.3 A	Asphalt Field Density Test Report						X									
32	01 45 29	3.3 B	Asphalt Aggregate Test Report						X									
33	01 45 29	3.5 A	Concrete Materials Certification						X	X								
34	01 45 29	3.5 B	Concrete Field Test Report						X									
35	01 45 29	3.5 C	Concrete Compression Test Report						X									
36	01 45 29	3.6 C	Reinforcement Test Report						X									
37	01 45 29	3.7 C	Prestressed Concrete Tendon Test Report						X									
38	01 45 29	3.8 A	Masonry Mortar Test Report						X									
39	01 45 29	3.8 B	Masonry Grout Test Report						X									
40	01 45 29	3.8 C	Masonry Unit Test Report						X									
41	01 45 29	3.8 D	Masonry Prism Test Report						X									
42	01 45 29	3.9 D	Steel Inspection and Test Report						X									
43	01 45 29	3.9 D	Steel Welder Certification							X								
44	01 45 35	1.6 A	Equipment Calibration Records						X			X						
45	01 45 35	1.6 A	SD-06 Test Reports						X									
46	01 45 35	1.6 A	Special Inspections						X									
47	01 45 35	1.6 A	SD-07 Certificates							X								
48	01 45 35	1.6 A	Fabrication Plant AC472 Accreditation							X								
49	01 45 35	1.6 A	Precast Concrete Institute Plant Certification							X								
50	01 45 35	1.6 A	Certificate of Compliance							X								
51	01 45 35	1.6 A	Special Inspector Qualifications							X								
52	01 45 35	1.6 A	SD-11 Closeout Submittals						X			X						
53	01 45 35	1.6 A	Interim Final Report of Special Inspections						X			X						
54	01 45 35	1.6 A	Final Report of Special Inspections						X			X						

ITEM NO.	SPEC. NO.	SPEC PARA NO.	DESCRIPTION OF ITEM SUBMITTED	TYPE OF SUBMITTAL									Planned Transmittal Date	Actual Transmittal Date	Planned Return Date	Acutal Return Date	Rvw Code: (R)ejected, (A)pproved, Approved as (N)oted	Remarks
				Data	Drawings	Instructions	Schedules	Statements	Reports	Certifications	Samples	Records						
55	01 57 19	1.2	Quality Control Records									X						
56	01 57 19	1.4 A.1	Environmental Protection Plan						X									
57	01 74 19	1.5 B	Debris Management Plan						X									
58	01 74 19	1.5 C	Designated Manager						X									
59	01 74 19	1.5 D	Monthly Debris Diversion Report						X									
60	01 74 19	1.5 E	Target Waste Diversion Rates						X									
61	01 74 19	1.5 F	Final Waste Diversion Report						X			X						
62	01 81 13	1.5 B	Sustainability Action Plan						X									
63	01 81 13	1.5 C	Low Pollutant-Emitting Materials Tracking Spreadsheet						X									
64	01 81 13	1.5 D	Construction Indoor Air Quality (IAQ) Management Plan						X									
65	01 81 13	1.5 F	Monthly Sustainable Construction Progress Report						X									
66	01 81 13	1.5 G	Closeout Report						X			X						
67	01 81 13	1.5 H	Flush-out Documentation						X			X						
68	03 01 30.71	1.6 A	Manufacturer's Data	X														
69	03 01 30.71	1.6 C	Material Properties Proof of Compliance	X														
70	03 30 00	1.6 B	Shop Drawings		X													
71	03 30 00	1.6 C	Mill Test Reports						X									
72	03 30 00	1.6 D	Manufacturer's Certificates							X								
73	03 30 00	1.6 E	Testing Agency for Concrete Mix Design	X														
74	03 30 00	1.6 F	Shoring and Reshoring Sequence				X											
75	03 41 33	1.4 B	Shop Drawings		X													
76	03 41 33	1.4 C	Product Design Criteria	X														
77	03 41 33	1.4 D	Mix Designs	X														
78	03 41 33	1.4 E	Permissible Design Deviations	X														
79	03 41 33	1.4 F	Test Reports						X									
80	04 05 13	1.4 B	Manufacturer's Literature and Data	X														
81	04 05 13	1.4 C	Certificates							X								
82	04 05 16	1.4 B	Manufacturer's Literature and Data	X														

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				Data	Drawings	Instructions	Schedules	Statements	Reports	Certifications	Samples	Records						
83	04 05 16	1.4 C	Test Reports						X									
84	04 05 16	1.4 D	Certificates							X								
85	04 20 00	1.4 B	Submittal Drawings		X													
86	04 20 00	1.4 C	Manufacturer's Literature and Data	X														
87	04 20 00	1.4 D	Samples								X							
88	04 20 00	1.4 E	Certificates							X								
89	04 20 00	1.4 F	Delegated Design Drawings and Calculations	X	X													
90	05 12 00	1.4 B	Submittal Drawings		X													
91	05 12 00	1.4 C	Test Reports						X									
92	05 12 00	1.4 D	Certificates							X								
93	05 12 00	1.4 E	Qualifications							X								
94	05 12 00	1.4 F	Delegated Design Drawings and Calculations	X	X													
95	05 12 00	1.4 G	Record Surveys						X			X						
96	05 50 00	1.3 B	Manufacturer's Literature and Data	X														
97	05 50 00	1.3 C	Shop Drawings		X													
98	05 50 00	1.3 D	Setting Drawings and Instructions		X	X												
99	06 10 00	1.3 B	Sustainable Design Data	X														
100	06 10 00	1.3 C	Manufacturer's Literature and Data	X														
101	06 10 00	1.3 D	Manufacturer's Certificate							X								
102	07 01 50.19	1.5 B	Submittal Drawings		X													
103	07 01 50.19	1.5 C	Manufacturer's Literature and Data	X														
104	07 01 50.19	1.5 D	Field Inspection Reports						X									
105	07 13 52	1.4 B	Submittal Drawings	X														
106	07 13 52	1.4 C	Manufacturer's Literature and Data		X													
107	07 13 52	1.4 D	Warranty				X											
108	07 13 52	1.4 E	Samples								X							
109	07 13 52	1.4 F	Test Reports						X									
110	07 13 52	1.4 G	Certificates							X								

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				Data	Drawings	Instructions	Schedules	Statements	Reports	Certifications	Samples	Records						
111	07 13 52	1.4 H	Installer Qualifications					X		X								
112	07 22 00	1.4 B	Submittal Drawings		X													
113	07 22 00	1.4 C	Manufacturer's Literature and Data	X														
114	07 22 00	1.4 D	Sustainable Construction Submittals	X					X									
115	07 22 00	1.4 E	Installer Qualifications					X		X								
116	07 24 00	1.5 B	Manufacturer's Literature and Data	X														
117	07 24 00	1.5 C	Samples								X							
118	07 24 00	1.5 D	Test Reports						X									
119	07 24 00	1.5 E	Installer Qualifications					X		X								
120	07 53 23	1.5 B	Submittal Drawings		X													
121	07 53 23	1.5 C	Manufacturer's Literature and Data	X														
122	07 53 23	1.5 D	Samples								X							
123	07 53 23	1.5 E	Certificates							X								
124	07 53 23	1.5 F	Installer and Manufacturer Qualifications					X		X								
125	07 53 23	1.5 G	Field Quality Control Reports						X									
126	07 53 23	1.5 H	Temporary Protection Plan						X									
127	07 53 23	1.5 I	O&M Manuals			X												
128	07 60 00	1.5 B	Shop Drawings		X													
129	07 8400	1.3 B	Sustainable Design Submittals	X														
130	07 84 00	1.3 C	Installer Qualifications					X										
131	07 84 00	1.3 D	Inspector Qualifications					X										
132	07 84 00	1.3 E	Manufacturer's Literature, Data, and Installation	X					X									
133	07 84 00	1.3 F	List of FM, UL, or WH classification number of systems installed															
134	07 84 00	1.3 G	Certified laboratory test reports					X										
135	07 84 00	1.3 H	Manufacturer's Certificate							X								
136	07 92 00	1.5 B	Sustainable Design Submittals	X														
137	07 92 00	1.5 C	Installer Qualifications					X										
138	07 92 00	1.5 D	Contractor Certification							X								

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				Data	Drawings	Instructions	Schedules	Statements	Reports	Certifications	Samples	Records						
139	07 92 00	1.5 E	Manufacturer's Installation Instructions			X												
140	07 92 00	1.5 F	Samples								X							
141	07 92 00	1.5 G	Manufacturer's Literature and Data	X														
142	07 92 00	1.5 H	Manufacturer's Warranty					X										
143	08 11 13	1.4 B	Submittal Drawings		X													
144	08 11 13	1.4 C	Manufacturer's Literature and Data	X														
145	08 11 13	1.4 D	Manufacturer Qualifications					X										
146	08 71 00	1.6 B	Final Approved Schedules				X											
147	08 71 00	1.6 C	Hardware Schedule				X											
148	08 71 00	1.6 D	Samples and Manufacturer's Literature and Data	X							X							
149	08 71 00	1.6 E	Certificate of Compliance and Test Reports						X	X								
150	08 90 00	1.2 B	Shop Drawings		X													
151	08 90 00	1.2 C	Manufacturer's Literature and Data	X														
152	08 90 00	1.2 D	Color Samples								X							
153	09 22 16	1.4 B	Manufacturer's Literature and Data	X														
154	09 22 16	1.4 C	Shop Drawings		X													
155	09 22 16	1.4 D	Testing Reports						X									
156	09 29 00	1.4 B	Manufacturer's Literature and Data	X														
157	09 29 00	1.4 C	Shop Drawings		X													
158	09 29 00	1.4 D	Samples								X							
159	09 29 00	1.4 E	Testing Reports						X									
160	09 29 00	1.4 F	Manufacturer's Certificate							X								
161	09 30 13	1.3 B	Sustainable Design Submittals	X														
162	09 30 13	1.3 C	Samples								X							
163	09 30 13	1.3 D	Product Data	X														
164	09 30 13	1.3 E	Installer Qualifications					X										
165	09 91 00	1.3 B	Sustainable Design Submittals	X														
166	09 91 00	1.3 C	Manufacturer's Literature and Data	X														

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				Data	Drawings	Instructions	Schedules	Statements	Reports	Certifications	Samples	Records						
167	09 91 00	1.3 D	Sample Panels								X							
168	09 91 00	1.3 E	Sample of Identity Markers								X							
169	09 91 00	1.3 F	Certificates							X								
170	09 96 56	1.3 B	Manufacturer's Literature and Data	X														
171	09 96 56	1.3 C	Installer Qualifications					X										
172	09 96 56	1.3 D	Shop Drawings		X													
173	10 26 00	1.4 B	Shop Drawings		X													
174	10 26 00	1.4 C	Manufacturer's Literature and Data	X														
175	10 26 00	1.4 D	Test Reports						X									
176	10 26 00	1.4 E	Manufacturer's Warranty					X										
177	11 13 13	1.3 B	Manufacturer's Literature and Data	X														
178	11 13 13	1.3 C	Shop Drawings		X													
179	23 05 11	1.4 F	Shop Drawings		X													
180	23 05 11	1.4 G	Manufacturer's Literature and Data	X														
181	23 05 11	1.4 H	Maintenance Data and O&M Manuals	X		X												
182	23 05 12	1.4 A	Shop Drawings		X													
183	23 05 12	1.4 C	Certificates							X								
184	23 05 41	1.4 C	Manufacturer's Literature and Data	X														
185	23 05 41	1.4 D	Calculations						X									
186	23 05 93	1.4B	Certificates							X								
187	23 05 93	1.4C	Publications						X									
188	23 05 93	1.4D	Design Report						X									
189	23 05 93	1.4E	Testing and Balance Report						X									
190	23 05 93	1.4 C	Names and Qualifications of TAB Agency and TAB Specialists					X										
191	23 05 93	1.4 D	AABC, NEBB or TABB Publications					X										
192	23 05 93	1.4 E	Reports						X									
193	23 05 93	1.4 F	Test and Balance Report						X									
194	23 07 11	1.4 B	Shop Drawings		X													

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				Data	Drawings	Instructions	Schedules	Statements	Reports	Certifications	Samples	Records						
195	23 21 13	1.4 C	Manufacturer's Literature and Data	X														
196	23 21 13	1.4 D	Welder Qualifications							X								
197	23 21 13	1.4 E	Coordination Drawings		X													
198	23 21 13	1.4 F	As-Built Piping Diagrams		X													
199	23 21 13	1.4 G	O&M Manuals			X												
200	23 21 23	1.4 C	Manufacturer's Literature and Data	X														
201	23 21 23	1.4 D	Characteristic Curves	X														
202	23 21 23	1.4 E	O&M Manuals			X												
203	23 22 13	1.4 C	Manufacturer's Literature and Data	X														
204	23 22 13	1.4 D	Coordination Drawings		X													
205	23 22 13	1.4 E	As-Built Drawings		X													
206	23 22 13	1.4 F	O&M Manuals			X												
207	23 25 00	1.4 C	Manufacturer's Literature and Data	X														
208	23 25 00	1.4 D	Water Analysis Verification							X								
209	23 25 00	1.4 E	Materials Safety Data Sheet	X														
210	23 25 00	1.4 F	O&M Manuals			X												
211	26 05 11	1.13 E	Manufacturer's Literature and Data	X														
212	26 05 11	1.13 E	Shop Drawings		X													
213	26 05 11	1.10 F	O&M Manuals			X												
214	26 05 19	1.4 A.1	Shop Drawings		X													
215	26 05 19	1.4 A.2	Certificates							X								
216	26 05 26	1.4 A.1	Test Reports					X										
217	26 05 26	1.4 A.2	Certificates							X								
218	26 05 33	1.4 A.1	Product Data	X														
219	26 05 33	1.4 A.2	Certificates							X								
220	26 51 00	1.4 A.1	Manufacturer's Literature and Data	X														
221	26 51 00	1.4 A.1	Shop Drawings		X													
222	26 51 00	1.4 A.2	O&M Manuals			X												

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				Data	Drawings	Instructions	Schedules	Statements	Reports	Certifications	Samples	Records						
223	26 51 00	1.4 A.3	Certificates							X								
224	27 05 11	1.7 B	Parts List	X														
225	27 05 11	1.7 C	Manufacturer's Literature and Data	X														
226	27 05 11	1.7 D.	Sustainable Design Submittals	X														
227	27 05 11	1.7 E	Test Reports						X									
228	27 05 11	1.8 A	Closeout Submittals	X	X				X	X		X						
229	27 05 11	1.8 B	Record Wiring Diagrams	X	X							X						
230	27 05 26	1.3 B	Certificates							X								
231	27 05 33	1.3 B	Certificates							X								
232	27 10 00	1.3 B	Provide Conduit Size Requirements	X														
233	27 10 00	1.3 C	Shop Drawings		X													
234	27 10 00	1.3 C	Manufacturer's Literature and Data	X														
235	27 10 00	1.3 C	Certificates							X								
236	27 10 00	1.3 C	O&M Manuals			X												
237	31 20 00	1.7 B	Rock Excavation Report						X									
238	31 20 00	1.7 C.1	Resumes						X									
239	31 20 00	1.7 C.2	Soil Samples								X							
240	31 20 00	1.7 C.3	Procedures/Notifications					X										
241	31 66 15	1.7 B	Product Data	X														
242	31 66 15	1.7 C	Design Data	X														
243	31 66 15	1.7 D.	Designer Qualifications							X								
244	31 66 15	1.7 E	Installer Qualifications							X								
245	31 66 15	1.7 F	Surveyor Qualifications							X								
246	31 66 15	1.7 G	Installation Logs						X									
247	31 66 15	1.7 H	Field Test Reports						X									
248	31 66 15	1.7 I	Certificates							X								
249	32 05 23	1.4 B	Submittal Drawings		X													
250	32 05 23	1.4 C	Manufacturer's Literature and Data	X														

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				Data	Drawings	Instructions	Schedules	Statements	Reports	Certifications	Samples	Records						
251	32 05 23	1.4 D	Test Reports						X									
252	32 05 23	1.4 E	Certificates							X								
253	32 05 23	1.4 F	Concrete Mix Design	X														
254	32 05 23	1.4 G	Subbase Job-mix Design	X														
255	32 05 23	1.4 H	Proposed Concreting Methods	X														
256	32 12 16	1.5 B	Data and Test Reports	X					X									
257	32 12 16	1.5 C	Certificates							X								
258	32 12 16	1.5 D	State Highway Department Specifications	X														
259	32 12 16	1.5 E	Material Safety Data Sheets	X														

- - - END - - -

SECTION 01 35 26
SAFETY REQUIREMENTS

TABLE OF CONTENTS

PART 1 - GENERAL

1.1 APPLICABLE PUBLICATIONS

A. Latest publications listed below form part of this Article to extent referenced. Publications are referenced in text by basic designations only.

B. American Society of Safety Engineers (ASSE):

A10.1-2011 ..... Pre-Project & Pre-Task Safety and Health Planning

A10.34-2012 ..... Protection of the Public on or Adjacent to Construction Sites

A10.38-2013 ..... Basic Elements of an Employer's Program to Provide a Safe and Healthful Work Environment American National Standard Construction and Demolition Operations

C. American Society for Testing and Materials (ASTM):

E84-2013 ..... Surface Burning Characteristics of Building Materials

D. The Facilities Guidelines Institute (FGI):

FGI Guidelines - 2010 Guidelines for Design and Construction of Healthcare Facilities

E. National Fire Protection Association (NFPA):

10-2018..... Standard for Portable Fire Extinguishers

30-2018..... Flammable and Combustible Liquids Code

51B-2019 ..... Standard for Fire Prevention During Welding, Cutting and Other Hot Work

70-2020..... National Electrical Code

70B-2019 ..... Recommended Practice for Electrical Equipment Maintenance

70E-2018 ..... Standard for Electrical Safety in the Workplace

99-2018..... Health Care Facilities Code

241-2019..... Standard for Safeguarding Construction, Alteration, and Demolition Operations

F. The Joint Commission (TJC)

TJC Manual ..... Comprehensive Accreditation and Certification Manual

G. U.S. Nuclear Regulatory Commission

10 CFR 20 ..... Standards for Protection Against Radiation

H. U.S. Occupational Safety and Health Administration (OSHA):

29 CFR 1910 ..... Safety and Health Regulations for General Industry

29 CFR 1926 ..... Safety and Health Regulations for Construction Industry

1.2 DEFINITIONS

A. Critical Lift. A lift with the hoisted load exceeding 75% of the crane's maximum capacity; lifts made out of the view of the operator (blind picks); lifts involving two or more cranes; personnel being hoisted; and special hazards such as lifts over occupied facilities, loads lifted

close to power-lines, and lifts in high winds or where other adverse environmental conditions exist; and any lift which the crane operator believes is critical.

B. OSHA “Competent Person” (CP). One who is capable of identifying existing and predictable hazards in the surroundings and working conditions which are unsanitary, hazardous or dangerous to employees, and who has the authorization to take prompt corrective measures to eliminate them (see 29 CFR 1926.32(f)).

C. "Qualified Person" means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.

D. High Visibility Accident. Any mishap which may generate publicity or high visibility.

E. Accident/Incident Criticality Categories:

1. No impact – near miss incidents that should be investigated but are not required to be reported to the VA.
2. Minor incident/impact – incidents that require first aid or result in minor equipment damage (less than $5000). These incidents must be investigated but are not required to be reported to the VA.
3. Moderate incident/impact – Any work-related injury or illness that results in:
    a. Days away from work (any time lost after day of injury/illness onset).
    b. Restricted work.
    c. Transfer to another job.
    d. Medical treatment beyond first aid.
    e. Loss of consciousness.
4. A significant injury or illness diagnosed by a physician or other licensed health care professional, even if it did not result in (1) through (5) above or,
5. Any incident that leads to major equipment damage (greater than $5000).

F. These incidents must be investigated and are required to be reported to the VA.

1. Major incident/impact – Any mishap that leads to fatalities, hospitalizations, amputations, and losses of an eye as a result of contractors’ activities. Or any incident which leads to major property damage (greater than $20,000) and/or may generate publicity or high visibility. These incidents must be investigated and are required to be reported to the VA as soon as practical, but not later than 2 hours after the incident.

G. Medical Treatment. Treatment administered by a physician or by registered professional personnel under the standing orders of a physician. Medical treatment does not include first aid treatment even through provided by a physician or registered personnel.

1.3 REGULATORY REQUIREMENTS

A. In addition to the detailed requirements included in the provisions of this contract, comply with 29 CFR 1926, comply with 29 CFR 1910 as incorporated by reference within 29 CFR 1926, comply with ASSE A10.34, and all applicable [federal, state, and local] laws, ordinances, criteria, rules, and regulations. Submit matters of interpretation of standards for resolution before starting work. Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements govern except with specific approval and acceptance by the Facility Safety Officer and Contracting Officer Representative.

B. VHA Directive 7712 Fire Protection.

C. VHA Directive 7715 Safety and Health During Construction.

1.4 ACCIDENT PREVENTION PLAN (APP)

A. The APP (aka Construction Safety & Health Plan) shall interface with the Contractor's overall safety and health program. Include any portions of the Contractor's overall safety and health program referenced in the APP in the applicable APP element and ensure it is site-specific. The Government considers the Prime Contractor to be the "controlling authority" for all worksite safety and health of each subcontractor(s). Contractors are responsible for informing their subcontractors of the safety provisions under the terms of the contract and the penalties for noncompliance, coordinating the work to prevent one craft from interfering with or creating hazardous working conditions for other crafts, and inspecting subcontractor operations to ensure that accident prevention responsibilities are being carried out.

B. The APP shall be prepared as follows:

1. Written in English by a qualified person who is employed by the Prime Contractor articulating the specific work and hazards pertaining to the contract (model language can be found in ASSE A10.33). Specifically articulating the safety requirements found within these VA contract safety specifications.
2. Address both the Prime Contractors and the subcontractors work operations.
3. State measures to be taken to control hazards associated with materials, services, or equipment provided by suppliers.
4. Address all the elements/sub-elements and in order as follows:
    a. **SIGNATURE SHEET**. Title, signature, and phone number of the following:
        1) Plan preparer (Qualified Person such as corporate safety staff person or contracted Certified Safety Professional with construction safety experience);
        2) Plan approver (company/corporate officers authorized to obligate the company);
        3) Plan concurrence (e.g., Chief of Operations, Corporate Chief of Safety, Corporate Industrial Hygienist, project manager or superintendent, project safety

professional). Provide concurrence of other applicable corporate and project personnel (Contractor).

b. **BACKGROUND INFORMATION**. List the following:
   1) Contractor.
   2) Contract number.
   3) Project name.
   4) Brief project description, description of work to be performed, and location; phases of work anticipated (these will require an AHA).

c. **STATEMENT OF SAFETY AND HEALTH POLICY**. Provide a copy of current corporate/company Safety and Health Policy Statement, detailing commitment to providing a safe and healthful workplace for all employees. The Contractor's written safety program goals, objectives, and accident experience goals for this contract should be provided.

d. **RESPONSIBILITIES AND LINES OF AUTHORITIES**. Provide the following:
   1) A statement of the employer's ultimate responsibility for the implementation of his SOH program.
   2) Identification and accountability of personnel responsible for safety at both corporate and project level. Contracts specifically requiring safety or industrial hygiene personnel shall include a copy of their resumes.
   3) The names of Competent and/or Qualified Person(s) and proof of competency/qualification to meet specific OSHA Competent/Qualified Person(s) requirements must be attached.
   4) Requirements that no work shall be performed unless a designated competent person is present on the job site.
   5) Requirements for pre-task Activity Hazard Analysis (AHAs).
   6) Lines of authority.
   7) Policies and procedures regarding noncompliance with safety requirements (to include disciplinary actions for violation of safety requirements) should be identified.

e. **SUBCONTRACTORS AND SUPPLIERS.** If applicable, provide procedures for coordinating SOH activities with other employers on the job site:
   1) Identification of subcontractors and suppliers (if known).
   2) Safety responsibilities of subcontractors and suppliers.

f. **TRAINING.**
   1) Site-specific SOH orientation training at the time of initial hire or assignment to the project for every employee before working on the project site is required.

2) Mandatory training and certifications that are applicable to this project (e.g., explosive actuated tools, crane operator, rigger, crane signal person, fall protection, electrical lockout/NFPA 70E, machine/equipment lockout, confined space, etc…) and any requirements for periodic retraining/recertification are required.
3) Procedures for ongoing safety and health training for supervisors and employees shall be established to address changes in site hazards/conditions.
4) OSHA 10-hour training is required for all workers on site and the OSHA 30-hour training is required for Trade Competent Persons (CPs).
5) The Contractor's project supervisor is required to attend GEMS and Safety training provided by VA St. Cloud. Training must be attended prior to being designated as a job supervisor on any VA St. Cloud construction project.
6) Submit training records of all such employees for approval before the start of work.

g. SAFETY AND HEALTH INSPECTIONS.

1) Specific assignment of responsibilities for a minimum daily job site safety and health inspection during periods of work activity: Who will conduct (e.g., "Site Safety and Health CP"), proof of inspector's training/qualifications, when inspections will be conducted, procedures for documentation, deficiency tracking system, and follow-up procedures.
2) Any external inspections/certifications that may be required (e.g., contracted CSP or CSHT)

h. **ACCIDENT/INCIDENT INVESTIGATION & REPORTING.** The Contractor shall conduct mishap investigations of all Moderate and Major as well as all High Visibility Incidents. The APP shall include accident/incident investigation procedure and identify person(s) responsible to provide the following to the Project Manager and Facility Safety Manager, Officer, or Contracting Officer Representative or Government Designated Authority:

1) Exposure data (man-hours worked).
2) Accident investigation reports.
3) Project site injury and illness logs.

i. **PLANS (PROGRAMS, PROCEDURES) REQUIRED.** Based on a risk assessment of contracted activities and on mandatory OSHA compliance programs, the Contractor shall address all applicable occupational, patient, and public safety risks in site-specific compliance and accident prevention plans. These Plans shall include but are not limited to procedures for addressing the risks associates with the following:

1) Emergency response.

2) Contingency for severe weather.
3) Fire Prevention.
4) Medical Support.
5) Posting of emergency telephone numbers.
6) Prevention of alcohol and drug abuse.
7) Site sanitation(housekeeping, drinking water, toilets).
8) Night operations and lighting.
9) Hazard communication program.
10) Welding/Cutting “Hot” work.
11) Electrical Safe Work Practices (Electrical LOTO/NFPA 70E).
12) General Electrical Safety.
13) Hazardous energy control (Machine LOTO).
14) Site-Specific Fall Protection & Prevention.
15) Excavation/trenching.
16) Asbestos abatement.
17) Lead abatement.
18) Crane Critical lift.
19) Respiratory protection.
20) Health hazard control program.
21) Radiation Safety Program.
22) Abrasive blasting.
23) Heat/Cold Stress Monitoring.
24) Crystalline Silica Monitoring (Assessment).
25) Demolition plan (to include engineering survey).
26) Formwork and shoring erection and removal.
27) PreCast Concrete.
28) Public (Mandatory compliance with ANSI/ASSE A10.34-2012).

C. Submit the APP to the Contracting Officer Representative or Government Designated Authority for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES a minimum of 14 calendar days prior to the date of the preconstruction conference for acceptance. Work cannot proceed without an accepted APP.

D. Once accepted by the Contracting Officer Representative or Government Designated Authority, the APP and attachments will be enforced as part of the contract. Disregarding the provisions of this contract or the accepted APP will be cause for stopping of work, at the discretion of the Contracting Officer in accordance with FAR Clause 52.236-13, *Accident Prevention*, until the matter has been rectified.

E. Once work begins, changes to the accepted APP shall be made with the knowledge and concurrence of the Contracting Officer Representative. Should any severe hazard exposure, i.e. imminent danger, become evident, stop work in the area, secure the area, and develop a plan to remove the exposure and control the hazard. Notify the Contracting Officer within 24 hours of discovery. Eliminate/remove the hazard. In the interim, take all necessary action to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public and the environment.

1.5 ACTIVITY HAZARD ANALYSES (AHAS)

A. AHAs are also known as Job Hazard Analyses, Job Safety Analyses, and Activity Safety Analyses. Before beginning each work activity involving a type of work presenting hazards not experienced in previous project operations or where a new work crew or sub-contractor is to perform the work, the Contractor(s) performing that work activity shall prepare an AHA (Example electronic AHA forms can be found on the US Army Corps of Engineers web site)

B. AHAs shall define the activities being performed and identify the work sequences, the specific anticipated hazards, site conditions, equipment, materials, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level of risk.

C. Work shall not begin until the AHA for the work activity has been accepted by the Contracting Officer Representative and discussed with all engaged in the activity, including the Contractor, subcontractor(s), and Government on-site representatives at preparatory and initial control phase meetings.

1. The names of the Competent/Qualified Person(s) required for a particular activity (for example, excavations, scaffolding, fall protection, other activities as specified by OSHA and/or other State and Local agencies) shall be identified and included in the AHA. Certification of their competency/qualification shall be submitted to the Government Designated Authority (GDA) for acceptance prior to the start of that work activity.
2. The AHA shall be reviewed and modified as necessary to address changing site conditions, operations, or change of competent/qualified person(s).
    a. If more than one Competent/Qualified Person is used on the AHA activity, a list of names shall be submitted as an attachment to the AHA. Those listed must be Competent/Qualified for the type of work involved in the AHA and familiar with current site safety issues.
    b. If a new Competent/Qualified Person (not on the original list) is added, the list shall be updated (an administrative action not requiring an updated AHA). The new person shall acknowledge in writing that he or she has reviewed the AHA and is familiar with current site safety issues.
3. Submit AHAs to the Contracting Officer Representative for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS,

PRODUCT DATA AND SAMPLES for review at least 14 calendar days prior to the start of each phase. Subsequent AHAs as shall be formatted as amendments to the APP. The analysis should be used during daily inspections to ensure the implementation and effectiveness of the activity's safety and health controls.

4. The AHA list will be reviewed periodically (at least monthly) at the Contractor supervisory safety meeting and updated as necessary when procedures, scheduling, or hazards change.
5. Develop the activity hazard analyses using the project schedule as the basis for the activities performed. All activities listed on the project schedule will require an AHA. The AHAs will be developed by the contractor, supplier, or subcontractor and provided to the prime contractor for review and approval and then submitted to the Project Manager and Facility Safety Manager, Officer, or Contracting Officer Representative or Government Designated Authority.

1.6 PRECONSTRUCTION CONFERENCE:

A. Contractor representatives who have a responsibility or significant role in implementation of the accident prevention program, as required by 29 CFR 1926.20(b)(1), on the project shall attend the preconstruction conference to gain a mutual understanding of its implementation. This includes the project superintendent, subcontractor superintendents, and any other assigned safety and health professionals.

B. Discuss the details of the submitted APP to include incorporated plans, programs, procedures, and a listing of anticipated AHAs that will be developed and implemented during the performance of the contract. This list of proposed AHAs will be reviewed at the conference and an agreement will be reached between the Contractor and the Contracting Officer's representative as to which phases will require an analysis. In addition, establish a schedule for the preparation, submittal, review, and acceptance of AHAs to preclude project delays.

C. Deficiencies in the submitted APP will be brought to the attention of the Contractor within 14 days of submittal, and the Contractor shall revise the plan to correct deficiencies and re-submit it for acceptance. Do not begin work until there is an accepted APP.

1.7 “SITE SAFETY AND HEALTH OFFICER” (SSHO) AND “COMPETENT PERSON” (CP)

A. The Prime Contractor shall designate a minimum of one SSHO at each project site that will be identified as the SSHO to administer the Contractor's safety program and government-accepted Accident Prevention Plan. Each subcontractor shall designate a minimum of one CP in compliance with 29 CFR 1926.20 (b)(2) that will be identified as a CP to administer their individual safety programs.

B. Further, all specialized Competent Persons for the work crews will be supplied by the respective contractor as required by 29 CFR 1926 (i.e. Asbestos, Electrical, Cranes, &

Derricks, Demolition, Fall Protection, Fire Safety/Life Safety, Ladder, Rigging, Scaffolds, and Trenches/Excavations).

C. These Competent Persons can have collateral duties as the subcontractor's superintendent and/or work crew lead persons as well as fill more than one specialized CP role (i.e. Asbestos, Electrical, Cranes, & Derricks, Demolition, Fall Protection, Fire Safety/Life Safety, Ladder, Rigging, Scaffolds, and Trenches/Excavations). However, the SSHO has be a separate qualified individual from the Prime Contractor's Superintendent and/or Quality Control Manager with duties only as the SSHO.

D. The SSHO or an equally-qualified Designated Representative/alternate will maintain a presence on the site during construction operations in accordance with FAR Clause 52.236-6: *Superintendence by the Contractor*. CPs will maintain presence during their construction activities in accordance with above mentioned clause. A listing of the designated SSHO and all known CPs shall be submitted prior to the start of work as part of the APP with the training documentation and/or AHA as listed in Section 1.8 below.

E. The repeated presence of uncontrolled hazards during a contractor's work operations will result in the designated CP as being deemed incompetent and result in the required removal of the employee in accordance with FAR Clause 52.236-5: Material and Workmanship, Paragraph (c).

1.8 TRAINING

A. The designated Prime Contractor SSHO must meet the requirements of all applicable OSHA standards and be capable (through training, experience, and qualifications) of ensuring that the requirements of 29 CFR 1926.16 and other appropriate Federal, State, and local requirements are met for the project. As a minimum the SSHO must have completed the OSHA 30-hour Construction Safety class and have five (5) years of construction industry safety experience or three (3) years if he/she possesses a Certified Safety Professional (CSP) or certified Construction Safety and Health Technician (CSHT) certification or have a safety and health degree from an accredited university or college.

B. All designated CPs shall have completed the OSHA 30-hour Construction Safety course within the past 5 years.

C. In addition to the OSHA 30 Hour Construction Safety Course, all CPs with high hazard work operations such as operations involving asbestos, electrical, cranes, demolition, work at heights/fall protection, fire safety/life safety, ladder, rigging, scaffolds, and trenches/excavations shall have a specialized formal course in the hazard recognition & control associated with those high hazard work operations. Documented "repeat" deficiencies in the execution of safety requirements will require retaking the requisite formal course.

D. All other construction workers shall have the OSHA 10-hour Construction Safety Outreach course and any necessary safety training to be able to identify hazards within their work environment.

E. Submit training records associated with the above training requirements to the Contracting Officer Representative for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES 14 calendar days prior to the date of the preconstruction conference for acceptance.

F. Prior to any worker for the contractor or subcontractors beginning work, they shall undergo a safety briefing provided by the SSHO or his/her designated representative. As a minimum, this briefing shall include information on the site-specific hazards, construction limits, VAMC safety guidelines, means of egress, break areas, work hours, locations of restrooms, use of VAMC equipment, emergency procedures, accident reporting etc... Documentation shall be provided to the Contracting Officer Representative that individuals have undergone contractor's safety briefing.

G. Ongoing safety training will be accomplished in the form of weekly documented safety meeting.

1.9 INSPECTIONS

A. The SSHO shall conduct frequent and regular safety inspections (daily) of the site and each of the subcontractors CPs shall conduct frequent and regular safety inspections (daily) of the work operations as required by 29 CFR 1926.20(b)(2). Each week, the SSHO shall conduct a formal documented inspection of the entire construction areas with the subcontractors' "Trade Safety and Health CPs" present in their work areas. Coordinate with, and report findings and corrective actions weekly to Contracting Officer Representative.

B. A Certified Safety Professional (CSP) with specialized knowledge in construction safety or a certified Construction Safety and Health Technician (CSHT) shall randomly conduct a monthly site safety inspection. The CSP or CSHT can be a corporate safety professional or independently contracted. The CSP or CSHT will provide their certificate number on the required report for verification as necessary.

1. Results of the inspection will be documented with tracking of the identified hazards to abatement.
2. The Contracting Officer Representative will be notified immediately prior to start of the inspection and invited to accompany the inspection.
3. Identified hazard and controls will be discussed to come to a mutual understanding to ensure abatement and prevent future reoccurrence.
4. A report of the inspection findings with status of abatement will be provided to the Contracting Officer Representative within one week of the onsite inspection.

1.10 ACCIDENTS, OSHA 300 LOGS, AND MAN-HOURS

A. The prime contractor shall establish and maintain an accident reporting, recordkeeping, and analysis system to track and analyze all injuries and illnesses, high visibility incidents, and accidental property damage (both government and contractor) that occur on site. Notify the Contracting Officer Representative as soon as practical, but no more than four hours after any accident meeting the definition of a Moderate or Major incidents, High Visibility Incidents, , or any weight handling and hoisting equipment accident. Within notification include contractor name; contract title; type of contract; name of activity, installation, or location where accident occurred; date and time of accident; names of personnel injured; extent of property damage, if any; extent of injury, if known, and brief description of accident (to include type of construction equipment used, PPE used, etc.). Preserve the conditions and evidence on the accident site until the or Contracting Officer Representative determine whether a government investigation will be conducted.

B. Conduct an accident investigation for all Minor, Moderate and Major incidents as defined in paragraph DEFINITIONS, and property damage accidents resulting in at least $20,000 in damages, to establish the root cause(s) of the accident. Complete the VA Form 2162 (or equivalent), and provide the report to the Contracting Officer Representative within 5 calendar days of the accident. The Contracting Officer Representative will provide copies of any required or special forms.

C. A summation of all man-hours worked by the contractor and associated sub-contractors for each month will be reported to the Contracting Officer Representative monthly.

D. A summation of all Minor, Moderate, and Major incidents experienced on site by the contractor and associated sub-contractors for each month will be provided to the Contracting Officer Representative monthly. The contractor and associated sub-contractors' OSHA 300 logs will be made available to the Contracting Officer Representative as requested.

1.11 PERSONAL PROTECTIVE EQUIPMENT (PPE)

A. PPE is governed in all areas by the nature of the work the employee is performing. For example, specific PPE required for performing work on electrical equipment is identified in NFPA 70E, Standard for Electrical Safety in the Workplace.

B. Mandatory PPE includes:

1. Hard Hats – unless written authorization is given by the Contracting Officer Representative in circumstances of work operations that have limited potential for falling object hazards such as during finishing work or minor remodeling. With authorization to relax the requirement of hard hats, if a worker becomes exposed to an overhead falling object hazard, then hard hats would be required in accordance with the OSHA regulations.

2. Safety glasses - unless written authorization is given by Contracting Officer Representative in circumstances of no eye hazards, appropriate safety glasses meeting the ANSI Z.87.1 standard must be worn by each person on site.
3. Appropriate Safety Shoes – based on the hazards present, safety shoes meeting the requirements of ASTM F2413-11 shall be worn by each person on site unless written authorization is given by the Contracting Officer Representative in circumstances of no foot hazards.
4. Hearing protection - Use personal hearing protection at all times in designated noise hazardous areas or when performing noise hazardous tasks.

1.12 INFECTION CONTROL

A. Infection Control is critical in all medical center facilities. Interior construction activities causing disturbance of existing dust, or creating new dust, must be conducted within ventilation-controlled areas that minimize the flow of airborne particles into patient areas. Exterior construction activities causing disturbance of soil or creates dust in some other manner must be controlled.

B. An AHA associated with infection control will be performed by VA personnel in accordance with FGI Guidelines (i.e. Infection Control Risk Assessment (ICRA)). The ICRA procedure found on the American Society for Healthcare Engineering (ASHE) website will be utilized. Risk classifications of Class II or lower will require approval by the Contracting Officer Representative before beginning any construction work. Risk classifications of Class III or higher will require a permit before beginning any construction work. Infection Control permits will be issued by the COR. The Infection Control Permits will be posted outside the appropriate construction area. More than one permit may be issued for a construction project if the work is located in separate areas requiring separate classes. The primary project scope area for this project is: **Class III**, however, work outside the primary project scope area may vary. The required infection control precautions with each class are as follows:

1. Class I requirements:
    a. During Construction Work:
        1) Notify the Contracting Officer.
        2) Execute work by methods to minimize raising dust from construction operations.
        3) Ceiling tiles: Immediately replace a ceiling tiles displaced for visual inspection.
    b. Upon Completion:
        1) Clean work area upon completion of task.
        2) Notify the Contracting Officer Representative.
2. Class II requirements:
    a. During Construction Work:
        1) Notify the Contracting Officer Representative.

2) Provide active means to prevent airborne dust from dispersing into atmosphere such as wet methods or tool mounted dust collectors where possible.
3) Water mist work surfaces to control dust while cutting.
4) Seal unused doors with duct tape.
5) Block off and seal air vents.
6) Remove or isolate HVAC system in areas where work is being performed.

b. Upon Completion:
1) Wipe work surfaces with cleaner/disinfectant.
2) Contain construction waste before transport in tightly covered containers.
3) Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area.
4) Upon completion, restore HVAC system where work was performed
5) Notify the Contracting Officer Representative.

3. Class III requirements:
a. During Construction Work:
1) Obtain permit from the Contracting Officer Representative.
2) Remove or Isolate HVAC system in area where work is being done to prevent contamination of duct system.
3) Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non-work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. Install construction barriers and ceiling protection carefully, outside of normal work hours.
4) Maintain negative air pressure, 0.01 inches of water gauge, within work site utilizing HEPA equipped air filtration units and continuously monitored with a digital display, recording and alarm instrument, which must be calibrated on installation, maintained with periodic calibration and monitored by the contractor.
5) Contain construction waste before transport in tightly covered containers.
6) Cover transport receptacles or carts. Tape covering unless solid lid.

b. Upon Completion:
1) Do not remove barriers from work area until completed project is inspected by the Contracting Officer Representative and thoroughly cleaned by the VA Environmental Services Department.
2) Remove construction barriers and ceiling protection carefully to minimize spreading of dirt and debris associated with construction, outside of normal work hours.
3) Vacuum work area with HEPA filtered vacuums.
4) Wet mop area with cleaner/disinfectant.

5) Upon completion, restore HVAC system where work was performed.
6) Return permit to the Contracting Officer Representative.

4. Class IV requirements:
   a. During Construction Work:
      1) Obtain permit from the Contracting Officer Representative.
      2) Isolate HVAC system in area where work is being done to prevent contamination of duct system.
      3) Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. Install construction barriers and ceiling protection carefully, outside of normal work hours.
      4) Maintain negative air pressure, 0.01 inches of water gauge, within work site utilizing HEPA equipped air filtration units and continuously monitored with a digital display, recording and alarm instrument, which must be calibrated on installation, maintained with periodic calibration and monitored by the contractor.
      5) Seal holes, pipes, conduits, and punctures.
      6) Construct anteroom and require all personnel to pass through this room so they can be vacuumed using a HEPA vacuum cleaner before leaving work site or they can wear cloth or paper coveralls that are removed each time they leave work site.
      7) All personnel entering work site are required to wear shoe covers. Shoe covers must be changed each time the worker exits the work area.
   b. Upon Completion:
      1) Do not remove barriers from work area until completed project is inspected by the Contracting Officer Representative with thorough cleaning by the VA Environmental Services Dept.
      2) Remove construction barriers and ceiling protection carefully to minimize spreading of dirt and debris associated with construction, outside of normal work hours.
      3) Contain construction waste before transport in tightly covered containers.
      4) Cover transport receptacles or carts. Tape covering unless solid lid.
      5) Vacuum work area with HEPA filtered vacuums.
      6) Wet mop area with cleaner/disinfectant.
      7) Upon completion, restore HVAC system where work was performed.
      8) Return permit to the Contracting Officer Representative.

C. Barriers shall be erected as required based upon classification (Class III & IV requires barriers) and shall be constructed as follows:
   1. Class III and IV - closed door with masking tape applied over the frame and door is acceptable for projects that can be contained in a single room.
   2. Construction, demolition or reconstruction not capable of containment within a single room must have the following barriers erected and made presentable on hospital occupied side:
      a. Class III & IV (where dust control is the only hazard, and an agreement is reached with the COR and Medical Center) - Airtight plastic barrier that extends from the floor to ceiling. Seams must be sealed with duct tape to prevent dust and debris from escaping
      b. Class III & IV - Drywall barrier erected with joints covered or sealed to prevent dust and debris from escaping.
      c. Class III & IV - Seal all penetrations in existing barrier airtight
      d. Class III & IV - Barriers at penetration of ceiling envelopes, chases and ceiling spaces to stop movement air and debris
      e. Class IV only - Anteroom or double entrance openings that allow workers to remove protective clothing or vacuum off existing clothing
      f. Class III & IV - At elevators shafts or stairways within the field of construction, overlapping flap minimum of two feet wide of polyethylene enclosures for personnel access.

D. Products and Materials:
   1. Sheet Plastic: Fire retardant polyethylene, 6-mil thickness meeting local fire codes
   2. Barrier Doors: Self Closing, One-hour (minimum; Two-hour, if replacing a two-hour building separation) fire-rated steel in steel frame, painted
   3. Dust proof one-hour (minimum; two-hour, if at a two-hour building separation) fire-rated drywall
   4. High Efficiency Particulate Air-Equipped filtration machine rated at 95% capture of 0.3 microns including pollen, mold spores and dust particles. HEPA filters should have ASHRAE 85 or other prefilter to extend the useful life of the HEPA. Provide both primary and secondary filtrations units. Maintenance of equipment and replacement of the HEPA filters and other filters will be in accordance with manufacturer’s instructions.
   5. Exhaust Hoses: Heavy duty, flexible steel reinforced; Ventilation Blower Hose
   6. Adhesive Walk-off Mats: Provide minimum size mats of 24 inches x 36 inches
   7. Disinfectant: Hospital-approved disinfectant or equivalent product
   8. Portable Ceiling Access Module

E. Before any construction on site begins, all contractor personnel involved in the construction or renovation activity shall be educated and trained in infection prevention measures established by the medical center.

F. A dust control program will be established and maintained as part of the contractor's infection preventive measures in accordance with the FGI Guidelines for Design and Construction of Healthcare Facilities. Prior to start of work, prepare a plan detailing project-specific dust protection measures with associated product data, including periodic status reports, and submit to the COR and Facility CSC for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

G. Medical center Infection Control personnel will monitor for airborne disease (e.g. aspergillosis) during construction. A baseline of conditions will be established by the medical center prior to the start of work and periodically during the construction stage to determine impact of construction activities on indoor air quality with safe thresholds established.

H. In general, the following preventive measures shall be adopted during construction to keep down dust and prevent mold.

1. Contractor shall verify that construction exhaust to exterior is not reintroduced to the medical center through intake vents, or building openings. HEPA filtration is required where the exhaust dust may reenter the medical center.
2. Exhaust hoses shall be exhausted so that dust is not reintroduced to the medical center.
3. Adhesive Walk-off/Carpet Walk-off Mats shall be used at all interior transitions from the construction area to occupied medical center area. These mats shall be changed as often as required to maintain clean work areas directly outside construction area at all times.
4. Vacuum and wet mop all transition areas from construction to the occupied medical center at the end of each workday. Vacuum shall utilize HEPA filtration. Maintain surrounding area frequently. Remove debris as it is created. Transport these outside the construction area in containers with tightly fitting lids.
5. The contractor shall not haul debris through patient-care areas without prior approval of the Resident Engineer and the Medical Center. When, approved, debris shall be hauled in enclosed dust proof containers or wrapped in plastic and sealed with duct tape. No sharp objects should be allowed to cut through the plastic. Wipe down the exterior of the containers with a damp rag to remove dust. All equipment, tools, material, etc. transported through occupied areas shall be made free from dust and moisture by vacuuming and wipe down.
6. There shall be no standing water during construction. This includes water in equipment drip pans and open containers within the construction areas. All accidental spills must be cleaned up and dried within 12 hours. Remove and dispose of porous materials that remain damp for more than 72 hours.

7. At completion, remove construction barriers and ceiling protection carefully, outside of normal work hours. Vacuum and clean all surfaces free of dust after the removal.

I. Final Cleanup:

1. Upon completion of project, or as work progresses, remove all construction debris from above ceiling, vertical shafts and utility chases that have been part of the construction.
2. Perform HEPA vacuum cleaning of all surfaces in the construction area. This includes walls, ceilings, cabinets, furniture (built-in or free standing), partitions, flooring, etc.
3. All new air ducts shall be cleaned prior to final inspection.

J. Exterior Construction

1. Contractor shall verify that dust will not be introduced into the medical center through intake vents, or building openings. HEPA filtration on intake vents is required where dust may be introduced.
2. Dust created from disturbance of soil such as from vehicle movement will be wetted with use of a water truck as necessary
3. All cutting, drilling, grinding, sanding, or disturbance of materials shall be accomplished with tools equipped with either local exhaust ventilation (i.e. vacuum systems) or wet suppression controls.

1.13 TUBERCULOSIS SCREENING

A. Contractor shall provide written certification that all contract employees assigned to the work site have had a pre-placement tuberculin screening within 90 days prior to assignment to the worksite and been found have negative TB screening reactions. Contractors shall be required to show documentation of negative TB screening reactions for any additional workers who are added after the 90-day requirement before they will be allowed to work on the work site. NOTE: This can be the Center for Disease Control (CDC) and Prevention and two-step skin testing or a Food and Drug Administration (FDA)-approved blood test.

1. Contract employees manifesting positive screening reactions to the tuberculin shall be examined according to current CDC guidelines prior to working on VHA property.
2. Subsequently, if the employee is found without evidence of active (infectious) pulmonary TB, a statement documenting examination by a physician shall be on file with the employer (construction contractor), noting that the employee with a positive tuberculin screening test is without evidence of active (infectious) pulmonary TB.
3. If the employee is found with evidence of active (infectious) pulmonary TB, the employee shall require treatment with a subsequent statement to the fact on file with the employer before being allowed to return to work on VHA property.

1.14 FIRE SAFETY

A. Fire Safety Plan: Establish and maintain a site-specific fire protection program in accordance with 29 CFR 1926. Prior to start of work, prepare a plan detailing project-specific fire safety

measures, including periodic status reports, and submit to the Contracting Officer Representative for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES. This plan may be an element of the Accident Prevention Plan.

B. Site and Building Access: Maintain free and unobstructed access to facility emergency services and for fire, police and other emergency response forces in accordance with NFPA 241.

C. Separate temporary facilities, such as trailers, storage sheds, and dumpsters, from existing buildings and new construction by distances in accordance with NFPA 241. For small facilities with less than 6 m (20 feet) exposing overall length, separate by 3m (10 feet).

D. Temporary Construction Partitions:

1. Install and maintain temporary construction partitions to provide smoke-tight separations between construction areas and adjoining areas. Construct partitions of gypsum board or treated plywood (flame spread rating of 25 or less in accordance with ASTM E84) on both sides of fire retardant treated wood or metal steel studs. Extend the partitions through suspended ceilings to floor slab deck or roof. Seal joints and penetrations. At door openings, install Class C, ¾ hour fire/smoke rated doors with self-closing devices.
2. Install one-hour (minimum; two-hour, if replacing a two-hour building separation) fire-rated temporary construction partitions to maintain integrity of existing exit stair enclosures, exit passageways, fire-rated enclosures of hazardous areas, horizontal exits, smoke barriers, vertical shafts and openings enclosures.
3. Close openings in smoke barriers and fire-rated construction to maintain fire ratings. Seal penetrations with listed through-penetration firestop materials in accordance with Section 07 84 00, FIRESTOPPING.

E. Temporary Heating and Electrical: Install, use and maintain installations in accordance with 29 CFR 1926, NFPA 241 and NFPA 70.

F. Means of Egress: Do not block exiting for occupied buildings, including paths from exits to roads. Minimize disruptions and coordinate with the Contracting Officer Representative.

G. Egress Routes for Construction Workers: Maintain free and unobstructed egress. Inspect daily. Report findings and corrective actions weekly to the Contracting Officer Representative.

H. Fire Extinguishers: Provide and maintain extinguishers in construction areas and temporary storage areas in accordance with 29 CFR 1926, NFPA 241 and NFPA 10.

I. Flammable and Combustible Liquids: Store, dispense and use liquids in accordance with 29 CFR 1926, NFPA 241 and NFPA 30.

J. Sprinklers: Install, test and activate new automatic sprinklers prior to removing existing sprinklers.

K. Existing Fire Protection: Do not impair automatic sprinklers, smoke and heat detection, and fire alarm systems, except for portions immediately under construction, and temporarily for connections. Provide fire watch for impairments more than 4 hours in a 24-hour period. Request interruptions in accordance with Article, OPERATIONS AND STORAGE AREAS, and coordinate with the Contracting Officer Representative. All existing or temporary fire protection systems (fire alarms, sprinklers) located in construction areas shall be tested as coordinated with the medical center. Parameters for the testing and results of any tests performed shall be recorded by the medical center and copies provided to the Resident Engineer.

L. Smoke Detectors: Prevent accidental operation. Remove temporary covers at end of work operations each day. Coordinate with the Contracting Officer Representative.

M. Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with the COR at least 8 hours in advance. Designate contractor's responsible project-site fire prevention program manager to permit hot work.

N. Fire Hazard Prevention and Safety Inspections: Inspect entire construction areas weekly. Coordinate with, and report findings and corrective actions weekly to the Contracting Officer Representative.

O. Smoking: Smoking is prohibited in and adjacent to construction areas inside existing buildings and additions under construction. In separate and detached buildings under construction, smoking is prohibited except in designated smoking rest areas.

P. Dispose of waste and debris in accordance with NFPA 241. Remove from buildings daily.

Q. If required, submit documentation to the COR that personnel have been trained in the fire safety aspects of working in areas with impaired structural or compartmentalization features.

1.15 ELECTRICAL

A. All electrical work shall comply with NFPA 70 (NEC), NFPA 70B, NFPA 70E, 29 CFR Part 1910 Subpart J – General Environmental Controls, 29 CFR Part 1910 Subpart S – Electrical, and 29 CFR 1926 Subpart K in addition to other references required by contract.

B. All qualified persons performing electrical work under this contract shall be licensed journeyman or master electricians. All apprentice electricians performing under this contract shall be deemed unqualified persons unless they are working under the immediate supervision of a licensed electrician or master electrician.

C. All electrical work will be accomplished de-energized and in the Electrically Safe Work Condition (refer to NFPA 70E for Work Involving Electrical Hazards, including Exemptions to Work Permit). Any Contractor, subcontractor or temporary worker who fails to fully comply with this requirement is subject to immediate termination in accordance with FAR clause 52.236-5(c). Only in rare circumstance where achieving an electrically safe work condition prior to beginning work would increase or cause additional hazards, or is infeasible due to

equipment design or operational limitations is energized work permitted. The Chief of Facilities Management with approval of the Medical Center Director will make the determination if the circumstances would meet the exception outlined above. An AHA and permit specific to energized work activities will be developed, reviewed, and accepted by the VA prior to the start of that activity.

1. Development of a Hazardous Electrical Energy Control Procedure is required prior to de-energization. A single Simple Lockout/Tagout Procedure for multiple work operations can only be used for work involving qualified person(s) de-energizing one set of conductors or circuit part source. Task specific Complex Lockout/Tagout Procedures are required at all other times.
2. Verification of the absence of voltage after de-energization and lockout/tagout is considered “energized electrical work” (live work) under NFPA 70E, and shall only be performed by qualified persons wearing appropriate shock protective (voltage rated) gloves and arc rate personal protective clothing and equipment, using Underwriters Laboratories (UL) tested and appropriately rated contact electrical testing instruments or equipment appropriate for the environment in which they will be used.
3. Personal Protective Equipment (PPE) and electrical testing instruments will be readily available for inspection by the the Contracting Officer Representative.

D. Before beginning any electrical work, an Activity Hazard Analysis (AHA) will be conducted to include Shock Hazard and Arc Flash Hazard analyses (NFPA Tables can be used only as a last alterative and it is strongly suggested a full Arc Flash Hazard Analyses be conducted). Work shall not begin until the AHA for the work activity and permit for energized work has been reviewed and accepted by the Contracting Officer Representative and discussed with all engaged in the activity, including the Contractor, subcontractor(s), and Government on-site representatives at preparatory and initial control phase meetings.

E. Ground-fault circuit interrupters. GFCI protection shall be provided where an employee is operating or using cord- and plug-connected tools related to construction activity supplied by 125-volt, 15-, 20-, or 30- ampere circuits. Where employees operate or use equipment supplied by greater than 125-volt, 15-, 20-, or 30- ampere circuits, GFCI protection or an assured equipment grounding conductor program shall be implemented in accordance with NFPA 70E - 2015, Chapter 1, Article 110.4(C)(2).

1.16 FALL PROTECTION

A. The fall protection (FP) threshold height requirement is 6 ft (1.8 m) for ALL WORK, unless specified differently or the OSHA 29 CFR 1926 requirements are more stringent, to include steel erection activities, systems-engineered activities (prefabricated) metal buildings, residential (wood) construction and scaffolding work.

1. The use of a Safety Monitoring System (SMS) as a fall protection method is prohibited.

2. The use of Controlled Access Zone (CAZ) as a fall protection method is prohibited.
3. A Warning Line System (WLS) may ONLY be used on floors or flat or low-sloped roofs (between 0 - 18.4 degrees or 4:12 slope) and shall be erected around all sides of the work area (See 29 CFR 1926.502(f) for construction of WLS requirements). Working within the WLS does not require FP. No worker shall be allowed in the area between the roof or floor edge and the WLS without FP. FP is required when working outside the WLS.
4. Fall protection while using a ladder will be governed by the OSHA requirements.

1.17 SCAFFOLDS AND OTHER WORK PLATFORMS

A. All scaffolds and other work platforms construction activities shall comply with 29 CFR 1926 Subpart L.

B. The fall protection (FP) threshold height requirement is 6 ft (1.8 m) as stated in Section 1.16.

C. The following hierarchy and prohibitions shall be followed in selecting appropriate work platforms.
1. Scaffolds, platforms, or temporary floors shall be provided for all work except that can be performed safely from the ground or similar footing.
2. Ladders less than 20 feet may be used as work platforms only when use of small hand tools or handling of light material is involved.
3. Ladder jacks, lean-to, and prop-scaffolds are prohibited.
4. Emergency descent devices shall not be used as working platforms.

D. Contractors shall use a scaffold tagging system in which all scaffolds are tagged by the Competent Person. Tags shall be color-coded: green indicates the scaffold has been inspected and is safe to use; red indicates the scaffold is unsafe to use. Tags shall be readily visible, made of materials that will withstand the environment in which they are used, be legible and shall include:
1. The Competent Person’s name and signature;
2. Dates of initial and last inspections.

E. Mast Climbing work platforms: When access ladders, including masts designed as ladders, exceed 20 ft (6 m) in height, positive fall protection shall be used.

1.18 EXCAVATION AND TRENCHES

A. All excavation and trenching work shall comply with 29 CFR 1926 Subpart P. Excavations less than 5 feet in depth require evaluation by the contractor’s “Competent Person” (CP) for determination of the necessity of an excavation protective system where kneeing, laying in, or stooping within the excavation is required.

B. All excavations and trenches 24 inches in depth or greater shall require a written trenching and excavation permit (verify if Minnesota and other local jurisdictions require separate state/jurisdiction-issued excavation permits). The permit shall have two sections, one section

will be completed prior to digging or drilling and the other will be completed prior to personnel entering the excavations greater than 5 feet in depth. Each section of the permit shall be provided to the COR prior to proceeding with digging or drilling and prior to proceeding with entering the excavation. After completion of the work and prior to opening a new section of an excavation, the permit shall be closed out and provided to the COR. The permit shall be maintained onsite and the first section of the permit shall include the following:

1. Estimated start time & stop time
2. Specific location and nature of the work.
3. Indication of the contractor's "Competent Person" (CP) in excavation safety with qualifications and signature. Formal course in excavation safety is required by the contractor's CP.
4. Indication of whether soil or concrete removal to an offsite location is necessary.
5. Indication of whether soil samples are required to determined soil contamination.
6. Indication of coordination with local authority (i.e. "One Call") or contractor's effort to determine utility location with search and survey equipment.
7. Indication of review of site drawings for proximity of utilities to digging/drilling.

C. The second section of the permit for excavations greater than five feet in depth shall include the following:

1. Determination of OSHA classification of soil. Soil samples will be from freshly dug soil with samples taken from different soil type layers as necessary and placed at a safe distance from the excavation by the excavating equipment. A pocket penetronmeter will be utilized in determination of the unconfined compression strength of the soil for comparison against OSHA table (Less than 0.5 Tons/FT2 – Type C, 0.5 Tons/FT2 to 1.5 Tons/FT2 – Type B, greater than 1.5 Tons/FT2 – Type A without condition to reduce to Type B).
2. Indication of selected protective system (sloping/benching, shoring, shielding). When soil classification is identified as "Type A" or "Solid Rock", only shoring or shielding or Professional Engineer designed systems can be used for protection. A Sloping/Benching system may only be used when classifying the soil as Type B or Type C. Refer to Appendix B of 29 CFR 1926, Subpart P for further information on protective systems designs.
3. Indication of the spoil pile being stored at least 2 feet from the edge of the excavation and safe access being provided within 25 feet of the workers.
4. Indication of assessment for a potential toxic, explosive, or oxygen deficient atmosphere where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist. Internal combustion engine equipment is not allowed in an excavation without providing force air

ventilation to lower the concentration to below OSHA PELs, providing sufficient oxygen levels, and atmospheric testing as necessary to ensure safe levels are maintained.

D. As required by OSHA 29 CFR 1926.651(b)(1), the estimated location of utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installations that reasonably may be expected to be encountered during excavation work, shall be determined prior to opening an excavation.
   1. The planned dig site will be outlined/marked in white prior to locating the utilities.
   2. Used of the American Public Works Association Uniform Color Code is required for the marking of the proposed excavation and located utilities.
   3. 811 will be called two business days before digging on all local or State lands and public Right-of Ways.
   4. Digging will not commence until all known utilities are marked.
   5. Utility markings will be maintained

E. Excavations will be hand dug or excavated by other similar safe and acceptable means as excavation operations approach within 3 to 5 feet of identified underground utilities. Exploratory bar or other detection equipment will be utilized as necessary to further identify the location of underground utilities.

1.19 CRANES

A. All crane work shall comply with 29 CFR 1926 Subpart CC.

B. Prior to operating a crane, the operator must be licensed, qualified or certified to operate the crane. Thus, all the provisions contained with Subpart CC are effective and there is no “Phase In” date.

C. A detailed lift plan for all lifts shall be submitted to the COR 14 days prior to the scheduled lift complete with route for truck carrying load, crane load analysis, siting of crane and path of swing and all other elements of a critical lift plan where the lift meets the definition of a critical lift. Critical lifts require a more comprehensive lift plan to minimize the potential of crane failure and/or catastrophic loss. The plan must be reviewed and accepted by the General Contractor before being submitted to the VA for review. The lift will not be allowed to proceed without prior acceptance of this document.

D. Crane operators shall not carry loads
   1. over the general public or VAMC personnel
   2. over any occupied building unless
      a. the top two floors are vacated
      b. or overhead protection with a design live load of 300 psf is provided

1.20 CONTROL OF HAZARDOUS ENERGY (LOCKOUT/TAGOUT)

A. All installation, maintenance, and servicing of equipment or machinery shall comply with 29 CFR 1910.147 except for specifically referenced operations in 29 CFR 1926 such as

concrete & masonry equipment [1926.702(j)], heavy machinery & equipment [1926.600(a)(3)(i)], and process safety management of highly hazardous chemicals (1926.64). Control of hazardous electrical energy during the installation, maintenance, or servicing of electrical equipment shall comply with Section 1.15 to include NFPA 70E and other VA specific requirements discussed in the section.

1.21 CONFINED SPACE ENTRY

A. All confined space entry shall comply with 29 CFR 1926, Subpart AA except for specifically referenced operations in 29 CFR 1926 such as excavations/trenches [1926.651(g)].

B. A site-specific Confined Space Entry Plan (including permitting process) shall be developed and submitted to the COR.

1.22 WELDING AND CUTTING

A. As specified in section 1.14, Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with the COR. Obtain permits from the COR at least 8 hours in advance. Designate contractor's responsible project-site fire prevention program manager to permit hot work.

1.23 LADDERS

A. All Ladder use shall comply with 29 CFR 1926 Subpart X.

B. All portable ladders shall be of sufficient length and shall be placed so that workers will not stretch or assume a hazardous position.

C. Manufacturer safety labels shall be in place on ladders.

D. Step Ladders shall not be used in the closed position.

E. Top steps or cap of step ladders shall not be used as a step.

F. Portable ladders, used as temporary access, shall extend at least 3 ft (0.9 m) above the upper landing surface.

1. When a 3 ft (0.9-m) extension is not possible, a grasping device (such as a grab rail) shall be provided to assist workers in mounting and dismounting the ladder.
2. In no case shall the length of the ladder be such that ladder deflection under a load would, by itself, cause the ladder to slip from its support.

G. Ladders shall be inspected for visible defects on a daily basis and after any occurrence that could affect their safe use. Broken or damaged ladders shall be immediately tagged "DO NOT USE," or with similar wording, and withdrawn from service until restored to a condition meeting their original design.

1.24 FLOOR & WALL OPENINGS

A. All floor and wall openings shall comply with 29 CFR 1926 Subpart M.

B. Floor and roof holes/openings are any that measure over 2 in (51 mm) in any direction of a walking/working surface which persons may trip or fall into or where objects may fall to the level below. Skylights located in floors or roofs are considered floor or roof hole/openings.

C. All floor, roof openings or hole into which a person can accidentally walk or fall through shall be guarded either by a railing system with toeboards along all exposed sides or a load-bearing cover. When the cover is not in place, the opening or hole shall be protected by a removable guardrail system or shall be attended when the guarding system has been removed, or other fall protection system.

1. Covers shall be capable of supporting, without failure, at least twice the weight of the worker, equipment and material combined.
2. Covers shall be secured when installed, clearly marked with the word “HOLE”, “COVER” or “Danger, Roof Opening-Do Not Remove” or color-coded or equivalent methods (e.g., red or orange “X”). Workers must be made aware of the meaning for color coding and equivalent methods.
3. Roofing material, such as roofing membrane, insulation or felts, covering or partly covering openings or holes, shall be immediately cut out. No hole or opening shall be left unattended unless covered.
4. Non-load-bearing skylights shall be guarded by a load-bearing skylight screen, cover, or railing system along all exposed sides.
5. Workers are prohibited from standing/walking on skylights.

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SECTION 01 42 19
REFERENCE STANDARDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the availability and source of references and standards specified in the project manual under paragraphs APPLICABLE PUBLICATIONS and/or shown on the drawings.

1.2 AVAILABILITY OF SPECIFICATIONS LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS FPMR PART 101-29 (FAR 52.211-1) (AUG 1998)

A. The GSA Index of Federal Specifications, Standards and Commercial Item Descriptions, FPMR Part 101-29 and copies of specifications, standards, and commercial item descriptions cited in the solicitation may be obtained for a fee by submitting a request to – GSA Federal Supply Service, Specifications Section, Suite 8100, 470 East L'Enfant Plaza, SW, Washington, DC 20407, Telephone (202) 619-8925, Facsimile (202) 619-8978.

B. If the General Services Administration or Department of Veterans Affairs issued this solicitation, a single copy of specifications, standards, and commercial item descriptions cited in this solicitation may be obtained free of charge by submitting a request to the addressee in paragraph (a) of this provision. Additional copies will be issued for a fee.

1.3 AVAILABILITY FOR EXAMINATION OF SPECIFICATIONS NOT LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS (FAR 52.211-4) (JUN 1988)

A. The specifications and standards cited in this solicitation can be examined at the following location:

DEPARTMENT OF VETERANS AFFAIRS
Office of Construction & Facilities Management
Facilities Quality Service (00CFM1A)
425 Eye Street N.W, (sixth floor)
Washington, DC 20001
Telephone Numbers: (202) 632-5249 or (202) 632-5178
Between 9:00 AM - 3:00 PM

1.4 AVAILABILITY OF SPECIFICATIONS NOT LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS (FAR 52.211-3) (JUN 1988)

A. The specifications cited in this solicitation may be obtained from the associations or organizations listed below.

AA Aluminum Association Inc.
http://www.aluminum.org

AABC	Associated Air Balance Council https://www.aabc.com
AAMA	American Architectural Manufacturer's Association http://www.aamanet.org
AASHTO	American Association of State Highway and Transportation Officials http://www.aashto.org
AATCC	American Association of Textile Chemists and Colorists http://www.aatcc.org
ACGIH	American Conference of Governmental Industrial Hygienists http://www.acgih.org
ACI	American Concrete Institute http://www.aci-int.net
ACPA	American Concrete Pipe Association http://www.concrete-pipe.org
ACPPA	American Concrete Pressure Pipe Association http://www.acppa.org
ADC	Air Diffusion Council http://flexibleduct.org
AGA	American Gas Association http://www.aga.org
AGC	Associated General Contractors of America http://www.agc.org
AGMA	American Gear Manufacturers Association, Inc. http://www.agma.org
AH	American Hort https://www.americanhort.org
AHAM	Association of Home Appliance Manufacturers http://www.aham.org
AIA	American Institute of Architects http://www.aia.org
AISC	American Institute of Steel Construction http://www.aisc.org
AISI	American Iron and Steel Institute http://www.steel.org
AITC	American Institute of Timber Construction https://aitc-glulam.org
AMCA	Air Movement and Control Association, Inc. http://www.amca.org
ANSI	American National Standards Institute, Inc. http://www.ansi.org
APA	The Engineered Wood Association http://www.apawood.org
ARI	Air-Conditioning and Refrigeration Institute http://www.ari.org

ARPM	Association for Rubber Product Manufacturers https://arpm.com
ASABE	American Society of Agricultural and Biological Engineers https://www.asabe.org
ASCE	American Society of Civil Engineers http://www.asce.org
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers http://www.ashrae.org
ASME	American Society of Mechanical Engineers http://www.asme.org
ASSE	American Society of Sanitary Engineering International http://www.asse-plumbing.org
ASTM	American Society for Testing and Materials International http://www.astm.org
AWI	Architectural Woodwork Institute https://www.awinet.org
AWS	American Welding Society https://www.aws.org
AWWA	American Water Works Association https://www.awwa.org
BHMA	Builders Hardware Manufacturers Association https://www.buildershardware.com
BIA	The Brick Industry Association http://www.gobrick.com
CAGI	Compressed Air and Gas Institute https://www.cagi.org
CGA	Compressed Gas Association, Inc. https://www.cganet.com
CI	The Chlorine Institute, Inc. https://www.chlorineinstitute.org
CISCA	Ceilings and Interior Systems Construction Association https://www.cisca.org
CISPI	Cast Iron Soil Pipe Institute https://www.cispi.org
CLFMI	Chain Link Fence Manufacturers Institute https://www.chainlinkinfo.org
CPA	Composite Panel Association https://www.compositepanel.org
CPMB	Concrete Plant Manufacturers Bureau https://www.cpmb.org
CRA	California Redwood Association http://www.calredwood.org
CRSI	Concrete Reinforcing Steel Institute https://www.crsi.org

CTI	Cooling Technology Institute https://www.cti.org
DHA	Decorative Hardwoods Association https://www.decorativehardwoods.org
DHI	Door and Hardware Institute https://www.dhi.org
EGSA	Electrical Generating Systems Association http://www.egsa.org
EEI	Edison Electric Institute https://www.eei.org
EPA	United States Environmental Protection Agency https://www.epa.gov
ETL	ETL Testing Services http://www.intertek.com
FAA	Federal Aviation Administration https://www.faa.gov
FCC	Federal Communications Commission https://www.fcc.gov
FPS	Forest Products Society http://www.forestprod.org
GANA	Glass Association of North America http://www.glasswebsite.com
FM	Factory Mutual Global Insurance https://www.fmglobal.com
GA	Gypsum Association https://gypsum.org
GSA	General Services Administration https://www.gsa.gov
HI	Hydraulic Institute http://www.pumps.org
ICC	International Code Council https://shop.iccsafe.org
ICEA	Insulated Cable Engineers Association https://www.icea.net
ICAC	Institute of Clean Air Companies http://www.icac.com
IEEE	Institute of Electrical and Electronics Engineers https://www.ieee.org\
IGMA	Insulating Glass Manufacturers Alliance https://www.igmaonline.org
IMSA	International Municipal Signal Association http://www.imsasafety.org
MBMA	Metal Building Manufacturers Association https://www.mbma.com

MSS	Manufacturers Standardization Society of the Valve and Fittings Industry http://msshq.org
NAAMM	National Association of Architectural Metal Manufacturers https://www.naamm.org
PHCC	Plumbing-Heating-Cooling Contractors Association https://www.phccweb.org
NBS	National Bureau of Standards See - NIST
NBBI	The National Board of Boiler and Pressure Vessel Inspectors https://www.nationalboard.org
NEC	National Electric Code See - NFPA National Fire Protection Association
NEMA	National Electrical Manufacturers Association https://www.nema.org
NFPA	National Fire Protection Association https://www.nfpa.org
NHLA	National Hardwood Lumber Association https://www.nhla.com
NIH	National Institute of Health https://www.nih.gov
NIST	National Institute of Standards and Technology https://www.nist.gov
NELMA	Northeastern Lumber Manufacturers Association, Inc. http://www.nelma.org
NPA	National Particleboard Association (See CPA, Composite Panel Association)
NSF	National Sanitation Foundation http://www.nsf.org
OSHA	Occupational Safety and Health Administration Department of Labor https://www.osha.gov
PCA	Portland Cement Association https://www.cement.org
PCI	Precast Prestressed Concrete Institute https://www.pci.org
PPI	Plastics Pipe Institute https://www.plasticpipe.org
PEI	Porcelain Enamel Institute http://www.porcelainenamel.com
PTI	Post-Tensioning Institute http://www.post-tensioning.org
RFCI	Resilient Floor Covering Institute https://www.rfci.com
RIS	Redwood Inspection Service (See Western Wood Products Association) https://www.wwpa.org

SCMA	Southern Cypress Manufacturers Association http://www.cypressinfo.org
SDI	Steel Door Institute http://www.steeldoor.org
SJI	Steel Joist Institute https://www.steeljoist.org
SMACNA	Sheet Metal & Air-Conditioning Contractors' National Association https://www.smacna.org
SSPC	The Society for Protective Coatings https://www.sspc.org
STI	Steel Tank Institute https://www.steeltank.com
SWI	Steel Window Institute https://www.steelwindows.com
TCNA	Tile Council of North America https://www.tcnatile.com
TEMA	Tubular Exchanger Manufacturers Association http://www.tema.org
TPI	Truss Plate Institute https://www.tpinst.org
UBC	The Uniform Building Code (See ICC)
UL	Underwriters' Laboratories Incorporated https://www.ul.com
ULC	Underwriters' Laboratories of Canada https://www.ulc.ca
WCLB	West Coast Lumber Inspection Bureau http://www.wclib.org
WDMA	Window and Door Manufacturers Association https://www.wdma.com
WRCLA	Western Red Cedar Lumber Association https://www.realcedar.com
WWPA	Western Wood Products Association http://www.wwpa.org

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SECTION 01 45 29
TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies materials testing activities and inspection services required during project construction to be provided by a Testing Laboratory retained by Department of Veterans Affairs.

1.2 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

B. American Association of State Highway and Transportation Officials (AASHTO):

T27-11 ..... Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates

T96-02 (R2006) ..... Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

T99-10 ..... Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5 Kg (5.5 lb.) Rammer and a 305 mm (12 in.) Drop

T104-99 (R2007) ..... Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate

T180-10 ..... Standard Method of Test for Moisture-Density Relations of Soils using a 4.54 kg (10 lb.) Rammer and a 457 mm (18 in.) Drop

T191-02(R2006) ..... Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method

T310-13 ..... Standard Method of Test for In-place Density and Moisture Content of Soil and Soil-aggregate by Nuclear Methods (Shallow Depth)

C. American Society for Testing and Materials (ASTM):

A370-12 ..... Standard Test Methods and Definitions for Mechanical Testing of Steel Products

A416/A416M-10..... Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete

C31/C31M-10 ..... Standard Practice for Making and Curing Concrete Test Specimens in the Field

C33/C33M-11a ..... Standard Specification for Concrete Aggregates

C39/C39M-12 ..... Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

C109/C109M-11b ..... Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
C136-06 ..... Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
C138/C138M-10b ..... Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
C140-12 ..... Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
C143/C143M-10a ..... Standard Test Method for Slump of Hydraulic Cement Concrete
C172/C172M-10 ..... Standard Practice for Sampling Freshly Mixed Concrete
C173/C173M-10b ..... Standard Test Method for Air Content of freshly Mixed Concrete by the Volumetric Method
C330/C330M-09 ..... Standard Specification for Lightweight Aggregates for Structural Concrete
C567/C567M-11 ..... Standard Test Method for Density Structural Lightweight Concrete
C780-11 ..... Standard Test Method for Pre-construction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
C1019-11 ..... Standard Test Method for Sampling and Testing Grout
C1064/C1064M-11 ..... Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete
C1077-11c ..... Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
C1314-11a ..... Standard Test Method for Compressive Strength of Masonry Prisms
D422-63(2007) ..... Standard Test Method for Particle-Size Analysis of Soils
D698-07e1 ..... Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
D1140-00(2006) ..... Standard Test Methods for Amount of Material in Soils Finer than No. 200 Sieve
D1143/D1143M-07e1 ... Standard Test Methods for Deep Foundations Under Static Axial Compressive Load
D1188-07e1 ..... Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
D1556-07 ..... Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
D1557-09 ..... Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft lbf/ft3 (2,700 KNm/m3))

D2166-06 ..... Standard Test Method for Unconfined Compressive Strength of Cohesive Soil
D2167-08)..... Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
D2216-10 ..... Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D2974-07a ..... Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
D3666-11 ..... Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
D3740-11 ..... Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as used in Engineering Design and Construction
D6938-10 ..... Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
E94-04(2010)..... Standard Guide for Radiographic Examination
E164-08 ..... Standard Practice for Contact Ultrasonic Testing of Weldments
E329-11c ..... Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
E543-09 ..... Standard Specification for Agencies Performing Non-Destructive Testing
E605-93(R2011) ..... Standard Test Methods for Thickness and Density of Sprayed Fire Resistive Material (SFRM) Applied to Structural Members
E709-08 ..... Standard Guide for Magnetic Particle Examination
E1155-96(R2008) ..... Determining FF Floor Flatness and FL Floor Levelness Numbers
F3125/F3125M-15 ..... Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions

D. American Welding Society (AWS):
D1.D1.1M-10 ..... Structural Welding Code-Steel

1.3 REQUIREMENTS

A. Accreditation Requirements: Construction materials testing laboratories must be accredited by a laboratory accreditation authority and will be required to submit a copy of the Certificate of Accreditation and Scope of Accreditation. The laboratory's scope of accreditation must include the appropriate ASTM standards (i.e.; E329, C1077, D3666, D3740, A880, E543) listed in the technical sections of the specifications. Laboratories engaged in Hazardous

Materials Testing shall meet the requirements of OSHA and EPA. The policy applies to the specific laboratory performing the actual testing, not just the “Corporate Office.”

B. Inspection and Testing: Testing laboratory shall inspect materials and workmanship and perform tests described herein and additional tests requested by COR. When it appears materials furnished, or work performed by Contractor fail to meet construction contract requirements, Testing Laboratory shall direct attention of COR to such failure.

C. Written Reports: Testing laboratory shall submit test reports to COR, Contractor, unless other arrangements are agreed to in writing by the COR. Submit reports of tests that fail to meet construction contract requirements on colored paper.

D. Verbal Reports: Give verbal notification to COR immediately of any irregularity.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EARTHWORK

A. General: The Testing Laboratory shall provide qualified personnel, materials, equipment, and transportation as required to perform the services identified/required herein, within the agreed to schedule and/or time frame. The work to be performed shall be as identified herein and shall include but not be limited to the following:

1. Observe fill and subgrades during proof-rolling to evaluate suitability of surface material to receive fill or base course. Provide recommendations to the COR regarding suitability or unsuitability of areas where proof-rolling was observed. Where unsuitable results are observed, witness excavation of unsuitable material and recommend to COR extent of removal and replacement of unsuitable materials and observe proof-rolling of replaced areas until satisfactory results are obtained.
2. Provide part time observation of fill placement and compaction and field density testing in building areas and provide part time observation of fill placement and compaction and field density testing in pavement areas to verify that earthwork compaction obtained is in accordance with contract documents.
3. Provide supervised geotechnical technician to inspect excavation, subsurface preparation, and backfill for structural fill.

B. Testing Compaction:

1. Determine maximum density and optimum moisture content for each type of fill, backfill and subgrade material used, in compliance with ASTM D698 and/or ASTM D1557.
2. Make field density tests in accordance with the primary testing method following ASTM D6938 wherever possible. Field density tests utilizing ASTM D1556 shall be utilized on a case by case basis only if there are problems with the validity of the results from the primary method due to specific site field conditions. Should the testing laboratory propose

these alternative methods, they should provide satisfactory explanation to the COR before the tests are conducted.

a. Building Slab Subgrade: At least one test of subgrade for every 185 m^2 (2000 square feet) of building slab, but in no case fewer than three tests. In each compacted fill layer, perform one test for every 185 m^2 (2000 square feet) of overlaying building slab, but in no case fewer than three tests.
b. Foundation Wall Backfill: One test per 30 m (100 feet) of each layer of compacted fill but in no case fewer than two tests.
c. Pavement Subgrade: One test for each 335 m^2 (400 square yards), but in no case fewer than two tests.
d. Curb, Gutter, and Sidewalk: One test for each 90 m (300 feet), but in no case fewer than two tests.
e. Footing Subgrade: At least one test for each layer of soil on which footings will be placed. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested subgrade when acceptable to COR. In each compacted fill layer below wall footings, perform one field density test for every 30 m (100 feet) of wall. Verify subgrade is level, all loose or disturbed soils have been removed, and correlate actual soil conditions observed with those indicated by test borings.

C. Fill and Backfill Material Gradation: One test per 200 cubic yards stockpiled or in-place source material. Gradation of fill and backfill material shall be determined in accordance with ASTM C136.
D. Testing for Footing Bearing Capacity: Evaluate if suitable bearing capacity material is encountered in footing subgrade.
E. Testing Materials: Test suitability of on-site and off-site borrow as directed by COR.

3.2 FOUNDATION PILES

A. Helical Anchors used to support tension loads
B. Helical piles used to support compression loads
C. Witness load test procedure for conformance with ASTM D1143 and interpret test data to verify geotechnical recommendations for pile capacity. Submit load test report in accordance with ASTM D1143.
D. Review Contractor's equipment, methods, and procedures prior to starting any work on site. Provide continuous inspection of pile installation. Maintain a record of all pertinent phases of operation for submittal to COR.
E.

3.3 ASPHALT CONCRETE PAVING

A. Aggregate Base Course:

1. Determine maximum density and optimum moisture content for aggregate base material in accordance with AASHTO T180, Method D.
2. Make a minimum of three field density tests on each day's final compaction on each aggregate course in accordance with AASHTO T191.
3. Sample and test aggregate as necessary to insure compliance with specification requirements for gradation, wear, and soundness as specified in the applicable state highway standards and specifications.

B. Asphalt Concrete:

1. Aggregate: Sample and test aggregates in stock pile and hot-bins as necessary to insure compliance with specification requirements for gradation (AASHTO T27), wear (AASHTO T96), and soundness (AASHTO T104).
2. Temperature: Check temperature of each load of asphalt concrete at mixing plant and at site of paving operation.
3. Density: Make a minimum of two field density tests in accordance with ASTM D1188 of asphalt base and surface course for each day's paving operation.

3.4 SITE WORK CONCRETE

A. Test site work concrete including materials for concrete as required in Article CONCRETE of this section.

3.5 CONCRETE

A. Batch Plant Inspection and Materials Testing:

1. Perform continuous batch plant inspection until concrete quality is established to satisfaction of COR with concurrence of Contracting Officer and perform periodic inspections thereafter as determined by COR.
2. Periodically inspect and test batch proportioning equipment for accuracy and report deficiencies to COR.
3. Sample and test mix ingredients as necessary to ensure compliance with specifications.
4. Sample and test aggregates daily and as necessary for moisture content. Test the dry rodded weight of the coarse aggregate whenever a sieve analysis is made, and when it appears there has been a change in the aggregate.
5. Certify, in duplicate, ingredients and proportions and amounts of ingredients in concrete conform to approved trial mixes. When concrete is batched or mixed off immediate building site, certify (by signing, initialing or stamping thereon) on delivery slips (duplicate) that ingredients in truck-load mixes conform to proportions of aggregate weight, cement factor, and water-cement ratio of approved trial mixes.

B. Field Inspection and Materials Testing:

1. Provide a technician at site of placement at all times to perform concrete sampling and testing.

2. Review the delivery tickets of the ready-mix concrete trucks arriving on-site. Notify the Contractor if the concrete cannot be placed within the specified time limits or if the type of concrete delivered is incorrect. Reject any loads that do not comply with the Specification requirements. Rejected loads are to be removed from the site at the Contractor's expense. Any rejected concrete that is placed will be subject to removal.
3. Take concrete samples at point of placement in accordance with ASTM C172. Mold and cure compression test cylinders in accordance with ASTM C31. Make at least three cylinders for each 40 m3 (50 cubic yards) or less of each concrete type, and at least three cylinders for any one day's pour for each concrete type. After good concrete quality control has been established and maintained as determined by COR make three cylinders for each 80 m3 (100 cubic yards) or less of each concrete type, and at least three cylinders from any one day's pour for each concrete type. Label each cylinder with an identification number. COR may require additional cylinders to be molded and cured under job conditions.
4. Perform slump tests in accordance with ASTM C143. Test the first truck each day, and every time test cylinders are made. Test pumped concrete at the hopper and at the discharge end of the hose at the beginning of each day's pumping operations to determine change in slump.
5. Determine the air content of concrete per ASTM C173. For concrete required to be air-entrained, test the first truck and every 20 m3 (25 cubic yards) thereafter each day. For concrete not required to be air-entrained, test every 80 m3 (100 cubic yards) at random. For pumped concrete, initially test concrete at both the hopper and the discharge end of the hose to determine change in air content.
6. If slump or air content fall outside specified limits, make another test immediately from another portion of same batch.
7. Perform unit weight tests in compliance with ASTM C138 for normal weight concrete and ASTM C567 for lightweight concrete. Test the first truck and each time cylinders are made.
8. Notify laboratory technician at batch plant of mix irregularities and request materials and proportioning check.
9. Verify that specified mixing has been accomplished.
10. Environmental Conditions: Determine the temperature per ASTM C1064 for each truckload of concrete during hot weather and cold weather concreting operations:
    a. When ambient air temperature falls below 4.4 degrees C (40 degrees F), record maximum and minimum air temperatures in each 24 hour period; record air temperature inside protective enclosure; record minimum temperature of surface of hardened concrete.

b. When ambient air temperature rises above 29.4 degrees C (85 degrees F), record maximum and minimum air temperature in each 24 hour period; record minimum relative humidity; record maximum wind velocity; record maximum temperature of surface of hardened concrete.

11. Inspect the reinforcing steel placement, including bar size, bar spacing, top and bottom concrete cover, proper tie into the chairs, and grade of steel prior to concrete placement. Submit detailed report of observations.
12. Observe conveying, placement, and consolidation of concrete for conformance to specifications.
13. Observe condition of formed surfaces upon removal of formwork prior to repair of surface defects and observe repair of surface defects.
14. Observe curing procedures for conformance with specifications, record dates of concrete placement, start of preliminary curing, start of final curing, end of curing period.
15. Observe preparations for placement of concrete:
    a. Inspect handling, conveying, and placing equipment, inspect vibrating and compaction equipment.
    b. Inspect preparation of construction, expansion, and isolation joints.
16. Observe preparations for protection from hot weather, cold weather, sun, and rain, and preparations for curing.
17. Observe concrete mixing:
    a. Monitor and record amount of water added at project site.
    b. Observe minimum and maximum mixing times.
18. Measure concrete flatwork for levelness and flatness as follows:
    a. Perform Floor Tolerance Measurements F_F and F_L in accordance with ASTM E1155. Calculate the actual overall F- numbers using the inferior/superior area method.
    b. Perform all floor tolerance measurements within 48 hours after slab installation and prior to removal of shoring and formwork.
    c. Provide the Contractor and the COR with the results of all profile tests, including a running tabulation of the overall F_F and F_L values for all slabs installed to date, within 72 hours after each slab installation.
19. Other inspections:
    a. Grouting under base plates.
    b. Grouting anchor bolts and reinforcing steel in hardened concrete.

C. Laboratory Tests of Field Samples:

1. Test compression test cylinders for strength in accordance with ASTM C39. For each test series, test one cylinder at 7 days and one cylinder at 28 days. Use remaining cylinder as a spare tested as directed by COR. Compile laboratory test reports as follows:

Compressive strength test shall be result of one cylinder, except when one cylinder shows evidence of improper sampling, molding or testing, in which case it shall be discarded and strength of spare cylinder shall be used.

2. Make weight tests of hardened lightweight structural concrete in accordance with ASTM C567.
3. Furnish certified compression test reports (duplicate) to COR. In test report, indicate the following information:
    a. Cylinder identification number and date cast.
    b. Specific location at which test samples were taken.
    c. Type of concrete, slump, and percent air.
    d. Compressive strength of concrete in MPa (psi).
    e. Weight of lightweight structural concrete in kg/m^3 (pounds per cubic feet).
    f. Weather conditions during placing.
    g. Temperature of concrete in each test cylinder when test cylinder was molded.
    h. Maximum and minimum ambient temperature during placing.
    i. Ambient temperature when concrete sample in test cylinder was taken.
    j. Date delivered to laboratory and date tested.

3.6 REINFORCEMENT

A. Review mill test reports furnished by Contractor.

B. Make one tensile and one bend test in accordance with ASTM A370 from each pair of samples obtained.

C. Written report shall include, in addition to test results, heat number, manufacturer, type and grade of steel, and bar size.

D. Perform tension tests of mechanical and welded splices in accordance with ASTM A370.

3.7 PRESTRESSED CONCRETE

A. Inspection at Plant: Forms, placement and concrete cover of reinforcing steel and tendons, placement and finishing of concrete, and tensioning of tendons.

B. Concrete Testing: Test concrete including materials for concrete required in Article, CONCRETE of this section, except make two test cylinders for each day's production of each strength of concrete produced.

C. Test tendons for conformance with ASTM A416 and furnish report to COR.

D. Inspect members to insure that specification requirements for curing and finishes have been met.

3.8 MASONRY

A. Mortar Tests:

1. Laboratory compressive strength test:

a. Comply with ASTM C780.
b. Obtain samples during or immediately after discharge from batch mixer.
c. Furnish molds with 50 mm (2 inch), 3 compartment gang cube.
d. Test one sample at 7 days and 2 samples at 28 days.

2. Two tests during first week of operation; one test per week after initial test until masonry completion.

B. Grout Tests:

1. Laboratory compressive strength test:
   a. Comply with ASTM C1019.
   b. Test one sample at 7 days and 2 samples at 28 days.
   c. Perform test for each 230 m^2 (2500 square feet) of masonry.

C. C. Masonry Unit Tests:

1. Laboratory Compressive Strength Test:
   a. Comply with ASTM C140.
   b. Test 3 samples for each 460 m^2 (5000 square feet) of wall area.

D. Prism Tests: For each type of wall construction indicated, test masonry prisms per ASTM C1314 for each 460 m2 (5000 square feet) of wall area. Prepare one set of prisms for testing at 7 days and one set for testing at 28 days.

3.9 STRUCTURAL STEEL

A. General: Provide shop and field inspection and testing services to certify structural steel work is done in accordance with contract documents. Welding shall conform to AWS D1.1 Structural Welding Code.

B. Prefabrication Inspection:

1. Review design and shop detail drawings for size, length, type and location of all welds to be made.
2. Approve welding procedure qualifications either by pre-qualification or by witnessing qualifications tests.
3. Approve welder qualifications by certification or retesting.
4. Approve procedure for control of distortion and shrinkage stresses.
5. Approve procedures for welding in accordance with applicable sections of AWS D1.1.

C. Fabrication and Erection:

1. Weld Inspection:
   a. Inspect welding equipment for capacity, maintenance and working condition.
   b. Verify specified electrodes and handling and storage of electrodes in accordance with AWS D1.1.
   c. Inspect preparation and assembly of materials to be welded for conformance with AWS D1.1.

d. d. Inspect preheating and interpass temperatures for conformance with AWS D1.1.
e. Measure 25 percent of fillet welds.
f. Welding Magnetic Particle Testing: Test in accordance with ASTM E709 for a minimum of:
1) 20 percent of all shear plate fillet welds at random, final pass only.
2) 20 percent of all continuity plate and bracing gusset plate fillet welds, at random, final pass only.
3) 100 percent of tension member fillet welds (i.e., hanger connection plates and other similar connections) for root and final passes.
4) 20 percent of length of built-up column member partial penetration and fillet welds at random for root and final passes.
5) 100 percent of length of built-up girder member partial penetration and fillet welds for root and final passes.
g. Verify that correction of rejected welds are made in accordance with AWS D1.1.
h. Testing and inspection do not relieve the Contractor of the responsibility for providing materials and fabrication procedures in compliance with the specified requirements.

2. Bolt Inspection:
a. Inspect high-strength bolted connections in accordance AISC Specifications for Structural Joints Using ASTM F3125 Bolts.
b. Slip-Critical Connections: Inspect 10 percent of bolts, but not less than 2 bolts, selected at random in each connection in accordance with AISC Specifications for Structural Joints Using ASTM F3125 Bolts. Inspect all bolts in connection when one or more are rejected.
c. Fully Pre-tensioned Connections: Inspect 10 percent of bolts, but not less than 2 bolts, selected at random in 25 percent of connections in accordance with AISC Specification for Structural Joints Using ASTM F3125 Bolts. Inspect all bolts in connection when one or more are rejected.
d. Bolts installed by turn-of-nut tightening may be inspected with calibrated wrench when visual inspection was not performed during tightening.
e. Snug Tight Connections: Inspect 10 percent of connections verifying that plies of connected elements have been brought into snug contact.
f. Inspect field erected assemblies; verify locations of structural steel for plumbness, level, and alignment.

D. Submit inspection reports, record of welders and their certification, and identification, and instances of noncompliance to COR.

3.10 TYPE OF TEST: APPROXIMATE NUMBER OF TESTS REQUIRED

A. Earthwork:

Laboratory Compaction Test, Soils:	12
Field Density, Soils (AASHTO T191, T205, or T310)	37

B. Aggregate Base:

Laboratory Compaction, (AASHTO T180)	1 per source
Field Density, (AASHTO T191)	22
Aggregate, Base Course Gradation (AASHTO T27)	1 per source
Wear (AASHTO T96)	5
Soundness (AASHTO T104)	5

C. Asphalt Concrete:

Field Density, (AASHTO T230)	Per MnDOT 2360
Aggregate, Asphalt Concrete Gradation (AASHTO T27)	Per MnDOT 2360
Wear (AASHTO T96)	Per MnDOT 2360
Soundness (AASHTO T104)	Per MnDOT 2360

D. Concrete:

Making and Curing Concrete Test Cylinders (ASTM C31)	36
Compressive Strength, Test Cylinders (ASTM C39)	36
Concrete Slump Test (ASTM C143)	36
Concrete Air Content Test (ASTM C173)	36
Aggregate, Normal Weight: Gradation (ASTM C33)	6
Deleterious Substances (ASTM C33)	6
Soundness (ASTM C33)	6
Abrasion (ASTM C33)	6

E. Reinforcing Steel:

Tensile Test (ASTM A370)	6
Bend Test (ASTM A370)	6
Mechanical Splice (ASTM A370)	6
Welded Splice Test (ASTM A370)	6

F. Prestressed Concrete:

Testing Strands (ASTM A416)	6

G. Masonry:

Making and Curing Test Cubes (ASTM C109)	6
Compressive Strength, Test Cubes (ASTM C109)	6
Sampling and Testing Mortar, Comp. Strength (ASTM C780)	6
Sampling and Testing Grout, Comp. Strength (ASTM C1019)	6
Masonry Unit, Compressive Strength (ASTM C140)	6
Prism Tests (ASTM C1314)	4

H. Structural Steel:

Magnetic Particle Testing of Welds (ASTM E709) 15

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SECTION 01 45 35

SPECIAL INSPECTIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Special Inspection and testing specified requirements.

1.2 APPLICABLE PUBLICATIONS

A. The publication listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

B. American Society of Civil Engineers (ASCE)

1. ASCE 7 - (2010; Errata 2011; Supp 2 2013) Minimum Design Loads for Buildings and Other Structures

C. International Code Council (ICC)

1. ICC IBC - (2018) International Building Code

1.3 GENERAL REQUIREMENTS

A. Perform Special Inspections in accordance with the Statement of Special Inspections, Schedule of Special Inspections and Chapter 17 of ICC IBC. The Statement of Special Inspections and Schedule of Special Inspections are included as an attachment to this specification. Special Inspections are to be performed by an independent third party and are intended to ensure that the work of the prime contractor is in accordance with the Contract Documents and applicable building codes. Special inspections do not take the place of the three phases of control inspections performed by the Contractor's QC Manager or any testing and inspections required by other sections of the specifications.

B. Structural observations will be performed by the Government. The contractor must provide notification to the Contracting Officer 14 days prior to the following points of construction that structural observations need to occur:

1.4 DEFINITIONS

A. Continuous Special Inspections – The constant monitoring of specific tasks by a special inspector. These inspections must be carried out continuously over the duration of the particular tasks.

B. Periodic Special Inspections – Special Inspections by the special inspector who is intermittently present where the work to be inspected has been or is being performed. Specific time interval on a specific Special Inspection should be indicated on the Schedule of Special Inspections.

C. Perform – Perform these Special Inspections tasks for each welded joint or member.

D. Observe – Observe these Special Inspections items on a random daily basis. Operations need not be delayed pending these inspections.

E. Special Inspector (SI) – A qualified person retained by the contractor and approved by the Contracting Officer as having the competence necessary to inspect a particular type of construction requiring Special Inspections. The SI must be an independent third party hired directly by the Prime Contractor.

F. Associate Special Inspector (ASI) – A qualified person who assists the SI in performing Special Inspections but must perform inspection under the direct supervision of the SI and cannot perform inspections without the SI on site.

G. Third Party – A third party inspector must not be company employee of the Contractor or any Sub-Contractor performing the work to be inspected.

H. Special Inspector of Record (SIOR) – SIOR must be an independent third party hired directly by the Prime Contractor and is required for the following project conditions:

1. Nominal design wind speed in excess of 49 m/sec 100 mph; and assigned to Risk Category III, IV, or V.

I. Contracting Officer – The Government official having overall authority for administrative contracting actions. Certain contracting actions may be delegated to the Contracting Officer's Representative (COR).

J. Contractor’s Quality Control (QC) Manager – An individual retained by the prime contractor having the overall responsibility for the contractor's QC organization.

K. Designer of Record (DOR) – A registered design professional is contracted by the Government as an A/E responsible for the overall design and review of submittal documents prepared by others. The DOR is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws in state in which the design professional works. The DOR is also referred to as the Engineer of Record (EOR) in design code documents.

L. Schedule of Special Inspections (SSI) – A document developed by the DOR identifying the material, systems, components and work required to have Special Inspections.

1. List of the Architectural Designated Seismic Systems – these components are in or attached to a Risk Category IV or V structure and are needed for continued operation of the facility or their failure could impair the continued operation of the facility.
2. List of the Mechanical Designated Seismic Systems
   a. For Seismic Design Category C or Risk V, list the following:
      1) Heating, ventilation, and air-conditioning (HVAC) ductwork containing hazardous materials and anchorage of such ductwork
      2) Piping systems and mechanical units containing flammable, combustible, or highly toxic materials.
   b. For Seismic Design Category D, E, or F or Risk Category V list mechanical system that meet one of the following:

1) Life safety component required to function after an earthquake
2) Component that contains hazardous content,
3) All components in an essential facility needed for continued operation after an earthquake.

3. List of the Electrical Designated Systems
   a. For Seismic Design Category C or Risk V, list the anchorage of electrical equipment used for emergency or standby power systems.
   b. For Seismic Design Category D, E or F list electrical system that meet one of the following:
      1) Life safety component required to function after an earthquake
      2) Component that contains hazardous content,
      3) All components in an essential facility needed for continued operation after an earthquake.
4. List of elements that are part of the progressive collapse resistance system.
   a. Provide a description of the following as they apply:
      1) Elements of the tie force system consisting of internal longitudinal and transverse, vertical, and peripheral tie.
      2) Elements of the alternate path system.
      3) Elements having enhanced local resistance. The Statement of Special Inspections and the Schedule of Special Inspections will be included as an attachment to this specification
         a) Schedule of Special Inspections – A schedule which lists each of the required Special Inspections, the extent to which each Special Inspections is to be performed, and the required frequency for each in accordance with ICC IBC Chapter 17. Template found here:


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Schedule of SI Temp


SECTION 01 45 35
Statement of SI Tem

1.5 DESIGNATED SEISMIC SYSTEM – THOSE NONSTRUCTURAL COMPONENTS THAT REQUIRE DESIGN IN ACCORDANCE WITH ASCE 7 CHAPTER 13 AND FOR WHICH THE COMPONENT IMPORTANCE FACTOR, IP, IS GREATER THAN 1.0. THIS DESIGNATION APPLIES TO SYSTEMS THAT ARE REQUIRED TO BE OPERATIONAL FOLLOWING THE DESIGN EARTHQUAKE FOR RC I - IV STRUCTURES AND FOLLOWING THE MCER FOR RC V STRUCTURES. ALL SYSTEMS IN RC V FACILITIES DESIGNATED AS MC-1 IN ACCORDANCE WITH UFC 3-310-04 ARE CONSIDERED PART OF THE DESIGNATED SEISMIC SYSTEMS. DESIGNATED SEISMIC SYSTEMS WILL BE IDENTIFIED BY OWNER AND WILL HAVE AN IMPORTANCE FACTOR IP = 1.5

1.6 SUBMITTALS

A. Government approval is required for all submittals. CQC Special Inspection reports shall be

submitted under this Specification section and follow the [Special Inspection]: [Applicable Specification section or description] naming convention. Submit the following:

1. NDT Procedures and Equipment' Calibration Records;
2. SD-06 Test Reports;
3. Special Inspections
4. SD-07 Certificates;
5. Fabrication Plant
6. AC472 Accreditation;
7. Precast Concrete Institute (PCI) Certified Plant;
8. Certificate of Compliance;
9. Special Inspector Qualifications;
10. SD-11 Closeout Submittals;
11. Interim Final Report of Special Inspections;
12. Comprehensive Final Report of Special Inspections;

B. Special Inspector Qualifications: Submit qualifications for each SI, ASI, and the SIOR from the following certifying associations: American Concrete Institute (ACI); American Welding Society (AWS); International Code Council (ICC); Nondestructive Testing (NDT); National Institute for Certification in Engineering Technologies (NICET); Precast/Prestressed Concrete Institute (PCI); Underwriters Laboratories (UL). Qualifications should be in accordance with the following minimums;

QUALIFICATIONS

Area	Special Inspector	Associated Special Inspector	SIOR
SIOR			Registered Professional Engineer
Steel Construction and High Strength Bolting	ICC Structural Steel and Bolting Special Inspector certificate with on year of related experience, or Registered Professional Engineer with related experience.	Engineer-In-Training with one year of related experience.	
Welding Structural Steel (For highly complex steel use only AWS Certified Welding Inspectors)	ICC Welding Special Inspector certificate with one year of related experience or AWS Certified Welding Inspector	AWS Certified Associate Welding Inspector	
Nondestructive Testing of Welds	NDT Level II Certificate	NDT Level II Certificate plus one year of related experience	

Area	Special Inspector	Associated Special Inspector	SIOR
Concrete Construction	ICC Reinforced Concrete Special Inspector Certificate with one year of related experience, or ACI Concrete Construction Special Inspector, or NICET Concrete Technician Level III Certificate in Construction Materials Testing, or, Registered Professional Engineer with related experience	ACI Concrete Construction Special Inspector in Training, or Engineer-In-Training with one year of related experience	
Prestressed Concrete Construction	ICC Pre-stressed Special Inspector Certificate with one year of related experience, or PCI Quality Control Technician/ Inspector Level II Certificate with one year of related experience, or Registered Professional Engineer with related experience.	PCI Quality Control Technician/ Inspector Level I Certificate with one year of related experience, or Engineer-In-Training with one year of related experience	
Masonry Construction	ICC Structural Masonry Special Inspector Certificate with one year of related experience, or Registered Professional Engineer with related experience	Engineer-In-Training with one year of related experience	
Verification of Site Soil Condition, Fill Placement, and Load-Bearing Requirements	ICC Soils Special Inspector Certificate with one year of related experience, or NICET Soils Technician Level II Certificate in Construction Material Testing, or NICET Geotechnical Engineering Technician Level II Construction or Generalist Certificate, or Geologist-In-Training with one year of related experience, or Registered Professional Engineer with related experience	NICET Soils Technician Level I Certificate in Construction Material Testing with one year of related experience, or NICET Geotechnical Engineering Technician Level I Construction, or Generalist Certificate with one year of related experience, or Engineer-In-Training with one year of related experience	
Mastic and Intumescent Fire Resistant Coatings	ICC Spray-applied Fireproofing Special Inspector Certificate, or ICC Fire Inspector I Certificate with one year of related experience, or Registered Professional Engineer with related experience	Engineer-In-Training with one year of related experience.	
Exterior Insulation and Finish Systems (EIFS)	AWCI EIFS Inspector Certificate, or Exterior Design Institute Certificate, or Registered Professional Engineer with related experience	Engineer-In-Training with one year of related experience	

Area	Special Inspector	Associated Special Inspector	SIOR
Fire-Resistant Penetrations and Joints	Passed the UL Firestop Exam with one year of related experience, or Passed the FM Firestop Exam with one year of related experience, or Registered Professional Engineer with related experience	Engineer-In-Training with one year of related experience.	

PART 2 - PRODUCTS

2.1 FABRICATORS SPECIAL INSPECTION

A. Special Inspections of fabricator's work performed in the fabricator's shop is required to be inspected in accordance with the Statement of Special Inspections and the Schedule of Special Inspections unless the fabricator is certified by the approved agency to perform such work without Special Inspections. Submit the applicable certification(s) from the following list to the Contracting Officer for information to allow work performed in the fabricator's shop to not be subjected to Special Inspections.

B. The following certifications meet the requirements for fabricator approval in accordance with paragraph 1704.2.5.2 of IBC:

1. American Institute of Steel Construction (AISC) Certified Fabrication Plant, Category STD.
2. International Accreditation Service, AC472 Accreditation Steel Joist Institute Membership
3. Precast Concrete Institute (PCI) Certified Plant, Group C

C. At the completion of fabrication, submit a certificate of compliance, to be included with the comprehensive final report of Special **Inspections, stating that the materials supplied and work performed by** the fabricator are in accordance the construction documents.

PART 3 - EXECUTION

3.1 SCHEDULE OF SPECIAL INSPECTIONS

A. A schedule which lists each of the required Special Inspections, the extent to which each Special Inspections is to be performed, and the required frequency for each in accordance with ICC IBC Chapter 17 is attached, following this section.


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Schedule of SI Temp


SECTION 01 45 35
Statement of SI Tem

3.2 RESPONSIBILIES MATRIX

Inspector	Responsibility	Condition
SIOR	a. Supervise all Special Inspectors required by the contract documents and the IBC. b. Submit a SIOR Letter of Acceptance to the Contracting Officer attesting to acceptance of the duties of SIOR, signed and sealed by the SIOR. c. Verify the qualifications of all of the Special Inspectors. d. Verify the qualifications of fabricators.	Applicable when SIOR is required
	e. Submit Special Inspections agency's written practices for the monitoring and control of the agency's operations to include the following: 1. The agency's procedures for the selection and administration of inspection personnel, describing the training, experience and examination requirements for qualifications and certification of inspection personnel. 2. The agency's inspection procedures, including general inspection, material controls, and visual welding inspection. f. Submit qualification records for nondestructive testing (NDT) technicians designated for the project. Submit NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.	Applicable when SIOR is required and when the structural design is required to follow AISC341 for seismic design of steel structures
	g. Prepare a Special Inspections Project Manual, which will cover the following: 1. Roles and responsibilities of the following individuals during Special Inspections: SIOR, SI, General Contractor, Subcontractors, QC Manager, and DOR. 2. Organizational chart and/or communication plan, indicating lines of communication 3. Contractor's internal plan for scheduling inspections. Address items such as timeliness of inspection requests, who to contact for inspection requests, and availability of alternate inspectors. Contractor's internal plan for scheduling inspections. Address items such as timeliness of inspection requests, who to contact for inspection requests, and availability of alternate inspectors. 4. Indicate the government reporting procedures. 5. Propose forms or templates to be used by SI and SIOR to document inspections. 6. Indicate procedures for tracking nonconforming work and verification that corrective work is complete. 7. Indicate how the SIOR and/or SI will participate in weekly QC meetings. 8. Indicate how Special Inspections of shop fabricated items will be handled when the fabricator's shop is not certified per paragraph FABRICATOR SPECIAL INSPECTIONS.	Applicable when SIOR is required

Inspector	Responsibility	Condition
	9. Include a section in the manual that covers each specific item requiring Special Inspections that is indicated on the Schedule of Special Inspections. Provide names and qualifications of each special inspector who will be performing the Special Inspections for each specific item. Provide detail on how the Special Inspections are to be carried out for each item so that the expectations are clear for the General Contractor and the Subcontractor performing the work. Make a copy of the Special Inspections Project Manual available on the job site during construction. Submit a copy of the Special Inspections Project Manual for approval. h. Attend coordination and mutual understanding meeting where the information in the Special Inspections Project Manual will be reviewed to verify that all parties have a clear understanding of the Special Inspections provisions and the individual duties and responsibilities of each party. i. Maintain a 3- ring binder for the Special Inspector's daily and biweekly reports and the Special Inspections Project Manual. This file must be located in a conspicuous place in the project trailer/office to allow review by the Contracting Officer and the DOR. j. Submit a copy of the Special Inspector's daily reports to the QC Manager. k. Discrepancies that are observed during Special Inspections must be reported to the QC Manager for correction. If discrepancies are not corrected before the special inspector leaves the site the observed discrepancies must be documented in the daily report. l. Submit a biweekly Special Inspections report until all work requiring Special Inspections is complete. A report is required for each biweekly period in which Special Inspections activity occurs, and must include the following: 1. A brief summary of the work performed during the reporting time frame. 2. Changes and/or discrepancies with the drawings, specifications, and mechanical or electrical component certification if they require seismic systems, that were observed during the reporting period. 3. Discrepancies which were resolved or corrected. 4. A list of nonconforming items requiring resolution. 5. All applicable test results including nondestructive testing reports. m. For large, complex projects, at the completion of each Definable Feature of Work (DFOW) requiring Special Inspections, submit an interim final report of Special Inspections that documents the Special Inspections completed for that DFOW and corrections of all discrepancies noted in the daily reports. The interim final report of Special Inspections must be signed, dated and bear the seal of the SIOR.	

Inspector	Responsibility	Condition
QC Manager	a. If there is no SIOR, QC Manager must Supervise all Special Inspectors required by the contract documents and the IBC; Verify the qualifications of all of the Special Inspectors; Verify the qualifications of fabricators; Maintain a 3- ring binder for the Special Inspector's daily and biweekly reports. This file must be located in a conspicuous place in the project trailer/office to allow review by the Contracting Officer and the DOR.	Applicable when SIOR is not required
	b. Maintain a rework items list that includes discrepancies noted on the Special Inspectors daily report.	n/a
Special Inspectors	a. Inspect all elements of the project for which the special inspector is qualified to inspect and are identified in the Schedule of Special Inspections. b. Attend preparatory phase meetings related to the Definable Feature of Work (DFOW) for which the special inspector is qualified to inspect.	
	c. Submit Special Inspections agency's written practices for the monitoring and control of the agency's operations to include the following: 1. The agency's procedures for the selection and administration of inspection personnel, describing the training, experience and examination requirements for qualifications and certification of inspection personnel. 2. The agency's inspection procedures, including general inspection, material controls, and visual welding inspection. d. Submit qualification records for nondestructive testing (NDT) technicians designated for the project. e. Submit NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.]	Applicable when SIOR is NOT required and when the structural design is required to follow AISC 341 for seismic design of steel structures
	f. Submit a copy of the daily reports to the QC Manager. g. Discrepancies that are observed during Special Inspections must be reported to the QC Manager for correction. If discrepancies are not corrected before the special inspector leaves the site the observed discrepancies must be documented in the daily report. h. Submit a biweekly Special Inspection Report until all inspections are complete. A report is required for each biweekly period in which Special Inspections activity occurs, and must include the following: 1. A brief summary of the work performed during the reporting time frame 2. Changes and/or discrepancies with the drawings, specifications, and mechanical or electrical component certification if they require seismic systems that were observed during the reporting period. 3. Discrepancies which were resolved or corrected.	Applicable when SIOR is not required

Inspector	Responsibility	Condition
	4. A list of nonconforming items requiring resolution. 5. All applicable test result including nondestructive testing reports. i. For large, complex projects, at the completion of each Definable Feature of Work (DFOW) requiring Special Inspections, submit an interim final report of Special Inspections that documents the Special Inspections completed for that DFOW and corrections of all discrepancies noted in the daily reports. The interim final report of Special Inspections must be signed, dated and bear the seal of the SIOR. j. At the completion of the project submit a comprehensive final report of Special Inspections that documents the Special Inspections completed for the project and corrections of all discrepancies noted in the daily reports. The comprehensive final report of Special Inspections must be signed, dated and indicate the certification of the special inspector qualifying them to conduct the inspection.	
	k. Submit daily reports to the SIOR	Applicable when SIOR is required

3.3 DEFECTIVE WORK

A. Check work as it progresses, but failure to detect any defective work or materials must in no way prevent later rejection if defective work or materials are discovered, nor obligate the Government to accept such work.

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SCHEDULE OF SPECIAL INSPECTIONS

Reference 01 45 35 for all requirements not noted as part of this schedule.

INSPECTION DEFINITIONS:

PERFORM: Perform these tasks for each weld, fastener or bolted connection, and noted verification.

OBSERVE: Observe these items randomly during the course of each work day to insure that applicable requirements are being met. Operations need not be delayed pending these inspections at contractor's risk.

DOCUMENT: Document, with a report, that the work has been performed in accordance with the contract documents. This is in addition to any other reports required in the Special Inspections guide specification.

CONTINUOUS: Constant monitoring of identified tasks by a special inspector over the duration of performance of said tasks.

DESIGNER NOTES (to be deleted after reviewing):

1. This schedule contains minimum requirements. Do not delete applicable inspection tasks unless notes in blue indicate it is acceptable to do so.
2. Blue text = designers notes. The designer must review and edit all blue text in this schedule prior to inserting this schedule into the special inspections spec (UFGS 01 45 35).
3. Check section boxes with ANY inspection tasks applicable to your project. You may choose to delete unchecked sections or leave them in the scheduled unchecked.
4. Individual rows/tasks that that are not applicable to the project may be left in the section, as the inspector can determine whether they occur/apply (e.g. metal trusses in the light gauge framing section for example).
5. Design discipline sections are color coded for easier reference by designers. This schedule does NOT need to be printed in color.
6. When finished editing, delete this note box and save this schedule as a PDF and insert into the project specifications (special inspections section).

A. STRUCTURAL - STEEL – WELDING SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

STEEL INSPECTION PRIOR TO WELDING – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.2.1, AISC 360-10: Table C-N5.4-1		
TASK	INSPECTION TYPE[1]	DESCRIPTION
1. Verify that the welding procedures specification (WPS) is available	**PERFORM**	
2. Verify manufacturer certifications for welding consumables are available	**PERFORM**	
3. Verify material identification	**PERFORM**	Type and grade.
4. Welder Identification System	**PERFORM**	The fabricator or erector, as applicable, shall maintain a system by which a welder who has welded a joint or member can be identified. Stamps, if used, shall be the low-stress type.
5. Fit-up of groove welds (including joint geometry)	OBSERVE	✓ Joint preparation ✓ Dimensions (alignment, root opening, root face, bevel) ✓ Cleanliness (condition of steel surfaces) ✓ Tacking (tack weld quality and location) ✓ Backing type and fit (if applicable)
6. Configuration and finish of access holes	OBSERVE	
7. Fit-up of fillet welds	OBSERVE	✓ Dimensions (alignment, gaps at root) ✓ Cleanliness (condition of steel surfaces) ✓ Tacking (tack weld quality and location)
STEEL INSPECTION DURING WELDING – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.2.1, AISC 360-10: Table C-N5.4-2		
TASK	INSPECTION TYPE	DESCRIPTION
8. Use of qualified welders	**PERFORM**	Welding by welders, welding operators, and tack welders who are qualified in conformance with requirements.
9. Control and handling of welding consumables	OBSERVE	✓ Packaging ✓ Electrode atmospheric exposure control
10. No welding over cracked tack welds	OBSERVE	
11. Environmental conditions	OBSERVE	✓ Wind speed within limits ✓ Precipitation and temperature
12. Welding Procedures Specification followed	OBSERVE	✓ Settings on welding equipment ✓ Travel speed ✓ Selected welding materials ✓ Shielding gas type/flow rate ✓ Preheat applied ✓ Interpass temperature maintained (min./max.) ✓ Proper position (F, V, H, OH) ✓ Intermix of filler metals avoided
13. Welding techniques	OBSERVE	✓ Interpass and final cleaning ✓ Each pass within profile limitations ✓ Each pass meets quality requirements

[1] **PERFORM**: Perform these tasks for each weld, fastener or bolted connection, and required verification.
OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

A. STRUCTURAL - STEEL – WELDING SECTION (CONTINUED)

STEEL INSPECTION AFTER WELDING – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 2015 1705.2.1, AISC 360-10: Table C-N5.4-3		
TASK	INSPECTION TYPE [1]	DESCRIPTION
14. Welds cleaned	OBSERVE	
15. Size, length, and location of all welds	**PERFORM**	Size, length, and location of all welds conform to the requirements of the detail drawings.
16. Welds meet visual acceptance criteria	**PERFORM AND DOCUMENT**	✓ Crack prohibition ✓ Weld/base-metal fusion ✓ Crater cross section ✓ Weld profiles ✓ Weld size ✓ Undercut ✓ Porosity
17. Arc strikes	**PERFORM**	
18. k-area	**PERFORM**	When welding of doubler plates, continuity plates or stiffeners has been performed in the k-area, visually inspect the web k-area for cracks.
19. Backing removed, weld tabs removed and finished, and fillet welds added where required	**PERFORM**	
20. Repair activities	**PERFORM AND DOCUMENT**	
21. Document acceptance or rejection of welded joint or member	**PERFORM**	

END SECTION

[1] **PERFORM**: Perform these tasks for each weld, fastener or bolted connection, and required verification.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

B. STRUCTURAL - STEEL – BOLTING SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

STEEL INSPECTION TASKS PRIOR TO BOLTING – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.2.1, AISC 360-10: Table C-N5.6-1		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Manufacture's certifications available for fastener materials	**PERFORM**	
2. Fasteners marked in accordance with ASTM requirements	OBSERVE	
3. Proper fasteners selected for joint detail (grade, type, bolt length if threads are to be excluded from shear plane)	OBSERVE	
4. Proper bolting procedure selected for joint detail	OBSERVE	
5. Connecting elements, including appropriate faying surface condition and hole preparation, if specified, meet applicable requirements	OBSERVE	
6. Proper storage provided for bolts, nuts, washers, and other fastener components	OBSERVE	
STEEL INSPECTION TASKS DURING BOLTING – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.2.1, AISC 360-10: Table C-N5.6-2		
TASK	INSPECTION TYPE [1]	DESCRIPTION
7. Fastener assemblies of suitable condition, placed in all holes and washers (if required) are positioned as required	OBSERVE	
8. Joint brought to the snug-tight condition prior to pretensioning operation	OBSERVE	
9. Fastener component not turned by the wrench prevented from rotating	OBSERVE	
10. Bolts are pretensioned in accordance with RCSC Specification, progressing systematically from the most rigid point toward the free edges	OBSERVE	
STEEL INSPECTION TASKS AFTER BOLTING – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.2.1, AISC 360-10: Table C-N5.6-3		
TASK	INSPECTION TYPE [1]	DESCRIPTION
11. Document acceptance or rejection of all bolted connections	**DOCUMENT**	

END SECTION

[1] **PERFORM**: Perform these tasks for each weld, fastener or bolted connection, and required verification.
OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

C. STRUCTURAL - STEEL - NON DESTRUCTIVE TESTING SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

NONDESTRUCTIVE TESTING OF WELDED JOINTS – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.2.1, AISC 360-10: Section N5.5		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Use of qualified nondestructive testing personnel	**PERFORM**	Visual weld inspection and nondestructive testing (NDT) shall be conducted by personnel qualified in accordance with AWS D1.8 clause 7.2
2. CJP groove welds	OBSERVE	**[NOTE: DOR must delete this row if section D (SEISMIC PROVISIONS SECTION) is checked]** Dye penetrant testing (DT) and ultrasonic testing (UT) shall be performed on 20% of CJP groove welds for materials greater than 5/16" (8mm) thick. Testing rate must be increased to 100% if greater than 5% of welds tested have unacceptable defects.
3. Welded joints subject to fatigue	OBSERVE	Dye penetrant testing (DT) and Ultrasonic testing (UT) shall be performed on 100% of welded joints identified on contract drawings as being subject to fatigue.
4. Weld tab removal sites	OBSERVE	At the end of welds where weld tabs have been removed, magnetic particle testing shall be performed on the same beam-to-column joints receiving UT

END SECTION

[1] **PERFORM**: Perform these tasks for each weld, fastener or bolted connection, and required verification.
OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

D. STRUCTURAL - STEEL – AISC 341 REQUIREMENTS (SEISMIC PROVISIONS) SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☐

NONDESTRUCTIVE TESTING OF WELDED JOINTS – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.2.1, AISC 341-10: Section J6.2		
TASK	INSPECTION TYPE [1]	DESCRIPTION
[NOTE: DOR may uncheck this section for projects NOT designed in accordance with AISC 341 (Seismic Provisions) or for projects designed according to AISC 341, but using an R value equal to 3]		
5. CJP groove welds	OBSERVE	Dye penetrant testing (DT) and ultrasonic testing (UT) shall be performed on 100% of CJP groove welds for materials greater than 5/16" thick (8mm).
6. Beam cope and access hole.	OBSERVE	At welded splices and connections, thermally cut surfaces of beam copes and access holes shall be tested using magnetic particle testing (MT) or dye penetrant testing (DT), when the flange thickness exceeds 1 1/2 in. for rolled shapes, or when the web thickness exceeds 1 1/2 in. for built-up shapes.
7. K-area NDT (AISC 341)	**PERFORM**	Where welding of doubler plates, continuity plates or stiffeners has been performed in the k-area, the web shall be tested for cracks using magnetic particle testing (MT). The MT inspection area shall include the k-area base metal within 3-inches of the weld. The MT shall be performed no sooner than 48 hours following completion of the welding.
8. Placement of reinforcing or contouring fillet welds	**DOCUMENT**	

END SECTION

[1] **PERFORM**: Perform these tasks for each weld, fastener or bolted connection, and required verification.
OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

E. STRUCTURAL - STEEL - COMPOSITE CONSTRUCTION [1]

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☐

COMPOSITE CONSTRUCTION PRIOR TO PLACING CONCRETE – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.2.1, AISC 360-10: Table N6.1, AISC 341-10: Table J9-1		
TASK	INSPECTION TYPE [2]	DESCRIPTION
1. Placement and installation of steel headed stud anchors	**PERFORM**	
2. Material identification of reinforcing steel (Type/Grade)	OBSERVE	
3. Determination of carbon equivalent for reinforcing steel other than ASTM A706	OBSERVE	
4. Proper reinforcing steel size, spacing, clearances, support, and orientation	OBSERVE	
5. Reinforcing steel has been tied and supported as required	OBSERVE	

END SECTION

F. STRUCTURAL - STEEL - OTHER INSPECTIONS

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

OTHER STEEL INSPECTIONS – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.2.1, AISC 341-10: Tables J8-1 & J10-1		
TASK	INSPECTION TYPE [2]	DESCRIPTION
1. Anchor rods and other embedments supporting structural steel	**PERFORM**	Verify the diameter, grade, type, and length of the anchor rod or embedded item, and the extent or depth of embedment prior to placement of concrete.
2. Fabricated steel or erected steel frame	OBSERVE	Verify compliance with the details shown on the construction documents, such as braces, stiffeners, member locations and proper application of joint details at each connection.
3. Reduced beam sections (RBS) where/if occurs	**DOCUMENT**	✓ Contour and finish ✓ Dimensional tolerances
4. Protected zones	**DOCUMENT**	No holes or unapproved attachments made by fabricator or erector
5. H-piles where/if occurs	**DOCUMENT**	No holes or unapproved attachments made by the responsible contractor

END SECTION

[1] See Concrete Construction Section for all concrete related inspection of composite steel construction.

[2] **PERFORM**: Perform these tasks for each weld, fastener or bolted connection, and required verification.
OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

G. STRUCTURAL - COLD-FORMED METAL DECK - PLACEMENT SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☐

METAL DECK INSPECTION PRIOR TO DECK PLACEMENT – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.1		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Verify compliance of materials (deck and all deck accessories) with construction documents, including profiles, material properties, and base metal thickness	**PERFORM**	
2. Document acceptance or rejection of deck and deck accessories	**DOCUMENT**	
METAL DECK INSPECTION DURING DECK PLACEMENT – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.2		
TASK	INSPECTION TYPE [1]	DESCRIPTION
3. Verify compliance of deck and all deck accessories installation with construction documents	**PERFORM**	
4. Verify deck materials are represented by the mill certifications that comply with the construction documents	**PERFORM**	
5. Document acceptance or rejection of installation of deck and deck accessories	**DOCUMENT**	
METAL DECK INSPECTION AFTER DECK PLACEMENT – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.3		
TASK	INSPECTION TYPE [1]	DESCRIPTION
6. Welding procedure specification (WPS) available	**PERFORM**	
7. Manufactures certifications for welding consumables available	OBSERVE	
8. Material identification (type/grade)	OBSERVE	
9. Check welding equipment	OBSERVE	

END SECTION

[1] **PERFORM**: Perform these tasks for each weld, fastener or bolted connection, and required verification.
OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

H. STRUCTURAL - COLD-FORMED METAL DECK – WELDING SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☐

METAL DECK INSPECTION DURING WELDING – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.4		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Use of qualified welders	OBSERVE	
2. Control and handling of welding consumables	OBSERVE	
3. Environmental conditions (wind speed, moisture, temperature)	OBSERVE	
4. WPS followed	OBSERVE	
METAL DECK INSPECTION AFTER WELDING – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.5		
TASK	INSPECTION TYPE [1]	DESCRIPTION
5. Verify size and location of welds, including support, sidelap, and perimeter welds.	**PERFORM**	
6. Welds meet visual acceptance criteria	**PERFORM**	
7. Verify repair activities	**PERFORM**	
8. Document acceptance or rejection of welds	**DOCUMENT**	

END SECTION

[1] **PERFORM**: Perform these tasks for each weld, fastener or bolted connection, and required verification.
OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

I. STRUCTURAL - COLD-FORMED METAL DECK – FASTENING SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☐

METAL DECK INSPECTION BEFORE MECHANICAL FASTENING – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.6		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Manufacturer installation instructions available for mechanical fasteners	OBSERVE	
2. Proper tools available for fastener installation	OBSERVE	
METAL DECK INSPECTION DURING MECHANICAL FASTENING – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.7		
TASK	INSPECTION TYPE [1]	DESCRIPTION
3. Fasteners are positioned as required	OBSERVE	
4. Fasteners are installed in accordance with manufacturer's instructions	OBSERVE	
METAL DECK INSPECTION AFTER MECHANICAL FASTENING – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.8		
TASK	INSPECTION TYPE [1]	DESCRIPTION
5. Check spacing, type, and installation of support fasteners	**PERFORM**	
6. Check spacing, type, and installation of sidelap fasteners	**PERFORM**	
7. Check spacing, type, and installation of perimeter fasteners	**PERFORM**	
8. Verify repair activities	**PERFORM**	
9. Document acceptance or rejection of mechanical fasteners	**DOCUMENT**	

END SECTION

[1] **PERFORM**: Perform these tasks for each weld, fastener or bolted connection, and required verification.
OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

J. STRUCTURAL - LIGHT GAUGE STEEL FRAMING AND/OR LIGHT GAUGE TRUSSES SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☐

LIGHT GAUGE STEEL CONSTRUCTION AND CONNECTIONS – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.2.2, 1705.11.2, 1705.11.3, UFC 4 023 03		
TASK	INSPECTION TYPE[1]	DESCRIPTION
1. Trusses spanning 60-feet or greater where/if applies	**PERFORM**	Verify that temporary and permanent truss restraint/bracing is installed in accordance with approved truss submittal package.
2. Welded connections (seismic and/or wind resisting system)	OBSERVE	Visually inspect all welds composing part of the main wind or seismic force resisting system, including shearwalls, braces, collectors (drag struts), and hold-downs. **[NOTE: DOR must identify critical wind and/or seismic force resisting welds in the contract drawings so that the special inspector can confirm compliance.]**
3. Connections (seismic and/or wind resisting system)	OBSERVE	Visually inspect all screw attachment, bolting, anchoring and other fastening of components within the main wind or seismic force resisting system, including roof deck, roof framing, exterior wall covering, wall to roof/floor connections, braces, collectors (drag struts) and hold-downs. **[NOTE: DOR must identify critical wind and/or seismic force resisting connection/fastener components in the contract drawings so that the special inspector can confirm compliance.]**
4. Cold-formed steel (progressive collapse resisting system where/if applies)	OBSERVE	Verify proper welding operations, screw attachment, bolting, anchoring and other fastening of components within the progressive collapse resisting system, including horizontal tie force elements, vertical tie force elements and bridging elements (UFC 4 023 03). **[NOTE: DOR must identify critical progressive collapse resisting connection/fastener components in the contract drawings so that the special inspector can confirm compliance.]**

END SECTION

K. STRUCTURAL - OPEN-WEB STEEL JOISTS SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☐

OPEN-WEB STEEL JOISTS AND JOIST GIRDERS – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC TABLE 1705.2.3		
TASK	INSPECTION TYPE[1]	DESCRIPTION
1. Installation of open-web steel joists and joist girders	OBSERVE	✓ End connections – welded or bolted ✓ Bridging – horizontal and diagonal

END SECTION

[1] **PERFORM**: Perform these tasks for each weld, fastener or bolted connection, and required verification.
OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

L. STRUCTURAL - CONCRETE CONSTRUCTION SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

CONCRETE CONSTRUCTION, INCLUDING COMPOSITE DECK – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC TABLE 1705.3 (ACI 318 REFERENCES NOTED IN IBC TABLE)		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Inspect reinforcement, including prestressing tendons, and verify placement.	OBSERVE	Verify prior to placing concrete that reinforcing is of specified type, grade and size; that it is free of oil, dirt and unacceptable rust; that it is located and spaced properly; that hooks, bends, ties, stirrups and supplemental reinforcement are placed correctly; that lap lengths, stagger and offsets are provided; and that all mechanical connections are installed per the manufacturer's instructions and/or evaluation report.
2. Reinforcing bar welding	OBSERVE	✓ Verify weldability of reinforcing bars other than ASTM A 706 ✓ Inspect single-pass fillet welds, maximum 5/16" in accordance with AWS D1.4
3. All other welding	**CONTINUOUS**	Visually inspect all welds in accordance with AWS D1.4
4. Cast in place anchors and post installed drilled anchors (downward inclined)	OBSERVE	Verify prior to placing concrete that cast in place anchors and post installed drilled anchors have proper embedment, spacing and edge distance.
5. Post-installed adhesive anchors in horizontal or upward inclined orientations	**CONTINUOUS AND DOCUMENT**	✓ Inspect as required per approved ICC-ES report ✓ Verify that installer is certified for installation of horizontal and overhead installation applications ✓ Inspect proof loading as required by the contract documents
6. Verify use of required mix design	OBSERVE	Verify that all mixes used comply with the approved construction documents
7. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete	**CONTINUOUS**	At the time fresh concrete is sampled to fabricate specimens for strength test verify these tests are performed by qualified technicians.
8. Inspect concrete and/or shotcrete placement for proper application techniques	**CONTINUOUS**	Verify proper application techniques are used during concrete conveyance and depositing avoids segregation or contamination. Verify that concrete is properly consolidated.
9. Verify maintenance of specified curing temperature and technique	OBSERVE	Inspect curing, cold weather protection, and hot weather protection procedures.
10. Pre-stressed concrete	**CONTINUOUS**	Verify application of prestressing forces and grouting of bonded prestressing tendons.

CONTINUED ON FOLLOWING PAGE

[1] **OBSERVE**: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.
CONTINUOUS: Constant monitoring of identified tasks by a special inspector over the duration of performance of said tasks.

K. STRUCTURAL - CONCRETE CONSTRUCTION (CONTINUED)

CONCRETE CONSTRUCTION, INCLUDING COMPOSITE DECK – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC TABLE 1705.3 (ACI 318 REFERENCES NOTED IN IBC TABLE)		
TASK	INSPECTION TYPE [1]	DESCRIPTION
11. Inspect erection of precast concrete members	OBSERVE	
12. Verify in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	OBSERVE	
13. Inspect formwork for shape, location and dimensions of the concrete member being formed.	OBSERVE	

END SECTION

[1] **OBSERVE**: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.
CONTINUOUS: Constant monitoring of identified tasks by a special inspector over the duration of performance of said tasks.

M. STRUCTURAL - MASONRY CONSTRUCTION SECTION (ALL RISK CATEGORIES)

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

MASONRY CONSTRUCTION – VERIFY THE FOLLOWING ARE IN COMPLIANCE AT START OF CONSTRUCTION IBC 1705.4 (ACI 530-13 TABLE 3.1.2 & 3.1.3)		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Compliance with approved submittals prior to start	OBSERVE	
2. Proportions of site-mixed mortar.	OBSERVE	
3. Grade and type of reinforcement, anchor bolts, and prestressing tendons and anchorages	OBSERVE	
4. Prestressing technique	OBSERVE	
5. Properties of thin bed mortar for AAC masonry	OBSERVE	
MASONRY CONSTRUCTION – VERIFY THE FOLLOWING ARE IN COMPLIANCE PRIOR TO GROUTING IBC 1705.4 (ACI 530-13 TABLE 3.1.2 & 3.1.3)		
TASK	INSPECTION TYPE [1]	DESCRIPTION
6. Grout space	**CONTINUOUS**	**[NOTE: DOR must either delete 'OBSERVE' for Risk Category IV/V, or delete 'CONTINUOUS' for Risk Categories I/II/ III]**
7. Proportions of site-prepared grout and prestressing grout for bonded tendons	OBSERVE	
8. Proportions of site-mixed grout and prestressing grout for bonded tendons	OBSERVE	
9. Placement of masonry units and mortar joints	OBSERVE	
10. Welding of reinforcement	**CONTINUOUS**	
MASONRY CONSTRUCTION – VERIFY THE FOLLOWING ARE IN COMPLIANCE DURING CONSTRUCTION IBC 1705.4 (ACI 530-13 TABLE 3.1.2 & 3.1.3)		
TASK	INSPECTION TYPE [1]	DESCRIPTION
11. Size and location of structural elements is in compliance	OBSERVE	
12. Preparation, construction, and protection of masonry during cold weather (temperature below 40°F (4.4°c) or hot weather (temp above 90°F (32.2°C))	OBSERVE	
13. Application and measurement of prestressing force	**CONTINUOUS**	
14. Placement of grout and prestressing grout for bonded tendons	**CONTINUOUS**	
15. Placement of AAC masonry units and construction of thin bed mortar joints	**CONTINUOUS**	Continuous for first 5000 square feet only (465 square meters).
16. Observe preparation of grout specimens, mortar specimens, and/or prisms	OBSERVE	
17. Type, size and placement of reinforcement, connectors, anchor bolts and prestressing tendons and anchorages, including details of anchorage of masonry to structural members, frames, or other construction	**CONTINUOUS**	**[NOTE: DOR must either delete 'OBSERVE' for Risk Category IV/V, or delete 'CONTINUOUS' for Risk Categories I/II/III]**

END SECTION

[1] **OBSERVE**: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

CONTINUOUS: Constant monitoring of identified tasks by a special inspector over the duration of performance of said tasks.

N. STRUCTURAL - WOOD CONSTRUCTION – SPECIALTY ITEMS SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

WOOD CONSTRUCTION – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.5		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. High-load diaphragms where applicable	OBSERVE	Verify thickness and grade of sheathing, size of framing members at panel edges, nail diameters and length, and the number of fastener lines and that fastener spacing is per approved contract documents.
2. Metal-plate connected wood trusses spanning 60 feet or greater	OBSERVE	Verify that the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package

END SECTION

O. STRUCTURAL - WOOD CONSTRUCTION - SEISMIC & WIND SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☐

WOOD CONSTRUCTION SEISMIC AND WIND – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.5		
TASK	INSPECTION TYPE [1]	DESCRIPTION
[NOTE: DOR may uncheck this section where sheathing nailing/fasteners (both shearwall and roof) are consistently greater than 4" on center, or if the design wind speed is less than 110 mph (49 meters/sec) AND the seismic design category is A or B]		
1. Nailing, bolting, anchoring and other fastening of elements of the main wind/seismic force-resisting system	OBSERVE	Includes connectors for: shearwall sheathing, roof/floor sheathing, drag struts/collectors, braces, hold downs, roof and floor framing connections to exterior walls.

END SECTION

P. STRUCTURAL – ISOLATION AND ENERGY DISSIPATION SYSTEMS SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☐

ISOLATION AND ENERGY DISSIPATION SYSTEMS – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC TABLE 1705.2.3		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Fabrication and installation	OBSERVE	Verify that fabrication and installation of isolator units and energy dissipation devices conform to manufacturer's recommendations and approved construction documents

END SECTION

[1] **OBSERVE**: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

Q. GEOTECHNICAL - SOILS INSPECTION SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

SOILS INSPECTION – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.6		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Materials below shallow foundations are adequate to achieve the design bearing capacity.	OBSERVE	
2. Excavations are extended to proper depth and have reached proper material	OBSERVE	
3. Verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill	**CONTINUOUS**	
4. Prior to placement of compacted fill, inspect subgrade and verify that site has been prepared properly.	OBSERVE	During fill placement, the special inspector shall verify that proper materials and procedures are used in accordance with the provisions of the approved geotechnical report

END SECTION

R. GEOTECHNICAL - DRIVEN DEEP FOUNDATION ELEMENTS SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☐

DEEP DRIVEN FOUNDATION CONSTRUCTION – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.5		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Verify element materials, sizes and lengths comply with requirements	**CONTINUOUS**	
2. Inspect driving operations and maintain complete and accurate records for each element	**CONTINUOUS**	
3. Verify placement locations and plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achiever design capacity, record tip and butt elevations and document ay damage to foundation element	**CONTINUOUS**	

END SECTION

[1] **OBSERVE**: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

CONTINUOUS: Constant monitoring of identified tasks by a special inspector over the duration of performance of said tasks.

S. GEOTECHNICAL - HELICAL PILE FOUNDATIONS SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

HELICAL PILE FOUNDATIONS – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.9		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Record installation equipment used, pile dimensions, tip elevations, final depth, final installation torque and other pertinent installation data. The approved geotechnical report and the contract documents shall be used to determine compliance	**CONTINUOUS**	

END SECTION

T. GEOTECHNICAL - CAST IN PLACE DEEP FOUNDATION ELEMENTS SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

CAST IN PLACE DEEP FOUNDATION ELEMENTS – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.8		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Inspect drilling operations and maintain complete and accurate records for each element.	**CONTINUOUS**	
2. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock (if applicable and adequate end-bearing strata capacity. Record concrete or grout volumes	**CONTINUOUS**	

END SECTION

[1] **CONTINUOUS:** Constant monitoring of identified tasks by a special inspector over the duration of performance of said tasks.

U. FIRE PROTECTION - SPRAYED FIRE-RESISTANT MATERIALS SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

SPRAYED FIRE RESISTANT MATERIALS – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.14		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Surface condition	OBSERVE	Prior to application confirm that surface has been prepared per the approved fire-resistance design and manufacturer's instructions.
2. Application	OBSERVE	Prior to application confirm that the substrate meets the minimum ambient temperature per the approved fire-resistance design and manufacturer's instructions.
3. Material thickness	OBSERVE	Verify that the thickness of the SFRM to structural elements is not less than the thickness require by the fire-resistant design in more that 10 percent of the measurement, but in no case less than minimum allowable thickness required by 1705.14.
4. Material density	OBSERVE	Verify that the thickness of the SFRM to structural elements is not less than the thickness require by the fire-resistant design in more than 10 percent of the measurement, but in no case less than minimum allowable thickness required by IBC 1705.14.5
5. Bond strength	OBSERVE	Verify cohesive/adhesive bond strength of the cured SFRM applied to the structural element is not less than 150psf and according to IBC 1705.14.6

END SECTION

V. FIRE PROTECTION - MASTIC AND INTUMESCENT COATINGS SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

MASTIC AND INTUMESCENT FIRE-RESISTANT COATINGS – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.15		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Surface preparation	OBSERVE	Inspections shall be performed in accordance with AWCI 12-B and the contract documents

END SECTION

W. FIRE PROTECTION – FIRE RESISTANT PENETRATIONS AND JOINTS SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

FIRE RESISTANT PENETRATIONS AND JOINTS – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.17		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Inspections of penetration firestop systems conducted in accordance with ASTM E 2174.	OBSERVE	**[NOTE: This section applies to Risk Category III, IV, & V only. DOR may choose to uncheck this section where project is assigned to Risk Category I or II. Confirm Risk Category with Structural Engineer]**
2. Inspections of fire-resistant joint systems conducted in accordance with ASTM E 2393	OBSERVE	

END SECTION

[1] **OBSERVE**: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

X. FIRE PROTECTION – SMOKE CONTROL SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

SMOKE CONTROL – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.17		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Verify device locations and perform leakage testing	OBSERVE	Perform during erection of ductwork and prior to concealment
2. Pressure difference testing, flow measurements and detection and control verification	OBSERVE	Perform prior to occupancy and after sufficient completion

END SECTION

[1] **OBSERVE**: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

Y. ARCHITECTURAL - EXTERIOR INSULATION AND FINISH SYSTEMS SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS) – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.16		
TASK	INSPECTION TYPE [1]	DESCRIPTION
1. Water resistive barrier coating applied over a sheathing substrate.	OBSERVE	Verify that water resistive barrier coating complies with ASTM E 2570. **[NOTE: not applicable to masonry or concrete wall applications. Uncheck this section in those cases]**

END SECTION

Z. ARCHITECTURAL – ARCHITECTURAL COMPONENTS

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

ARCHITECTURAL COMPONENTS – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.12.5, 1705.12.7		
TASK	INSPECTION TYPE [1]	DESCRIPTION
[NOTE: This section is not applicable to Seismic Design Categories A, B, & C. Uncheck this section if one of those categories applies. Confirm Seismic Design Category with the structural engineer]		
1. Erection and fastening of exterior cladding and interior and exterior veneer.	OBSERVE	Verify appropriate materials, fasteners and attachment at commencement of work and at completion. **Inspector Note: Inspection not required if height is less than 30 feet or weight is less than 5psf**
2. Interior and exterior non-load bearing walls	OBSERVE	Verify appropriate materials, fasteners and attachment at commencement of work and at completion. **Inspector Note: Inspection not required if height is less than 30 feet. Also, Interior non-load bearing walls need not be inspected if weighing less than 15psf**
3. Access floors	OBSERVE	Verify that anchorage complies with approved construction documents. Inspection of post-installed anchors shall comply with approved ICC-ES report
4. Storage racks	OBSERVE	Verify that anchorage complies with approved construction documents. Inspection of post-installed anchors shall comply with approved ICC-ES report. **Inspector Note: Not required for racks less than 8 feet in height**

END SECTION

[1] **OBSERVE**: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

AA. PLUMBING/MECHANICAL/ELECTRICAL DESIGNATED SEISMIC SYSTEMS SECTION

THIS SECTION APPLICABLE IF BOX IS CHECKED: ☒

PLUMBING, MECHANICAL AND ELECTRICAL - DESIGNATED SEISMIC SYSTEMS IBC 1705.12.4		
TASK	INSPECTION TYPE [1]	DESCRIPTION
[NOTE: This section is not applicable to Seismic Design Categories A or B. Uncheck this section if one of those categories applies. Confirm Seismic Design Category with structural engineer]		
1. Designated Seismic Systems equipment verification	OBSERVE	✓ Verify model number and serial number are in conformance with project specific seismic qualification (PSSQ) ✓ Verify Tag ID is correct and installed per specifications
2. Designated Seismic Systems equipment Mounting	OBSERVE	✓ Verify that Anchor Base Bolting is installed per PSSQ ✓ Verify that Equipment Bracing is Installed per PSSQ ✓ Verify that Bracing Attachments are installed per PSSQ
3. Designated Seismic Systems utility Conduit/Piping	OBSERVE	✓ Verify that Conduit/Piping is connected to the equipment per PSSQ (flex or rigid) ✓ Verify that Conduit/Piping is seismically supported independently of equipment and in accordance with PSSQ support requirements
4. Designated Seismic Systems clearance	OBSERVE	✓ Adjacent Equipment – Verify that there is adequate gap to eliminate possibility of pounding ✓ Conduit/Piping - Verify that there is adequate gap to eliminate possibility of pounding

END SECTION

[1] **OBSERVE**: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

SECTION 01 57 19
TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the control of environmental pollution and damage that the Contractor must consider for air, water, and land resources. It includes management of visual aesthetics, noise, solid waste, radiant energy, and radioactive materials, as well as other pollutants and resources encountered or generated by the Contractor. The Contractor is obligated to consider specified control measures with the costs included within the various contract items of work.

B. Environmental pollution and damage is defined as the presence of chemical, physical, or biological elements or agents which:

1. Adversely affect human health or welfare,
2. Unfavorably alter ecological balances of importance to human life,
3. Effect other species of importance to humankind.
4. Degrade the utility of the environment for aesthetic, cultural, and historical purposes.

C. Definitions of Pollutants:

1. Chemical Waste: Petroleum products, bituminous materials, salts, acids, alkalis, herbicides, pesticides, organic chemicals, and inorganic wastes.
2. Debris: Combustible and noncombustible wastes, such as leaves, tree trimmings, ashes, and waste materials resulting from construction or maintenance and repair work.
3. Sediment: Soil and other debris that has been eroded and transported by runoff water.
4. Solid Waste: Rubbish, debris, garbage, and other discarded solid materials resulting from industrial, commercial, and agricultural operations and from community activities.
5. Surface Discharge: The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers, creeks, and/or "water of the United States" and would require a permit to discharge water from the governing agency.
6. Rubbish: Combustible and noncombustible wastes such as paper, boxes, glass and crockery, metal and lumber scrap, tin cans, and bones.
7. Sanitary Wastes:
    a. Sewage: Domestic sanitary sewage and human and animal waste.
    b. Garbage: Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.

1.2 QUALITY CONTROL

A. Establish and maintain quality control for the environmental protection of all items set forth herein.

B. Record on daily reports any problems in complying with laws, regulations, and ordinances. Note any corrective action taken.

1.3 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. U.S. National Archives and Records Administration (NARA):
33 CFR 328 ..... Definitions

1.4 SUBMITTALS

A. In accordance with Section, 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:

1. Environmental Protection Plan: After the contract is awarded and prior to the commencement of the work, the Contractor shall meet with the Contracting Officer's Representative (COR) to discuss the proposed Environmental Protection Plan and to develop mutual understanding relative to details of environmental protection. Not more than 20 days after the meeting, the Contractor shall prepare and submit to the Contracting Officer for approval, a written and/or graphic Environmental Protection Plan including, but not limited to, the following:
   a. Name(s) of person(s) within the Contractor's organization who is (are) responsible for ensuring adherence to the Environmental Protection Plan.
   b. Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site.
   c. Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.
   d. Description of the Contractor's environmental protection personnel training program.
   e. A list of Federal, State, and local laws, regulations, and permits concerning environmental protection, pollution control, noise control and abatement that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations, and permits.
   f. Methods for protection of features to be preserved within authorized work areas including trees, shrubs, vines, grasses, ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, and archeological and cultural resources.
   g. Procedures to provide the environmental protection that comply with the applicable laws and regulations. Describe the procedures to correct pollution of the environment

due to accident, natural causes, or failure to follow the procedures as described in the Environmental Protection Plan.

h. Permits, licenses, and the location of the solid waste disposal area.

i. Drawings showing locations of any proposed temporary excavations or embankments for haul roads, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials. Include as part of an Erosion Control Plan approved by the District Office of the U.S. Soil Conservation Service and the Department of Veterans Affairs.

j. Environmental Monitoring Plans for the job site including land, water, air, and noise.

k. Work Area Plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas. This plan may be incorporated within the Erosion Control Plan.

l. Inclusion of “best management practices” and methodologies.

B. Approval of the Contractor's Environmental Protection Plan will not relieve the Contractor of responsibility for adequate and continued control of pollutants and other environmental protection measures.

1.5 PROTECTION OF ENVIRONMENTAL RESOURCES

A. Protect environmental resources within the project boundaries and those affected outside the limits of permanent work during the entire period of this contract. Confine activities to areas defined by the specifications and drawings.

B. Protection of Land Resources: Prior to construction, identify all land resources to be preserved within the work area. Do not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and landforms without permission from the COR. Do not fasten or attach ropes, cables, or guys to trees for anchorage unless specifically authorized, or where special emergency use is permitted. Provide erosion control plans, in phases where required.

1. Work Area Limits: Prior to any construction, mark the areas that require work to be performed under this contract. Mark or fence isolated areas within the general work area that are to be saved and protected. Protect monuments, works of art, and markers before construction operations begin. Convey to all personnel the purpose of marking and protecting all necessary objects.

2. Protection of Landscape: Protect trees, shrubs, vines, grasses, land forms, and other landscape features shown on the drawings to be preserved by marking, fencing, or using any other approved techniques.

a. Box and protect from damage existing trees and shrubs to remain on the construction site.

b. Immediately repair all damage to existing trees and shrubs by trimming, cleaning, and painting with antiseptic tree paint.
c. Do not store building materials or perform construction activities closer to existing trees or shrubs than the farthest extension of their limbs.

3. Reduction of Exposure of Unprotected Erodible Soils: Plan and conduct earthwork to minimize the duration of exposure of unprotected soils. Clear areas in reasonably sized increments only as needed to use. Form earthwork to final grade as shown. Immediately protect side slopes and back slopes upon completion of rough grading.
4. Temporary Protection of Disturbed Areas: Construct diversion ditches, benches, and berms to retard and divert runoff from the construction site to protected drainage areas approved under paragraph 208 of the Clean Water Act.
   a. Sediment Basins: Trap sediment from construction areas in temporary or permanent sediment basins that accommodate the runoff of a local 2 (design year) storm. After each storm, pump the basins dry and remove the accumulated sediment. Control overflow/drainage with paved weirs or by vertical overflow pipes, draining from the surface.
   b. Reuse or conserve the collected topsoil sediment as directed by the COR. Topsoil use and requirements are specified in Section 31 20 00, EARTHWORK.
   c. Institute effluent quality monitoring programs as required by Federal, State, and local environmental agencies.
5. Erosion and Sedimentation Control Devices: The erosion and sediment controls selected and maintained by the Contractor shall be such that water quality standards are not violated as a result of the Contractor's activities. Construct or install all temporary and permanent erosion and sedimentation control features on the Environmental Protection Plan. Maintain temporary erosion and sediment control measures such as berms, dikes, drains, sedimentation basins, grassing, and mulching, until permanent drainage and erosion control facilities are completed and operative.
6. Manage borrow areas off Government property to minimize erosion and to prevent sediment from entering nearby water courses or lakes.
7. Manage and control spoil areas on and off Government property to limit spoil to areas on the Environmental Protection Plan and prevent erosion of soil or sediment from entering nearby water courses or lakes.
8. Protect adjacent areas from despoilment by temporary excavations and embankments.
9. Handle and dispose of solid wastes in such a manner that will prevent contamination of the environment. Place solid wastes (excluding clearing debris) in containers that are emptied on a regular schedule. Transport all solid waste off Government property and dispose of waste in compliance with Federal, State, and local requirements.

10. Store chemical waste away from the work areas in corrosion resistant containers and dispose of waste in accordance with Federal, State, and local regulations.
11. Handle discarded materials other than those included in the solid waste category as directed by the COR.

C. Protection of Water Resources: Keep construction activities under surveillance, management, and control to avoid pollution of surface and ground waters and sewer systems. Implement management techniques to control water pollution by the listed construction activities that are included in this contract.
   1. Washing and Curing Water: Do not allow wastewater directly derived from construction activities to enter water areas. Collect and place wastewater in retention ponds allowing the suspended material to settle, the pollutants to separate, or the water to evaporate.
   2. Control movement of materials and equipment at stream crossings during construction to prevent violation of water pollution control standards of the Federal, State, or local government.
   3. Monitor water areas affected by construction.

D. Protection of Fish and Wildlife Resources: Keep construction activities under surveillance, management, and control to minimize interference with, disturbance of, or damage to fish and wildlife. Prior to beginning construction operations, list species that require specific attention along with measures for their protection.

E. Protection of Air Resources: Keep construction activities under surveillance, management, and control to minimize pollution of air resources. Burning is not permitted on the job site. Keep activities, equipment, processes, and work operated or performed, in strict accordance with the State of Minnesota and Federal emission and performance laws and standards. Maintain ambient air quality standards set by the Environmental Protection Agency, for those construction operations and activities specified.
   1. Particulates: Control dust particles, aerosols, and gaseous by-products from all construction activities, processing, and preparation of materials (such as from asphaltic batch plants) at all times, including weekends, holidays, and hours when work is not in progress.
   2. Particulates Control: Maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulates which would cause a hazard or a nuisance. Sprinklering, chemical treatment of an approved type, light bituminous treatment, baghouse, scrubbers, electrostatic precipitators, or other methods are permitted to control particulates in the work area.
   3. Hydrocarbons and Carbon Monoxide: Control monoxide emissions from equipment to Federal and State allowable limits.

4. Odors: Control odors of construction activities and prevent obnoxious odors from occurring.

F. Reduction of Noise: Minimize noise using every action possible. Perform noise-producing work in less sensitive hours of the day or week as directed by the COR. Maintain noise-produced work at or below the decibel levels and within the time periods specified.

1. Perform construction activities involving repetitive, high-level impact noise only between 8:00 a.m. and 4:30p.m unless otherwise permitted by local ordinance or the COR. Repetitive impact noise on the property shall not exceed the following dB limitations:

Time Duration of Impact Noise	Sound Level in dB
More than 12 minutes in any hour	70
Less than 30 seconds of any hour	85
Less than three minutes of any hour	80
Less than 12 minutes of any hour	75

2. Provide sound-deadening devices on equipment and take noise abatement measures that are necessary to comply with the requirements of this contract, consisting of, but not limited to, the following:

a. Maintain maximum permissible construction equipment noise levels at 15 meter (50 feet) (dBA):

EARTHMOVING		MATERIALS HANDLING	
FRONT LOADERS	75	CONCRETE MIXERS	75
BACKHOES	75	CONCRETE PUMPS	75
DOZERS	75	CRANES	75
TRACTORS	75	DERRICKS IMPACT	75
SCAPERS	80	PILE DRIVERS	95
GRADERS	75	JACK HAMMERS	75
TRUCKS	75	ROCK DRILLS	80
PAVERS, STATIONARY	80	PNEUMATIC TOOLS	80
PUMPS	75	SAWS	75
GENERATORS	75	VIBRATORS	75
COMPRESSORS	75		

b. Use shields or other physical barriers to restrict noise transmission.

c. Provide soundproof housings or enclosures for noise-producing machinery.

d. Use efficient silencers on equipment air intakes.

e. Use efficient intake and exhaust mufflers on internal combustion engines that are maintained so equipment performs below noise levels specified.

f. Line hoppers and storage bins with sound deadening material.

g. Conduct truck loading, unloading, and hauling operations so that noise is kept to a minimum.

3. Measure sound level for noise exposure due to the construction at least once every five successive working days while work is being performed above 55 dB(A) noise level. Measure noise exposure at the property line or 15 m (50 feet) from the noise source, whichever is greater. Measure the sound levels on the A weighing network of a General Purpose sound level meter at slow response. To minimize the effect of reflective sound waves at buildings, take measurements at 900 to 1800 mm (three to six feet) in front of any building face. Submit the recorded information to the COR noting any problems and the alternatives for mitigating actions.

G. Restoration of Damaged Property: If any direct or indirect damage is done to public or private property resulting from any act, omission, neglect, or misconduct, the Contractor shall restore the damaged property to a condition equal to that existing before the damage at no additional cost to the Government. Repair, rebuild, or restore property as directed or make good such damage in an acceptable manner.

H. Final Clean-up: On completion of project and after removal of all debris, rubbish, and temporary construction, Contractor shall leave the construction area in a clean condition satisfactory to the COR. Cleaning shall include off the station disposal of all items and materials not required to be salvaged, as well as all debris and rubbish resulting from demolition and new work operations.

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SECTION 01 74 19
CONSTRUCTION WASTE MANAGEMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the requirements for the management of non-hazardous building construction and demolition waste.

B. Waste disposal in landfills shall be minimized to the greatest extent possible. Of the inevitable waste that is generated, as much of the waste material as economically feasible shall be salvaged, recycled, or reused.

C. Contractor shall use all reasonable means to divert construction and demolition waste from landfills and incinerators, and facilitate their salvage and recycle not limited to the following:

1. Waste Management Plan development and implementation.
2. Techniques to minimize waste generation.
3. Sorting and separating of waste materials.
4. Salvage of existing materials and items for reuse or resale.
5. Recycling of materials that cannot be reused or sold.

D. At a minimum the following waste categories shall be diverted from landfills:

1. Soil.
2. Inerts (eg, concrete, masonry, and asphalt).
3. Clean dimensional wood and palette wood.
4. Green waste (biodegradable landscaping materials).
5. Engineered wood products (plywood, particle board and I-joists, etc).
6. Metal products (eg, steel, wire, beverage containers, copper, etc).
7. Sheathings
8. Cardboard, paper and packaging.
9. Bitumen roofing materials.
10. Plastics (eg, ABS, PVC).
11. Carpet and/or pad.
12. Gypsum board.
13. Insulation.
14. Paint.
15. Fluorescent lamps.

1.2 RELATED WORK

A. Section 02 41 00, DEMOLITION.

B. Section 01 00 00, GENERAL REQUIREMENTS.

1.3 QUALITY ASSURANCE

A. Contractor shall practice efficient waste management when sizing, cutting, and installing building products. Processes shall be employed to ensure the generation of as little waste as possible. Construction /Demolition waste includes products of the following:
   1. Excess or unusable construction materials.
   2. Packaging used for construction products.
   3. Poor planning and/or layout.
   4. Construction error.
   5. Over ordering.
   6. Weather damage.
   7. Contamination.
   8. Mishandling.
   9. Breakage.

B. Establish and maintain the management of non-hazardous building construction and demolition waste set forth herein. Conduct a site assessment to estimate the types of materials that will be generated by demolition and construction.

C. Contractor shall develop and implement procedures to recycle construction and demolition waste to a minimum of 50 percent.

D. Contractor shall be responsible for implementation of any special programs involving rebates or similar incentives related to recycling. Any revenues or savings obtained from salvage or recycling shall accrue to the contractor.

E. Contractor shall provide all demolition, removal, and legal disposal of materials. Contractor shall ensure that facilities used for recycling, reuse and disposal shall be permitted for the intended use to the extent required by local, state, federal regulations.

F. Contractor shall assign a specific area to facilitate separation of materials for reuse, salvage, recycling, and return. Such areas are to be kept neat and clean and clearly marked in order to avoid contamination or mixing of materials.

G. Contractor shall provide on-site instructions and supervision of separation, handling, salvaging, recycling, reuse and return methods to be used by all parties during waste generating stages.

H. Record on daily reports any problems in complying with laws, regulations and ordinances with corrective action taken.

1.4 TERMINOLOGY

A. Class III Landfill: A landfill that accepts non-hazardous resources such as household, commercial and industrial waste resulting from construction, remodeling, repair, and demolition operations.

B. Clean: Untreated and unpainted; uncontaminated with adhesives, oils, solvents, mastics and like products.

C. Construction and Demolition Waste: Includes all non-hazardous resources resulting from construction, remodeling, alterations, repair and demolition operations.

D. Dismantle: The process of parting out a building in such a way as to preserve the usefulness of its materials and components.

E. Disposal: Acceptance of solid wastes at a legally operating facility for the purpose of land filling (includes Class III landfills and inert fills).

F. Inert Backfill Site: A location, other than inert fill or other disposal facility, to which inert materials are taken for the purpose of filling an excavation, shoring or other soil engineering operation.

G. Inert Fill: A facility that can legally accept inert waste, such as asphalt and concrete exclusively for the purpose of disposal.

H. Inert Solids/Inert Waste: Non-liquid solid resources including, but not limited to, soil and concrete that does not contain hazardous waste or soluble pollutants at concentrations in excess of water-quality objectives established by a regional water board, and does not contain significant quantities of decomposable solid resources.

I. Mixed Debris: Loads that include commingled recyclable and non-recyclable materials generated at the construction site.

J. Mixed Debris Recycling Facility: A solid resource processing facility that accepts loads of mixed construction and demolition debris for the purpose of recovering re-usable and recyclable materials and disposing non-recyclable materials.

K. Permitted Waste Hauler: A company that holds a valid permit to collect and transport solid wastes from individuals or businesses for the purpose of recycling or disposal.

L. Recycling: The process of sorting, cleansing, treating, and reconstituting materials for the purpose of using the altered form in the manufacture of a new product. Recycling does not include burning, incinerating or thermally destroying solid waste.

1. On-site Recycling – Materials that are sorted and processed on site for use in an altered state in the work, i.e. concrete crushed for use as a sub-base in paving.
2. Off-site Recycling – Materials hauled to a location and used in an altered form in the manufacture of new products.

M. Recycling Facility: An operation that can legally accept materials for the purpose of processing the materials into an altered form for the manufacture of new products. Depending on the types of materials accepted and operating procedures, a recycling facility may or may not be required to have a solid waste facilities permit or be regulated by the local enforcement agency.

N. Reuse: Materials that are recovered for use in the same form, on-site or off-site.

O. Return: To give back reusable items or unused products to vendors for credit.

P. Salvage: To remove waste materials from the site for resale or re-use by a third party.

Q. Source-Separated Materials: Materials that are sorted by type at the site for the purpose of reuse and recycling.

R. Solid Waste: Materials that have been designated as non-recyclable and are discarded for the purposes of disposal.

S. Transfer Station: A facility that can legally accept solid waste for the purpose of temporarily storing the materials for re-loading onto other trucks and transporting them to a landfill for disposal, or recovering some materials for re-use or recycling.

1.5 SUBMITTALS

A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, furnish the following:

B. Prepare and submit to the COR a written demolition debris management plan. The plan shall include, but not be limited to, the following information:

1. Procedures to be used for debris management.
2. Techniques to be used to minimize waste generation.
3. Analysis of the estimated job site waste to be generated:
    a. List of each material and quantity to be salvaged, reused, recycled.
    b. List of each material and quantity proposed to be taken to a landfill.
4. Detailed description of the Means/Methods to be used for material handling.
    a. On site: Material separation, storage, protection where applicable.
    b. Off site: Transportation means and destination. Include list of materials.
        1. Description of materials to be site-separated and self-hauled to designated facilities.
        2. Description of mixed materials to be collected by designated waste haulers and removed from the site.
    c. The names and locations of mixed debris reuse and recycling facilities or sites.
    d. The names and locations of trash disposal landfill facilities or sites.
    e. Documentation that the facilities or sites are approved to receive the materials.

C. Designated Manager responsible for instructing personnel, supervising, documenting and administer over meetings relevant to the Waste Management Plan.

D. Monthly summary of construction and demolition debris diversion and disposal, quantifying all materials generated at the work site and disposed of or diverted from disposal through recycling.

E. Target waste diversion rate by material and an overall diversion rate.

F. Final report documenting the results of implementation of the preconstruction waste management plan.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

B. U.S. Green Building Council (USGBC): LEED Green Building Rating System for New Construction

C. Green Building Initiative (GBI): Green Globes for New Construction 2019

1.7 RECORDS

A. Maintain records to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed by landfill or incineration. Records shall be kept in accordance with the LEED Reference Guide and LEED Template.

PART 2 - PRODUCTS

2.1 MATERIALS

A. List of each material and quantity to be salvaged, recycled, reused.

B. List of each material and quantity proposed to be taken to a landfill.

C. Material tracking data: Receiving parties, dates removed, transportation costs, weight tickets, tipping fees, manifests, invoices, net total costs or savings.

PART 3 - EXECUTION

3.1 COLLECTION

A. Provide all necessary containers, bins and storage areas to facilitate effective waste management.

B. Clearly identify containers, bins and storage areas so that recyclable materials are separated from trash and can be transported to respective recycling facility for processing.

C. Hazardous wastes shall be separated, stored, disposed of according to local, state, federal regulations.

3.2 DISPOSAL

A. Contractor shall be responsible for transporting and disposing of materials that cannot be delivered to a source-separated or mixed materials recycling facility to a transfer station or disposal facility that can accept the materials in accordance with state and federal regulations.

B. Construction or demolition materials with no practical reuse or that cannot be salvaged or recycled shall be disposed of at a landfill or incinerator.

3.3 REPORT

A. With each application for progress payment, submit a summary of construction and demolition debris diversion and disposal including beginning and ending dates of period covered.

B. Quantify all materials diverted from landfill disposal through salvage or recycling during the period with the receiving parties, dates removed, transportation costs, weight tickets, manifests, invoices. Include the net total costs or savings for each salvaged or recycled material.

C. Quantify all materials disposed of during the period with the receiving parties, dates removed, transportation costs, weight tickets, tipping fees, manifests, invoices. Include the net total costs for each disposal.

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SECTION 01 81 13
SUSTAINABLE CONSTRUCTION REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section describes general requirements and procedures to comply with federal mandates and U.S. Department of Veterans Affairs (VA) policies for sustainable construction.

B. The Design Professional has selected materials and utilized integrated design processes that achieve the Government's objectives. Contractor is responsible to maintain and support these objectives in developing means and methods for performing work and in proposing product substitutions or changes to specified processes. Obtain approval from Contracting Officer for all changes and substitutions to materials or processes. Proposed changes must meet, or exceed, materials or processes specified.

1.2 RELATED WORK

A. Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

B. Section 01 74 19 CONSTRUCTION WASTE MANANGEMENT.

1.3 DEFINITIONS

A. Recycled Content: Recycled content of materials is defined according to Federal Trade Commission Guides for the Use of Environmental Marketing Claims (16 CFR Part 260). Recycled content value of a material assembly is determined by weight. Recycled fraction of assembly is multiplied by cost of assembly to determine recycled content value.

1. "Post-Consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
2. "Pre-Consumer" material is defined as material diverted from waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

B. Biobased Products: Biobased products are derived from plants and other renewable agricultural, marine, and forestry materials and provide an alternative to conventional petroleum derived products. Biobased products include diverse categories such as lubricants, cleaning products, inks, fertilizers, and bioplastics.

C. Low Pollutant-Emitting Materials: Materials and products which are minimally odorous, irritating, or harmful to comfort and well-being of installers and occupants.

D. Volatile Organic Compounds (VOC): Chemicals that are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects.

1.4 REFERENCE STANDARDS

A. Carpet and Rug Institute Green Label Plus program.

B. U.S. Department of Agriculture BioPreferred program (USDA BioPreferred).

C. U.S. Environmental Protection Agency Comprehensive Procurement Guidelines (CPG).

D. U.S. Environmental Protection Agency WaterSense Program (WaterSense).

E. U.S. Environmental Protection Agency ENERGY STAR Program (ENERGY STAR).

F. U. S. Department of Energy Federal Energy Management Program (FEMP).

G. Green Electronic Council EPEAT Program (EPEAT).

1.5 SUBMITTALS

A. All submittals to be provided by contractor to COR.

B. Sustainability Action Plan:

1. Submit documentation as required by this section; provide additional copies of typical submittals required under technical sections when sustainable construction requires copies of record submittals.
2. Within 30 days after Preconstruction Meeting provide a narrative plan for complying with requirements stipulated within this section.
3. Sustainability Action Plan must:
    a. Make reference to sustainable construction submittals defined by this section.
    b. Address all items listed under PERFORMANCE CRITERIA.
    c. Indicate individual(s) responsible for implementing the plan.

C. Low Pollutant-Emitting Materials Tracking Spreadsheet: Within 30 days after Preconstruction Meeting provide a preliminary Low Pollutant-Emitting Materials Tracking Spreadsheet. The Low Pollutant-Emitting Materials Tracking Spreadsheet must be an electronic file and include all materials on Project in categories described under Low Pollutant-Emitting Materials in 01 81 13.

D. Construction Indoor Air Quality (IAQ) Management Plan:

1. Not more than 30 days after Preconstruction Meeting provide a Construction IAQ Management Plan as an electronic file including descriptions of the following:
    a. Instruction procedures for meeting or exceeding minimum requirements of ANSI/SMACNA 008-2008, Chapter 3, including procedures for HVAC Protection, Source Control, Pathway Interruption, Housekeeping, and Scheduling.
    b. Instruction procedures for protecting absorptive materials stored on-site or installed from moisture damage.
    c. Schedule of submission of photographs of on-site construction IAQ management measures such as protection of ducts and on-site stored oil installed absorptive materials.

d. Instruction procedures if air handlers must be used during construction, including a description of filtration media to be used at each return air grille.
e. Instruction procedure for replacing all air-filtration media immediately prior to occupancy after completion of construction, including a description of filtration media to be used at each air handling or air supply unit.
f. Instruction procedures and schedule for implementing building flush-out.

E. Product Submittals:
1. Recycled Content: Submit product data from manufacturer indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content (excluding MEP systems equipment and components).
2. Biobased Content: Submit product data for products to be installed or used which are included in any of the USDA BioPreferred program's product categories. Data to include percentage of biobased content and source of biobased material.
3. Low Pollutant-Emitting Materials: Submit product data confirming compliance with relevant requirements for all materials on Project in categories described under Low Pollutant-Emitting Materials in 01 81 13.
4. For applicable products and equipment, submit product documentation confirming ENERGY STAR label, FEMP certification, WaterSense, and/or EPEAT certification.

F. Sustainable Construction Progress Reports: Concurrent with each Application for Payment, submit a Sustainable Construction Progress Report to confirm adherence with Sustainability Action Plan.
1. Include narratives of revised strategies for bringing work progress into compliance with plan and product submittal data.
2. Include updated and current Low Pollutant-Emitting Materials Tracking Spreadsheet.
3. Include construction waste tracking, in tons or cubic yards, including waste description, whether diverted or landfilled, hauler, and percent diverted for comingled quantities; and excluding land-clearing debris and soil. Provide haul receipts and documentation of diverted percentages for comingled wastes.

G. Closeout Submittals: Within 14 days after Substantial Completion provide the following:
1. Final version of Low Pollutant-Emitting Materials Tracking Spreadsheet.
2. Manufacturer's cut sheets and product data highlighting the Minimum Efficiency Reporting Value (MERV) for filtration media installed at return air grilles during construction if permanently installed air handling units are used during construction.
3. Manufacturer's cut sheets and product data highlighting the Minimum Efficiency Reporting Value (MERV) for final filtration media in air handling units.
4. Minimum 18 construction photographs including six photographs taken on three different occasions during construction of ANSI/SMACNA 008-2008, Chapter 3 approaches

employed, along with a brief description of each approach, documenting implementation of IAQ management measures, such as protection of ducts and on-site stored or installed absorptive materials.

5. Flush-out Documentation:
   a. Product data for filtration media used during flush-out.
   b. Product data for filtration media installed immediately prior to occupancy.
   c. Signed statement describing building air flush-out procedures including dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.

1.6 QUALITY ASSURANCE

A. Preconstruction Meeting: After award of Contract and prior to commencement of Work, schedule and conduct meeting with COR/Resident Engineer and Architect to discuss the Project Sustainable Action Plan content as it applies to submittals, project delivery, required Construction Indoor Air Quality (IAQ) Management Plan, and other Sustainable Construction Requirements. The purpose of this meeting is to develop a mutual understanding of the Sustainable Construction Requirements and coordination of contractor's management of these requirements with the Contracting Officer and the Construction Quality Manager.

B. Construction Job Conferences: Status of compliance with Sustainable Construction Requirements of these specifications will be an agenda item at regular job meetings conducted during the course of work at the site.

1.7 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

B. VHA Directive 0058 VHA Green Purchasing Program.

C. VHA Directive 7707 HVA Green Environmental Management System (GEMS).

D. Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993.

E. Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.

F. Green Seal Standard GC-36, Commercial Adhesives, October 19, 2000.

G. South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.

H. South Coast Air Quality Management District (SCAQMD) Rule 1168, July 1, 2005 and rule amendment date of January 7, 2005.

I. Sheet Metal and Air Conditioning National Contractors' Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd Edition (ANSI/SMACNA 008-2008), Chapter 3.

J. California Department of Public Health Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, Version 1.1, Emission Testing method for California Specification 01350 (CDPH Standard Method V1.1-2010).

K. Federal Trade Commission Guides for the Use of Environmental Marketing Claims (16 CFR Part 260).

L. ASHRAE Standard 52.2-2007.

PART 2 – PRODUCTS

2.1 PERFORMANCE CRITERIA

A. Construction waste diversion from landfill disposal must comprise at least 50 percent of total construction waste, excluding land clearing debris and soil. Alternative daily cover (ADC) does not qualify as material diverted from disposal.

B. Low Pollutant-Emitting Materials:

1. Adhesives, sealants and sealant primers applied on site within the weatherproofing membrane must comply with VOC limits of SCAQMD Rule 1168:

a. Flooring Adhesives and Sealants:

1)	Ceramic Tile Adhesives and Grout:	65 g/L.
2)	Cove Base Adhesives:	50 g/L.
3)	Multipurpose Construction Adhesives:	70 g/L.
4)	Porous Material (Except Wood) Substrate:	50 g/L.
5)	Architectural Non-Porous Sealant Primer:	250 g/L.
6)	Architectural Porous Sealant Primer:	775 g/L.
7)	Other Sealant Primer:	750 g/L.
8)	Architectural Sealant:	250 g/L.
9)	Other Sealant:	420 g/L.

b. Non-Flooring Adhesives and Sealants:

1)	Drywall and Panel Adhesives:	50 g/L.
2)	Multipurpose Construction Adhesives:	70 g/L.
3)	Metal-to-Metal Substrate Adhesives:	30 g/L.
4)	Plastic Foam Substrate Adhesive:	50 g/L.
5)	Porous Material (Except Wood) Substrate Adhesive:	50 g/L.
6)	Fiberglass Substrate Adhesive:	80 g/L.
7)	Architectural Non-Porous Sealant Primer:	250 g/L.
8)	Architectural Porous Sealant Primer:	775 g/L.
9)	Other Sealant Primer:	750 g/L.
10)	PVC Welding Adhesives:	510 g/L.
11)	CPVC Welding Adhesives:	490 g/L.

12) ABS Welding Adhesives: 325 g/L.
13) Plastic Cement Welding Adhesives: 250 g/L.
14) Adhesive Primer for Plastic: 550 g/L.
15) Contact Adhesive: 80 g/L.
16) Special Purpose Contact Adhesive: 250 g/L.
17) Architectural Sealants: 250 g/L.
18) Other Sealants: 420 g/L.

2. Aerosol adhesives applied on site within the weatherproofing membrane must comply with the following Green Seal GS-36.
   a. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent VOCs by weight.
   b. Aerosol Adhesive, General-Purpose Web Spray: 55 percent VOCs by weight.
   c. Special-Purpose Aerosol Adhesive (All Types): 70 percent VOCs by weight.
3. Paints and coatings applied on site within the weatherproofing membrane must comply with the following criteria:
   a. VOC test method for paints and coatings is to be in accordance with 40 CFR 59 (EPA Method 24). Part 60, Appendix A with the exempt compounds' content determined by Method 303 (Determination of Exempt Compounds) in the South Coast Air Quality Management District's (SCAQMD) "Laboratory Methods of Analysis for Enforcement Samples" manual.
   b. VOC content limits for paints and coatings established in Green Seal Standard GS-11.
   c. VOC content limit for anti-corrosive and anti-rust paints applied to interior ferrous metal substrates of 250 g/L established in Green Seal GC-03.
   d. Clear wood finishes, floor coatings, stains, primers, sealers, and shellacs applied to interior elements must not exceed VOC content limits established in SCAQMD Rule 1113 or the limits listed below, whichever is lower.
   e. Comply with the following VOC content limits:
      1) Anti-Corrosive/Antirust Paints: 250 g/L.
      2) Floor Coating: 100 g/L.
      3) Interior Flat Paint, Coating or Primer: 50 g/L.
      4) Interior Non-Flat Paint, Coating or Primer: 150 g/L.
      5) Dry-Fog Coatings: 400 gram/liter.
      6) Primers, Sealers, and Undercoaters: 200 g/L.
      7) Zinc-Rich Industrial Maintenance Primers: 340 gram/liter.
      8) Pretreatment Wash Primers: 420 gram/liter.
      9) Concrete Curing Compounds: 350 g/L.
      10) Japans/Faux Finishing Coatings: 350 g/L.

11) Magnesite Cement Coatings: 450 g/L.
12) Shellacs, Clear: 730 gram/liter.
13) Shellacs, Pigmented: 550 gram/liter.
14) Waterproofing Sealers: 250 g/L.
15) Wood Preservatives: 350 g/L.
16) Low-Solids Coatings: 120 g/L.

C. Recycled Content:
1. Any products being installed or used that are listed on EPA Comprehensive Procurement Guidelines designated product list must meet or exceed the EPA's recycled content recommendations. The EPA Comprehensive Procurement Guidelines categories include:
a. Building insulation.
b. Cement and concrete.
c. Consolidated and reprocessed latex paint.
d. Flowable fill.
e. Laminated paperboard.
f. Nonpressure pipe.
g. Roofing materials.
h. Compost and fertilizer made from recovered organic materials.

D. Biobased Content:
1. Materials and equipment being installed or used that are listed on the USDA BioPreferred program product category list must meet or exceed USDA's minimum biobased content threshold. Refer to individual specification sections for detailed requirements applicable to that section.
a. USDA BioPreferred program categories include:
1) Adhesive and Mastic Removers.
2) Cleaners.
3) Corrosion Preventatives.
4) Erosion Control Materials.
5) Dust Suppressants.
6) Fertilizers.
7) Floor Cleaners and Protectors.
8) Hydraulic Fluids.
9) Industrial Cleaners.
10) Interior Paints and Coatings.
11) Mulch and Compost Materials.
12) Multipurpose Cleaners.
13) Multipurpose Lubricants.

14) Packaging Films.
15) Paint Removers.
16) Plastic Insulating Foam.
17) Pneumatic Equipment Lubricants.
18) Concrete Sealers.

E. Materials, products, and equipment being installed which fall into any of the following product categories must be Energy Star-labeled.
1. Applicable Energy Star product categories include:
a. Light Fixtures.

F. Materials, products, and equipment being installed which fall into any of the following categories must be FEMP-designated. FEMP-designated product categories include:
1. Light Emitting Diode (LED) Luminaires.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Construction Indoor Air Quality Management:
1. During construction, meet or exceed recommended control measures of ANSI/SMACNA 008-2008, Chapter 3.
2. Protect stored on-site and installed absorptive materials from moisture damage.
3. If permanently installed air handlers are used during construction, filtration media with a minimum efficiency reporting value (MERV) of 8 must be used at each return air grille, as determined by ASHRAE Standard 52.2-1999 (with errata but without addenda). Replace all filtration media immediately prior to occupancy.
4. Perform building flush-out as follows:
a. After construction ends, prior to occupancy and with interior finishes installed, perform a building flush-out by supplying a total volume of 14000 cu. ft. of outdoor air per sq. ft. of floor area while maintaining an internal temperature of at least 60 degrees Fahrenheit and a relative humidity no higher than 60 percent. OR
b. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. of outdoor air per sq. ft. of floor area to the space. Once a space is occupied, it must be ventilated at a minimum rate of 0.30 cfm per sq. ft. of outside air or design minimum outside air rate determined until a total of 14000 cu. ft./sq. ft. of outside air has been delivered to the space. During each day of flush-out period, ventilation must begin a minimum of three hours prior to occupancy and continue during occupancy.

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SECTION 02 41 00
DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies demolition and removal of portions of buildings, utilities, other structures, and debris from trash dumps shown.

1.2 RELATED WORK

A. Demolition and removal of roads, walks, curbs, and on-grade slabs outside buildings to be demolished: Section 31 20 00, EARTHWORK.

B. Safety Requirements: Section 01 35 26 Safety Requirements Article, ACCIDENT PREVENTION PLAN (APP).

C. Disconnecting utility services prior to demolition: Section 01 00 00, GENERAL REQUIREMENTS.

D. Reserved items that are to remain the property of the Government: Section 01 00 00, GENERAL REQUIREMENTS.

E. Asbestos Removal: Section 00 3110, AVAILABLE PROJECT INFORMATION.

F. Environmental Protection: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

G. Construction Waste Management: Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT.

H. Infectious Control: Section 01 35 26, SAFETY REQUIREMENTS.

1.3 PROTECTION

A. Perform demolition in such manner as to eliminate hazards to persons and property; to minimize interference with use of adjacent areas, utilities and structures or interruption of use of such utilities; and to provide free passage to and from such adjacent areas of structures. Comply with requirements of GENERAL CONDITIONS Article, ACCIDENT PREVENTION.

B. Provide safeguards, including warning signs, barricades, temporary fences, warning lights, and other similar items that are required for protection of all personnel during demolition and removal operations. Comply with requirements of Section 01 00 00, GENERAL REQUIREMENTS, Article PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES AND IMPROVEMENTS.

C. Maintain fences, barricades, lights, and other similar items around exposed excavations until such excavations have been completely filled.

D. Prevent spread of flying particles and dust. Sprinkle rubbish and debris with water to keep dust to a minimum. Do not use water if it results in hazardous or objectionable condition such as, but not limited to; ice, flooding, or pollution. Vacuum and dust the work area daily.

E. In addition to previously listed fire and safety rules to be observed in performance of work, include following:

1. No wall or part of wall shall be permitted to fall outwardly from structures.
2. Maintain stairways in each structure in usable condition to highest remaining floor. Keep stairway free of obstructions and debris.
3. Wherever a cutting torch or other equipment that might cause a fire is used, provide and maintain fire extinguishers nearby ready for immediate use. Instruct all possible users in use of fire extinguishers.
4. Keep hydrants clear and accessible at all times. Prohibit debris from accumulating within a radius of 4500 mm (15 feet) of fire hydrants.

F. Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The contractor shall take necessary precautions to avoid damages to existing items to remain in place, to be reused, or to remain the property of the Medical Center; any damaged items shall be repaired or replaced as approved by the COR. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition or removal works. Repairs, reinforcement, or structural replacement must have COR's approval.

G. The work shall comply with the requirements of Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

H. The work shall comply with the requirements of Section 01 00 00, GENERAL REQUIREMENTS and Section 01 35 26, SAFETY REQUIREMENTS.

1.4 UTILITY SERVICES

A. Demolish and remove outside utility service lines shown to be removed.

B. Remove abandoned outside utility lines that would interfere with installation of new utility lines and new construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 DEMOLITION

A. Completely demolish and remove portions of buildings and structures, including all appurtenances related or connected thereto, as noted below:

1. As required for installation of new utility service lines.
2. To full depth within an area defined by hypothetical lines located 1500 mm (5 feet) outside building lines of new structures.

B. Debris, including brick, concrete, stone, metals, and similar materials shall become property of Contractor and shall be disposed of by the Contractor daily, off the Medical Center to avoid accumulation at the demolition site. Stockpiling of materials is not permitted, except where coordinated with and approved in advance by the COR. Break up concrete slabs below grade that do not require removal from present location into pieces not exceeding 600 mm (24 inches) square to permit drainage. Contractor shall dispose debris in compliance with applicable federal, state, or local permits, rules and/or regulations.

C. Remove and legally dispose of all materials, other than earth to remain as part of project work, from any trash dumps shown. Materials removed shall become property of contractor and shall be disposed of in compliance with applicable federal, state, or local permits, rules and/or regulations. All materials in the indicated trash dump areas, including above surrounding grade and extending to a depth of 1500mm (5feet) below surrounding grade, shall be included as part of the lump sum compensation for the work of this section. Materials that are located beneath the surface of the surrounding ground more than 1500 mm (5 feet), or materials that are discovered to be hazardous, shall be handled as unforeseen. The removal of hazardous material shall be referred to Hazardous Materials specifications.

D. Remove existing utilities as indicated or uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the COR. When Utility lines are encountered that are not indicated on the drawings, the COR shall be notified prior to further work in that area.

3.2 CLEAN-UP

A. On completion of work of this section and after removal of all debris, leave site in clean condition satisfactory to COR. Clean-up shall include off the Medical Center disposal of all items and materials not required to remain property of the Government as well as all debris and rubbish resulting from demolition operations.

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SECTION 03 01 30.71
REHABILITATION OF CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes the treatment of concrete surfaces with a penetrating corrosion inhibitor to reduce the effects of corrosion in reinforced concrete.

1.2 RELATED WORK

A. Safety Requirements: GENERAL CONDITIONS Article, ACCIDENT PREVENTION.

B. Environmental Protection: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

C. Construction Waste Management: Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT.

D. Infectious Control: Section 01 00 00, GENERAL REQUIREMENTS, Article 1.7, INFECTION PREVENTION MEASURES.

E. DEMOLITION: Section 02 41 00.

F. CAST-IN-PLACE CONCRETE: Section 03 30 00.

1.3 QUALITY ASSURANCE

A. Manufacturing qualifications: The manufacturer of the specified product shall be ISO 9001 certified and have in existence a recognized ongoing quality assurance program independently audited on a regular basis.

B. Contractor qualifications: Contractor shall be qualified in the field of concrete repair and protection with 5 or more documented years of experience.

1. Contractor shall maintain qualified personnel who have received product training by a manufacturer’s representative.

C. Install materials in accordance with all safety and weather conditions required by manufacturer or as modified by applicable rules and regulations of local, state and federal authorities having jurisdiction. Consult Material Safety Data Sheets for complete handling recommendations.

D. Manufacturer must be capable of testing on-site for the presence of the corrosion inhibitor at the specified depth.

1.4 DELIVERY, STORAGE, AND HANDLING

A. All materials must be delivered in original, unopened containers with the manufacturer’s name, labels, product identification, and batch numbers. Damaged material must be removed from the site immediately.

B. Store all materials off the ground and protect from rain, freezing or excessive heat until ready for use.

C. Condition the specified product as recommended by the manufacturer.

1.5 JOB CONDITIONS

A. Environmental Conditions: Do not apply material if it is raining or snowing or if such conditions appear to be imminent.

B. Minimum application temperature: 35 degrees Fahrenheit and rising.

C. Protection: Take precautions to avoid damage to any surface near the work zone due to mixing and handling of the specified material.

1.6 SUBMITTALS

A. Submit two copies of manufacturer's literature, including product data sheets and Material safety Data Sheets (MSDS).

B. Corrosion rate field monitoring using linear polarization resistance by an independent, qualified monitoring company demonstrating an ability to reduce corrosion rates by a minimum of 65%.

C. Proof of compliance with the properties specified in Section 2.03 PERFORMANCE CRITERIA.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Penetrating corrosion inhibiting impregnation coating.

1. The material shall be an organic and inorganic in nature and environmentally safe.
2. The materials shall be water based.
3. The materials shall be not contain calcium nitrite.
4. The material shall not form a vapor barrier.
5. The material shall not be a mixed inhibitor.

B. Sika FerroGard 903: Manufactured by Sika Corporation, or equal, considered to conform to the requirements of this specification.

2.2 PERFORMANCE CRITERIA

A. Typical properties of the penetrating corrosion inhibiting impregnation coating:

1. Viscosity (Brookfield Viscometer, Spindle #1, Speed 100) 15cps.
2. Color: Pale Yellow
3. Density: 1.13 (9.4 lbs./gal.)
4. PH: 11 (+/-1)
5. Flash point: None (water-based)

B. Corrosion testing of penetrating corrosion inhibiting impregnation coating:

1. The material must form a continuous film on the reinforcing steel and displace chlorides ions from the steel surface (X-ray Photon Spectroscopy (XPS) and Secondary Ion Mass Spectroscopy (SIMS).

2. The material must penetrate independently of orientation (horizontal, vertical, overhead) at a rate up to 1/10 to 4/5 inches (2.5 to 20mm) per day, depending on density of concrete. (Secondary Neutron Mass Spectroscopy (SNMS).
3. The material must have demonstrated the reduction in corrosion currents after treatment as calculated by the Cracked Beam Corrosion Tests of concrete. (Adapted from ASTM G 109)
4. The material must form a protective layer on the reinforcing steel of high integrity measured at 100A thickness. (X-ray Photon Spectroscopy and Secondary Ion Mass Spectroscopy)
5. The material must penetrate up to three inches (76mm) in 28 days. (Secondary Neutron Mass Spectroscopy)
6. The material must be capable of reducing active corrosion rates by a minimum of 65%. This reduction shall be demonstrated by project references and an independent corrosion engineer using linear polarization resistance.

PART 3 – EXECUTION

3.1 SURFACE PREPARATION:

A. Concrete surfaces must be prepared by suitable mechanical means, by abrasive blast cleaning or high pressure water at sufficient volume and pressure to remove all surface contaminants such as oil, grease, curing membranes, efflorescence, algae, moss, dirt, etc. All loose materials and any existing coatings must be removed to provide a clean, sound, dry and absorbent surface prior to application of the corrosion inhibitor.

3.2 MIXING AND APPLICATION:

A. Apply corrosion inhibitor at a total minimum consumption rate of 200 sf/gallon/coat by brush, roller or low pressure spray in two coats (dependent on absorbency) for a total consumption of 100 sf./gallon.
   1. Note: When the corrosion inhibitor is to be applied, thoroughly wash down surfaces using clean water. Any white powdery residue must be removed by water jetting using adequate volume and pressure.
   2. Note: Best results are usually obtained by low pressure spray application.
   3. Note: Between applying the subsequent coats of the corrosion inhibitor allow the previous coats to absorb into the concrete and dry (approximately 2-6 hours minimum dependent on temperature and humidity).
   4. Note: The treated area should be protected from rain or frost for a period of at least 24 hours after application of the corrosion inhibitor.

B. Adhere to all procedures, limitations and cautions for this product in the manufacturers current printed technical data sheet and literature.

3.3 CLEANING

A. The material can be cleaned from tools with water.

B. Leave finished work and work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

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SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies cast-in-place structural concrete and materials and mixes for other concrete.

1.2 RELATED WORK

A. Section 01 45 29, TESTING LABORATORY SERVICES: Materials testing and inspection during construction.

B. Section 32 05 23, CONCRETE FOR EXTERIOR IMPROVEMENTS: Concrete walks and similar exterior site work.

1.3 TESTING AGENCY FOR CONCRETE MIX DESIGN

A. Testing agency for the trial concrete mix design retained and reimbursed by the Contractor and approved by COR. For all other testing, refer to Section 01 45 29 Testing Laboratory Services.

B. Testing agency maintaining active participation in Program of Cement and Concrete Reference Laboratory (CCRL) of National Institute of Standards and Technology.

C. Testing agency shall furnish equipment and qualified technicians to establish proportions of ingredients for concrete mixes.

1.4 TOLERANCES

A. Formwork: ACI 117, except the elevation tolerance of formed surfaces before removal of shores is +0 mm (+0 inch) and -20 mm (-3/4 inch).

B. Reinforcement Fabricating and Placing: ACI 117, except that fabrication tolerance for bar sizes Nos. 10, 13, and 16 (Nos. 3, 4, and 5) (Tolerance Symbol 1 in Fig. 2.1(a), ACI, 117) used as column ties or stirrups is +0 mm (+0 inch) and -13 mm (-1/2 inch) where gross bar length is less than 3600 mm (12 feet), or +0 mm (+0 inch) and -20 mm (-3/4 inch) where gross bar length is 3600 mm (12 feet) or more.

C. Cross-Sectional Dimension: ACI 117, except tolerance for thickness of slabs 12 inches or less is +20 mm (+3/4 inch) and - 6 mm (-1/4 inch). Tolerance of thickness of beams more than 300 mm (12 inch) but less than 900 mm (3 feet) is +20 mm (+3/4 inch) and -10 mm (-3/8 inch).

D. Slab Finishes: ACI 117, Section 4.5.6, F-number method in accordance with ASTM E1155, except as follows:

E. Test entire slab surface, including those areas within 600 mm (2 feet) of construction joints and vertical elements that project through slab surface.

F. Maximum elevation change which may occur within 600 mm (2 feet) of any column or wall element is 6 mm (0.25 inches).

G. Allow sample measurement lines that are perpendicular to construction joints to extend past joint into previous placement no further than 1500 mm (5 feet).

1.5 REGULATORY REQUIREMENTS

A. ACI SP-66 – ACI Detailing Manual.

B. ACI 318 - Building Code Requirements for Reinforced Concrete.

C. ACI 301 – Standard Specifications for Structural Concrete.

1.6 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES. All items indicated below are required submittals requiring Contracting Officer's Representative (COR) review and approval.

B. Shop Drawings: Reinforcing steel: Complete shop drawings

C. Mill Test Reports:

1. Reinforcing Steel.
2. Cement.

D. Manufacturer's Certificates:

1. Abrasive aggregate.
2. Air-entraining admixture.
3. Chemical admixtures, including chloride ion content.
4. Liquid membrane-forming compounds for curing concrete.
5. Non-shrinking grout.
6. Liquid hardener.
7. Waterstops.
8. Expansion joint filler.
9. Adhesive binder.

E. Testing Agency for Concrete Mix Design: Approval request including qualifications of principals and technicians and evidence of active participation in program of Cement and Concrete Reference Laboratory (CCRL) of National Institute of Standards and Technology.

F. Shoring and Reshoring Sequence: Submit for approval a shoring and reshoring sequence for flat slab/flat plate portions, prepared by a registered Professional Engineer. As a minimum, include timing of form stripping, reshoring, number of floors to be re-shored and timing of re-shore removal to serve as an initial outline of procedures subject to modification as construction progresses. Submit revisions to sequence, whether initiated by COR (see FORMWORK) or Contractor.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Conform to ACI 304. Store aggregate separately for each kind or grade, to prevent segregation of sizes and avoid inclusion of dirt and other materials.

B. Deliver cement in original sealed containers bearing name of brand and manufacturer, and marked with net weight of contents. Store in suitable watertight building in which floor is raised at least 300 mm (1 foot) above ground. Store bulk cement and fly ash in separate suitable bins.

C. Deliver other packaged materials for use in concrete in original sealed containers, plainly marked with manufacturer's name and brand, and protect from damage until used.

1.8 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.

B. American Concrete Institute (ACI):

117-10..... Specifications for Tolerances for Concrete Construction and Materials and Commentary

211.1-91(R2009) ..... Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

211.2-98(R2004) ..... Standard Practice for Selecting Proportions for Structural Lightweight Concrete

214R-11(R2019)..... Guide to Evaluation of Strength Test Results of Concrete

301-16..... Specifications for Structural Concrete

304R-00(R2009)..... Guide for Measuring, Mixing, Transporting, and Placing Concrete

305.1-14..... Specification for Hot Weather Concreting

306.1-90(R2002) ..... Standard Specification for Cold Weather Concreting

308.1-11..... Specification for Curing Concrete

309R-05..... Guide for Consolidation of Concrete

318/318-19..... Building Code Requirements for Structural Concrete and Commentary

347R-14..... Guide to Formwork for Concrete

SP-66-04..... ACI Detailing Manual

C. American National Standards Institute and American Hardboard Association (ANSI/AHA):

A135.4-2012 ..... Basic Hardboard

D. ASTM International (ASTM):

A615/A615M-20..... Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement

A653/A653M-20..... Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process

A706/A706M-16..... Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement

A767/A767M-19..... Standard Specification for Zinc Coated (Galvanized) Steel Bars for Concrete Reinforcement
A775/A775M-19..... Standard Specification for Epoxy Coated Steel Reinforcing Bars
A820/820M-16 ..... Standard Specification for Steel Fibers for Fiber Reinforced Concrete
A996/A996M-16..... Standard Specification for Rail Steel and Axle Steel Deformed Bars for Concrete Reinforcement
A1064/A1064M-18a..... Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
C31/C31M-19a ..... Standard Practice for Making and Curing Concrete Test Specimens in the field
C33/C33M-18 ..... Standard Specification for Concrete Aggregates
C39/C39M-20 ..... Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C94/C94M-19a ..... Standard Specification for Ready Mixed Concrete
C143/C143M-20 ..... Standard Test Method for Slump of Hydraulic Cement Concrete
C150C150M-20 ..... Standard Specification for Portland Cement
C171-16 ..... Standard Specification for Sheet Materials for Curing Concrete
C172C172M-17 ..... Standard Practice for Sampling Freshly Mixed Concrete
C173/C173M-16... ..... Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
C192/C192M-19 ..... Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
C231/C231M-17a ..... Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C260/C260M-10a(2016)Standard Specification for Air Entraining Admixtures for Concrete
C309-19 ..... Standard Specification for Liquid Membrane Forming Compounds for Curing Concrete
C330/C330M-17a ..... Standard Specification for Lightweight Aggregates for Structural Concrete
C494/C494M-19 ..... Standard Specification for Chemical Admixtures for Concrete
C666/C666M-15 ..... Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
C881/C881M-20 ..... Standard Specification for Epoxy Resin Base Bonding Systems for Concrete
C1107/1107M-20..... Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)

C1315-19 ..... Standard Specification for Liquid Membrane Forming Compounds Having Special Properties for Curing and Sealing Concrete
D6/D6M-95(2018)..... Standard Test Method for Loss on Heating of Oil and Asphaltic Compounds
D297-15(2019) ..... Standard Test Methods for Rubber Products Chemical Analysis
D412—16..... Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
D1751-18 ..... Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
D4263-83(2018) ..... Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
E1155-20 ..... Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers
F1249-20 ..... Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor
F1869-16a ..... Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

E. American Welding Society (AWS):
D1.4/D1.4M-18 ..... Structural Welding Code – Steel Reinforcing Bars

F. Concrete Reinforcing Steel Institute (CRSI):
Handbook 2008

G. National Cooperative Highway Research Program (NCHRP):
Report On ..... Concrete Sealers for the Protection of Bridge Structures

H. U. S. Department of Commerce Product Standard (PS):
PS 1-07..... Structural Plywood
PS 20-20..... American Softwood Lumber Standard

I. U. S. Army Corps of Engineers Handbook for Concrete and Cement:
CRD C513 ..... Rubber Waterstops
CRD C572 ..... Polyvinyl Chloride Waterstops

PART 2 – PRODUCTS

2.1 FORMS

A. Wood: PS 20 free from loose knots and suitable to facilitate finishing concrete surface specified; tongue and grooved.

B. Plywood: PS-1 Exterior Grade B-B (concrete-form) 16 mm (5/8 inch), or 20 mm (3/4 inch) thick for unlined contact form. B-B High Density Concrete Form Overlay optional.

C. Form Lining:

1. Hardboard: ANSI/AHA A135.4, Class 2 with one (S1S) smooth side)
2. Plywood: Grade B-B Exterior (concrete-form) not less than 6 mm (1/4 inch) thick.
3. Plastic, fiberglass, or elastomeric capable of reproducing the desired pattern or texture.

D. Form Ties: Develop a minimum working strength of 13.35 kN (3000 pounds) when fully assembled. Ties shall be adjustable in length to permit tightening of forms and not have any lugs, cones, washers to act as spreader within form, nor leave a hole larger than 20 mm (3/4 inch) diameter, or a depression in exposed concrete surface, or leave metal closer than 40 mm (1 1/2 inches) to concrete surface. Wire ties not permitted. Cutting ties back from concrete face not permitted.

2.2 MATERIALS

A. Portland Cement: ASTM C150 Type I or II.

B. Fly Ash: ASTM C618, Class C or F including supplementary optional requirements relating to reactive aggregates and alkalies, and loss on ignition (LOI) not to exceed 5 percent. Do not exceed more than 25 percent total cementitious content by weight.

C. Coarse Aggregate: ASTM C33.

1. Size 67 or Size 467 may be used for footings and walls over 300 mm (12 inches) thick.
2. Coarse aggregate for interior slabs on grade shall conform to the following:
    a. Dense or well graded aggregate.
        1) Percent retained on each sieve below the top size and above the No. 100 sieve:
            a) 8 to 18 percent for 1-1/2 inches (38 mm)top size.
            b) 8 to 22 percent for 3/4 or 1 inch (19 or 25 mm) top size.
        2) The above requirements may be deviated from based on locally available material.
            a) One or two non-adjacent sieves sizes may fall outside of the limits set above.
            b) Percent retained on two adjacent sieves sizes shall not be less than 5 percent of the above required.
            c) Percent retained on three adjacent sieve sizes shall not be less than 8 percent of the above required.
            d) When the percent retained on each of two adjacent sieve sizes is less than 8 percent the total percent retained on either of these sieves and the adjacent outside sieve should be at least 13 percent (for example, if both the No. 4 and No. 8 (4.75 and 2.36 mm)sieves have 6 percent retained on each item then: 1. the total retained on the 3/8 inch and No. 4 (9.5 and 4.75 mm) sieves should be at least 13 percent, and 2. the total retained on the No. 8 and No. 16 (2.36 and 1.18 mm) sieves should be at least 13 percent.
3. Coarse aggregate for applied topping, encasement of steel columns, and metal pan stair fill shall be Size 7.

4. Maximum size of coarse aggregates not more than one-fifth of narrowest dimension between sides of forms, one-third of depth of slabs, nor three-fourth of minimum clear spacing between reinforcing bars.

D. Lightweight Aggregates for Structural Concrete: ASTM C330, Table 1. Maximum size of aggregate not larger than one-fifth of narrowest dimension between forms, nor three-fourth of minimum clear distance between reinforcing bars. Contractor to furnish certified report to verify that aggregate is sound and durable, and has a durability factor of not less than 80 based on 300 cycles of freezing and thawing when tested in accordance with ASTM C666.

E. Fine Aggregate: ASTM C33. Fine aggregate for applied concrete floor topping shall pass a 4.75 mm (No. 4) sieve, 10 percent maximum shall pass a 150 µm (No. 100) sieve.

F. Mixing Water: Fresh, clean, and potable.

G. Admixtures:

1. Water Reducing Admixture: ASTM C494, Type A and not contain more chloride ions than are present in municipal drinking water.
2. Water Reducing, Retarding Admixture: ASTM C494, Type D and not contain more chloride ions than are present in municipal drinking water.
3. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C494, Type F or G, and not contain more chloride ions than are present in municipal drinking water. Use of superplasticizer requires COR approval.
4. Non-Corrosive, Non-Chloride Accelerator: ASTM C494, Type C or E, and not contain more chloride ions than are present in municipal drinking water. Admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory of at least one year duration using an acceptable accelerated corrosion test method such as that using electrical potential measures.
5. Air Entraining Admixture: ASTM C260.
6. Microsilica: Use only with prior review and acceptance of the COR. Use only in conjunction with high range water reducer.
7. Calcium Nitrite corrosion inhibitor: ASTM C494 Type C.
8. Prohibited Admixtures: Calcium chloride, thiocyanate or admixtures containing more than 0.05 percent chloride ions are not permitted.
9. Certification: Written conformance to the requirements above and the chloride ion content of the admixture prior to mix design review.

H. Vapor Barrier: ASTM F1249, 0.25 mm (10 mil) WVT 0.012 foot/hr.

I. Reinforcing Steel: ASTM A615, or ASTM A996, deformed, grade as shown.

J. Welded Wire Fabric: ASTM A185.

K. Epoxy Coated Reinforcing Bars: ASTM A775.

L. Supports, Spacers, and Chairs: Types which will hold reinforcement in position shown in accordance with requirements of ACI 318 except as specified.

M. Expansion Joint Filler: ASTM D1751.

N. Sheet Materials for Curing Concrete: ASTM C171.

O. Liquid Membrane-forming Compounds for Curing Concrete: ASTM C309, Type I, with fugitive dye, and shall meet the requirements of ASTM C1315.Compound shall be compatible with scheduled surface treatment, such as paint and resilient tile, and shall not discolor concrete surface.

P. Abrasive Aggregate: Aluminum oxide grains or emery grits.

Q. Liquid Hardener and Dustproofer: Fluosilicate solution of magnesium fluosilicate or zinc fluosilicate. Magnesium and zinc may be used separately or in combination as recommended by manufacturer. Use only on exposed slab. Do not use where floor is covered with resilient flooring, paint or other finish coating.

R. Moisture Vapor Emissions & Alkalinity Control Sealer: 100 percent active colorless aqueous siliconate solution concrete surface.

1. ASTM C1315 Type 1 Class A, and ASTM C309 Type 1 Class A, penetrating product to have no less than 34 percent solid content, leaving no sheen, volatile organic compound (VOC) content rating as required to suite regulatory requirements. The product shall have at least a five (5) year documented history in controlling moisture vapor emission from damaging floor covering, compatible with all finish materials.
2. MVE 15-Year Warranty:
    a. When a floor covering is installed on a below grade, on grade, or above grade concrete slab treated with Moisture Vapor Emissions & Alkalinity Control Sealer according to manufacturer’s instruction, sealer manufacturer shall warrant the floor covering system against failure due to moisture vapor migration or moisture-born contaminates for a period of fifteen (15) years from the date of original installation. The warranty shall cover all labor and materials needed to replace all floor covering that fails due to moisture vapor emission & moisture born contaminates.

S. Penetrating Sealer: For use on parking garage ramps and decks. High penetration silane sealer providing minimum 95 percent screening per National Cooperative Highway Research Program (NCHRP) No. 244 standards for chloride ion penetration resistance. Requires moist (non-membrane) curing of slab.

T. Non-Shrink Grout:

1. ASTM C1107, pre-mixed, produce a compressive strength of at least 18 MPa at three days and 35 MPa (5000 psi) at 28 days. Furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95 percent bearing under a 1200 mm x 1200 mm (4 foot by 4 foot) base plate.

2. Where high fluidity or increased placing time is required, furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95 percent under an 450 mm x 900 mm (18 inch by 36 inch) base plate.

U. Adhesive Binder: ASTM C881.

V. Waterstops:

1. Polyvinyl Chloride Waterstop: CRD C572.
2. Rubber Waterstops: CRD C513.
3. Bentonite Waterstop: Flexible strip of bentonite 25 mm x 20 mm (1 inch by 3/4 inch), weighing 8.7 kg/m (5.85 pounds per foot) composed of Butyl Rubber Hydrocarbon (ASTM D297), Bentonite (SS-S-210-A) and Volatile Matter (ASTM D6).
4. Non-Metallic Hydrophilic: Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water shall conform to ASTM D412 as follows: Tensile strength 420 psi minimum; ultimate elongation 600 percent minimum. Hardness shall be 50 minimum on the type A durameter and the volumetric expansion ratio in in 70 deg water shall be 3 to 1 minimum.

W. Porous Backfill: Crushed stone or gravel graded from 25 mm to 20 mm (1 inch to 3/4 inch).

X. Fibers:

1. Synthetic Fibers: Monofilament or fibrillated polypropylene fibers for secondary reinforcing of concrete members. Use appropriate length and 0.9 kg/m3 (1.5 lb. per cubic yard). Product shall have a UL rating.

Y. Epoxy Joint Filler: Two component, 100 percent solids compound, with a minimum shore D hardness of 50.

Z. Bonding Admixture: Non-rewettable, polymer modified, bonding compound.

AA. Access Cover, Frame, and Accessories – Sealed Salt Hatch Lid:

1. 24” diameter black flat sealed composite cover with composite frame.
2. Load rating = 56,000 lbs.
3. Lifting handle with foot pedal.
4. Lifting handle storage cabinet.
5. 12 rubber key housing plugs.
6. USFL600 composite cover as manufactured by Fibrelite shall be considered an acceptable product.

BB. Fiber reinforced polymer (FRP) structural reinforcement and strengthening shall be as indicated on Drawings, as manufactured by Simpson Strong Tie or approved equal.

2.3 CONCRETE MIXES

A. Mix Designs: Proportioned in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318.
   1. If trial mixes are used, make a set of at least 6 cylinders in accordance with ASTM C192 for test purposes from each trial mix; test three for compressive strength at 7 days and three at 28 days.
   2. Submit a report of results of each test series, include a detailed listing of the proportions of trial mix or mixes, including cement, fly ash, admixtures, weight of fine and coarse aggregate per m3 (cubic yard) measured dry rodded and damp loose, specific gravity, fineness modulus, percentage of moisture, air content, water-cement-fly ash ratio, and consistency of each cylinder in terms of slump. Include dry unit weight of lightweight structural concrete.
   3. Prepare a curve showing relationship between water-cement-fly ash ratio at 7-day and 28-day compressive strengths. Plot each curve using at least three specimens.
   4. If the field experience method is used, submit complete standard deviation analysis.

B. Fly Ash Testing: Submit certificate verifying conformance with ASTM 618 initially with mix design and for each truck load of fly ash delivered from source. Submit test results performed within 6 months of submittal date. Notify the COR immediately when change in source is anticipated.
   1. Testing Laboratory used for fly ash certification/testing shall participate in the Cement and Concrete Reference Laboratory (CCRL) program. Submit most recent CCRL inspection report.

C. After approval of mixes no substitution in material or change in proportions of approval mixes may be made without additional tests and approval of the COR or as specified. Making and testing of preliminary test cylinders may be carried on pending approval of cement and fly ash, providing Contractor and manufacturer certify that ingredients used in making test cylinders are the same. The COR may allow Contractor to proceed with depositing concrete for certain portions of work, pending final approval of cement and fly ash and approval of design mix.

D. Cement Factor: Maintain minimum cement factors in Table I regardless of compressive strength developed above minimums. Use Fly Ash as an admixture with maximum of 25 percent replacement by weight in all structural work. Increase this replacement to 40 percent for mass concrete, and reduce it to 10 percent for drilled piers and caissons. Fly ash shall not be used in high-early mix design.

TABLE I - CEMENT AND WATER FACTORS FOR CONCRETE

Concrete Strength		Non-Air-Entrained	Air-Entrained	
Min. 28 Day Comp. Str. MPa (psi)	Min. Cement kg/m3 (lbs/c. yd)	Max. Water Cement Ratio	Min. Cement kg/m3 (lbs/c. yd)	Max. Water Cement Ratio
35 (5000)1,3	375 (630)	0.45	385 (650)	0.40
30 (4000)1,3	325 (550)	0.55	340 (570)	0.50
25 (3000)1,3	280 (470)	0.65	290 (490)	0.55
25 (3000)1,2	300 (500)	See 4 below	310 (520)	See 4 below

1. If trial mixes are used, the proposed mix design shall achieve a compressive strength 8.3 MPa (1200 psi) in excess of f'c. For concrete strengths above 35 Mpa (5000 psi), the proposed mix design shall achieve a compressive strength 9.7 MPa (1400 psi) in excess of f'c.
2. Lightweight Structural Concrete. Pump mixes may require higher cement values.
3. For concrete exposed to high sulfate content soils maximum water cement ratio is 0.44.
4. Determined by Laboratory in accordance with ACI 211.1 for normal concrete or ACI 211.2 for lightweight structural concrete.

E. Maximum Slump: Maximum slump, as determined by ASTM C143 with tolerances as established by ASTM C94, for concrete to be vibrated shall be as shown in Table II.

TABLE II - MAXIMUM SLUMP, MM (INCHES)

Type of Construction	Normal Weight Concrete	
Reinforced Footings and Substructure Walls	75mm (3 inches)	
Slabs, Beams, Reinforced Walls, and Columns	100 mm (4 inches)	

F. Slump may be increased by the use of the approved high-range water-reducing admixture (superplasticizer). Tolerances as established by ASTM C94. Concrete containing the high-range-water-reducing admixture may have a maximum slump of 225 mm (9 inches). The concrete shall arrive at the job site at a slump of 50 mm to 75 mm (2 inches to 3 inches), and 75 mm to 100 mm (3 inches to 4 inches) for lightweight concrete. This should be verified, and then the high-range-water-reducing admixture added to increase the slump to the approved level.

G. Air-Entrainment: Air-entrainment of normal weight concrete shall conform with Table III. Air-entrainment of lightweight structural concrete shall conform with Table IV. Determine air content by either ASTM C173 or ASTM C231.

**TABLE III - TOTAL AIR CONTENT
FOR VARIOUS SIZES OF COARSE AGGREGATES (NORMAL CONCRETE)**

Nominal Maximum Size of Total Air Content	Coarse Aggregate, mm (Inches) Percentage by Volume
10 mm (3/8 in).6 to 10	13 mm (1/2 in).5 to 9
20 mm (3/4 in).4 to 8	25 mm (1 in).3-1/2 to 6-1/2
40 mm (1 1/2 in).3 to 6	

**TABLE IV
AIR CONTENT OF LIGHTWEIGHT STRUCTURAL CONCRETE**

Nominal Maximum size of Total Air Content	Coarse Aggregate, mm's (Inches) Percentage by Volume
Greater than 10 mm (3/8 in) 4 to 8	10 mm (3/8 in) or less 5 to 9

H. High early strength concrete, made with Type III cement or Type I cement plus non-corrosive accelerator, shall have a 7-day compressive strength equal to specified minimum 28-day compressive strength for concrete type specified made with standard Portland cement.

I. Concrete slabs placed at air temperatures below 10 degrees C (50 degrees Fahrenheit) use non-corrosive, non-chloride accelerator. Concrete required to be air entrained use approved air entraining admixture. Pumped concrete, synthetic fiber concrete, architectural concrete, concrete required to be watertight, and concrete with a water/cement ratio below 0.50 use high-range water-reducing admixture (superplasticizer).

J. Durability: Use air entrainment for exterior exposed concrete subjected to freezing and thawing and other concrete shown or specified. For air content requirements see Table III or Table IV.

K. Enforcing Strength Requirements: Test as specified in Section 01 45 29, TESTING LABORATORY SERVICES, during the progress of the work. Seven-day tests may be used as indicators of 28-day strength. Average of any three 28-day consecutive strength tests of laboratory-cured specimens representing each type of concrete shall be equal to or greater than specified strength. No single test shall be more than 3.5 MPa (500 psi) below specified strength. Interpret field test results in accordance with ACI 214. Should strengths shown by test specimens fall below required values, the COR may require any one or any combination of the following corrective actions, at no additional cost to the Government:

1. Require changes in mix proportions by selecting one of the other appropriate trial mixes or changing proportions, including cement content, of approved trial mix.
2. Require additional curing and protection.

3. If five consecutive tests fall below 95 percent of minimum values given in Table I or if test results are so low as to raise a question as to the safety of the structure, the COR may direct Contractor to take cores from portions of the structure. Use results from cores tested by the Contractor retained testing agency to analyze structure.
4. If strength of core drilled specimens falls below 85 percent of minimum value given in Table I, the COR may order load tests, made by Contractor retained testing agency, on portions of building so affected. Load tests in accordance with ACI 318 and criteria of acceptability of concrete under test as given therein.
5. Concrete work, judged inadequate by structural analysis, by results of load test, or for any reason, shall be reinforced with additional construction or replaced, if directed by the COR.

2.4 BATCHING AND MIXING

A. General: Concrete shall be "Ready-Mixed" and comply with ACI 318 and ASTM C94, except as specified. Batch mixing at the site is permitted. Mixing process and equipment must be approved by the COR. With each batch of concrete, furnish certified delivery tickets listing information in Paragraph 16.1 and 16.2 of ASTM C94. Maximum delivery temperature of concrete is 38 degrees C (100 degrees Fahrenheit). Minimum delivery temperature as follows:

Atmospheric Temperature	Minimum Concrete Temperature
-1. degrees to 4.4 degrees C (30 degrees to 40 degrees F)	15.6 degrees C (60 degrees F.)
-17 degrees C to -1.1 degrees C (0 degrees to 30 degrees F.)	21 degrees C (70 degrees F.)

1. Services of aggregate manufacturer's representative shall be furnished during the design of trial mixes and as requested by the COR for consultation during batching, mixing, and placing operations of lightweight structural concrete. Services will be required until field controls indicate that concrete of required quality is being furnished. Representative shall be thoroughly familiar with the structural lightweight aggregate, adjustment and control of mixes to produce concrete of required quality. Representative shall assist and advise the COR.

PART 3 – EXECUTION

3.1 FORMWORK

A. General: Design in accordance with ACI 347 is the responsibility of the Contractor. The Contractor shall retain a registered Professional Engineer to design the formwork, shores, and reshores.

1. Form boards and plywood forms may be reused for contact surfaces of exposed concrete only if thoroughly cleaned, patched, and repaired and the COR approves their reuse.
2. Provide forms for concrete footings unless the COR determines forms are not necessary.
3. Corrugated fiberboard forms: Place forms on a smooth firm bed, set tight, with no buckled cartons to prevent horizontal displacement, and in a dry condition when concrete is placed.

B. Treating and Wetting: Treat or wet contact forms as follows:
1. Coat plywood and board forms with non-staining form sealer. In hot weather, cool forms by wetting with cool water just before concrete is placed.
2. Clean and coat removable metal forms with light form oil before reinforcement is placed. In hot weather, cool metal forms by thoroughly wetting with water just before placing concrete.
3. Use sealer on reused plywood forms as specified for new material.

C. Size and Spacing of Studs: Size and space studs, wales and other framing members for wall forms so as not to exceed safe working stress of kind of lumber used nor to develop deflection greater than 1/270 of free span of member.

D. Unlined Forms: Use plywood forms to obtain a smooth finish for concrete surfaces. Tightly butt edges of sheets to prevent leakage. Back up all vertical joints solidly and nail edges of adjacent sheets to same stud with 6d box nails spaced not over 150 mm (6 inches) apart.

E. Lined Forms: May be used in lieu of unlined plywood forms. Back up form lining solidly with square edge board lumber securely nailed to studs with all edges in close contact to prevent bulging of lining. No joints in lining and backing may coincide. Nail abutted edges of sheets to same backing board. Nail lining at not over 200 mm (8 inches) on center along edges and with at least one nail to each square foot of surface area; nails to be 3d blued shingle or similar nails with thin flatheads.

F. Architectural Liner: Attach liner as recommended by the manufacturer with tight joints to prevent leakage.

G. Wall Form Ties: Locate wall form ties in symmetrically level horizontal rows at each line of wales and in plumb vertical tiers. Space ties to maintain true, plumb surfaces. Provide one row of ties within 150 mm (6 inches) above each construction joint. Space through-ties adjacent to horizontal and vertical construction joints not over 450 mm (18 inches) on center.
1. Tighten row of ties at bottom of form just before placing concrete and, if necessary, during placing of concrete to prevent seepage of concrete and to obtain a clean line. Ties to be entirely removed shall be loosened 24 hours after concrete is placed and shall be pulled from least important face when removed.
2. Coat surfaces of all metal that is to be removed with paraffin, cup grease or a suitable compound to facilitate removal.

H. Inserts, Sleeves, and Similar Items: Flashing reglets, steel strips, masonry ties, anchors, wood blocks, nailing strips, grounds, inserts, wire hangers, sleeves, drains, guard angles, forms for floor hinge boxes, inserts or bond blocks for elevator guide rails and supports, and other items specified as furnished under this and other sections of specifications and required to be in their final position at time concrete is placed shall be properly located, accurately positioned, and built into construction, and maintained securely in place.

1. Locate inserts or hanger wires for furred and suspended ceilings only in bottom of concrete joists, or similar concrete member of overhead concrete joist construction.
2. Install sleeves, inserts and similar items for mechanical services in accordance with drawings prepared specially for mechanical services. Contractor is responsible for accuracy and completeness of drawings and shall coordinate requirements for mechanical services and equipment.
3. Do not install sleeves in beams, joists or columns except where shown or permitted by the COR. Install sleeves in beams, joists, or columns that are not shown, but are permitted by the COR, and require no structural changes, at no additional cost to the Government.
4. Minimum clear distance of embedded items such as conduit and pipe is at least three times diameter of conduit or pipe, except at stub-ups and other similar locations.
5. Provide recesses and blockouts in floor slabs for door closers and other hardware as necessary in accordance with manufacturer's instructions.

I. Construction Tolerances:

1. Set and maintain concrete formwork to assure erection of completed work within tolerances specified and to accommodate installation of other rough and finish materials. Accomplish remedial work necessary for correcting excessive tolerances. Erected work that exceeds specified tolerance limits shall be remedied or removed and replaced, at no additional cost to the Government.
2. Permissible surface irregularities for various classes of materials are defined as "finishes" in specification sections covering individual materials. They are to be distinguished from tolerances specified which are applicable to surface irregularities of structural elements.

3.2 PLACING REINFORCEMENT

A. General: Details of concrete reinforcement in accordance with ACI 318 unless otherwise shown.

B. Placing: Place reinforcement conforming to CRSI DA4, unless otherwise shown.

1. Place reinforcing bars accurately and tie securely at intersections and splices with 1.6 mm (16 gauge) black annealed wire. Use epoxy-coated tie wire with epoxy-coated reinforcing. Secure reinforcing bars against displacement during the placing of concrete by spacers, chairs, or other similar supports. Portions of supports, spacers, and chairs in

contact with formwork shall be made of plastic in areas that will be exposed when building is occupied. Type, number, and spacing of supports conform to ACI 318. Where concrete slabs are placed on ground, use concrete blocks or other non-corrodible material of proper height, for support of reinforcement. Use of brick or stone supports will not be permitted.

2. Lap welded wire fabric at least 1 1/2 mesh panels plus end extension of wires not less than 300 mm (12 inches) in structural slabs. Lap welded wire fabric at least 1/2 mesh panels plus end extension of wires not less than 150 mm (6 inches) in slabs on grade.
3. Splice column steel at no points other than at footings and floor levels unless otherwise shown.

C. Spacing: Minimum clear distances between parallel bars, except in columns and multiple layers of bars in beams shall be equal to nominal diameter of bars. Minimum clear spacing is 25 mm (1 inch) or 1-1/3 times maximum size of coarse aggregate.

D. Splicing: Splices of reinforcement made only as required or shown or specified. Accomplish splicing as follows:

1. Lap splices: Do not use lap splices for bars larger than Number 36 (Number 11). Minimum lengths of lap as shown.
2. Welded splices: Splicing by butt-welding of reinforcement permitted providing the weld develops in tension at least 125 percent of the yield strength (fy) for the bars. Welding conform to the requirements of AWS D1.4. Welded reinforcing steel conform to the chemical analysis requirements of AWS D1.4.
    a. Submit test reports indicating the chemical analysis to establish weldability of reinforcing steel.
    b. Submit a field quality control procedure to insure proper inspection, materials and welding procedure for welded splices.
    c. Department of Veterans Affairs retained testing agency shall test a minimum of three splices, for compliance, locations selected by the COR.
3. Mechanical Splices: Develop in tension and compression at least 125 percent of the yield strength (fy) of the bars. Stresses of transition splices between two reinforcing bar sizes based on area of smaller bar. Provide mechanical splices at locations indicated. Use approved exothermic, tapered threaded coupling, or swaged and threaded sleeve. Exposed threads and swaging in the field not permitted.
    a. Initial qualification: In the presence of the COR, make three test mechanical splices of each bar size proposed to be spliced. Department of Veterans Affairs retained testing laboratory will perform load test.

b. During installation: Furnish, at no additional cost to the Government, one companion (sister) splice for every 50 splices for load testing. Department of Veterans Affairs retained testing laboratory will perform the load test.

E. Bending: Bend bars cold, unless otherwise approved. Do not field bend bars partially embedded in concrete, except when approved by the COR.

F. Cleaning: Metal reinforcement, at time concrete is placed, shall be free from loose flaky rust, mud, oil, or similar coatings that will reduce bond.

G. Future Bonding: Protect exposed reinforcement bars intended for bonding with future work by wrapping with felt and coating felt with a bituminous compound unless otherwise shown.

3.3 VAPOR BARRIER

A. Except where membrane waterproofing is required, interior concrete slab on grade shall be placed on a continuous vapor barrier.

1. Place 100 mm (4 inches) of fine granular fill over the vapor barrier to act as a blotter for concrete slab.
2. Vapor barrier joints lapped 150 mm (6 inches) and sealed with compatible waterproof pressure-sensitive tape.
3. Patch punctures and tears.

3.4 CONSTRUCTION JOINTS

A. Unless otherwise shown, location of construction joints to limit individual placement shall not exceed 24,000 mm (80 feet) in any horizontal direction, except slabs on grade which shall have construction joints shown. Allow 48 hours to elapse between pouring adjacent sections unless this requirement is waived by the COR.

B. Locate construction joints in suspended floors near the quarter-point of spans for slabs, beams or girders, unless a beam intersects a girder at center, in which case joint in girder shall be offset a distance equal to twice width of beam. Provide keys and inclined dowels as shown. Provide longitudinal keys as shown.

C. Place concrete for columns slowly and in one operation between joints. Install joints in concrete columns at underside of deepest beam or girder framing into column.

D. Allow 2 hours to elapse after column is cast before concrete of supported beam, girder or slab is placed. Place girders, beams, grade beams, column capitals, brackets, and haunches at the same time as slab unless otherwise shown.

E. Install polyvinyl chloride or rubber water seals, as shown in accordance with manufacturer's instructions, to form continuous watertight seal.

3.5 EXPANSION JOINTS AND CONTRACTION JOINTS

A. Clean expansion joint surfaces before installing premolded filler and placing adjacent concrete.

B. Install polyvinyl chloride or rubber water seals, as shown in accordance with manufacturer's instructions, to form continuous watertight seal.

C. Provide contraction (control) joints in floor slabs as indicated on the contract drawings. Joints shall be either formed or saw cut, to the indicated depth after the surface has been finished. Complete saw joints within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.6 PLACING CONCRETE

A. Preparation:
   1. Remove hardened concrete, wood chips, shavings and other debris from forms.
   2. Remove hardened concrete and foreign materials from interior surfaces of mixing and conveying equipment.
   3. Have forms and reinforcement inspected and approved by the COR before depositing concrete.
   4. Provide runways for wheeling equipment to convey concrete to point of deposit. Keep equipment on runways which are not supported by or bear on reinforcement. Provide similar runways for protection of vapor barrier on coarse fill.

B. Bonding: Before depositing new concrete on or against concrete which has been set, thoroughly roughen and clean existing surfaces of laitance, foreign matter, and loose particles.
   1. Preparing surface for applied topping:
      a. Remove laitance, mortar, oil, grease, paint, or other foreign material by sand blasting. Clean with vacuum type equipment to remove sand and other loose material.
      b. Broom clean and keep base slab wet for at least four hours before topping is applied.
      c. Use a thin coat of one part Portland cement, 1.5 parts fine sand, bonding admixture; and water at a 50: 50 ratio and mix to achieve the consistency of thick paint. Apply to a damp base slab by scrubbing with a stiff fiber brush. New concrete shall be placed while the bonding grout is still tacky.

C. Conveying Concrete: Convey concrete from mixer to final place of deposit by a method which will prevent segregation. Method of conveying concrete is subject to approval of the COR.

D. Placing: For special requirements see Paragraphs, HOT WEATHER and COLD WEATHER.
   1. Do not place concrete when weather conditions prevent proper placement and consolidation, or when concrete has attained its initial set, or has contained its water or cement content more than 1 1/2 hours.
   2. Deposit concrete in forms as near as practicable in its final position. Prevent splashing of forms or reinforcement with concrete in advance of placing concrete.
   3. Do not drop concrete freely more than 3000 mm (10 feet) for concrete containing the high-range water-reducing admixture (superplasticizer) or 1500 mm (5 feet) for

conventional concrete. Where greater drops are required, use a tremie or flexible spout (canvas elephant trunk), attached to a suitable hopper.

4. Discharge contents of tremies or flexible spouts in horizontal layers not exceeding 500 mm (20 inches) in thickness, and space tremies such as to provide a minimum of lateral movement of concrete.
5. Continuously place concrete until an entire unit between construction joints is placed. Rate and method of placing concrete shall be such that no concrete between construction joints will be deposited upon or against partly set concrete, after its initial set has taken place, or after 45 minutes of elapsed time during concrete placement.
6. On bottom of members with severe congestion of reinforcement, deposit 25 mm (1 inch) layer of flowing concrete containing the specified high-range water-reducing admixture (superplasticizer). Successive concrete lifts may be a continuation of this concrete or concrete with a conventional slump.

E. Consolidation: Conform to ACI 309. Immediately after depositing, spade concrete next to forms, work around reinforcement and into angles of forms, tamp lightly by hand, and compact with mechanical vibrator applied directly into concrete at approximately 450 mm (18 inch) intervals. Mechanical vibrator shall be power driven, hand operated type with minimum frequency of 5000 cycles per minute having an intensity sufficient to cause flow or settlement of concrete into place. Vibrate concrete to produce thorough compaction, complete embedment of reinforcement and concrete of uniform and maximum density without segregation of mix. Do not transport concrete in forms by vibration.

1. Use of form vibration shall be approved only when concrete sections are too thin or too inaccessible for use of internal vibration.
2. Carry on vibration continuously with placing of concrete. Do not insert vibrator into concrete that has begun to set.

3.7 HOT WEATHER

A. Follow the recommendations of ACI 305 or as specified to prevent problems in the manufacturing, placing, and curing of concrete that can adversely affect the properties and serviceability of the hardened concrete. Methods proposed for cooling materials and arrangements for protecting concrete shall be made in advance of concrete placement and approved by the COR.

3.8 COLD WEATHER

A. Follow the recommendations of ACI 306 or as specified to prevent freezing of concrete and to permit concrete to gain strength properly. Use only the specified non-corrosive, non-chloride accelerator. Do not use calcium chloride, thiocyantes or admixtures containing more than 0.05 percent chloride ions. Methods proposed for heating materials and arrangements for

protecting concrete shall be made in advance of concrete placement and approved by the COR.

3.9 PROTECTION AND CURING

A. Conform to ACI 308: Initial curing shall immediately follow the finishing operation. Protect exposed surfaces of concrete from premature drying, wash by rain and running water, wind, mechanical injury, and excessively hot or cold temperatures. Keep concrete not covered with membrane or other curing material continuously wet for at least 7 days after placing, except wet curing period for high-early-strength concrete shall be not less than 3 days. Keep wood forms continuously wet to prevent moisture loss until forms are removed. Cure exposed concrete surfaces as described below. Other curing methods may be used if approved by the COR.

1. Liquid curing and sealing compounds: Apply by power-driven spray or roller in accordance with the manufacturer's instructions. Apply immediately after finishing. Maximum coverage 10m2/L (400 square feet per gallon) on steel troweled surfaces and 7.5m2/L (300 square feet per gallon) on floated or broomed surfaces for the curing/sealing compound.
2. Plastic sheets: Apply as soon as concrete has hardened sufficiently to prevent surface damage. Utilize widest practical width sheet and overlap adjacent sheets 50 mm (2 inches). Tightly seal joints with tape.
3. Paper: Utilize widest practical width paper and overlap adjacent sheets 50 mm (2 inches). Tightly seal joints with sand, wood planks, pressure-sensitive tape, mastic or glue.

3.10 REMOVAL OF FORMS

A. Remove in a manner to assure complete safety of structure after the following conditions have been met.

1. Where structure as a whole is supported on shores, forms for beams and girder sides, columns, and similar vertical structural members may be removed after 24 hours, provided concrete has hardened sufficiently to prevent surface damage and curing is continued without any lapse in time as specified for exposed surfaces.
2. Take particular care in removing forms of architectural exposed concrete to insure surfaces are not marred or gouged, and that corners and arises are true, sharp and unbroken.

B. Control Test: Use to determine if the concrete has attained sufficient strength and curing to permit removal of supporting forms. Cylinders required for control tests taken in accordance with ASTM C172, molded in accordance with ASTM C31, and tested in accordance with ASTM C39. Control cylinders cured and protected in the same manner as the structure they represent. Supporting forms or shoring not removed until strength of control test cylinders have attained at least 70 percent of minimum 28-day compressive strength specified.

Exercise care to assure that newly unsupported portions of structure are not subjected to heavy construction or material loading.

3.11 CONCRETE SURFACE PREPARATION

A. Metal Removal: Unnecessary metal items cut back flush with face of concrete members.

B. Patching: Maintain curing and start patching as soon as forms are removed. Do not apply curing compounds to concrete surfaces requiring patching until patching is completed. Use cement mortar for patching of same composition as that used in concrete. Use white or gray Portland cement as necessary to obtain finish color matching surrounding concrete. Thoroughly clean areas to be patched. Cut out honeycombed or otherwise defective areas to solid concrete to a depth of not less than 25 mm (1 inch). Cut edge perpendicular to surface of concrete. Saturate with water area to be patched, and at least 150 mm (6 inches) surrounding before placing patching mortar. Give area to be patched a brush coat of cement grout followed immediately by patching mortar. Cement grout composed of one part Portland cement, 1.5 parts fine sand, bonding admixture, and water at a 50:50 ratio, mix to achieve consistency of thick paint. Mix patching mortar approximately 1 hour before placing and remix occasionally during this period without addition of water. Compact mortar into place and screed slightly higher than surrounding surface. After initial shrinkage has occurred, finish to match color and texture of adjoining surfaces. Cure patches as specified for other concrete. Fill form tie holes which extend entirely through walls from unexposed face by means of a pressure gun or other suitable device to force mortar through wall. Wipe excess mortar off exposed face with a cloth.

C. Upon removal of forms, clean vertical concrete surface that is to receive bonded applied cementitious application with wire brushes or by sand blasting to remove unset material, laitance, and loose particles to expose aggregates to provide a clean, firm, granular surface for bond of applied finish.

3.12 CONCRETE FINISHES

A. Vertical and Overhead Surface Finishes:

1. Unfinished areas: Vertical and overhead concrete surfaces exposed in pipe basements, pipe spaces, pipe trenches, above suspended ceilings, manholes, and other unfinished areas will not require additional finishing.
2. Interior and exterior exposed areas to be painted: Remove fins, burrs and similar projections on surfaces flush, and smooth by mechanical means approved by the COR, and by rubbing lightly with a fine abrasive stone or hone. Use ample water during rubbing without working up a lather of mortar or changing texture of concrete.
3. Interior and exterior exposed areas finished: Give a grout finish of uniform color and smooth finish treated as follows:

a. After concrete has hardened and laitance, fins and burrs removed, scrub concrete with wire brushes. Clean stained concrete surfaces by use of a hone stone.
b. Apply grout composed of one part of Portland cement, one part fine sand, smaller than a 600 µm (No. 30) sieve. Work grout into surface of concrete with cork floats or fiber brushes until all pits, and honeycombs are filled.
c. After grout has hardened slightly, but while still plastic, scrape grout off with a sponge rubber float and, about 1 hour later, rub concrete vigorously with burlap to remove any excess grout remaining on surfaces.
d. In hot, dry weather use a fog spray to keep grout wet during setting period. Complete finish of area in same day. Make limits of finished areas at natural breaks in wall surface. Leave no grout on concrete surface overnight.

4. Textured: Finish as specified. Maximum quantity of patched area 0.2 m2 (2 square feet) in each 93 m2 (1000 square feet) of textured surface.

B. Slab Finishes:

1. Monitoring and Adjustment: Provide continuous cycle of placement, measurement, evaluation and adjustment of procedures to produce slabs within specified tolerances. Monitor elevations of structural steel in key locations before and after concrete placement to establish typical deflection patterns for the structural steel. Determine elevations of cast-in-place slab soffits prior to removal of shores. Provide information to the COR and floor consultant for evaluation and recommendations for subsequent placements.
2. Set perimeter forms to serve as screed using either optical or laser instruments. For slabs on grade, wet screeds may be used to establish initial grade during strike-off, unless the COR determines that the method is proving insufficient to meet required finish tolerances and directs use of rigid screed guides. Where wet screeds are allowed, they shall be placed using grade stakes set by optical or laser instruments. Use rigid screed guides, as opposed to wet screeds, to control strike-off elevation for all types of elevated (non slab-on-grade) slabs. Divide bays into halves or thirds by hard screeds. Adjust as necessary where monitoring of previous placements indicates unshored structural steel deflections to other than a level profile.
3. Place slabs monolithically. Once slab placement commences, complete finishing operations within same day. Slope finished slab to floor drains where they occur, whether shown or not.
4. Use straightedges specifically made for screeding, such as hollow magnesium straightedges or power strike-offs. Do not use pieces of dimensioned lumber. Strike off and screed slab to a true surface at required elevations. Use optical or laser instruments to check concrete finished surface grade after strike-off. Repeat strike-off as necessary.

Complete screeding before any excess moisture or bleeding water is present on surface. Do not sprinkle dry cement on the surface.

5. Immediately following screeding, and before any bleed water appears, use a 3000 mm (10 foot) wide highway straightedge in a cutting and filling operation to achieve surface flatness. Do not use bull floats or darbys, except that darbying may be allowed for narrow slabs and restricted spaces.
6. Wait until water sheen disappears and surface stiffens before proceeding further. Do not perform subsequent operations until concrete will sustain foot pressure with maximum of 6 mm (1/4 inch) indentation.
7. Scratch Finish: Finish base slab to receive a bonded applied cementitious application as indicated above, except that bull floats and darbys may be used. Thoroughly coarse wire broom within two hours after placing to roughen slab surface to insure a permanent bond between base slab and applied materials.
8. Float Finish: Slabs to receive unbonded toppings, steel trowel finish, fill, mortar setting beds, or a built-up roof, and ramps, stair treads, platforms (interior and exterior), and equipment pads shall be floated to a smooth, dense uniform, sandy textured finish. During floating, while surface is still soft, check surface for flatness using a 3000 mm (10 foot) highway straightedge. Correct high spots by cutting down and correct low spots by filling in with material of same composition as floor finish. Remove any surface projections and re-float to a uniform texture.
9. Steel Trowel Finish: Concrete surfaces to receive resilient floor covering or carpet, monolithic floor slabs to be exposed to view in finished work, future floor roof slabs, applied toppings, and other interior surfaces for which no other finish is indicated. Steel trowel immediately following floating. During final troweling, tilt steel trowel at a slight angle and exert heavy pressure to compact cement paste and form a dense, smooth surface. Finished surface shall be smooth, free of trowel marks, and uniform in texture and appearance.
10. Broom Finish: Finish exterior slabs, ramps, and stair treads with a bristle brush moistened with clear water after surfaces have been floated. Brush in a direction transverse to main traffic. Match texture approved by the COR from sample panel.
11. Finished slab flatness (FF) and levelness (FL) values comply with the following minimum requirements:
    a. Areas that will be exposed, receive thin-set tile or resilient flooring:
        1) Slab on grade:
            a) Specified overall value FF 36/FL 20
            b) Minimum local value FF 24/FL 15
        2) Level suspended slabs (shored until after testing) and topping slabs

a) Specified overall value FF 30/FL 20
b) Minimum local value FF 24/FL 15

3) Unshored suspended slabs:
a) Specified overall value FF 30
b) Minimum local value FF 24

4) Level tolerance such that 80 percent of all points fall within a 20 mm (3/4 inch) envelope +10 mm, -10 mm (+3/8 inch, -3/8 inch) from the design elevation.

b. "Specified overall value" is based on the composite of all measured values in a placement derived in accordance with ASTM E1155.

c. "Minimum local value" (MLV) describes the flatness or levelness below which repair or replacement is required. MLV is based on the results of an individual placement and applies to a minimum local area. Minimum local area boundaries may not cross a construction joint or expansion joint. A minimum local area will be bounded by construction and/or control joints, or by column lines and/or half-column lines, whichever is smaller.

12. Measurements
a. Department of Veterans Affairs retained testing laboratory will take measurements as directed by the COR, to verify compliance with FF, FL, and other finish requirements. Measurements will occur within 72 hours after completion of concrete placement (weekends and holidays excluded). Make measurements before shores or forms are removed to insure the "as-built" levelness is accurately assessed. Profile data for above characteristics may be collected using a laser level or any Type II apparatus (ASTM E1155, "profileograph" or "dipstick"). Contractor's surveyor shall establish reference elevations to be used by Department of Veterans Affairs retained testing laboratory.

b. Contractor not experienced in using FF and FL criteria is encouraged to retain the services of a floor consultant to assist with recommendations concerning adjustments to slab thicknesses, finishing techniques, and procedures on measurements of the finish as it progresses in order to achieve the specific flatness and levelness numbers.

13. Acceptance/ Rejection:
a. If individual slab section measures less than either of specified minimum local F_F/F_L numbers, that section shall be rejected and remedial measures shall be required. Sectional boundaries may be set at construction and contraction (control) joints, and not smaller than one-half bay.

b. If composite value of entire slab installation, combination of all local results, measures less than either of specified overall F_F/F_L numbers, then whole slab shall be rejected and remedial measures shall be required.

14. Remedial Measures for Rejected Slabs: Correct rejected slab areas by grinding, planing, surface repair with underlayment compound or repair topping, retopping, or removal and replacement of entire rejected slab areas, as directed by the COR, until a slab finish constructed within specified tolerances is accepted.

3.13 SURFACE TREATMENTS:

A. Use on exposed concrete floors except those specified to receive non-slip finish.

B. Liquid Densifier/Sealer: Apply in accordance with manufacturer's directions just prior to completion of construction.

C. Non-Slip Finish: Except where safety nosing and tread coverings are shown, apply non-slip abrasive aggregate to treads and platforms of concrete steps and stairs, and to surfaces of exterior concrete ramps and platforms. Broadcast aggregate uniformly over concrete surface at rate of application of 8 percent per 1/10th m2 (7.5 percent per square foot) of area. Trowel concrete surface to smooth dense finish. After curing, rub treated surface with abrasive brick and water to slightly expose abrasive aggregate.

3.14 APPLIED TOPPING

A. Separate concrete topping on floor base slab of thickness and strength shown. Topping mix shall have a maximum slump of 200 mm (8 inches) for concrete containing a high-range water-reducing admixture (superplasticizer) and 100 mm (4 inches) for conventional mix. Neatly bevel or slope at door openings and at slabs adjoining spaces not receiving an applied finish.

B. Placing: Place continuously until entire section is complete, struck off with straightedge, leveled with a highway straightedge or highway bull float, floated and troweled by machine to a hard dense finish. Slope to floor drains as required. Do not start floating until free water has disappeared and no water sheen is visible. Allow drying of surface moisture naturally. Do not hasten by "dusting" with cement or sand.

3.15 RESURFACING FLOORS

A. Remove existing flooring areas to receive resurfacing to expose existing structural slab and extend not less than 25 mm (1 inch) below new finished floor level. Prepare exposed structural slab surface by roughening, broom cleaning, and dampening. Apply specified bonding grout. Place topping while the bonding grout is still tacky.

3.16 PRECAST CONCRETE ITEMS

A. Precast concrete items, not specified elsewhere. Cast using 25 MPa (5000 psi) air-entrained concrete to shapes and dimensions shown. Finish to match corresponding adjacent concrete surfaces. Reinforce with steel for safe handling and erection.

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SECTION 03 41 33
PRECAST STRUCTURAL PRETENSIONED CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies precast prestressed concrete construction including design not shown, fabrication, erection, and other related items including bearing pads and anchorage.

B. Precast prestressed concrete includes double tees, hollow- core slabs, beams, and columns, solid precast slabs.

1.2 RELATED WORK

A. Section 01 45 29, TESTING LABORATORY SERVICES: Materials testing and inspection during construction.

B. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete.

C. Section 07 92 00, JOINT SEALANTS: Sealants and Caulking.

D. Section 09 91 00, PAINTING: Repair of abraded galvanized and painted surfaces.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Precast concrete manufacturing plant shall be certified by Prestressed Concrete Institute, Plant Certification Program, prior to start of production.

B. In lieu of above qualification, contractor shall meet and pay for following requirements:

1. Retain an independent testing or consulting firm approved by the Contracting Officer's Representative (COR).
2. This firm shall inspect precast plant at two-week intervals during production and issue a report, certified by a Professional Structural Engineer registered in the state of the project, verifying that materials, methods, products and quality control meet all requirements of specifications and drawings. When report indicates to the contrary, the COR may reject any or all products produced during period of noncompliance with above requirements.

C. Precast concrete work shall be performed by firms with a minimum of 5 years experience that demonstrates capability, subject to approval by the COR, to produce and erect type of work specified.

D. Precast concrete manufacturer shall have on staff or shall retain a qualified Professional Structural Engineer registered in the state of the project to certify precast concrete conforms in all aspects to requirements of ACI 318.

E. Erector Qualifications: Regularly engaged for at least 5 years in erection of precast structural concrete similar to requirements of this project.

F. Requirements of Regulatory Agencies: Local codes plus applicable specifications, standards and codes are a part of these specifications.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. All items indicated below are required submittals requiring COR review and approval.

B. Shop Drawings:

1. Erection Drawings:
    a. Plans and/or elevations locating and defining material furnished by manufacturer.
    b. Sections and details showing connections, cast-in items and their relation to structure.
    c. Description of all loose, cast-in and field hardware.
    d. Field installed anchor location drawings.
    e. Erection sequences and handling requirements.
    f. Dead, live and other applicable loads used in design.
2. Production drawings:
    a. Elevation view of each member.
    b. Sections and details to indicate quantities and position of reinforcing steel, anchors, inserts, and essential embedded hardware.
    c. Lifting and erection inserts.
    d. Dimensions and finishes.
    e. Prestress for strand and concrete strengths.
    f. Estimated cambers.
    g. Method of transportation.

C. Product Design Criteria:

1. Loadings for design:
    a. Initial handling and erection stresses.
    b. Dead and live loads as specified on contract drawings.
    c. Other loads specified for member where they are applicable.
    d. Deflection of precast members shall be limited as follows:
        1) Vertical Live Load - Span/360
        2) Wind Load - 0.0025 x Floor to Floor Height
    e. Design shall provide for thermal movements of completed structure.
2. Design calculations of products shall be performed by a Professional Structural Engineer registered in the state of the project with a minimum of 5 years experience in precast prestressed concrete design.

3. Design shall be in accordance with applicable codes, ACI 318 and the PCI Design Handbook.
4. Details for waterproof joints between precast members.

D. Mix Designs: Submit proposed concrete mix designs and appropriate test data as specified in Part 2 of this section.

E. Permissible Design Deviations:
1. Design connections according to the conceptual details shown in the contract documents.
2. Design deviations will be permitted only after COR's written approval of manufacturer's proposed design supported by complete design calculations and drawings.
3. Design deviations shall provide an installation equivalent to basic intent without incurring additional cost to the COR.

F. Test Reports: Concrete and other material.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling:
1. Lift and support precast concrete members during manufacturing, stockpiling, transporting and erection operations only at lifting or supporting points, or both, as shown on contract and shop drawings, and with approved lifting devices. Lifting devices shall have a minimum safety factor of 4. Exterior lifting hardware shall have a minimum safety factor of 5.
2. Transportation, site handling, and erection shall be performed with acceptable equipment and methods, and by qualified personnel.

B. Storage:
1. Store all units off ground.
2. Place stored units so that identification marks are discernible.
3. Separate stacked members by battens across full width of each bearing point.
4. Stack so that lifting devices are accessible and undamaged.
5. Do not use upper members of stacked tier as storage area for shorter member or heavy equipment.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.

B. ASTM International(ASTM):

A36/A36M-19..... Standard Specification for Carbon Structural Steel

A123/A123M-17..... Standard Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A153/A153M-16a..... Standard Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

A307-14e1 ..... Standard Specifications for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
A416/A416M-18..... Standard Specification for Low-relation, Seven-Wire Steel Strand for Prestressed Concrete
A615/A615M-20..... Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
A706/A706M-16..... Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
A767/A767M-19..... Standard Specification for Zinc Coated (Galvanized) Steel Bars for Concrete Reinforcement
A775/A775M-19..... Standard Specification for Epoxy Coated Steel Reinforcing Bars
A1064/A1064M-18a..... Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
C33/C33M-18 ..... Standard Specification for Concrete Aggregates
C88/C88M-18 ..... Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C150/C150M-20 ..... Standard Specification for Portland Cement
C260/C260M-10a(2016)Standard Specification for Air Entraining Admixtures for Concrete
C330/C330M-17a ..... Standard Specification for Lightweight Aggregates for Structural Concrete
C494/C494M-19 ..... Standard Specification for Chemical Admixtures for Concrete
F3125/F3125M-19e1 .... Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120ksi (830MPa) and 150ksi (1040MPa) Minimum Tensile Strength, Inch and Meter Dimensions

C. American Concrete Institute (ACI):

117-10..... Standard Specifications for Tolerances for Concrete Construction and Materials
318/318R-19..... Building Code Requirements for Structural Concrete and Commentary

D. Prestressed Concrete Institute (PCI):

MNL-116-99..... Manual for Quality Control for Plants and Production of Precast Concrete Products Fourth Edition
MNL-127-99..... Erector’s Manual: Standards and Guidelines for the Erection of Precast Concrete Products

E. American Welding Society (AWS):

D1.1/D1.1M-20 ..... Structural Welding Code - Steel
D1.4-18 ..... Structural Welding Code – Steel Reinforcing Bars

PART 2 - PRODUCTS

2.1 MATERIALS

A. Portland Cement: ASTM C150, Type I or III.

B. Aggregates: ASTM C33, Coarse and Fine.

C. Lightweight Coarse Aggregate: ASTM C330, maximum size 19mm (3/4 inch), maximum 15 percent loss when tested in accordance with ASTM C88.

D. Air-entraining Admixture: ASTM C260.

E. Chemical Admixtures: ASTM C494.

F. Mixing Water: Fresh, clean, and potable.

G. Reinforcing Steel: ASTM A615M, Grade 400 MPa (ASTM A615, Grade 60), deformed.

H. Weldable Reinforcing Steel: ASTM A706M, Grade 400 MPa, (ASTM A706 Grade 60).

I. Galvanized Reinforcing Steel: ASTM A767M, Grade 400 MPa, (ASTM A767, Grade 60) Class II, hot-dipped galvanized after fabrication and bending.

J. Epoxy-Coated Reinforcing Steel: ASTM A775M, Grade 400 MPa, (ASTM A775, Grade 60).

K. Anchor Bolts: ASTM A307, low-carbon steel bolts, regular hexagon nuts and carbon steel washers, galvanized.

L. High-Strength Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon bolts, and hardened washers complying with ASTM F3125/F3125M, galvanized.

M. Welded Wire Fabric: ASTM A1064.

N. Wire Reinforcement: ASTM A1064.

O. Prestressing Steel: ASTM A416, Grade 250K or 270K, uncoated, 7-wire, stress-relieved strand.

P. Anchors and Inserts: ASTM A36 structural steel plates and shapes, ASTM A153 or ASTM A123 hot dipped galvanized finish.

Q. Non-metallic Shrinkage-Resistant Grout: Proprietary pre-mixed, non-metallic, non-corrosive, non-staining product containing selected silica sands, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents, complying with CRD-C-621. Minimum cube strength of 62 MPa (9000 psi) at 28 days when placed at flowable consistency.

R. Bearing Pads:

1. Elastomeric Pads: Vulcanized, chloroprene elastomeric compound, molded to size or cut from a molded sheet, 50-60 shore A durometer.
2. Laminated Fabric-Rubber Pads: Preformed, unused synthetic fibers and new, unvulcanized rubber. Surface hardness of 70-80 shore A durometer.
3. Sliding Pads: Manufactured assembly with Polyetrafluoroethylene (PTFE) surface, with glass fiber reinforcing as required for service load bearing stress. Combine with elastomeric base where required for full contact bearing.

4. Plastic: Multi-monomer plastic strips, non-leaching and able to support construction loads with no visible overall expansion.

S. Welded Studs: AWS D1.1.

T. Welded Rebar: AWS D1.4.

U. Caulking and Sealants: Specified under Section 07 92 00, JOINT SEALANTS.

V. Accessories: Provide clips, hangers, and other accessories required for installation of project units and for support of subsequent construction or finishes.

2.2 CONCRETE MIXES

A. Normal-Weight Concrete:

1. Compressive Strength: 35 MPa (5000 psi) minimum at 28 days.
2. Release Strength: 25 MPa (3500 psi) minimum at transfer of prestress.

B. Do not use calcium chloride, chloride ions or other salts.

2.3 FABRICATION

A. Fabrication Procedures: PCI MNL-116.

B. Fabrication Tolerances: PC MNL-ll6 and ACI 117 for reinforcing steel placement.

C. Finishes:

1. Standard Underside: Resulting from casting against approved forms using good industry practice in cleaning of forms, design of concrete mix, placing and curing. Small surface holes caused by air bubbles, normal color variations, normal form joint marks, and minor chips and spalls will be tolerated, but no major or unsightly imperfections, honeycomb, or other defects will be permitted.
2. Standard Top: Result of vibrating screed and additional hand finishing at projections. Normal color variations, minor indentations, minor chips and spalls will be permitted. No major imperfections, honeycomb, or defects will be permitted.
3. Exposed Vertical Ends: Strands shall be recessed and the ends of member will receive sacked finish.

D. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing, complying with CRSI recommendations. For exposed-to-view concrete surfaces, shear legs of supports are in contact with forms, provide supports with legs that are plastic protected or stainless steel protected.

E. Use epoxy coated reinforcing whenever concrete cover is less than 50 mm (2 inches) for top surfaces exposed to deicing salts, brackish water or salt spray, such as in parking garage decks.

F. Openings: Primarily on thin sections, factory fabricate those openings 250 mm (10 inches) round or square or larger as shown on drawings. Locate and field drill or cut other openings

where no contact is made with prestressing or reinforcing steel after precast prestressed products have been erected. Opening shall be approved by COR before drilling or cutting.

G. Patching: Patching will be acceptable providing structural adequacy of product and appearance are not impaired.

H. Defective Work: Precast concrete units which do not conform to specified requirements, including strength, tolerances, and finishes, shall be removed and replaced with precast concrete units that meet the requirements of this section. Contractor is also responsible for cost of corrections to other work affected by or resulting from corrections to precast concrete work.

I. Fasteners: Cast in galvanized hardware such structural inserts, bolts and plates as required by drawings.

PART 3 - EXECUTION

3.1 ERECTION

A. Site Access: Provide suitable access to building, proper drainage, and firm, level bearing for hauling and erection equipment to operate under their own power.

B. Preparation:

1. Provide true, level surfaces on field placed bearing walls and other field placed supporting members.
2. Place and accurate align anchor bolts, plates or dowels in column footings, grade beams and other field placed support members.
3. Shoring required for composite beams and slab shall have a minimum load factor of 1.5 times (dead load plus construction loads).

C. Installation: Installation of precast prestressed concrete shall be performed by the fabricator or a competent erector in accordance with PCI MNL-127. Lift members with suitable lifting devices at points provided by manufacturer. Temporary shoring and bracing, when necessary, shall comply with manufacturer's recommendations.

D. Alignment: Align and level precast members as required by the approved shop drawings. Level out variations between adjacent members by jacking, loading, or any other feasible method as recommended by the manufacturer and acceptable to COR. Individual pieces are considered plumb, level, and aligned if the error does not exceed 1:500 excluding structural deformation caused by loads.

3.2 FIELD WELDING

A. Field welding is to be done by qualified welders using equipment and materials compatible to base material in accordance with AWS D1.1 and AWS D1.4.

B. Field coat with galvanized paint specified under Section 09 91 00, PAINTING all welded connections.

3.3 ATTACHMENTS

A. Do not use powder-actuated or air-driven fasteners or drill the precast units for surface attachment of accessory items unless otherwise accepted by the precast manufacturer.

3.4 INSPECTION AND ACCEPTANCE

A. Final inspection and acceptance of erected precast prestressed concrete shall be made by COR to verify conformance with drawings and specifications.

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SECTION 04 05 13
MASONRY MORTARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Masonry mortar installed by other masonry sections.

1.2 RELATED REQUIREMENTS

A. Mortar used in Section:

1. Section 04 05 16, MASONRY GROUTING.
2. Section 04 20 00, UNIT MASONRY.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. ASTM International (ASTM):

C40/C40M-11 ..... Organic Impurities in Fine Aggregates for Concrete.

C91/C91M-12 ..... Masonry Cement.

C144-11 ..... Aggregate for Masonry Mortar.

C150/C150M-15 ..... Portland Cement.

C207-06(2011) ..... Hydrated Lime for Masonry Purposes.

C270-14a ..... Mortar of Unit Masonry.

C595/C595M-15e1 ..... Blended Hydraulic Cements.

C780-15 ..... Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.

C979/C979M-10 ..... Pigments for Integrally Colored Concrete.

C1329/C1329M-15 ..... Mortar Cement.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Literature and Data:

1. Description of each product.

C. Certificates: Certify each product complies with specifications.

1. Portland cement.
2. Masonry cement.
3. Mortar cement.
4. Hydrated lime.
5. Fine aggregate.
6. Color admixture.

1.5 QUALITY ASSURANCE

A. Preconstruction Testing:
   1. Engage independent testing laboratory to tests and submit reports.
      a. Deliver samples to laboratory in number and quantity required for testing.
   2. Test mortar and materials specified.
   3. Mortar:
      a. Test for compressive strength and water retention according to ASTM C270.
      b. Minimum Mortar compressive strengths 28 days:
         1) Type M: 17.2 MPa (2,500 psi).
         2) Type S: 12.4 MPa (1,800 psi).
         3) Type N: 5.1 MPa (750 psi).
   4. Non Staining Cement: Test for water soluble alkali.
      a. Water Soluble Alkali: Maximum 0.03 percent.
   5. Sand: Test for deleterious substances, organic impurities, soundness and grading.

1.6 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.

B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, production run number, and manufacture date.

C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

A. Store masonry materials under waterproof covers on planking clear of ground.
   1. Protect loose, bulk materials from contamination.

B. Protect products from damage during handling and construction operations.

1.8 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 MATERIALS

A. Hydrated Lime: ASTM C207, Type S.

B. Aggregate for Masonry Mortar: ASTM C144 and as follows:
   1. Light colored sand for mortar for laying face brick.
   2. White plastering sand meeting sieve analysis for mortar joints for pointing and laying of structural facing tile units except that 100 percent passes No. 8 sieve, and maximum 5 percent retained on No. 16 sieve.

3. Test sand for color value according to ASTM C40/C40M. Sand producing color darker than specified standard is unacceptable.

C. Blended Hydraulic Cement: ASTM C595/C595M, Type IS, IP.

D. Masonry Cement: ASTM C91/C91M. Type N, S, Or M.

1. Use white masonry cement whenever white mortar is specified.

E. Mortar Cement: ASTM C1329/C1329M, Type N, S or M.

F. Portland Cement: ASTM C150/C150M, Type I.

1. Use white Portland cement wherever white mortar is specified.

G. Pigments: ASTM C979/C979M; inorganic, inert, mineral pigments only, unaffected by atmospheric conditions, nonfading, alkali resistant, and water insoluble.

H. Water: Potable, free of substances that are detrimental to mortar, masonry, and metal.

2.2 PRODUCTS - GENERAL

A. Provide each product from one manufacturer and from one production run.

2.3 MIXES

A. Pointing Mortar for New Work:

1. Pointing Mortar for Glazed Structural Facing Tile:

a. Proportion by volume: One part white Portland cement, two parts of graded white sand passing Number 50 sieve, and 1/8 part hydrated lime.

B. Masonry Mortar: ASTM C270.

1. Admixtures:

a. Do not use mortar admixtures, and color admixtures unless approved by Contracting Officer's Representative.

b. Do not use antifreeze compounds.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing construction and completed work from damage.

3.2 MIXING

A. Measure ingredients by volume using known capacity container.

B. Mix for 3 to 5 minutes in a mechanically operated mortar mixer.

C. Mix water with dry ingredients in sufficient amount to provide a workable mixture which will adhere to vertical surfaces of masonry units.

D. Mortar Stiffened Because of Water Loss Through Evaporation:

1. Re-temper by adding water to restore to proper consistency and workability.

2. Discard mortar reaching initial set or unused within two hours of mixing.

E. Pointing Mortar:

1. Mix dry ingredients with enough water to produce damp mixture of workable consistency retaining shape when formed into ball.
2. Allow mortar to stand in dampened condition for 60 to 90 minutes.
3. Add water to bring mortar to a workable consistency before use.

3.3 MORTARING

A. Type M Mortar: Use for precast concrete panels, and parging below grade.

B. Type S Mortar: Use for masonry containing vertical reinforcing bars (non-engineered), masonry below grade, and engineered reinforced unit masonry work.

C. Brick Veneer Over Back Up Walls: Use Type S Portland cement-lime mortar.

D. Type N Mortar: Use for other masonry work.

E. Type N Mortar: Use for pointing items and tuck pointing specified.

3.4 FIELD QUALITY CONTROL

A. Field Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.

1. Take and test samples during progress of work according to ASTM C780.

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SECTION 04 05 16
MASONRY GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Grout for filling hollow concrete masonry cores.

1.2 RELATED WORK

A. Section 04 20 00, UNIT MASONRY: Grout

B. Section 09 30 13, CERAMIC/PORCELAIN TILING: Ready-Mixed Grout.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American National Standards Institute (ANSI):

A118.6-19 - ..... Standard Cement Grouts for Tile Installation.

C. ASTM International (ASTM):

C40/C40M-20 - ..... Organic Impurities in Fine Aggregates for Concrete.

C150/C150M-20 - ..... Portland Cement.

C207-18 - ..... Hydrated Lime for Masonry Purposes.

C404-18 - ..... Aggregates for Masonry Grout.

C476-20 - ..... Grout for Masonry.

C595/C595M-20 - ..... Blended Hydraulic Cement.

C979/C979M-16 - ..... Pigments for Integrally Colored Concrete.

C1019-19 - ..... Sampling and Testing Grout.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. All items indicated below are required submittals requiring Contracting Officer's Representative (COR) review and approval.

B. Manufacturer's Literature and Data:

1. Description of each product.

C. Test Reports: Certify each product complies with specifications.

1. Grout, each type.
2. Cement.
3. Aggregate.

D. Certificates: Certify each product complies with specifications.

1. Blended hydraulic cement.
2. Portland cement.
3. Grout.
4. Hydrated lime.
5. Aggregate.

6. Color admixture.

1.5 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.

B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, production run number, and manufacture date.

1.6 STORAGE AND HANDLING

A. Store masonry materials under waterproof covers on planking clear of ground, and protect damage from handling, dirt, stain, water and wind.

B. Protect products from damage during handling and construction operations.

1.7 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 MATERIALS

A. Grout Components:

1. Hydrated Lime: ASTM C207, Type S.
2. Aggregate For Masonry Grout: ASTM C404, Size 8.
3. Blended Hydraulic Cement: ASTM C595, Type IS, IP.
4. Portland Cement: ASTM C150, Type I.
5. Liquid Acrylic Resin:
   a. A formulation of acrylic polymers and modifiers in liquid form designed for use as an additive for mortar to improve physical properties.
6. Water: Potable, free of substances that are detrimental to grout, masonry, and metal.

2.2 PRODUCTS - GENERAL

A. Provide each product from one manufacturer and from one production run.

2.3 MIXES

A. Grout: ASTM C476; fine grout and coarse grout.

B. Ready-Mixed Grout: ANSI A118.8.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing construction and completed work from damage.

C. Clean mortar from masonry cells protruding more than 13 mm (1/2 inch) to permit grout flow.

D. Remove debris from grout spaces.

E. Verify reinforcement is correctly placed before placing grout.

3.2 MIXING

A. Mix grout in mechanically operated mixer.

1. Mix grout for five minutes, minimum.

B. Measure ingredients by volume using container of known capacity.

C. Mix water with grout dry ingredients.

1. Slump Range: 200 to 275 mm (8 to 11 inches).

3.3 GROUTING

A. Install grout according to Section 04 20 00, UNIT MASONRY.

B. Use fine grout for filling wall cavities and hollow concrete masonry units where smallest cell dimension is 50 mm (2 inches) or less.

C. Use either fine grout or coarse grout for filling wall cavities and hollow concrete masonry units where smallest cell dimension is greater than 50 mm (2 inches).

D. Use grout for filling bond beam or lintel units.

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SECTION 04 20 00
UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Concrete masonry unit (CMU) assemblies for:

1. Exterior walls.
2. Interior walls.

1.2 RELATED REQUIREMENTS

A. Sealants and Sealant Installation: Section 07 92 00, JOINT SEALANTS.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American Concrete Institute (ACI):

315-99..... Details and Detailing of Concrete Reinforcement.

530.1/ASCE 6/TMS 602-13 Specification for Masonry Structures.

C. ASTM International (ASTM):

A615/A615M-15ae1..... Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

A951/A951M-14..... Steel Wire for Masonry Joint Reinforcement.

A1064/A1064M-15..... Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

C55-14a..... Concrete Building Brick.

C56-13..... Structural Clay Nonloadbearing Tile.

C67-14..... Sampling and Testing Brick and Structural Clay Tile.

C90-14..... Load-Bearing Concrete Masonry Units.

C126-15..... Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units.

C216-15..... Facing Brick (Solid Masonry Units Made From Clay or Shale).

C744-14..... Prefaced Concrete and Calcium Silicate Masonry Units.

D1056-14..... Flexible Cellular Materials - Sponge or Expanded Rubber.

D2240-05(2010) ..... Rubber Property-Durometer Hardness.

F1667-15 ..... Driven Fasteners: Nails, Spikes, and Staples.

D. American Welding Society (AWS):

D1.4/D1.4M-11 ..... Structural Welding Code - Reinforcing Steel.

E. Brick Industry Association (BIA):

TN 11B-88 ..... Guide Specifications for Brick Masonry, Part 3.

F. Federal Specifications (Fed. Spec.):

FF-S-107C(2)..... Screws, Tapping and Drive.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:

1. Fabrication, bending, and placement of reinforcing bars. Comply with ACI 315. Show bar schedules, diagrams of bent bars, stirrup spacing, lateral ties and other arrangements and assemblies.
2. Special masonry shapes, profiles, and placement.
3. Masonry units for typical window and door openings, and, for special conditions as affected by structural conditions.

C. Manufacturer's Literature and Data:

1. Description of each product.
2. Installation instructions.

D. Samples:

1. Face brick: Sample panel, 200 mm by 400 mm (8 inches by 16 inches,) showing full color range and texture of bricks, bond, and proposed mortar joints.
2. Ceramic Glazed Facing Brick: Sample panel, 200 mm by 400 mm (8 inches by 16 inches,) showing full color range and texture of bricks, bond, and proposed mortar joints.
3. Concrete masonry units, when exposed in finish work.
4. Anchors and Ties: Each type.
5. Joint Reinforcing: 1200 mm (48 inches) long each type.

E. Certificates: Certify products comply with specifications.

1. Face brick.
2. Solid and load-bearing concrete masonry units, including fire-resistant rated units.

F. Delegated Design Drawings and Calculations: Signed and sealed by responsible design professional.

1.5 QUALITY ASSURANCE

A. Welders and Welding Procedures Qualifications: AWS D1.4/D1.4M.

1.6 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.

B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, color, production run number, and manufacture date.

C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

A. Store products above grade, protected from contamination.

B. Protect products from damage during handling and construction operations.

1.8 FIELD CONDITIONS

A. Hot and Cold Weather Requirements: Comply with ACI 530.1/ASCE 6/TMS 602.

1.9 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Delegated Design: Prepare submittal documents including design calculations and drawings signed and sealed by registered design professional, licensed in state where work is located.

2.2 PRODUCTS - GENERAL

A. Provide each product from one manufacturer and from one production run.

2.3 UNIT MASONRY PRODUCTS

A. Brick:
   1. Face Brick:
      a. ASTM C216, Grade SW, Type FBS.
      b. Brick when tested according to ASTM C67: Classified slightly efflorescent or better.
      c. Size: Modular.
   2. One Face Exposed: Grade S, Type I.
   3. Two Faces Exposed: Grade S, Type II.

B. Concrete Masonry Units (CMU):
   1. Hollow and Solid Load-Bearing Concrete Masonry Units: ASTM C90.
      a. Unit Weight: Normal weight.
   2. Sizes: Modular, 200 mm by 400 mm (8 inches by 16 inches) nominal face dimension; thickness as indicated on drawings.

C. Use keyed surface structural clay tile units required to receive plaster or mortar.

2.4 ANCHORS, TIES, AND REINFORCEMENT

A. Steel Reinforcing Bars: ASTM A615/A615M; Grade 60, deformed bars.

B. Joint Reinforcement:
   1. Form from wire complying with ASTM A951/A951M.
   2. Hot dipped galvanized after fabrication.
   3. Width of joint reinforcement 40 mm (1.6 inches) less than nominal thickness of masonry wall or partition.
   4. Cross wires welded to longitudinal wires.
   5. Joint reinforcement minimum 3000 mm (10 feet) long, factory cut.
   6. Joint reinforcement with crimp formed drip is not acceptable.

7. Maximum spacing of cross wires 400 mm (16 inch) to longitudinal wires.
8. Ladder Design:
    a. Longitudinal wires deformed 4 mm (0.16 inch).
    b. Cross wires2.6 mm (0.10 inch).
9. Trussed Design:
    a. Longitudinal and cross wires minimum 4 mm (0.16 inch nominal) diameter.
    b. Longitudinal wires deformed.
10. Multiple Wythes and Cavity Wall Ties:
    a. Longitudinal wires 4 mm (0.16 inch), two in each wythe with ladder truss wires 4 mm (0.16 inch) overlay, welded to each longitudinal wire.
    b. Longitudinal wires 4 mm (0.16 inch) with U shape 4 mm (0.16 inch) rectangular ties extending into other wythe minimum 75 mm (3 inches) spaced 400 mm on center (16 inches). Adjustable type with U shape tie designed to receive 4 mm (0.16 inch) pintle projecting into other wythe 75 mm (3 inches min.).

C. Dovetail Anchors:
1. Corrugated steel dovetail anchors formed of 1.5 mm (0.06 inch) thick by 25 mm (1 inch) wide galvanized steel, 90 mm (3-1/2 inches) long where used to anchor 100 mm (4 inch) nominal thick masonry units, 140 mm (5-1/2 inches) long for masonry units more than 100 mm (4 inches) thick.
2. Triangular wire dovetail anchor 100 mm (4 inch) wide formed of 4 mm (9 gage) steel wire with galvanized steel dovetail insert. Anchor length to extend minimum 75 mm (3 inches) into masonry, 25 mm (1 inch) into 40 mm (1-1/2 inch) thick units.
3. Form dovetail anchor slots from 0.6 mm (0.02 inch) thick galvanized steel (with felt or fiber filler).

D. Individual Ties:
1. Rectangular ties: Form from 5 mm (3/16 inch) diameter galvanized steel rod to rectangular shape minimum 50 mm (2 inches) wide by sufficient length for ends of ties to extend within 25 mm (1 inch) of each face of wall. Ties that are crimped to form drip are not acceptable.
2. Adjustable Cavity Wall Ties:
    a. Adjustable wall ties may be furnished at Contractor's option.
    b. Two piece type permitting up to 40 mm (1-1/2 inch) adjustment.
    c. Form ties from 5 mm (3/16 inch) diameter galvanized steel wire.
    d. Form one piece to rectangular shape 105 mm (4-1/8 inches) wide by length required to extend into bed joint 50 mm (2 inches).

e. Form other piece to 75 mm (3 inch) long by 75 mm (3 inch) wide shape, having 75 mm (3 inch) long bent section for engaging 105 mm (4-1/8 inch) wide piece to form adjustable connection.

E. Wall Ties, (Mesh or Wire):

1. Mesh wall ties formed of ASTM A1064/A1064M, W0.5, 2 mm, (0.08 inch) galvanized steel wire 13 mm by 13 mm (1/2 inch by 1/2 inch) mesh, 75 mm (3 inches) wide by 200 mm (8 inches) long.
2. Rectangular wire wall ties formed of W1.4, 3 mm, (0.12 inch) galvanized steel wire 50 mm (2 inches) wide by 200 mm (8 inches) long.

2.5 ACCESSORIES

A. Shear Keys:

1. Solid extruded cross-shaped section of rubber, neoprene, or polyvinyl chloride, with durometer hardness of approximately 80 when tested according to ASTM D2240, and minimum shear strength of 3.5 MPa (500 psi).
2. Shear Key Dimensions: Nominal 70 mm by 8 mm for long flange and 38 mm by 16 mm for short flange (2-3/4 inches by 5/16 inch for long flange, and 1-1/2 inches by 5/8 inch for short flange).

B. Weeps:

1. Weep Hole Wicks: Glass fiber ropes, 10 mm (3/8 inch) minimum diameter, 300 mm (12 inches) long.
2. Weep Tubing: Round, polyethylene, 9 mm (3/8 inch) diameter, 100 mm (4 inches) long.
3. Weep Hole: Flexible PVC louvered configuration with rectangular closure strip at top.

C. Cavity Drain Material: Open mesh polyester sheets or strips to prevent mortar droppings from clogging the cavity.

D. Preformed Compressible Joint Filler:

1. Thickness and depth to fill joint.
2. Closed Cell Neoprene: ASTM D1056, Type 2, Class A, Grade 1, B2F1.
3. Non-Combustible Type: ASTM C612, Type 5, Max. Temp.1800 degrees F.

E. Box Board:

1. Mineral Fiber Board: ASTM C612, Type 1.
2. 25 mm (1 inch) thickness.
3. Other spacing material having similar characteristics is acceptable subject to Contracting Officer's Representative's approval.

F. Masonry Cleaner:

1. Detergent type cleaner selected for each type masonry.
2. Acid cleaners are not acceptable.

3. Use soapless type specially prepared for cleaning brick or concrete masonry as appropriate.

G. Fasteners:
1. Concrete Nails: ASTM F1667, Type I, Style 11, 19 mm (3/4 inch) minimum length.
2. Masonry Nails: ASTM F1667, Type I, Style 17, 19 mm (3/4 inch) minimum length.
3. Screws: FS-FF-S-107, Type A, AB, SF thread forming or cutting.

H. Welding Materials: AWS D1.4/D1.4M, type to suit application.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Install products according to manufacturer's instructions and approved submittal drawings.
1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

B. Keep finish work free from mortar smears or spatters, and leave neat and clean.

C. Wall Openings:
1. When items are not available when walls are built, prepare openings for subsequent installation.

D. Tooling Joints:
1. Do not tool until mortar has stiffened enough to retain thumb print when thumb is pressed against mortar.
2. Tool while mortar is soft enough to be compressed into joints and not raked out.
3. Finish joints in exterior face masonry work with jointing tool, and provide smooth, water-tight concave joint unless specified otherwise.
4. Tool Exposed interior joints in finish work concave unless specified otherwise.

E. Partition Height:
1. Extend partitions to overhead construction.

F. Wall, Furring, and Partition Units:
1. Lay out field units to provide one-half running bond, unless indicated otherwise.
2. Align head joints of alternate vertical courses.
3. Minimum Masonry Unit Length: 100 mm (4 inches).
4. On interior partitions provide 6 mm (1/4 inch) open joint for caulking between existing construction, exterior walls, concrete work, and abutting masonry partitions.
5. Use minimum 100 mm (4 inches) nominal thick masonry for free standing furring, unless indicated otherwise.
6. Do not abut existing plastered surfaces except suspended ceilings with new masonry partitions.

G. Before connecting new masonry with previously laid masonry, remove loosened masonry or mortar, and clean and wet work in place as specified under wetting.

H. When new masonry partitions start on existing floors, machine cut existing floor finish material down to concrete surface.

I. Chases:

1. Do not install chases in masonry walls and partitions exposed to view in finished work, including painted or coated finishes on masonry.
2. Masonry 100 mm (4 inch) nominal thick may have electrical conduits 25 mm (1 inch) or less in diameter when covered with soaps, or other finishes.
3. Fill recess chases after installation of conduit, with mortar and finish flush.
4. When pipes or conduits, or both occur in hollow masonry unit partitions retain minimum one web of hollow masonry units.

J. Wetting and Wetting Test:

1. Test and wet brick and clay tile according to BIA TN 11B.
2. Do not wet concrete masonry units or glazed structural facing tile before laying.

K. Temporary Formwork: Provide formwork and shores as required for temporary support of reinforced masonry elements.

L. Construct formwork to conform to shape, line and dimensions indicated on drawings. Make sufficiently tight to prevent mortar, grout, or concrete leakage. Brace, tie and support formwork as required to maintain position and shape during construction and curing of reinforced masonry.

M. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other reasonable temporary construction loads.

N. Minimum Curing Times Before Removing Shores and Forms:

1. Girders and Beams: 10 days.
2. Slabs: 7 days.
3. Reinforced Masonry Soffits: 7 days.

3.2 INSTALLATION - ANCHORAGE

A. Veneer to Concrete Walls:

1. Install dovetail slots in concrete vertically at 400 mm (16 inches) on centers.
2. Locate dovetail anchors at 400 mm (16 inch) maximum vertical intervals.
3. Anchor new masonry facing to existing concrete with adjustable cavity wall ties spaced at 400 mm, (16 inches) maximum vertical intervals, and at 400 mm (16 inches) maximum horizontal intervals. Fasten ties to concrete with power actuated fasteners or concrete nails.

B. Masonry Facing to Backup and Cavity Wall Ties:

1. Use individual ties for new work.

2. Stagger ties in alternate courses, and space at 400 mm (16 inches) maximum vertically, and 400 mm (16 inches) horizontally.
3. Anchor new masonry facing to existing masonry with adjustable cavity wall ties spaced at 400 mm (16 inch) maximum vertical intervals and at every second masonry unit horizontally. Fasten ties to masonry with masonry nails.
4. Option: Install joint reinforcing for multiple wythes and cavity wall ties spaced maximum 400 mm (16 inches) vertically.
5. Tie interior and exterior wythes of reinforced masonry walls together with individual ties. Provide ties at intervals maximum 400 mm (16 inches) on center horizontally, and 400 mm (16 inches) on center vertically. Lay ties in the same line vertically in order to facilitate vibrating of the grout pours.

C. Anchorage of Abutting Masonry:
1. Anchor abutting interior masonry partitions to existing concrete and existing masonry construction, with adjustable wall ties. Extend ties minimum 100 mm (4 inches) into joints of new masonry. Fasten ties to existing concrete and masonry construction, with powder actuated drive pins, nail or other means that provides rigid anchorage. Install anchors at 400 mm (16 inch) maximum vertical intervals.

D. Masonry Furring:
1. Anchor masonry furring less than 100 mm (4 inches) nominal thick to masonry walls or to concrete with adjustable wall ties or dovetail anchors.
2. Space at maximum 400 mm (16 inches) on center in both directions.

3.3 INSTALLATION - REINFORCEMENT

A. Joint Reinforcement:
1. Install joint reinforcement in CMU wythe of combination brick and CMU, cavity walls, and single wythe concrete masonry unit walls or partitions.
2. Reinforcing is acceptable in lieu of individual ties for anchoring brick facing to CMU backup in exterior masonry walls.
3. Locate joint reinforcement in mortar joints at 400 mm (16 inch) maximum vertical intervals.
4. Additional joint reinforcement is required in mortar joints at both 200 mm (8 inches) and 400 (16 inches) above and below windows, doors, louvers and similar openings in masonry.

B. Steel Reinforcing Bars:
1. Install reinforcing bars in cells of hollow masonry units where required for vertical reinforcement and in bond beam units for horizontal reinforcement. Install in wall cavities of reinforced masonry walls where indicated on drawings.
2. Bond Beams:

a. Form Bond beams of load-bearing concrete masonry units filled with grout and reinforced with two No. 15m (No. 5) reinforcing bars unless shown otherwise. Do not cut reinforcement.
b. Brake bond beams only at expansion joints and at control joints, if shown.

3.4 INSTALLATION - BRICK EXPANSION AND CMU CONTROL JOINTS

A. Provide brick expansion joint (EJ) and CMU control joints (CJ) where indicated on drawings.
B. Keep joint free of mortar and other debris.
C. Joints Occur In Masonry Walls:
1. Install preformed compressible joint filler in brick wythe.
2. Install cross shaped shear keys in concrete masonry unit wythe with preformed compressible joint filler on both sides of shear key.
D. Use standard notched concrete masonry units (sash blocks) made in full and half-length units where shear keys are used to create a continuous vertical joint. Alter Structural clay tile units to accommodate shear key flanges.
E. Interrupt joint reinforcement at expansion and control joints.
F. Fill opening in exposed face of expansion and control joints with sealant as specified in Section 07 92 00, JOINT SEALANTS.

3.5 INSTALLATION - ISOLATION JOINT

A. Where full height walls and partitions lie parallel or perpendicular to and under structural beams and shelf angles, provide minimum 9 mm (3/8 inch) separation between walls and partitions and bottom of beams and shelf angles.
B. Insert continuous full width strip of non-combustible type compressible joint filler.
C. Fill opening in exposed face of isolation joints with sealant as specified in Section 07 92 00, JOINT SEALANTS.

3.6 INSTALLATION - BRICKWORK

A. Lay clay brick according to BIA TN 11B.
B. Laying:
1. Lay brick in one-half running bond with bonded corners, unless indicated otherwise. Match bond of existing building on alterations and additions.
2. Maintain bond pattern throughout.
3. Do not use brick smaller than half-brick at any angle, corner, break, and jamb.
4. Where length of cut brick is greater than one half length, maintain vertical joint location.
5. Do not structurally bond multi-wythe brick walls, unless indicated on drawings.
6. Before starting work, lay facing brick on foundation wall and adjust bond to openings, angles, and corners.
7. Lay brick for sills with wash and drip.

8. Build solid brickwork as required for anchorage of items.

C. Joints:
1. Exterior And Interior Joint Widths: Lay for three equal joints in 200 mm (8 inches) vertically, unless shown otherwise.
2. Rake joints for pointing with colored mortar when colored mortar is not full depth.

D. Weep Holes:
1. Install weep holes at 600 mm (24 inches) on center in bottom of vertical joints of exterior masonry veneer or cavity wall facing over foundations, bond beams, and other water stops in wall. Unless shown otherwise on drawings.
2. Form weep holes using wicks made of mineral fiber insulation strips turned up 200 mm (8 inches) in cavity. Anchor top of strip to backup to securely hold in place.
3. Install sand or pea gravel in cavity approximately 75 mm (3 inches) high between weep holes.

E. Cavity Walls:
1. Keep air space clean of mortar accumulations and debris.
2. Lay the interior wythe of the masonry wall full height where dampproofing vity face. Coordinate to install dampproofing before laying outer wythe.
3. Insulated Cavity Type Exterior Walls:
   a. Install insulation against cavity face of inner masonry wythe.
   b. Place insulation between rows of ties or joint reinforcing. Adhere insulation to masonry surface with a bonding agent as recommended by insulation manufacturer.
   c. Lay outer masonry wythe up with air space between insulation and masonry units.

3.7 INSTALLATION - CONCRETE MASONRY UNITS

A. Types and Uses:
1. Provide special concrete masonry shapes as required. Provide solid concrete masonry units, where full units cannot be installed, or where needed for anchorage of accessories.
2. Do not install brick jambs in exposed finish work.
3. Install concrete building brick only as filler in backup material where not exposed.

B. Laying:
1. Lay concrete masonry units with 9 mm (3/8 inch) joints, with a bond overlap of minimum 1/4 of unit length, except where stack bond is indicated on drawings.
2. Do not wet concrete masonry units before laying.
3. Bond external corners of partitions by overlapping alternate courses.
4. Lay first course in a full mortar bed.
5. Set anchorage items as work progress.
6. Where ends of anchors, bolts, and other embedded items, project into voids of units, completely fill voids with mortar or grout.

7. Provide 6 mm (1/4 inch) open joint for sealant between existing construction, exterior walls, concrete work, and abutting masonry partitions.
8. Lay concrete masonry units with full face shell mortar beds and fill head joint beds for depth equivalent to face shell thickness.
9. Lay concrete masonry units so cores of units, that are to be filled with grout, are vertically continuous with joints of cross webs of such cores completely filled with mortar. Unobstructed core openings minimum 50 mm (2 inches) by 75 mm (3 inches).
10. Do not wedge masonry against steel reinforcing. Minimum 13 mm (1/2 inch) clear distance between reinforcing and masonry units.
11. Install deformed reinforcing bars of sizes indicated on drawings.
12. At time of placement, ensure steel reinforcement is free of loose rust, mud, oil, and other contamination capable of affecting bond.
13. Place steel reinforcement at spacing indicated on drawings before grouting.
14. Minimum clear distance between parallel bars: One bar diameter.
15. Hold vertical steel reinforcement in place vertically by centering clips, caging devices, tie wire, or other approved methods.
16. Support vertical bars near each end and at maximum 192 bar diameter on center.
17. Splice reinforcement or attach reinforcement to dowels by placing in contact and securing with wire ties.
18. Stagger splices in adjacent horizontal reinforcing bars. Lap reinforcing bars at splices a minimum of 40 bar diameters.
19. Grout cells of concrete masonry units, containing reinforcing bars, solid as specified.
20. Install cavity and joint reinforcement as masonry work progresses.
21. Rake joints 6 to 10 mm (1/4 to 3/8 inch) deep for pointing with colored mortar when colored mortar is not full depth.

3.8 POINTING

A. Fill joints with pointing mortar using rubber float trowel to apply mortar solidly into raked joints.
B. Wipe off excess mortar from joints of glazed masonry units with dry cloth.
C. Tool exposed joints to smooth concave joint.
D. At joints with existing work, match existing joint.

3.9 GROUTING

A. Preparation:
   1. Clean grout space of mortar droppings before placing grout.
   2. Close cleanouts.
   3. Install vertical solid masonry dams across grout space for full height of wall at intervals of maximum 9000 mm (30 feet). Do not bond dam units into wythes as masonry headers.

4. Verify reinforcing bars are installed as indicated on drawings.

B. Placing:
   1. Place grout in grout space in lifts as specified.
   2. Consolidate each grout lift after free water has disappeared but before plasticity is lost.
   3. Do not slush with mortar or use mortar with grout.
   4. Interruptions:
      a. When grouting must be stopped for more than an hour, top off grout 40 mm (1-1/2 inches) below top of last masonry course.
      b. Grout from dam to dam on high lift method.
      c. Longitudinal run of masonry may be stopped off only by raking back one-half masonry unit length in each course and stopping grout 100 mm (4 inches) back of rake on low lift method.

C. Puddling Method:
   1. Consolidate by puddling with grout stick during and immediately after placing.
   2. Grout cores of concrete masonry units containing reinforcing bars solid as masonry work progresses.

D. Low Lift Method:
   1. Construct masonry to 1.5 m (5 feet) maximum height before grouting.
   2. Grout in one continuous operation and consolidate grout by mechanical vibration and reconsolidate after initial water loss and settlement has occurred.

E. High Lift Method:
   1. Do not pour grout until masonry wall has cured minimum of 4 hours.
   2. Place grout in 1.5 m (5 feet) maximum lifts.
   3. Exception:
      a. Where following conditions are met, place grout in 3.86 m (12.67 feet) maximum lifts.
      b. Masonry has cured minimum of 4 hours.
      c. Grout slump is maintained between 250 and 275 mm (10 and 11 inches).
      d. No intermediate reinforced bond beams are placed between top and bottom of grout lift.
   4. When vibrating succeeding lifts, extend vibrator 300 to 450 mm (12 to 18 inches) into preceding lift.

3.10 PLACING REINFORCEMENT

A. General: Clean reinforcement of loose rust, mill scale, earth, ice or other materials which will reduce bond to mortar or grout. Do not use reinforcement bars with kinks or bends not shown on drawings or approved submittal drawings, or bars with reduced cross-section due to excessive rusting or other causes.

B. Position reinforcement accurately at spacing indicated on drawings. Support and secure vertical bars against displacement. Install horizontal reinforcement as masonry work progresses. Where vertical bars are shown in close proximity, provide clear distance between bars of minimum one bar diameter or 25 mm (1 inch), whichever is greater.

C. Splice reinforcement bars only where indicated on drawings, unless approved by Contracting Officer's Representative. Provide lapped splices. In splicing vertical bars or attaching to dowels, lap ends, place in contact and wire tie.

D. Provide minimum lap as indicated on approved submittal drawings, or if not indicated, minimum 48 bar diameters.

E. Embed metal ties in mortar joints as work progresses, with minimum mortar cover of 15 mm (5/8 inch) on exterior face of walls and 13 mm (1/2 inch) at other locations.

F. Embed prefabricated horizontal joint reinforcement as work progresses, with minimum cover of 15 mm (5/8 inch) on exterior face of walls and 13 mm (1/2 inch) at other locations. Lap joint reinforcement minimum 150 mm (6 inches) at ends. Use prefabricated “L” and “T” sections to provide continuity at corners and intersections. Cut and bend joint reinforcement for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.

G. Anchoring: Anchor reinforced masonry work to supporting structure as indicated on drawings.

H. Anchor reinforced masonry walls at intersections with non-reinforced masonry.

3.11 INSTALLATION OF REINFORCED CONCRETE UNIT MASONRY

A. Do not wet concrete masonry units (CMU).

B. Lay CMU units with full-face shell mortar beds. Fill vertical head joints (end joints between units) solidly with mortar from face of unit to distance behind face equal to thickness of longitudinal face shells. Solidly bed cross-webs of starting courses in mortar. Maintain head and bed 9 mm (3/8 inch) joint widths.

C. Where solid CMU units are shown, lay with full mortar head and bed joints.

D. Walls:

1. Pattern Bond: Lay CMU wall units in 1/2-running bond with vertical joints in each course centered on units in courses above and below, unless otherwise indicated. Bond and interlock each course at corners and intersections. Use special-shaped units where shown, and as required for corners, jambs, sash, control joints, lintels, bond beams and other special conditions.
2. Maintain vertical continuity of core or cell cavities, which are to be reinforced and grouted, to provide minimum clear dimension indicated and to provide minimum clearance and grout coverage for vertical reinforcement bars. Keep cavities free of mortar. Solidly bed webs in mortar where adjacent to reinforced cores or cells.
3. Where horizontally reinforced beams (bond beams) are indicated on drawings, use special units or modify regular units to allow for placement of continuous horizontal

reinforcement bars. Place small mesh expanded metal lath or wire screening in mortar joints under bond beam courses over cores or cells of non-reinforced vertical cells, or provide units with solid bottoms.

E. Grouting:
   1. Use fine grout for filling spaces less than 100 mm (4 inches) in one or both horizontal directions.
   2. Use coarse grout for filling 100 mm (4 inch) spaces or larger in both horizontal directions.
   3. Grouting Technique: At Contractor's option, use either low-lift or high-lift grouting techniques.

F. Low-Lift Grouting:
   1. Provide minimum clear dimension of 50 mm (2 inches) and clear area of 5160 sq. mm (8 sq. inches) in vertical cores to be grouted.
   2. Place vertical reinforcement before grouting of CMU. Extend above elevation of maximum pour height as required for splicing. Support in position at vertical intervals not exceeding 192 bar diameters nor 3 m (10 feet).
   3. Lay CMU to maximum pour height. Do not exceed 1.5 m (5 feet) height, or if bond beam occurs below 1.5 m (5 feet) height, stop pour 38 mm (1-1/2 inches) below top of bond beam.
   4. Rod or vibrate grout during placing. Place grout continuously; do not interrupt pouring of grout for more than one hour. Terminate grout pours 38 mm (1-1/2 inches) below top course of pour.
   5. Bond Beams: Stop grout in vertical cells 38 mm (1-1/2 inches) below bond beam course. Place horizontal reinforcement in bond beams; lap at corners and intersections as indicated on drawings. Place grout in bond beam course before filling vertical cores above bond beam.

G. High-Lift Grouting:
   1. Do not use high-lift grouting technique for grouting of CMU unless minimum cavity dimension and area is 75 mm (3 inches) and 6450 sq. mm (10 sq. inches), respectively.
   2. Provide cleanout holes in first course at vertical cells which are to be filled with grout.
   3. Use units with one face shell removed and provide temporary supports for units above, or use header units with concrete brick supports, or cut openings in one face shell.
   4. Construct masonry to full height of maximum grout pour before placing grout.
   5. Limit grout lifts to maximum height of 1.5 m (5 feet) and grout pour to maximum height of 7.3 m (24 feet), for single wythe hollow concrete masonry walls, unless otherwise indicated.
   6. Place vertical reinforcement before grouting. Place before or after laying masonry units, to suit application. Tie vertical reinforcement to dowels at base of masonry where shown

and thread CMU over or around reinforcement. Support vertical reinforcement at intervals not exceeding 192 bar diameters nor 3 m (10 feet).

7. Where individual bars are placed after laying masonry, place wire loops extending into cells as masonry is laid and loosen before mortar sets. After insertion of reinforcement bar, pull loops and bar to proper position and tie free ends.
8. Where reinforcement is prefabricated into cage units before placing, fabricate units with vertical reinforcement bars and lateral ties of the size and spacing indicated.
9. Place horizontal beam reinforcement as masonry units are laid.
10. Preparation of Grout Spaces: Before grouting, inspect and clean grout spaces. Remove dust, dirt, mortar droppings, loose pieces of masonry and other foreign materials from grout spaces. Clean reinforcement and adjust to proper position. Clean top surface of structural members supporting masonry to ensure bond. After final cleaning and inspection, close cleanout holes and brace closures to resist grout pressures.
11. Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist displacement of masonry units and breaking of mortar bond. Install shores and bracing, if required, before starting grouting operations.
12. Limit grout pours to sections which can be completed in one working day with maximum one hour interruption of pouring operation. Place grout in lifts which do not exceed 1.5 m (5 feet). Allow minimum 30 minutes and maximum one hour between lifts. Mechanically consolidate each lift.
13. Place grout in lintels or beams over openings in one continuous pour.
14. Where bond beam occurs more than one course below top of pour, fill bond beam course to within 25 mm (1 inch) of vertically reinforced cavities, during construction of masonry.
15. When more than one pour is required to complete a given section of masonry, extend reinforcement beyond masonry as required for splicing. Pour grout to within 38 mm (1-1/2 inches) of top course of first pour. After grouted masonry is cured, lay masonry units and place reinforcement for second pour section before grouting. Repeat sequence if more pours are required.

3.12 CONSTRUCTION TOLERANCES

A. Lay masonry units plumb, level and true to line within tolerances according to ACI 530.1/ASCE 6/TMS 602 and as follows:

B. Maximum variation from plumb:
   1. In 3000 mm (10 feet) - 6 mm (1/4 inch).
   2. In 6000 mm (20 feet) - 9 mm (3/8 inch).
   3. In 12,000 mm (40 feet) or more - 13 mm (1/2 inch).

C. Maximum variation from level:
   1. In any bay or up to 6000 mm (20 feet) - 6 mm (1/4 inch).

2. In 12,000 mm (40 feet) or more - 13 mm (1/2 inch).

D. Maximum variation from linear building lines:

1. In any bay or up to 6000 mm (20 feet) - 13 mm (1/2 inch).
2. In 12,000 mm (40 feet) or more - 19 mm (3/4 inch).

E. Maximum variation in cross-sectional dimensions of columns and thickness of walls from dimensions shown:

1. 13 mm (1/2 inch).

F. Maximum variation in prepared opening dimensions:

1. Accurate to minus 0 mm (0 inch).
2. Plus 6 mm (1/4 inch).

3.13 CLEANING AND REPAIR

A. General:

1. Clean exposed masonry surfaces on completion.
2. Protect adjoining construction materials and landscaping during cleaning operations.
3. Cut out defective exposed new joints to depth of approximately 19 mm (3/4 inch) and repoint.
4. Remove mortar droppings and other foreign substances from wall surfaces.

B. Brickwork:

1. First wet surfaces with clean water, then wash down with detergent solution. Do not use muriatic acid.
2. Brush with stiff fiber brushes while washing, and immediately wash with clean water.
3. Remove traces of detergent, foreign streaks, or stains of any nature.

C. Concrete Masonry Units:

1. Immediately following setting, brush exposed surfaces free of mortar or other foreign matter.
2. Allow mud to dry before brushing.

- - E N D - -

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel shapes, plates, and bars.
2. Structural pipe.
3. Bolts, nuts, and washers.

1.2 RELATED REQUIREMENTS

A. Materials Testing And Inspection During Construction: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Painting: Section 09 91 00, PAINTING.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American Institute of Steel Construction (AISC):

AISC Manual..... Steel Construction Manual, 14th Ed.
303-10..... Code of Structural Steel Buildings and Bridges.
360-10..... Specification for Structural Steel Buildings.

C. The American Society of Mechanical Engineers (ASME):

B18.22.1-09 ..... Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers.

D. American Welding Society (AWS):

D1.1/D1.1M-15 ..... Structural Welding Code - Steel.

E. ASTM International (ASTM):

A6/A6M-14..... General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
A36/A36M-14..... Carbon Structural Steel.
A53/A53M-12..... Pipe, Steel, Black and Hot-Dip, Zinc-Coated, Welded and Seamless.
A123/A123M-15..... Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
A242/A242M-13..... High-Strength Low-Alloy Structural Steel.
A283/A283M-13..... Low and Intermediate Tensile Strength Carbon Steel Plates.
A307-14 ..... Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
A500/A500M-13..... Cold-Formed Welded and Seamless Carbon Steel Structural Tubing and Rounds and Shapes.
A501/A501M-14..... Hot-Formed Welded and Seamless Carbon Steel Structural Tubing and Rounds and Shapes.

A572/A572M-15..... High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

A992/A992M-15..... Structural Shapes.

F2329/F2329M-15 ..... Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy steel Bolts, Screws, washers, Nuts, and Special Threaded Fasteners.

F3125/F3125M-15 ..... Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions

F. Master Painters Institute (MPI):

No. 18 ..... Primer, Zinc Rich, Organic.

G. Military Specifications (Mil. Spec.):

MIL-P-2103..... Paint, High Zinc Dust Content, Galvanizing, Repair.

H. Occupational Safety and Health Administration (OSHA):

29 CFR 1926.752(e)..... Guidelines For Establishing The Components Of A Site-Specific Erection Plan.

29 CFR 1926-2001 ..... Safety Standards for Steel Erection.

I. Research Council on Structural Connections (RCSC) of The Engineering Foundation: Specification for Structural Joints Using ASTM F3125 Bolts.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:

1. Show size, configuration, and fabrication and installation details.

C. Test Reports: Certify products comply with specifications.

1. Welders' qualifying tests.

D. Certificates: Certify each product complies with specifications.

1. Structural steel.
2. Steel connections.
3. Welding materials.
4. Shop coat primer paint.

E. Qualifications: Substantiate qualifications comply with specifications.

1. Fabricator.
2. Installer.
3. Welders and welding procedures.

F. Delegated Design Drawings and Calculations: Signed and sealed by responsible Architect/Engineer.

1. Connection calculations.

G. Record Surveys: Signed and sealed by responsible surveyor or engineer.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: AISC Quality Certification participant designated as AISC Certified Plant, Category STD.
   1. Regularly fabricates specified products.
   2. Fabricated specified products with satisfactory service on five similar installations for minimum five years.

B. Installer Qualifications: AISC Quality Certification Program participant designated as AISC-Certified Erector, Category ACSE.
   1. Regularly installs specified products.
   2. Installed specified products with satisfactory service on five similar installations for minimum five years.

C. Before commencement of Work, ensure steel erector provides written notification required by OSHA 29 CFR 1926.752(e). Submit a copy of the notification to Contracting Officer's Representative.

D. Welders and Welding Procedures Qualifications: AWS D1.1/D1.1M.

1.6 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Delegated Design: Prepare submittal documents including design calculations and drawings signed and sealed by registered design professional, licensed in state where project is located.

B. Design structural steel framing connections complying with specified performance:
   1. Load Capacity: Resist loads indicated on drawings. For loads not shown, load capacity shall resist full capacity of supported member.. Account for connection and member loads and eccentricities.
      a. Request additional design criteria when necessary to complete connection design.
   2. Configuration: Design and detail all connections for each member size, steel grade and connection type to resist the loads and reactions indicated on the drawings or specified herein. Use details consistent with details shown on drawings, supplementing where necessary. The details shown on drawings are conceptual and do not indicate the required weld sizes or number of bolts unless specifically noted. Use rational engineering design and standard practice in detailing, accounting for all loads and eccentricities in both the connection and the members. Promptly notify the Contracting Officer Representative of any location where the connection design criteria is not clearly

indicated. The design of all connections is subject to the review and acceptance of the Contracting Officer's Representative. Submit structural calculations prepared and sealed by a qualified engineer registered in the state where the project is located. Submit calculations for review before preparation of detail drawings.

2.2 MATERIALS

A. W-Shapes:
   1. ASTM A992/A992M.
   2. ASTM A572/A572M; Grade 50.

B. Channel and Angles:
   1. ASTM A36/A36M.
   2. ASTM A572/A572M; Grade 50.

C. Plates and Bars:
   1. ASTM A36/A36M.
   2. ASTM A572/A572M; Grade 50.

D. Hollow Structural Sections:
   1. ASTM A501/A501M.

E. Structural Pipe: ASTM A53/A53M, Grade B.

F. Bolts, Nuts and Washers: Galvanized for galvanized framing.
   1. High-strength bolts, including nuts and washers: ASTM F3125.

G. Welding Materials: AWS D1.1, type to suit application.

H. Drilled Anchors shall be as indicated on the Drawings, as manufactured by HILTI or approved equal.

I. Concrete Nails shall be as indicated on the Drawings, as manufactured by HILTI or approved equal.

2.3 FABRICATION

A. Fabricate structural steel according to Chapter M, AISC 360.

B. Shop and Field Connections:
   1. Weld connections according to AWS D1.1/D1.1M. Welds shall be made only by welders and welding operators who have been previously qualified by tests as prescribed in AWS D1.1 to perform type of work required.
   2. High-Strength Bolts: High-strength bolts tightened to a bolt tension minimum 70 percent of their minimum tensile strength. Tightening done with properly calibrated wrenches, by turn-of-nut method or by use of direct tension indicators (bolts or washers). Tighten bolts in connections identified as slip-critical using Direct Tension Indicators. Twist-off torque bolts are not an acceptable alternate fastener for slip critical connections.

2.4 FINISHES

A. Shop Priming:
   1. Prime paint structural steel according to AISC 303, Section 6.
B. Shop Finish Painting: Apply primer and finish paint as specified in Section 09 91 00, PAINTING.
C. Do not paint:
   1. Surfaces within 50 mm (2 inches) of field welded joints.
   2. Surfaces indicated to be encased in concrete.
   3. Surfaces receiving sprayed on fireproofing.
   4. Beam top flanges receiving shear connector studs applied.
D. Structural Steel Galvanizing: ASTM A123/A123M, hot dipped, after fabrication. Touch-up after erection: Clean and wire brush any abraded and other spots worn through zinc coating, including threaded portions of bolts and welds and touch-up with galvanizing repair paint.
   1. Galvanize structural steel framing installed at exterior locations.
E. Bolts, Nuts, and Washers Galvanizing: ASTM F2329, hot-dipped.

2.5 ACCESSORIES

A. General: Shop paint steel according to AISC 303, Section 6.
B. Finish Paint System: Primer and finish as specified in Section 09 91 00, PAINTING.
C. Galvanizing Repair Paint: MPI No. 18.

PART 3 - EXECUTION

3.1 ERECTION

A. Erect structural steel according to AISC 303 and AISC 360.
B. Set structural steel accurately at locations and elevations indicated on drawings.
C. Maintain erection tolerances of structural steel within AISC 303 requirements.
D. Weld and bolt connections as specified for shop connections.

3.2 FIELD PAINTING

A. After welding, clean and prime weld areas to match adjacent finish.
B. Touch-up primer damaged by construction operations.
C. Apply galvanizing repair paint to galvanized coatings damaged by construction operations.
D. Finish Painting: As specified in Section 09 91 00, PAINTING.

3.3 FIELD QUALITY CONTROL

A. Record Survey:
   1. Measure and record structural steel framing plumbness, level, and alignment after completing bolting and welding and before installation of work supported by structural steel.

2. Identify deviations from allowable tolerances specified in AISC Manual.

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SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies items and assemblies fabricated from structural steel shapes and other materials as shown and specified.

B. Items specified.

1. Safety Nosings
2. Railings

1.2 RELATED WORK

A. Salt hatch: Section 03 30 00, CAST-IN-PLACE CONCRETE.

B. Prime and finish painting: Section 09 91 00, PAINTING.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Literature and Data:

1. Safety Nosings

C. Shop Drawings:

1. Each item specified, showing complete detail, location in the project, material and size of components, method of joining various components and assemblies, finish, and location, size and type of anchors.
2. Mark items requiring field assembly for erection identification and furnish erection drawings and instructions.
3. Provide templates and rough-in measurements as required.

D. Furnish setting drawings and instructions for installation of anchors to be preset into concrete and masonry work, and for the positioning of items having anchors to be built into concrete or masonry construction.

1.4 QUALITY ASSURANCE

A. Each manufactured product shall meet, as a minimum, the requirements specified, and shall be a standard commercial product of a manufacturer regularly presently manufacturing items of type specified.

B. Each product type shall be the same and be made by the same manufacturer.

C. Assembled product to the greatest extent possible before delivery to the site.

D. Include additional features, which are not specifically prohibited by this specification, but which are a part of the manufacturer's standard commercial product.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society of Mechanical Engineers (ASME):

B18.6.1-97 ..... Wood Screws

B18.2.2-87(R2010) ..... Square and Hex Nuts

C. American Society for Testing and Materials (ASTM):

A36/A36M-14 ..... Structural Steel

A47-99(R2014) ..... Malleable Iron Castings

A48-03(R2012) ..... Gray Iron Castings

A53-12 ..... Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

A123-15 ..... Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A240/A240M-15 ..... Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications.

A269-15 ..... Seamless and Welded Austenitic Stainless Steel Tubing for General Service

A307-14 ..... Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

A391/A391M-07(R2015) Grade 80 Alloy Steel Chain

A786/A786M-15 ..... Rolled Steel Floor Plate

B221-14 ..... Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

B456-11 ..... Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium

B632-08 ..... Aluminum-Alloy Rolled Tread Plate

C1107-13 ..... Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

D3656-13 ..... Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns

F436-16 ..... Hardened Steel Washers

F468-06(R2015) ..... Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws and Studs for General Use

F593-13 ..... Stainless Steel Bolts, Hex Cap Screws, and Studs

F1667-15 ..... Driven Fasteners: Nails, Spikes and Staples

D. American Welding Society (AWS):

D1.1-15 ..... Structural Welding Code Steel

D1.2-14 ..... Structural Welding Code Aluminum

D1.3-18 ..... Structural Welding Code Sheet Steel

E. National Association of Architectural Metal Manufacturers (NAAMM)

AMP 521-01(R2012)..... Pipe Railing Manual

AMP 500-06..... Metal Finishes Manual

MBG 531-09(R2017) .... Metal Bar Grating Manual

MBG 532-09 ..... Heavy Duty Metal Bar Grating Manual

F. Structural Steel Painting Council (SSPC)/Society of Protective Coatings:

SP 1-15..... No. 1, Solvent Cleaning

SP 2-04..... No. 2, Hand Tool Cleaning

SP 3-04..... No. 3, Power Tool Cleaning

G. Federal Specifications (Fed. Spec):

RR-T-650E..... Treads, Metallic and Nonmetallic, Nonskid

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. In addition to the dead loads, design fabrications to support the following live loads unless otherwise specified.

B. Railings and Handrails: 900 N (200 pounds) in any direction at any point.

C. Manhole Covers: 1200 kg/m^2 (250 pounds per square foot).

2.2 MATERIALS

A. Structural Steel: ASTM A36.

B. Stainless Steel: ASTM A240, Type 302 or 304.

C. Floor Plate:

1. Steel ASTM A786.

D. Modular Channel Units:

1. Factory fabricated, channel shaped, cold formed sheet steel shapes, complete with fittings bolts and nuts required for assembly.
2. Form channel within turned pyramid shaped clamping ridges on each side.
3. Provide case hardened steel nuts with serrated grooves in the top edges designed to be inserted in the channel at any point and be given a quarter turn so as to engage the channel clamping ridges. Provide each nut with a spring designed to hold the nut in place.
4. Factory finish channels and parts with oven baked primer when exposed to view. Channels fabricated of ASTM A525, G90 galvanized steel may have primer omitted in concealed locations. Finish screws and nuts with zinc coating.
5. Fabricate snap-in closure plates to fit and close exposed channel openings of not more than 0.3 mm (0.0125 inch) thick stainless steel.

E. Grout: ASTM C1107, pourable type.

F. Insect Screening: ASTM D3656.

2.3 HARDWARE

A. Rough Hardware:

1. Furnish rough hardware with a standard plating, applied after punching, forming and assembly of parts; galvanized, cadmium plated, or zinc-coated by electro-galvanizing process. Galvanized G-90 where specified.
2. Use G90 galvanized coating on ferrous metal for exterior work unless non-ferrous metal or stainless is used.

B. Fasteners:

1. Bolts with Nuts:
   a. ASME B18.2.2.
   b. ASTM A307 for 415 MPa (60,000 psi) tensile strength bolts.
   c. ASTM F468 for nonferrous bolts.
   d. ASTM F593 for stainless steel.
2. Screws: ASME B18.6.1.
3. Washers: ASTM F436, type to suit material and anchorage.
4. Nails: ASTM F1667, Type I, style 6 or 14 for finish work.

2.4 FABRICATION GENERAL

A. Material

1. Use material as specified. Use material of commercial quality and suitable for intended purpose for material that is not named or its standard of quality not specified.
2. Use material free of defects which could affect the appearance or service ability of the finished product.

B. Size:

1. Size and thickness of members as shown.
2. When size and thickness is not specified or shown for an individual part, use size and thickness not less than that used for the same component on similar standard commercial items or in accordance with established shop methods.

C. Connections

1. Except as otherwise specified, connections may be made by welding, riveting or bolting.
2. Field riveting will not be approved.
3. Design size, number and placement of fasteners, to develop a joint strength of not less than the design value.
4. Holes, for rivets and bolts: Accurately punched or drilled and burrs removed.
5. Size and shape welds to develop the full design strength of the parts connected by welds and to transmit imposed stresses without permanent deformation or failure when subject to service loadings.

6. Use Rivets and bolts of material selected to prevent corrosion (electrolysis) at bimetallic contacts. Plated or coated material will not be approved.
7. Use stainless steel connectors for removable members machine screws or bolts.

D. Fasteners and Anchors
1. Use methods for fastening or anchoring metal fabrications to building construction as shown or specified.
2. Where fasteners and anchors are not shown, design the type, size, location and spacing to resist the loads imposed without deformation of the members or causing failure of the anchor or fastener, and suit the sequence of installation.
3. Use material and finish of the fasteners compatible with the kinds of materials which are fastened together and their location in the finished work.
4. Fasteners for securing metal fabrications to new construction only, may be by use of threaded or wedge type inserts or by anchors for welding to the metal fabrication for installation before the concrete is placed or as masonry is laid.
5. Fasteners for securing metal fabrication to existing construction or new construction may be expansion bolts, toggle bolts, power actuated drive pins, welding, self drilling and tapping screws or bolts.

E. Workmanship
1. General:
   a. Fabricate items to design shown.
   b. Furnish members in longest lengths commercially available within the limits shown and specified.
   c. Fabricate straight, true, free from warp and twist, and where applicable square and in same plane.
   d. Provide holes, sinkages and reinforcement shown and required for fasteners and anchorage items.
   e. Provide openings, cut-outs, and tapped holes for attachment and clearances required for work of other trades.
   f. Prepare members for the installation and fitting of hardware.
   g. Fabricate surfaces and edges free from sharp edges, burrs and projections which may cause injury.
2. Welding:
   a. Weld in accordance with AWS.
   b. Welds shall show good fusion, be free from cracks and porosity and accomplish secure and rigid joints in proper alignment.

c. Where exposed in the finished work, continuous weld for the full length of the members joined and have depressed areas filled and protruding welds finished smooth and flush with adjacent surfaces.
d. Finish welded joints to match finish of adjacent surface.

3. Joining:
   a. Miter or butt members at corners.
   b. Where frames members are butted at corners, cut leg of frame member perpendicular to surface, as required for clearance.
4. Anchors:
   a. Where metal fabrications are shown to be preset in concrete, weld 32 x 3 mm (1-1/4 by 1/8 inch) steel strap anchors, 150 mm (6 inches) long with 25 mm (one inch) hooked end, to back of member at 600 mm (2 feet) on center, unless otherwise shown.
5. Cutting and Fitting:
   a. Accurately cut, machine and fit joints, corners, copes, and miters.
   b. Fit removable members to be easily removed.
   c. Design and construct field connections in the most practical place for appearance and ease of installation.
   d. Fit pieces together as required.
   e. Fabricate connections for ease of assembly and disassembly without use of special tools.
   f. Joints firm when assembled.
   g. Conceal joining, fitting and welding on exposed work as far as practical.
   h. Do not show rivets and screws prominently on the exposed face.
   i. The fit of components and the alignment of holes shall eliminate the need to modify component or to use exceptional force in the assembly of item and eliminate the need to use other than common tools.

F. Finish:
1. Finish exposed surfaces in accordance with NAAMM AMP 500 Metal Finishes Manual.
2. Steel and Iron: NAAMM AMP 504.
   a. Zinc coated (Galvanized): ASTM A123, G90 unless noted otherwise.
   b. Surfaces exposed in the finished work:
      1) Finish smooth rough surfaces and remove projections.
      2) Fill holes, dents and similar voids and depressions with epoxy type patching compound.
   c. Shop Prime Painting:
      1) Surfaces of Ferrous metal:

a) Items not specified to have other coatings.
b) Galvanized surfaces specified to have prime paint.
c) Remove all loose mill scale, rust, and paint, by hand or power tool cleaning as defined in SSPC-SP2 and SP3.
d) Clean of oil, grease, soil and other detrimental matter by use of solvents or cleaning compounds as defined in SSPC-SP1.
e) After cleaning and finishing apply one coat of primer as specified in Section 09 91 00, PAINTING.

2) Non ferrous metals: Comply with MAAMM-500 series.

3. Stainless Steel: NAAMM AMP-504 Finish No. 4.

G. Protection:

1. Spot prime all abraded and damaged areas of zinc coating which expose the bare metal, using zinc rich paint on hot-dip zinc coat items and zinc dust primer on all other zinc coated items.

2.5 SAFETY NOSINGS

A. Fed. Spec. RR-T-650, Type C.
1. Aluminum: Class 2, Style 2.
2. Cast iron: Class 4.

B. Fabricate nosings for exterior use from cast aluminum, and nosings for interior use from either cast aluminum or cast iron. Use one Class throughout.

C. Fabricate nosings approximately 100 mm (4 inches) wide with not more than 9 mm (3/8 inch) nose.

D. Provide nosings with integral type anchors spaced not more than 100 mm (4 inches) from each end and intermediate anchors spaced approximately 375 mm (15 inches) on center.

E. Fabricate nosings to extend within 100 mm (4 inches) of ends of concrete stair treads except where shown to extend full width.

2.6 RAILINGS

A. In addition to the dead load design railing assembly to support live load specified.

B. Fabrication General:
1. Provide continuous welded joints, dressed smooth and flush.
2. Standard flush fittings, designed to be welded, may be used.
3. Exposed threads will not be approved.
4. Form handrail brackets to size and design shown.
5. Exterior Post Anchors.
a. Fabricate tube or pipe sleeves with closed ends or plates as shown.
b. Where inserts interfere with reinforcing bars, provide flanged fittings welded or threaded to posts for securing to concrete with expansion bolts.

c. Provide heavy pattern sliding flange base plate with set screws at base of pipe or tube posts.

C. Handrails:

1. Close free ends of rail with flush metal caps welded in place except where flanges for securing to walls with bolts are shown.
2. Make provisions for attaching handrail brackets to wall, posts, and handrail as shown.

D. Stainless Steel Railings:

1. Fabricate from 38 mm (1-1/2 inches) outside diameter stainless steel tubing, ASTM A269, having a wall thickness of 1.6 mm (0.065 inch).
2. Join sections by an internal connector to form hairline joints where field assembled.
3. Fabricate with continuous welded connections.
4. Fabricate brackets of stainless steel to design shown.
5. Fabricate stainless steel sleeves at least 150 mm (6 inches) deep having internal dimensions at least 13 mm (1/2 inch) greater than external dimensions of post.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set work accurately, in alignment and where shown, plumb, level, free of rack and twist, and set parallel or perpendicular as required to line and plane of surface.

B. Items set into concrete.

1. Provide temporary bracing for such items until concrete or masonry is set.
2. Place in accordance with setting drawings and instructions.

C. Field weld in accordance with AWS.

1. Design and finish as specified for shop welding.
2. Use continuous weld unless specified otherwise.

D. Install anchoring devices and fasteners as shown and as necessary for securing metal fabrications to building construction as specified. Power actuated drive pins may be used except for removable items and where members would be deformed or substrate damaged by their use.

E. Spot prime all abraded and damaged areas of zinc coating as specified and all abraded and damaged areas of shop prime coat with same kind of paint used for shop priming.

F. Secure escutcheon plate with set screw.

3.2 SAFETY NOSINGS

A. Except as specified and where preformed rubber treads are shown or specified install safety nosings at the following:

1. Exterior concrete steps.

B. Install flush with horizontal and vertical surfaces.

C. Install nosing to within 100 mm (4 inches) of ends of concrete stair treads, except where shown to extend full width.

3.3 RAILINGS

A. Stainless Steel Railing Posts:
   1. Secure fixed posts to concrete with embed plate.
   2. Secure posts to steel with welds.

B. Anchor to Walls:
   1. Anchor rails to concrete or solid masonry with machine screws through flanged fitting to steel plate.
      a. Anchor steel plate to concrete or solid masonry with expansion bolts.
      b. Anchor steel plate to hollow masonry with toggle bolts.

C. Handrails:
   1. Anchor brackets for metal handrails as detailed.
   2. Install brackets within 300 mm (12 inches) of return of walls, and at evenly spaced intermediate points not exceeding 1200 mm (4 feet) on centers unless shown otherwise.
   3. Expansion bolt to concrete or solid masonry.
   4. Toggle bolt to installed supporting frame wall and to hollow masonry unless shown otherwise.

3.4 CLEAN AND ADJUSTING

A. Adjust movable parts including hardware to operate as designed without binding or deformation of the members centered in the opening or frame and, where applicable, contact surfaces fit tight and even without forcing or warping the components.

B. Clean after installation exposed prefinished and plated items and items fabricated from stainless steel, aluminum and copper alloys, as recommended by the metal manufacture and protected from damage until completion of the project.

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SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies wood blocking, nailers, and rough hardware.

1.2 RELATED WORK

A. Sustainable design requirements: Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Sustainable Design Submittals, as described below:

1. Volatile organic compounds per volume as specified in PART 2 - PRODUCTS.

C. Manufacturer's Literature and Data:

1. Submit data for lumber, panels, hardware and adhesives.
2. Submit data for wood-preservative treatment from chemical treatment manufacturer and certification from treating plants that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
3. Submit data for fire retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
4. For products receiving a waterborne treatment, submit statement that moisture content of treated materials was reduced to levels specified before shipment to project site.

D. Manufacturer's certificate for unmarked lumber.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect lumber and other products from dampness both during and after delivery at site.

B. Pile lumber in stacks in such manner as to provide air circulation around surfaces of each piece.

C. Stack plywood and other board products so as to prevent warping.

D. Locate stacks on well drained areas, supported at least 152 mm (6 inches) above grade and cover with well-ventilated sheds having firmly constructed over hanging roof with sufficient end wall to protect lumber from driving rain.

1.5 QUALITY ASSURANCE:

A. Installer: A firm with a minimum of three (3) years' experience in the type of work required by this section.

1.6 GRADING AND MARKINGS:

A. Any unmarked lumber or plywood panel for its grade and species will not be allowed on VA Construction sites for lumber and material not normally grade marked, provide manufacturer's certificates (approved by an American Lumber Standards approved agency) attesting that lumber and material meet the specified the specified requirements.

1.7 APPLICABLE PUBLICATIONS:

A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in the text by basic designation only.

B. American Society of Mechanical Engineers (ASME):

B18.2.1-12(R2013)..... Square and Hex Bolts and Screws

B18.2.2-10 ..... Square and Hex Nuts

B18.6.1-81(R2008)..... Wood Screws

C. ASTM International (ASTM):

A653/A653M-13..... Steel Sheet Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot Dip Process

D198-14 ..... Test Methods of Static Tests of Lumber in Structural Sizes

D2344/D2344M-13 ..... Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates

F844-07a(R2013) ..... Washers, Steel, Plan (Flat) Unhardened for General Use

F1667-13 ..... Nails, Spikes, and Staples

D. American Wood Protection Association (AWPA):

AWPA Book of Standards

E. Commercial Item Description (CID):

A-A-55615..... Shield, Expansion (Wood Screw and Lag Bolt Self Threading Anchors)

F. Forest Stewardship Council (FSC):

FSC-STD-01-001(Ver. 4-0)FSC Principles and Criteria for Forest Stewardship

G. Military Specification (Mil. Spec.):

MIL-L-19140E..... Lumber and Plywood, Fire-Retardant Treated

H. Environmental Protection Agency (EPA):

40 CFR 59(2014)..... National Volatile Organic Compound Emission Standards for Consumer and Commercial Products

I. U.S. Department of Commerce Product Standard (PS)

PS 1-95..... Construction and Industrial Plywood

PS 20-10..... American Softwood Lumber Standard

PART 2 - PRODUCTS

2.1 LUMBER:

A. Unless otherwise specified, each piece of lumber must bear grade mark, stamp, or other identifying marks indicating grades of material, and rules or standards under which produced.
   1. Identifying marks are to be in accordance with rule or standard under which material is produced, including requirements for qualifications and authority of the inspection organization, usage of authorized identification, and information included in the identification.
   2. Inspection agency for lumber approved by the Board of Review, American Lumber Standards Committee, to grade species used.

B. Lumber Other Than Structural:
   1. Unless otherwise specified, species graded under the grading rules of an inspection agency approved by Board of Review, American Lumber Standards Committee.
   2. Furring, blocking, nailers and similar items 101 mm (4 inches) and narrower Standard Grade; and, members 152 mm (6 inches) and wider, Number 2 Grade.

C. Sizes:
   1. Conforming to PS 20.
   2. Size references are nominal sizes, unless otherwise specified, actual sizes within manufacturing tolerances allowed by standard under which produced.

D. Moisture Content:
   1. Maximum moisture content of wood products is to be as follows at the time of delivery to site.
      a. Boards and lumber 50 mm (2 inches) and less in thickness: 19 percent or less.
      b. Lumber over 50 mm (2 inches) thick: 25 percent or less.

E. Fire Retardant Treatment:
   1. Comply with Mil Spec. MIL-L-19140.
   2. Treatment and performance inspection, by an independent and qualified testing agency that establishes performance ratings.

F. Preservative Treatment:
   1. Do not treat Heart Redwood and Western Red Cedar.
   2. Treat wood members and plywood exposed to weather or in contact with plaster, masonry or concrete, including framing of open roofed structures; sills, sole plates, furring, and sleepers that are less than 610 mm (24 inches) from ground; nailers, edge strips, blocking, crickets, curbs, cant, vent strips and other members provided in connection with roofing and flashing materials.
   3. Treat other members specified as preservative treated (PT).

4. Preservative treat by the pressure method complying with AWPA Book use category system standards U1 and T1, except any process involving the use of Chromated Copper Arsenate (CCA) or other agents classified as carcinogenic for pressure treating wood is not permitted.

2.2 PLYWOOD:

A. Comply with PS 1.

B. Bear the mark of a recognized association or independent inspection agency that maintains continuing control over quality of plywood which identifies compliance by veneer grade, group number, span rating where applicable, and glue type.

C. Sheathing:

1. APA rated Exposure 1 or Exterior; panel grade CD or better.
2. Roof sheathing:
   a. Minimum 9 mm (11/32 inch) thick with span rating 24/0 or 12 mm (15/32 inch) thick with span rating for supports 406 mm (16 inches) on center unless specified otherwise.
   b. Minimum 15 mm (19/32 inch) thick or span rating of 40/20 or 18 mm (23/32 inch) thick or span rating of 48/24 for supports 610 mm (24 inches) on center.

2.3 ROUGH HARDWARE AND ADHESIVES:

A. Anchor Bolts:

1. ASME B18.2.1 and ASME B18.2.2 galvanized, 13 mm (1/2 inch) unless shown otherwise.
2. Extend at least 203 mm (8 inches) into masonry or concrete with ends bent 50 mm (2 inches).

B. Miscellaneous Bolts: Expansion Bolts: C1D A-A-55615; lag bolt, long enough to extend at least 65 mm (2-1/2 inches) into masonry or concrete. Provide 13 mm (1/2 inch) bolt unless shown otherwise.

C. Washers

1. ASTM F844.
2. Provide zinc or cadmium coated steel or cast iron for washers exposed to weather.

D. Screws:

1. Wood to Wood: ASME B18.6.1 or ASTM C1002.
2. Wood to Steel: ASTM C954, or ASTM C1002.

E. Nails:

1. Size and type best suited for purpose unless noted otherwise. Provide aluminum-alloy nails, plated nails, or zinc-coated nails, for nailing wood work exposed to weather and on roof blocking.
2. ASTM F1667:

a. Common: Type I, Style 10.
b. Concrete: Type I, Style 11.
c. Barbed: Type I, Style 26.
d. Masonry: Type I, Style 27.
e. Provide special nails designed for use with ties, strap anchors, framing connectors, joists hangers, and similar items. Nails not less than 32 mm (1-1/4 inches) long, 8d and deformed or annular ring shank.

F. Adhesives:
1. For field-gluing plywood to lumber roof systems: ASTM D3498.
2. Adhesives to have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, (EPA Method 24).

PART 3 - EXECUTION

3.1 INSTALLATION OF FRAMING AND MISCELLANEOUS WOOD MEMBERS:

A. Conform to applicable requirements of the following:
1. AFPA WCD1 for nailing and framing unless specified otherwise.
2. APA for installation of plywood.

B. Fasteners:
1. Nails.
a. Nail in accordance with the Recommended Nailing Schedule as specified in AFPA WCD1 where detailed nailing requirements are not specified in nailing schedule. Select nail size and nail spacing sufficient to develop adequate strength for the connection without splitting the members.
b. For sheathing, select length of nails sufficient to extend 25 mm (1 inch) into supports.
c. Use 8d or larger nails for nailing through 25 mm (1 inch) thick lumber and for toe nailing 50 mm (2 inch) thick lumber.
d. Use 16d or larger nails for nailing through 50 mm (2 inch) thick lumber.
e. Select the size and number of nails in accordance with the Nailing Schedule except for special nails with framing anchors.
f. Nailing Schedule; Using Common Nails:
1) Sheathing:
a) 152 mm (6 inch) wide or less to each joist face nail two (2) 8d nails.
b) Plywood or structural use panel to each stud or joist face nail 8d, at supported edges 152 mm (6 inches) on center and at intermediate supports 254 mm (10 inches) on center. When gluing plywood to joint framing increase nail spacing to 305 mm (12 inches) at supported edges and 508 mm (20 inches) o.c. at intermediate supports.

2. Bolts:
    a. Fit bolt heads and nuts bearing on wood with washers.
    b. Countersink bolt heads flush with the surface of nailers.
    c. Embed in concrete and solid masonry or provide expansion bolts. Special bolts or screws designed for anchor to solid masonry or concrete in drilled holes may be used.
    d. Provide toggle bolts to hollow masonry or sheet metal.
    e. Provide bolts to steel over 2.84 mm (0.112 inch, 11 gage) in thickness. Secure wood nailers to vertical structural steel members with bolts, placed one at ends of nailer and 610 mm (24 inch) intervals between end bolts. Provide clips to beam flanges.
3. Drill Screws to steel less than 2.84 mm (0.112 inch) thick.
    a. ASTM C1002 for steel less than 0.84 mm (0.033 inch) thick.
    b. ASTM C954 for steel over 0.84 mm (0.033 inch) thick.
4. Power actuated drive pins may be provided where practical to anchor to solid masonry, concrete, or steel.
5. Do not anchor to wood plugs or nailing blocks in masonry or concrete. Provide metal plugs, inserts or similar fastening.
6. Screws to Join Wood:
    a. Where shown or option to nails.
    b. ASTM C1002, sized to provide not less than 25 mm (1 inch) penetration into anchorage member.
    c. Spaced same as nails.

C. Cut notch, or bore in accordance with AFPA WCD1 passage of ducts wires, bolts, pipes, conduits and to accommodate other work. Repair or replace miscut, misfit or damaged work.

D. Blocking Nailers, and Furring:
1. Install furring, blocking, nailers, and grounds where shown.
2. Provide longest lengths practicable.
3. Provide fire retardant treated wood blocking where shown at openings and where shown or specified.
4. Layers of Blocking or Plates:
    a. Stagger end joints between upper and lower pieces.
    b. Nail at ends and not over 610 mm (24 inches) between ends.
    c. Stagger nails from side to side of wood member over 127 mm (5 inches) in width.

E. Sheathing:
1. Provide plywood or structural-use panels for sheathing.
2. Lay panels with joints staggered, with edge and ends 3 mm (1/8 inch) apart and nailed over bearings as specified.

3. Set nails not less than 9 mm (3/8 inch) from edges.
4. Install 50 mm by 101 mm (2 inch by 4 inch) blocking spiked between joists, rafters and studs to support edge or end joints of panels.

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SECTION 07 01 50.19
PREPARATION FOR RE-ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roofing membrane and selective roofing system component removal for new roof membrane installation.
2. Existing roofing membrane preparation for new roofing membrane installation.

B. Existing Roofing System: EPDM. System components include:

1. Aggregate ballast.
2. Roofing membrane.
3. Cover board.
4. Roof insulation.
5. Vapor retarder.

1.2 RELATED WORK

A. Section 06 10 00, ROUGH CARPENTRY: Replacement Roof Deck and Parapet Sheathing.

B. Section 07 53 23, ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING: New Roofing System.

C. Section 07 60 00, FLASHING AND SHEET METAL: Sheet Metal Counterflashing.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American National Standards Institute/Single-Ply Roofing Institute (ANSI/SPRI):

FX-1 (R2016)..... Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners.

C. American Society for Nondestructive Testing (ASNT):

SNT-TC-1A (2019) ..... Personnel Qualification and Certification for Nondestructive Testing.

D. ASTM International (ASTM):

C208-12(2017)e2 ..... Cellulosic Fiber Insulating Board.

C578-19..... Rigid, Cellular Polystyrene Thermal Insulation.

C728-17a..... Perlite Thermal Insulation Board.

C1177/C1177M-17 ..... Glass Mat Gypsum Substrate for Use as Sheathing.

C1278/C1278M-17 ..... Standard Specification Fiber-Reinforced Gypsum Panel.

D4263-83(2018) ..... Indicating Moisture in Concrete by the Plastic Sheet Method.

1.4 PREINSTALLATION MEETINGS

A. Conduct preinstallation meeting minimum 30 days before beginning Work of this section. Meeting may be held in conjunction with preinstallation meetings required by other sections.

1. Required Participants:

a. Contracting Officer's Representative.
b. Inspection and Testing Agency.
c. Contractor.
d. Installer.
e. Manufacturer's field representative.
f. Other installers responsible for adjacent and intersecting work.

2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
   a. Removal and installation schedule.
   b. Removal and installation sequence.
   c. Preparatory work.
   d. Protection before, during, and after installation.
   e. Removal and installation.
   f. Temporary roofing including daily terminations.
   g. Transitions and connections to other work.
   h. Inspecting and testing.
   i. Other items affecting successful completion.
3. Document and distribute meeting minutes to participants to record decisions affecting installation.

1.5 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:
   1. Show size, configuration, and installation details.

C. Manufacturer's Literature and Data:
   1. Description of each product.
   2. Description of temporary roof system and components.
   3. List of patching materials.
   4. Temporary roofing installation instructions and removal instructions.
   5. Preparation instructions to receive new roofing.
   6. Existing roofing warrantor's instructions.

D. Photographs: Document existing conditions potentially affected by roofing operations before work begins.

E. Field Inspection Reports:
   1. Certify warrantor inspected completed roofing and existing warranty remains in effect.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Same installer as Section 07 53 23, ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING.
2. Approved by existing roofing system warrantor when work affects existing roofing system under warranty.

1.7 FIELD CONDITIONS

A. Building Occupancy: Perform work to minimize disruption to normal building operations.
   1. Provide notice minimum 72 hours before beginning activities affecting normal building operations.

B. Existing Roofing Available Information:
   1. Examine available information before beginning work of this section.

C. Weather Limitations: Proceed with reroofing preparation only during dry weather conditions as specified for new roofing installation in Section 07 53 23, ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING.
   1. Remove only as much roofing in one day as can be made watertight in same day.

D. Hazardous materials are not expected in existing roofing system.
   1. Do not disturb suspected hazardous materials. When discovered, notify Contracting Officer's Representative.
   2. Hazardous materials discovered during execution of the work will be removed by Government as work of a separate contract.

1.8 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

B. Existing Warranties: Perform work to maintain existing roofing warranty in effect.
   1. Notify warrantor before beginning, and upon completion of reroofing.
   2. Obtain warrantor's instructions for maintaining existing warranty.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Patching Materials: Match existing roofing system materials.

B. Plywood Sheathing: See Section 06 10 00, ROUGH CARPENTRY.

C. Metal Flashing: See Section 07 60 00, FLASHING AND SHEET METAL.

D. Temporary Protection Materials:
   1. Expanded Polystyrene (EPS) Insulation: ASTM C578-19.
   2. Plywood: NIST DOC PS 1-19, Grade CD Exposure 1-18.
   3. Oriented Strand Board (OSB): NIST DOC PS 2-18, Exposure 1.

E. Temporary Roofing System Materials: Contractor's option.

F. Fasteners: Type and size required by roof membrane manufacturer to resist wind uplift.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing roofing system indicated to remain.

1. Cover roof membrane with temporary protection materials without impeding drainage.
2. Limit traffic and material storage to protected areas.
3. Maintain temporary protection until replacement roofing is completed.

C. Protect existing construction and completed work from damage.

D. Protect landscaping from damage.

E. Maintain access to existing walkways and adjacent occupied facilities.

F. Coordinate use of rooftop fresh air intakes with Contracting Officer's Representative to minimize effect on indoor air quality.

G. Ensure temporary protection materials are available for immediate use in case of unexpected rain.

H. Ensure roof drainage remains functional.

I. Keep drainage systems clear of debris.

J. Prevent water from entering building and existing roofing system.

K. Coordinate rooftop utilities remaining active during roofing work with Contacting Officer's Representative.

3.2 RE-ROOFING PREPARATION - GENERAL

A. Notify Contacting Officer's Representative of planned operations, daily.

1. Identify location and extent of roofing removal.
2. Request authorization to proceed.

3.3 OVERBURDEN REMOVAL

A. Remove aggregate ballast.

1. Store aggregate ballast for reuse.

B. Remove loose aggregate from bituminous membrane surface.

C. Remove insulation from protected roofing membrane.

1. Store insulation and drainage board for reuse.

3.4 PARTIAL ROOFING SYSTEM REMOVAL

A. Remove existing roofing completely, exposing structural roof deck at locations and to extent indicated on drawings.

3.5 DECK PREPARATION

A. Inspect structural roof deck after roofing system removal.

B. Concrete Roof Decks:

1. Visually confirm concrete roof deck is dry.

2. Perform moisture test according to ASTM D4263-83(2018) each day for each separate roof area.
    a. Proceed with roofing work only when moisture is not observed.

3.6 TEMPORARY ROOFING

A. Install temporary roofing to maintain building watertight.

B. Remove temporary roofing before installing new roofing.

3.7 BASE FLASHING REMOVAL

A. Expose base flashings to permit removal.
    1. Remove cap flashing and store for reuse.
    2. Metal Copings: Remove decorative cap and store for reuse.

B. Remove existing base flashings.
    1. Clean substrates to receive new flashings.

C. Replace counterflashings damaged during removal.
    1. Counterflashings: See Section 07 60 00 FLASHING AND SHEET METAL.

3.8 FIELD QUALITY CONTROL

A. Field Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.
    1. Fastener Pull Out Tests: ANSI/SPRI FX-1(2016).

B. Existing Roofing System Warrantor Services:
    1. Inspect reroofing preparation and roofing installation to verify compliance with existing warranty conditions.
    2. Submit reports of field inspections, and supplemental instructions issued during inspections.

3.9 DISPOSAL

A. Collect waste materials in containers.

B. Remove waste materials from project site, regularly, to prevent accumulation.

C. Legally dispose of waste materials.

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SECTION 07 13 52
MODIFIED BITUMINOUS SHEET WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modified bituminous sheet material used for exterior below grade waterproofing and split slab waterproofing.

1.2 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. Federal Specifications (Fed. Spec.):

UU-B-790A Notice 2 v04-1992 ..... Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent, and Fire Resistant).

C. ASTM International (ASTM):

C578-19 ..... Rigid, Cellular Polystyrene Thermal Insulation.

D41/D41M-11(2016) ..... Asphalt Primer Used in Roofing, Dampproofing and Waterproofing.

D4586/D4586M-07(2018) ..... Asphalt Roof Cement, Asbestos-Free.

D6380/D6380M-03(2018) ..... Asphalt Roll Roofing (Organic Felt).

D. American Hardboard Association (AHA):

A135.4-(r2020) ..... Basic Hardboard.

1.3 PREINSTALLATION MEETINGS

A. Conduct preinstallation meeting at project site minimum 30 days before beginning Work of this section.

1. Required Participants:
   a. Contracting Officer's Representative.
   b. Inspection and Testing Agency.
   c. Contractor.
   d. Installer.
   e. Other installers responsible for adjacent and intersecting work, including substrate, and flashing installers.
2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
   a. Installation schedule.
   b. Installation sequence.
   c. Preparatory work.
   d. Protection before, during, and after installation.
   e. Installation.
   f. Terminations.

g. Transitions and connections to other work.
h. Inspecting and testing.
i. Other items affecting successful completion.
j. Document and distribute meeting minutes to participants to record decisions affecting installation.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
B. Submittal Drawings: Show size, configuration, and installation details.
C. Manufacturer's Literature and Data:
1. Description of each product.
2. Installation instructions.
D. Warranty.
E. Samples:
1. Waterproofing and Flashing Sheet: 200 mm (8 inch) square, each type and color.
F. Test reports: Certify products comply with specifications.
G. Certificates: Certify products comply with specifications.
H. Qualifications: Substantiate qualifications comply with specifications:
1. Installer with project experience list.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
1. Regularly installs specified products.
2. Installed specified products with satisfactory service on five similar installations for minimum five years.
3. Project Experience List: Provide contact names and addresses for completed projects.

1.6 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.
B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, color, production run number, and manufacture date.
C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

A. Store products indoors in dry, weathertight conditioned facility.
B. Protect products from damage during handling and construction operations.

1.8 FIELD CONDITIONS

A. Environment:

1. Product Temperature: Minimum 4 degrees C (40 degrees F) for minimum 48 hours before installation.
2. Weather Limitations: Install waterproofing only during dry current and forecasted weather conditions.

1.9 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

B. Manufacturer's Warranty: Warrant waterproofing system against material and manufacturing defects and agree to repair any leak caused by a defect in the waterproofing system materials or workmanship of the installer.

1. Warranty Period: 10 years.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Waterproofing System: Modified bituminous sheet material for exterior below grade and split slab waterproofing.

2.2 PRODUCTS - GENERAL

A. Provide each product from one manufacturer.

B. Sustainable Construction Requirements:

1. Insulation Recycled Content: Rigid Foam: 9 percent total recycled content, minimum.

2.3 BITUMINOUS SHEET

A. Cold applied waterproofing membrane composed primarily of modified bituminous material prefabricated in sheet form designed for below grade exterior and split slab waterproofing. Sheet reinforced with fibers at manufacturer's option.

B. Thickness: Not less than 1.5 mm (60 mils), plus or minus 0.13 mm (5 mils), and bonded to 0.1 mm (4 mil) thick plastic sheet.

C. Provide release sheet to prevent bonding of bituminous sheet to itself.

2.4 PROTECTION MATERIAL

A. Polystyrene Insulation: ASTM C578, Type I or VIII, 13 mm (1/2 inch) minimum thickness.

B. Hardboard: AHA A135.4, Service Type, 6 mm (1/4 inch) thick.

C. Waterproofed Building Paper: Fed. Spec. UU-B-790A Notice 2, Type I, Grade C.

D. Roll Roofing: ASTM D6380/D6380M, Class S (smooth), Type III with minimum net mass per unit area of roofing, 2495 g/sq. m (51 lbs./100 sq. ft.).

2.5 ACCESSORIES

A. Patching Compound: Factory-prepared, non-shrinking, fast-setting, cementitious adhesive compound containing no ferrous metal or oxide.

B. Primer: ASTM D41/D41M.

C. Roof Cement: ASTM D4586/D4586M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.
   1. Concrete surfaces cured minimum time recommended by waterproofing manufacturer.
   2. Substrate to be dry as recommended by waterproofing manufacturer.

B. Protect existing construction and completed work from damage.

C. Correct substrate deficiencies.
   1. Fill voids, joints, and cracks with patching compound.

D. Clean substrates. Remove contaminants capable of preventing full adhesion.

E. Priming:
   1. Prime concrete and masonry surfaces.
   2. Application method, amount of primer and condition or primer before installation of bituminous sheet as recommended by primer manufacturer.
   3. Reprime when required according to manufacturer's instructions.

3.2 INSTALLATION - GENERAL

A. Install products according to manufacturer's instructions and approved submittal drawings.
   1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

3.3 WATERPROOFING INSTALLATION

A. Bituminous Sheet Installation:
   1. Remove release sheet before application.
   2. Lay bituminous sheet from low point to high point so laps shed water.
   3. Treat expansion, construction and control joints and evident working cracks as expansion joints. Apply bituminous sheet in double thickness over joint by first applying a strip of bituminous sheet minimum 200 mm (8 inches) wide, centered over joint.
   4. Lap seams minimum 50 mm (2 inches).
   5. Lay succeeding sheet with laps, and roll or press into place.
   6. Repair misaligned or inadequately lapped seams according to manufacturer’s instructions.
   7. Seal seams and terminations according to sheet manufacturer’s instructions.

B. Corner Treatment:
   1. At inside and outside corners, apply double cover using an initial strip minimum 280 mm (11 inches) wide, centered along axis of corner.
   2. Cover each strip completely by the regular application of bituminous sheet.
   3. Provide a fillet or cant on inside corners.
   4. Form cants using patching compound.
   5. Do not use wood, fiber, and insulating materials for cants.

C. Projection Treatment:
   1. Apply a double layer of bituminous sheet around pipes and similar projections at least 150 mm (6 inches) wide.

D. Patching:
   1. Repair tears, punctures, air blisters, and inadequately lapped seams, according to manufacturer’s instructions before protection course is applied.

E. Permanent Protection:
   1. Vertical Surfaces:
      a. Install hardboard, polystyrene insulation, or roll roofing protection material.
      b. Extend protection full height from footing to top of backfill.
      c. If graded backfill is used, use roll roofing or hardboard.
   2. Horizontal Surfaces:
      a. Install roll roofing protection under concrete wearing courses.
      b. Install roll roofing, hardboard, or polystyrene insulation under earth backfill.
      c. Where no concrete wearing course occurs or when surfaces will bear heavy traffic and will not immediately be covered with a wearing course, use protection specified for vertical surfaces.

F. Temporary Protection:
   1. When waterproofing materials are subjected to damage by sunlight and cannot be immediately protected as specified, protect waterproofing materials by waterproof building paper or suitable coating approved by manufacturer of waterproofing system used.

3.4 FIELD QUALITY CONTROL

A. Testing:
   1. Before any protection or wearing course is applied, test all horizontal applications of waterproofing with a minimum of 25 mm (1 inch) head of water above highest point and leave for 24 hours.
   2. Mark leaks and repair when waterproofing is dry.
   3. Certify, to Contracting Officer's Representative, that water tests have been made and that areas tested were found watertight.

B. Inspection:
   1. Do not cover waterproofed surfaces by other materials or backfill until work is approved by Contracting Officer's Representative.

3.5 CLEANING

A. Remove excess adhesive before adhesive sets.

B. Clean exposed waterproofing surfaces. Remove contaminants and stains.

3.6 PROTECTION

A. Protect waterproofing from construction operations.

B. Remove protective materials immediately before acceptance.

C. Repair damage.

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SECTION 07 22 00
ROOF AND DECK INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

B. Roof and deck insulation, substrate board, vapor retarder, and cover board on existing concrete deck substrates ready to receive roofing or waterproofing membrane.

C. Repairs and alteration work to existing roof insulation.

1.2 RELATED WORK

A. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS: Non-Flooring Adhesives and Sealants VOC Limits.

B. Section 06 10 00, ROUGH CARPENTRY: Blocking and Edge Strips.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American Society of Civil Engineers

ASCE 7-16..... Minimum Design Loads and Associated Criteria for Buildings and Other Structures

C. American Society of Heating, Refrigeration and Air Conditioning (ASHRAE):

Standard 90.1-13..... Energy Standard for Buildings Except Low-Rise Residential Buildings.

D. ASTM International (ASTM):

C726-17 ..... Mineral Fiber Roof Insulation Board.

C728-17a ..... Perlite Thermal Insulation Board.

C1177/C1177M-17 ..... Glass Mat Gypsum Substrate for Use as Sheathing.

C1289-19 ..... Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.

D41/D41M-11 (2016).... Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.

D312/D312M-16a ..... Asphalt Used in Roofing.

D2178/D2178M-15a ..... Asphalt Glass Felt Used in Roofing and Waterproofing.

D4586/D4586M-07(2018) Asphalt Roof Cement, Asbestos-Free.

E84-20 ..... Surface Burning Characteristics of Building Materials.

F1667-18a ..... Driven Fasteners: Nails, Spikes, and Staples.

E. National Roofing Contractors Association (NRCA):

Manual-15..... The NRCA Roofing Manual: Membrane Roof Systems-2019.

F. UL LLC (UL):

Listed Online Certifications Directory.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:

1. Show size, configuration, and installation details.
    a. Nailers and terminations.
    b. Layout of insulation showing slopes, tapers, penetrations, and edge conditions.

C. Manufacturer's Literature and Data:

1. Description of each product.

D. Sustainable Construction Submittals:

1. Recycled Content: Identify post-consumer and pre-consumer recycled content percentage by weight.
2. Low Pollutant-Emitting Materials:
    a. Show volatile organic compound types and quantities.

E. Qualifications: Substantiate qualifications meet specifications.

1. Installer.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Same installer as Division 07 roofing section installer.

1.6 DELIVERY

A. Comply with recommendations of NRCA Manual.

B. Deliver products in manufacturer's original sealed packaging.

C. Mark packaging, legibly. Indicate manufacturer's name or brand, type, and manufacture date.

D. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

A. Comply with recommendations of NRCA Manual.

B. Store products indoors in dry, weathertight facility.

C. Protect products from damage during handling and construction operations.

1.8 FIELD CONDITIONS

A. Environment: Install products when existing and forecasted weather permit installation according to manufacturer's instructions.

1.9 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

B. Manufacturer's Warranty: Warrant substrate board, vapor retarder, insulation, and cover board against material and manufacturing defects as part of Division 07 roofing system warranty.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Insulation Thermal Performance:
   1. Overall Average R-Value: maximum possible within existing roof insulation thickness.

B. Fire and Wind Uplift Resistance: Provide roof insulation complying with requirements specified in Division 07 roofing section.

2.2 PRODUCTS - GENERAL

A. Provide each product from one manufacturer.

B. Sustainable Construction Requirements:
   1. Insulation Recycled Content:
      a. Mineral Fiber: 75 percent total recycled content, minimum.
      b. Fiberglass: 20 percent total recycled content, minimum.
      c. Perlite Composite Board: 23 percent post-consumer recycled content, minimum.
      d. Rigid Foam: 9 percent total recycled content, minimum.
      e. Glass Fiber Reinforced Rigid Foam: 6 percent total recycled content, minimum.
   2. Low Pollutant-Emitting Materials: Comply with VOC limits specified in Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for the following products:
      a. Non-flooring adhesives and sealants.

2.3 ADHESIVES

A. Primer: ASTM D41/D41M.

B. Asphalt: ASTM D312, Type III or IV for vapor retarders and insulation.

C. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphaltic, asbestos-free, cold-applied adhesive formulated to adhere roof insulation to substrate or to another insulation layer.

D. Bead-Applied Urethane Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to adhere roof insulation to substrate or to another insulation layer.

E. Full-Spread Applied Urethane Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to adhere roof insulation to substrate or to another insulation layer.

F. Roof Cement: Asbestos free, ASTM D2822/D2822M, Type I or Type II; or, ASTM D4586/D4586M, Type I or Type II.

2.4 ROOF AND DECK INSULATION

A. Roof and Deck Insulation, General: Preformed roof insulation boards approved by roofing manufacturer.

B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, faced with glass fiber reinforced cellulosic felt facers on both major surfaces of the core foam.

C. Cellular Glass Board Insulation: ASTM C552, Type IV, kraft-paper sheet faced.

D. Perlite Board Insulation: ASTM C728, expanded perlite particles, selected binders, and cellulosic fibers with surface treated to reduce bitumen absorption.

E. Tapered Roof Insulation System:

1. Fabricate of mineral fiberboard, polyisocyanurate, perlite board, or cellular glass. Use only one insulation material for tapered sections. Use only factory-tapered insulation.
2. Cut to provide high and low points with crickets and slopes to scupper locations.
3. Minimum thickness of tapered sections; 38 mm (1-1/2 inch).
4. Minimum slope 1/48 (1/4 inch per 12 inches).

2.5 INSULATION ACCESSORIES

A. Glass (Felt): ASTM D2178/D2178M, Type VI, heavy duty ply sheet.

B. Cants and Tapered Edge Strips:

1. Tapered Edge Strips: 1/12 (1 inch per 12 inches), from 0 mm (0 inches), 300 mm to 450 mm (12 inches to 18 inches) wide.
   a. Mineral Fiberboard: ASTM C726.
   b. Perlite Board: ASTM C728.

C. Vapor Retarder:

1. Glass-Fiber Felts: ASTM D2178/D2178M, Type IV, asphalt impregnated.
2. Self-Adhering Sheet Vapor Retarder: ASTM D1970/D1970M, minimum 1.0 mm (40 mils) thick membrane of HDPE film fully coated with asphalt adhesive, or 0.76 to 1.0 mm (30 to 40 mils) thick membrane of butyl rubber based adhesive backed by a layer of high density cross-laminated polyethylene; maximum permeance rating of 6 ng/Pa/s/sq. m (0.1 perms).

D. Cover Board:

1. Glass-Mat, Water-Resistant Gypsum Roof Board: ASTM C1177/C1177M, 13 mm (1/2 inch) thick, factory primed.

2.6 ACCESSORIES

A. Fasteners: Corrosion-resistant carbon steel fasteners and galvalume-coated steel or plastic round plates for fastening substrate board and insulation to roof deck.

B. Nails: ASTM F1667; type to suit application.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Comply with requirements of Division 07 roofing section.

3.2 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing construction and completed work from damage.

3.3 INSTALLATION - GENERAL

A. Install products according to manufacturer's instructions.
   1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.
B. Comply with requirements of UL for insulated steel roof deck.
C. Attach substrate board and other products to meet requirements of Division 07 roofing section.

3.4 VAPOR RETARDER INSTALLATION

A. Vapor Retarder Installation, General:
   1. Install continuous vapor retarder on roof decks where indicated.
   2. At vertical surfaces, turn up vapor retarder to top of insulation or base flashing.
   3. Seal penetrations through vapor retarder with roof cement to prevent moisture entry from below.
B. Cast in Place Concrete Decks, Except Insulating Concrete:
   1. Prime deck as specified.
   2. Apply two plies of asphalt saturated felt mopped down to deck.
C. Precast Concrete Unit Decks Without Concrete Topping:
   1. Prime deck as specified.
   2. Apply two plies of asphalt saturated felt.
   3. Mop to deck, keeping bitumen 100 mm (4 inches) away from joints of precast units. Bridge joints with felt. Mop between plies as specified.

3.5 INSULATION INSTALLATION

A. Insulation Installation, General:
   1. Use same insulation as existing for roof repair and alterations unless specified otherwise.
B. Insulation Thickness:
   1. When actual insulation thickness differs from drawings, coordinate alignment and location of roof drains, flashing, gravel stops, fascias and similar items.
   2. Where tapered insulation is used, maintain insulation thickness at high points and roof edges shown on drawings.
      a. Low Point Thickness: Minimum 38 mm (1-1/2 inches).
   3. Use minimum two layers of insulation when required thickness is 68 mm (2.7 inch) or greater.
C. Lay insulating units with close joints, in regular courses and with end joints staggered.
   1. Stagger joints between layers minimum 150 mm (6 inches).
D. Lay units with long dimension perpendicular to the rolled (longitudinal) direction of the roofing felt.
E. Seal cut edges at penetrations and at edges against blocking with bitumen or roof cement.

F. Cut to fit tightly against blocking or penetrations.

G. Cover all insulation installed on the same day; comply with temporary protection requirements of Division 07 roofing section.

H. Installation Method:

1. Adhered Insulation:
    a. Prime substrate as required.
    b. Set each layer of insulation firmly in solid mopping of hot asphalt.
    c. Set each layer of insulation firmly in ribbons of bead-applied insulation adhesive.
    d. Set each layer of insulation firmly in uniform application of full-spread insulation adhesive.
2. Mechanically Fastened Insulation:
    a. Fasten insulation according to requirements in Division 07 roofing section.
    b. Fasten insulation to resist uplift pressures specified in Division 07 roofing section and ASCE-7.
3. Mechanically Fastened and Adhered Insulation:
    a. Fasten first layer of insulation according to "Mechanically Fastened Insulation" requirements.
    b. Fasten each subsequent layer of insulation according to "Adhered Insulation" requirements.

3.6 COVER BOARD INSTALLATION

A. Install cover boards over insulation with long joints in continuous straight lines with staggered end joints.

B. Offset cover board joints from insulation joints 150 mm (6 inches), minimum.

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SECTION 07 24 00
EXTERIOR INSULATION AND FINISH SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Direct exterior finish systems (DEFS).
2. Unit finishes as accent trim within DEFS.

1.2 RELATED WORK

A. Section 03 30 00, CAST-IN-PLACE CONCRETE.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. ASTM International (ASTM):

B117-19 ..... Operating Salt Spray (Fog) Apparatus.

C67/C67M-20 ..... Sampling and Testing Brick and Structural Clay Tile.

C177-19 ..... Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

C666/C666M-15 ..... Resistance of Concrete to Rapid Freezing and Thawing.

C920-18 ..... Elastomeric Joint Sealants.

D968-17 ..... Abrasion Resistance of Organic Coatings by Falling Abrasive.

D2794-93(2019) ..... Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

E84-20 ..... Surface Burning Characteristics of Building Materials.

E96/E96M-16..... Water Vapor Transmission of Materials.

E119-20 ..... Fire Tests of Building Construction and Materials.

E330/E330M-14..... Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

E331-00(2016)..... Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Wall by Uniform Static Air Pressure Differences.

E2486/E2486M-13(2018) Impact Resistance of Class PB and PI Exterior Insulation and Finish Systems (EIFS).

G90-17..... Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight.

1.4 PREINSTALLATION MEETINGS

A. Conduct preinstallation meeting minimum 30 days before beginning Work of this section.

1. Required Participants:
   a. Contracting Officer's Representative.
   b. Inspection and Testing Agency.

c. Contractor.
d. Installer.
e. Other installers responsible for adjacent and intersecting work, including air barriers and sealants.

2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
   a. Installation schedule.
   b. Installation sequence.
   c. Preparatory work.
   d. Protection before, during, and after installation.
   e. Installation.
   f. Terminations.
   g. Transitions and connections to other work.
   h. Inspecting and testing.
   i. Other items affecting successful completion.
3. Document and distribute meeting minutes to participants to record decisions affecting installation.

1.5 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Literature and Data:
   1. Description of each product.
   2. Installation instructions.
   3. Warranty.
   4. Standard color chart.

C. Samples: Two 300 mm (1 foot) square samples of simulated synthetic stucco finishes over cement board identical to proposed installation in thickness, color, texture and workmanship.

D. Test reports: Certify each product and complete system complies with specifications.

E. Qualifications: Substantiate qualifications comply with specifications.
   1. Installer with project experience list.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Regularly installs specified products.
   2. Installed specified products with satisfactory service on five similar installations for minimum five years.
      a. Project Experience List: Provide contact names and addresses for completed projects.

1.7 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.

B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, production run number, and manufacture date.

C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.8 STORAGE AND HANDLING

A. Store products indoors in dry, weathertight conditioned facility.

B. Protect products from damage during handling and construction operations.

1.9 FIELD CONDITIONS

A. Environment: Unless greater temperature is required by system manufacturer, install products only when ambient air temperature is minimum 7 degrees C (45 degrees F) and rising and predicted to persist for 24 hours after installation.

1.10 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

B. Manufacturer's Warranty: Warrant EIFS system materials against material and manufacturing defects.

1. Warranty Period: 10 years.

PART 2 - PRODUCTS

2.1 PRODUCTS - GENERAL

A. Provide system components from one manufacturer and from one production run.

2.2 DIRECT EXTERIOR FINISH SYSTEMS (DEFS)

A. Description: Synthetic stucco base coat and simulated stucco finish coat applied directly to substrate.

B. Stucco Finish:

1. Base coat: Ready-to-mix, Portland cement mortar containing dry latex polymers.
2. Finish coat: Pre-colored, ready-mixed, polymeric coating.
3. Color: Closest match to existing adjacent finish system color, selected from manufacturer’s standard colors.

C. Performance Requirements:

1. Surface Burning Characteristics: When tested according to ASTM E84.
   a. Flame Spread Rating: 25 maximum.
   b. Smoke Developed Rating: 450 maximum.
2. Abrasion Resistance: ASTM D968; 500 liters of light smoothing sand with no loss of film integrity.
3. Bond Strength (with gypsum board sheathing): ASTM C297/C297M, 345 kPa (50 psi).
4. Salt Spray Resistance: ASTM B117; 300 hours exposure with no deleterious effects.

5. Freeze/Thaw Resistance (with gypsum board sheathing): ASTM C666/C666M; 100 Cycles with no deterioration, no delamination.
6. Accelerated Weathering: ASTM G90; 2000 hours with no deterioration.
7. Rapid Deformation: ASTM D2794; No cracking or impact failure.

D. Accessories:

1. Trim, control joints and corner beads as recommended by DEFS manufacturer.
2. Joint Reinforcement:
   a. Reinforcing tape: Minimum 100 mm (4 inch) wide, polymer coated, open mesh glass fiber tape.
   b. Tape embedding material: Ready-to-mix Portland cement mortar base coat containing dry latex polymers.
3. Sealant: ASTM C920, Class 50 with 100 percent recovery. Type, grade and use as recommended by the sealant manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing construction and completed work from damage.

C. Notify Contracting Officer's Representative in writing of conditions detrimental to proper completion of work.

D. Do not proceed with work until unsatisfactory conditions are corrected.

3.2 INSTALLATION - GENERAL

A. Install products according to manufacturer's instructions.

1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

3.3 CONTROL JOINT INSTALLATION

A. See drawings for location of building control joints and surface control joints.

B. Install surface control joints as follows:

1. Direct Exterior Finish: Install at 6 meters (20 feet) maximum on center, both directions, erecting continuous vertical joints first at building expansion joints, intersection of dissimilar substrates or finishing materials where concentrated stresses or movement is anticipated. Leave 13 mm (1/2inch) minimum continuous gap between board panels to receive control joint.

3.4 SEALANT INSTALLATION

A. Direct Exterior Finish System: Apply sealant at intersections of substrate with windows, doors, control joints, other openings and locations as shown on drawings.

B. Do not apply sealant in locations intended for water drainage.

3.5 SYNTHETIC STUCCO FINISH INSTALLATION

A. Joint Reinforcement: Pre-fill concrete joints and imperfections with synthetic stucco base coat mixed according to manufacturer's directions.
   1. Immediately embed reinforcing tape into wet base coat and tightly trowel to board surface to avoid crowning joints.
   2. Cure for four hours minimum before applying base coat.

B. Base Coat: Uniformly apply base coat minimum 1.6 mm (1/16 inch) thick, smooth and flat over entire surface including joints and trim. Dampen substrate surface as necessary under rapid drying conditions.
   1. Embed reinforcing fabric in basecoat while wet and cover with basecoat material so fabric pattern is not visible.

C. Finish: Trowel apply exterior finish to base coat texturing surface as specified to uniform thickness of 1.5 mm to 5 mm (1/16 inch to 3/16 inch).
   1. Dampen base coat as necessary under rapid drying conditions.
   2. Extend finish so breaks between batches occur at surface breaks such as corners, control joints, windows, and other interruptions.

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SECTION 07 53 23
ETHYLENE-PROPYLENE-DIENE-MONOMER ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ethylene Propylene Diene Monomer (EPDM) sheet roofing ballasted to insulated concrete roof deck.

1.2 RELATED WORK

A. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS: Non-Flooring Adhesives and Sealants VOC Limits.

B. Section 07 01 50.19, PREPARATION FOR REROOFING: Preparation of Existing Membrane Roofs and Repair Areas.

C. Section 07 22 00, ROOF AND DECK INSULATION: Substrate Board, Vapor Retarder, Roof Insulation, and Cover Board.

D. Section 07 60 00, FLASHING AND SHEET METAL: Sheet Metal Counterflashing.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American National Standards Institute/Single-Ply Roofing Institute (ANSI/SPRI):

FX-1-16..... Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners.

RP-4 2019..... Wind Design Standard for Ballasted Single-ply Roofing Systems.

C. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):

7-16..... Minimum Design Loads For Buildings and Other Structures.

D. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):

90.1-13..... Energy Standard for Buildings Except Low-Rise Residential Buildings.

E. ASTM International (ASTM):

A276/A276M-17..... Stainless Steel Bars and Shapes.

B209-14 ..... Aluminum and Aluminum-Alloy Sheet and Plate.

B209M-14 ..... Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

C140/C140M-20a ..... Sampling and Testing Concrete Masonry Units and Related Units.

C1371-15..... Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.

D751-19 ..... Standard Test Methods for Coated Fabrics.

D1248-16 ..... Polyethylene Plastics Extrusion Materials for Wire and Cable.

D1876-08(2015)e1 ..... Peel Resistance of Adhesives (T-Peel Test).

D2103-15 ..... Polyethylene Film and Sheeting.

D2240-15e1 ..... Rubber Property-Durometer Hardness.
D3884-09(2017) ..... Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method).
D4263-83(2018) ..... Indicating Moisture in Concrete by the Plastic Sheet Method.
D4586/D4586M-07(2018) Asphalt Roof Cement, Asbestos-Free.
D4637/D4637M-15 ..... EPDM Sheet Used In Single-Ply Roof Membrane.
E96/E96M-16..... Water Vapor Transmission of Materials.
E408-13(2019)..... Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
G21-15..... Resistance of Synthetic Polymeric Materials to Fungi.

F. Federal Specifications (Fed. Spec.):
UU-B-790A ..... Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent and Fire Resistant).

G. National Roofing Contractors Association (NRCA):
Manual-19..... The NRCA Roofing Manual: Membrane Roof Systems.

H. UL LLC (UL):
580-06..... Tests for Uplift Resistance of Roof Assemblies.
1897-20..... Uplift Tests for Roof Covering Systems.

I. U.S. Department of Commerce National Institute of Standards and Technology (NIST):
DOC PS 1-19..... Structural Plywood.
DOC PS 2-18..... Performance Standard for Wood-Based Structural-Use Panels.

1.4 PREINSTALLATION MEETINGS

A. Conduct preinstallation meeting minimum 30 days before beginning Work of this section. Meeting may be held in conjunction with preinstallation meetings required by other sections.
1. Required Participants:
a. Contracting Officer's Representative.
b. Inspection and Testing Agency.
c. Contractor.
d. Installer.
e. Manufacturer's field representative.
f. Other installers responsible for adjacent and intersecting work, including flashings and utility penetrations.
2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
a. Installation schedule.
b. Installation sequence.
c. Preparatory work.
d. Protection before, during, and after installation.

e. Installation.
f. Terminations.
g. Transitions and connections to other work.
h. Inspecting and testing.
i. Other items affecting successful completion.
j. Pull out test of fasteners.
k. Material storage, including roof deck load limitations.

3. Document and distribute meeting minutes to participants to record decisions affecting installation.

1.5 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:
1. Roofing membrane layout.
2. Roofing membrane seaming and joint details.
3. Roof membrane penetration details.
4. Base flashing and termination details.

C. Manufacturer's Literature and Data:
1. Description of each product.
2. Minimum fastener pull out resistance.
3. Installation instructions.
4. Warranty.
5. Product Data for Federally-Mandated Bio-Based Materials: For roof materials, indicating USDA designation and compliance with definitions for bio-based products, Rapidly Renewable Materials, and certified sustainable wood content.

D. Samples:
1. Roofing Membrane: 150 mm (6 inch) square.
2. Base Flashing: 150 mm (6 inch) square.
3. Fasteners: Each type.
4. Roofing Membrane Seam: 300 mm (12 inches) square.

E. Certificates: Certify products comply with specifications.
1. Fire and windstorm classification.

F. Qualifications: Substantiate qualifications comply with specifications.
1. Installer, including supervisors with project experience list.
2. Manufacturer's field representative with project experience list.

G. Field quality control reports.

H. Temporary protection plan. Include list of proposed temporary materials.

I. Operation and Maintenance Data:
   1. Maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Approved by roofing system manufacturer as installer for roofing system with specified warranty.
   2. Regularly installs specified products.
   3. Installed specified products with satisfactory service on five similar installations for minimum five years.
      a. Project Experience List: Provide contact names and addresses for completed projects.
   4. Employs full-time supervisors experienced installing specified system and able to communicate with Contracting Officer's Representative and installer's personnel.

B. Manufacturer's Field Representative:
   1. Manufacturer's full-time technical employee or independent roofing inspector.
   2. Individual certified by Roof Consultants Institute as Registered Roof Observer.

1.7 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.

B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, and manufacture date.

C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.8 STORAGE AND HANDLING

A. Comply with NRCA Manual storage and handling requirements.

B. Store products indoors in dry, weathertight facility.

C. Store adhesives according to manufacturer's instructions.

D. Protect products from damage during handling and construction operations.

E. Products stored on the roof deck must not cause permanent deck deflection.

1.9 FIELD CONDITIONS

A. Environment:
   1. Product Temperature: Minimum 4 degrees C (40 degrees F) and rising before installation.
   2. Weather Limitations: Install roofing only during dry current and forecasted weather conditions.

1.10 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

B. Manufacturer's Warranty: Warrant roofing system against material and manufacturing defects and agree to repair any leak caused by a defect in the roofing system materials or workmanship of the installer.
   1. Warranty Period: 10 years.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Roofing System: Ballasted roofing membrane, base flashing, roof insulation, fasteners, cover boards, vapor retarders, ballast, and copings.

2.2 SYSTEM PERFORMANCE

A. Design roofing system meeting specified performance:
   1. Load Resistance: ASCE/SEI 7; Design criteria: as indicated on Drawings.

2.3 PRODUCTS - GENERAL

A. Provide roof system components from one manufacturer.
   1. Low Pollutant-Emitting Materials: Comply with VOC limits specified in Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for the following products:
      a. Non-flooring adhesives and sealants.

2.4 EPDM ROOFING MEMBRANE

A. EPDM Sheet: ASTM D4637/D4637M, Type II - internally reinforced.
   1. Thickness: 1.5 mm (60 mils).
   2. Color: Black.

B. Additional Properties:

PROPERTY	TEST METHOD	REQUIREMENT
Shore A Hardness	ASTM D2240	55 to 75 Durometer
Water Vapor Permeance	ASTM E96/E96M	Minimum 8 ng/Pa/s/sq. m (0.14 perms) Water Method
Fungi Resistance	ASTM G21	After 21 days, no sustained growth or discoloration.

2.5 MEMBRANE ACCESSORY MATERIALS

A. Sheet roofing manufacturer's specified products.

B. Flashing Sheet: Manufacturer's standard; same material, and color as roofing membrane.
   1. Self-curing EPDM flashing adaptable to irregular shapes and surfaces.
   2. Minimum Thickness: 1.5 mm (0.060 inch).

C. Factory Formed Flashings: Inside and outside corners, pipe boots, and other special flashing shapes to minimize field fabrication.

D. Splice Adhesive or Tape: Manufacturer's standard for roofing membrane and flashing sheet.

E. Splice Lap Sealant: Liquid EPDM rubber for exposed lap edge.

F. Bonding Adhesive: Manufacturer's standard, solvent based, to suit substrates.

G. Termination Bars: Manufacturer's standard, stainless steel or aluminum, 25 mm wide by 3 mm thick (1 inch wide by 1/8 inch thick) factory drilled for fasteners.

H. Battens: Manufacturer's standard, galvannealed or galvanized steel, 25 mm wide by 1.3 mm thick (1 inch wide by 0.05 inch thick), factory punched for fasteners.

I. Pipe Compression Clamp:
   1. Stainless steel drawband.
   2. Worm drive clamp device.

J. Fasteners: Manufacturer's standard coated steel with metal or plastic plates, to suit application.

K. Fastener Sealer: One part elastomeric adhesive sealant.

L. Temporary Closure Sealers (Night Sealant): Polyurethane two part sealer.

M. Primers, Splice Tapes, Cleaners, and Butyl Rubber Seals: As specified by roof membrane manufacturer.

N. Asphalt Roof Cement: ASTM D4586/D4586M.

2.6 SEPARATION SHEET

A. Polyethylene Film: ASTM D2103, 0.2 mm (6 mils) thick.

B. Building Paper: Fed. Spec. UU-B-790.
   1. Water Vapor Resistance: Type I, Grade A, Style 4, reinforced.
   2. Water Vapor Permeable: Type I, Grade D, Style 4, reinforced.

2.7 FLEXIBLE TUBING

A. Closed cell neoprene, butyl polyethylene, vinyl, or polyethylene tube or rod.

B. Diameter approximately 1-1/2 times joint width.

2.8 PROTECTION MAT OR SEPARATOR SHEET

A. Protection Mat:
   1. Water pervious; either woven or non-woven sheet of long chain polymeric filaments or yarns such as polypropylene, black polyethylene, polyester, or polyamide; or, polyvinylidene-chloride formed into a pattern with distinct and measurable openings.
   2. Filter fabric equivalent opening size (EOS): Not finer than the U.S.A. Standard Sieve Number 120 and not coarser than the U.S.A. Standard Sieve Number 100. EOS is defined as the number of the U.S.A. Standard Sieve having openings closest in size to the filter cloth openings.
   3. Edges of fabric selvaged or otherwise finished to prevent raveling.
   4. Abrasion Resistance:
      a. After being abraded in conformance with ASTM D3884 using rubber-hose abrasive wheels with one kg load per wheel and 1000 revolutions, perform tensile strength test as specified in ASTM D1682, paragraph.

b. Result: 25 kg (55 pounds) minimum in any principle direction.

5. Puncture Strength:
   a. ASTM D751 tension testing machine with ring clamp; steel ball replaced with an 8 mm (5/16 inch) diameter solid steel cylinder with a hemispherical tip centered within the ring clamp.
   b. Result: 57 kg (125 pounds) minimum.
6. Non-degrading under a wet or humid condition within minimum 4 degrees C (40 degrees F) to maximum 66 degrees C (150 degrees F) when exposed to ultraviolet light.
7. Minimum Sheet Width: 2400 mm (8 feet).

2.9 BALLAST

A. Ballast: ASTM D1863; with sized according to ASTM D448.
   1. Size 4 for 49 kg/square meter (10 pounds/square foot) or more.

2.10 ACCESSORIES

A. Temporary Protection Materials:
   1. Expanded Polystyrene (EPS) Insulation: ASTM C578.
   2. Plywood: NIST DOC PS 1, Grade CD Exposure 1.
   3. Oriented Strand Board (OSB): NIST DOC PS 2, Exposure 1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine and verify substrate suitability for product installation with roofing installer and roofing inspector present.
   1. Verify roof deck is clean, dry, and in-plane ready to receive roofing system.
B. Correct unsatisfactory conditions before beginning roofing work.

3.2 PREPARATION

A. Complete curbs, blocking, edge strips, and other components to which roofing and base flashing is attached before beginning roofing work:
B. Coordinate roofing membrane installation with flashing work and roof insulation work so insulation and flashing are installed concurrently to permit continuous roofing operations.
   1. Complete installation of flashing, insulation, and roofing in same day except for the area where temporary protection is required when work is stopped for inclement weather or end of work day.
C. Dry out surfaces that become wet from any cause during progress of the work before roofing work is resumed. Apply materials to dry substrates, only.
D. Broom clean roof decks. Remove dust, dirt and debris.
E. Remove projections capable of damaging roofing materials.
F. Concrete Decks, except Insulating Concrete:

1. Prime concrete decks. Keep primer back 100 mm (f4our inches) from precast concrete deck joints.
2. Allow primer to dry before application of bitumen.

G. Existing Membrane Roofs and Repair Areas:
1. Comply with Section 07 01 50.19 PREPARATION FOR REROOFING.

3.3 TEMPORARY PROTECTION

A. Install temporary protection consisting of a temporary seal and water cut-offs at the end of each day's work and when work is halted for an indefinite period or work is stopped when precipitation is imminent.

B. Install temporary cap flashing over top of base flashings where permanent flashings are not in place to protect against water intrusion into roofing system. Securely anchor in place to prevent blow off and damage by construction activities.

C. Temporarily seal exposed insulation surfaces within roofing membrane.
1. Apply temporary seal and water cut off by extending roofing membrane beyond insulation and securely embedding edge of the roofing membrane in 6 mm (1/4 inch) thick by 50 mm (2 inches) wide strip of temporary closure sealant. Weight roofing membrane edge with sandbags, to prevent displacement; space sandbags maximum 2400 mm (8 feet) on center.
2. Direct water away from work. Provide drainage, preventing water accumulation.
3. Check daily to ensure temporary seal remains watertight. Reseal open areas and weight down.

D. Before the work resumes, cut off and discard portions of roof membrane in contact with temporary seal.
1. Cut minimum 150 mm (6 inches) back from sealed edges and surfaces.

E. Remove sandbags and store for reuse.

3.4 INSTALLATION, GENERAL

A. Install products according to manufacturer's instructions and approved submittal drawings.
1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

B. Comply with NRCA Manual installation requirements.

C. Do not allow membrane and flashing to contact surfaces contaminated with asphalt, coal tar, oil, grease, or other substances incompatible with EPDM.

3.5 ROOFING INSTALLATION

A. Install membrane perpendicular to long dimension of insulation boards.

B. Begin membrane installation at roof low point and work towards high point. Lap membrane shingled in water flow direction.

C. Position membrane free of buckles and wrinkles.

D. Roll membrane out; inspect for defects as membrane is unrolled. Remove defective areas:
   1. Allow 30 minutes for membrane to relax before proceeding.
   2. Lap edges and ends minimum 75 mm (3 inches). Clean lap surfaces.
   3. Install seam adhesive or tape, unless furnished with factory applied adhesive strips. Apply pressure to develop full adhesion.
   4. Check seams to ensure continuous adhesion and correct defects.
   5. Finish seam edges with beveled bead of lap sealant.
   6. Finish seams same day as membrane is installed.
   7. Anchor membrane perimeter to roof deck and parapet wall as indicated on drawings.

E. Membrane Perimeter Anchorage:
   1. Install batten with fasteners at perimeter of each roof area, curb flashing, and similar penetrations on top of roof membrane as indicated on drawings.
   2. Mechanical Fastening:
      a. Space fasteners maximum 300 mm (12 inches) on center, starting 25 mm (1 inch) from ends.
      b. When battens are cut, round edge and corners before installing.
      c. Set fasteners in lap sealant and cover fastener head with fastener sealer, including batten.
      d. Stop batten where batten interferes with drainage. Space ends of batten 150 mm (6 inch) apart.
      e. Cover batten with 225 mm (9 inch) wide strip of flashing sheet. Seal laps with lap seam adhesive and finish edges with lap sealant.
      f. At fascia turn roofing membrane down over front edge of blocking or nailer. Secure roofing membrane to vertical portion of nailer; with fasteners spaced maximum 150 mm (6 inches) on centers.
      g. At parapet walls intersecting building walls and curbs, secure roofing membrane to structural deck with fasteners 150 mm (6 inches) on center or as shown in NRCA Manual.

F. Loosely Laid and Ballasted System Installation:
   1. Loosely lay roofing membrane.
   2. Adhere membrane to comply with ANSI/SPRI RP-4 requirements.

3.6 FLASHING INSTALLATION

A. Install flashings on same day as roofing membrane is installed. When flashing cannot be completely installed in one day, complete installation until flashing is watertight and provide temporary covers or seals.

B. Installing Base Flashing and Pipe Flashing:

1. Install flashing sheet to pipes, walls and curbs to minimum 200 mm (8 inches) height above roof surfaces and extend roofing manufacturer's standard lap dimension onto roofing membranes.
    a. Adhere flashing with bonding adhesive.
    b. Form inside and outside corners of flashing sheet according to NRCA Manual. Form pipe flashing according to NRCA Manual.
    c. Lap ends roofing manufacturer's standard dimension.
    d. Adhesively splice flashing sheets together, and adhesively splice flashing sheets to roofing membranes. Finish exposed edges with lap sealant.
2. Anchor top of flashing to walls and curbs with fasteners spaced maximum 150 mm (6 inches) on center. Use surface mounted fastening strip with sealant on ducts. Use pipe clamps on pipes or other round penetrations.
3. Apply sealant to top edge of flashing.

C. Repairs to Membrane and Flashings:
1. Remove sections of roofing membrane or flashing sheet that are creased, wrinkled, or fishmouthed.
2. Cover removed areas, cuts and damaged areas with patch extending 100 mm (4 inches) beyond damaged, cut, or removed area. Adhesively splice patch to roofing membrane or flashing sheet. Finish edge of lap with lap sealant.

3.7 BALLAST INSTALLATION

A. Install ballast as soon as roof membrane is installed.
B. Protective underlayment installation under ballast:
1. Loose lay protection mat or separator sheet over roofing membrane smooth and free of tension and stress without wrinkles. Do not stretch sheet.
2. Use full sheet width at perimeters with end laps held back minimum 3 m (10 feet) from roof edge at corners.
3. Lap ends minimum 300 mm (one foot).
4. Extend 50 to 75 mm (2 to 3 inches) above ballast at perimeter and penetrations.

C. Aggregate Installation:
1. Uniformly distribute aggregate over protective underlayment.
2. Place 65 kg/square meter (13.3 pounds/square foot) over a 1800 mm (6 foot) wide area around perimeter, for 3300 mm (11 foot) square corner area, for 1200 mm (4 foot) square area around drains, and 1200 mm (4 foot) wide area around penetrations over 600 mm (2 feet) square more than 1800 mm (6 feet) from the roof edge.
3. Place 49 kg/ square meter (10 pounds/square foot) over remaining roof areas.

3.8 FIELD QUALITY CONTROL

A. Field Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.

1. Fastener Pull Out Tests: ANSI/SPRI FX-1; one test for every 230 square meter (2,500 square foot) of deck. Perform tests for each combination of fastener type and roof deck type before installing roof insulation.
    a. Test at locations selected by Contracting Officer's Representative.
    b. Do not proceed with roofing work when pull out resistance is less than manufacturer's required resistance.
    c. Test Results:
        1) Repeat tests using different fastener type or use additional fasteners achieve pull out resistance required to meet specified wind uplift performance.
        2) Patch cementitious deck to repair areas of fastener tests holes.
2. Examine and probe roofing membrane and flashing seams in presence of Contracting Officer's Representative and Manufacturer's field representative.
    a. Probe seams to detect marginal bonds, voids, skips, and fishmouths.
    b. Cut 100 mm (4 inch) wide by 300 mm (12 inch) long samples through seams where directed by Contracting Officer's Representative.
    c. Cut one sample for every 450 meter (1500 feet) of seams.
    d. Cut samples perpendicular to seams.
    e. Failure of samples to pass ASTM D1876 test will be cause for rejection of work.
    f. Repair areas where samples are taken and where marginal bond, voids, and skips occur.
    g. Repair fishmouths and wrinkles by cutting to lay flat. Install patch over cut area extending 100 mm (4 inches) beyond cut.

B. Manufacturer Services:

1. Inspect initial installation, installation in progress, and completed work.
2. Issue supplemental installation instructions necessitated by field conditions.
3. Prepare and submit inspection reports.
4. Certify completed installation complies with manufacturer's instructions and warranty requirements.

3.9 CLEANING

A. Remove excess adhesive before adhesive sets.

B. Clean exposed roofing surfaces. Remove contaminants and stains.

3.10 PROTECTION

A. Protect roofing system from construction operations.

1. Protect roofing system when used for subsequent work platform, materials storage, or staging.
2. Distribute scaffolding loads to exert maximum 50 percent roofing system materials compressive strength.

B. Loose lay temporary insulation board overlaid with plywood or OSB.
   1. Weight boards to secure against wind uplift.

C. Remove protection when no longer required.

D. Repair damage.

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SECTION 07 60 00
FLASHING AND SHEET METAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Formed sheet metal work for wall and roof flashing, copings, fasciae, and drainage specialties are specified in this section.

1.2 RELATED WORK

A. Section 07 53 23 ETHYLENE-PROPYLENE-DIENE-MONOMER ROOFING Membrane base flashings and stripping.

B. Section 07 92 00, JOINT SEALANTS: Joint Sealants.

C. Section 09 91 00, PAINTING: Paint materials and application.

1.3 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only. Editions of applicable publications current on date of issue of bidding documents apply unless otherwise indicated.

B. Aluminum Association (AA):

AA-C22A42..... Chemically etched medium matte, with integrally colored anodic coating, Class I Architectural, 0.7 mils thick

AA-C22A44..... Chemically etched medium matte with electrolytically deposited metallic compound, integrally colored coating Class I Architectural, 0.7-mil thick finish

C. American National Standards Institute/Single-Ply Roofing Institute/Factory Mutual (ANSI/SPRI/FM):

4435/ES-1-11 ..... Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems

D. American Architectural Manufacturers Association (AAMA):

AAMA 620-02 ..... Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Aluminum

AAMA 621-02 ..... Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates

E. ASTM International (ASTM):

A240/A240M-20..... Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications.

A653/A653M-20..... Steel Sheet Zinc-Coated (Galvanized) or Zinc Alloy Coated (Galvanized) by the Hot- Dip Process

B32-08(2014)..... Solder Metal
B209-14 ..... Aluminum and Aluminum-Alloy Sheet and Plate
B370-12(2019)..... Copper Sheet and Strip for Building Construction
D173/D173M-03(2018). Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing
D412-16 ..... Vulcanized Rubber and Thermoplastic Elastomers-Tension
D1187/D1187M-97(2018) Asphalt Base Emulsions for Use as Protective Coatings for Metal
D1784-20 ..... Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
D3656/D3656M-13 ..... Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
D4586/D4586M-07(2018) Asphalt Roof Cement, Asbestos Free

F. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): Architectural Sheet Metal Manual.

G. National Association of Architectural Metal Manufacturers (NAAMM):
AMP 500-06..... Metal Finishes Manual

H. Federal Specification (Fed. Spec):
A-A-1925A ..... Shield, Expansion; (Nail Anchors)
UU-B-790A ..... Building Paper, Vegetable Fiber

I. International Code Commission (ICC): International Building Code, Current Edition

1.4 PERFORMANCE REQUIREMENTS

A. Wind Uplift Forces: Resist the following forces as indicated on the drawings.

B. Wind Design Standard: Fabricate and install copings tested per ANSI/SPRI/FM ES-1 to resist design pressure indicated on Drawings.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Shop Drawings: For all specified items, including:
1. Flashings
2. Copings
3. Gutter and Conductors

PART 2 - PRODUCTS

2.1 FLASHING AND SHEET METAL MATERIALS

A. Stainless Steel: ASTM A240, Type 302B, dead soft temper.

B. Aluminum Sheet: ASTM B209, alloy 3003-H14 except alloy used for color anodized aluminum shall be as required to produce specified color. Alloy required to produce specified color shall have the same structural properties as alloy 3003-H14.

C. Galvanized Sheet: ASTM, A653.

D. Nonreinforced, Elastomeric Sheeting: Elastomeric substances reduced to thermoplastic state and extruded into continuous homogenous sheet (0.056 inch) thick. Sheeting shall have not less than 7 MPa (1,000 psi) tensile strength and not more than seven percent tension-set at 50 percent elongation when tested in accordance with ASTM D412. Sheeting shall show no cracking or flaking when bent through 180 degrees over a 1 mm (1/32 inch) diameter mandrel and then bent at same point over same size mandrel in opposite direction through 360 degrees at temperature of -30°C (-20 °F).

2.2 FLASHING ACCESSORIES

A. Solder: ASTM B32; flux type and alloy composition as required for use with metals to be soldered.

B. Rosin Paper: Fed-Spec. UU-B-790, Type I, Grade D, Style 1b, Rosin-sized sheathing paper, weighing approximately 3 Kg/10 m² (6 pounds/100 square feet).

C. Bituminous Paint: ASTM D1187, Type I.

D. Fasteners:

1. Use copper, copper alloy, bronze, brass, or stainless steel for copper and copper clad stainless steel, and stainless steel for stainless steel and aluminum alloy. Use galvanized steel or stainless steel for galvanized steel.
2. Nails:
   a. Minimum diameter for copper nails: 3 mm (0.109 inch).
   b. Minimum diameter for aluminum nails 3 mm (0.105 inch).
   c. Minimum diameter for stainless steel nails: 2 mm (0.095 inch) and annular threaded.
   d. Length to provide not less than 22 mm (7/8 inch) penetration into anchorage.
3. Rivets: Not less than 3 mm (1/8 inch) diameter.
4. Expansion Shields: Fed Spec A-A-1925A.

E. Sealant: As specified in Section 07 92 00, JOINT SEALANTS for exterior locations.

F. Insect Screening: ASTM D3656, 18 by 18 regular mesh.

G. Roof Cement: ASTM D4586.

2.3 SHEET METAL THICKNESS

A. Except as otherwise shown or specified use thickness or weight of sheet metal as follows:

B. Concealed Locations (Built into Construction):

1. Stainless steel: 0.25 mm (0.010 inch) thick.
2. Galvanized steel: 0.5 mm (0.021 inch) thick.

C. Exposed Locations:

1. Stainless steel: 0.4 mm (0.015 inch).

D. Thickness of aluminum or galvanized steel is specified with each item.

2.4 FABRICATION, GENERAL

A. Jointing:

1. In general, stainless steel joints, except expansion and contraction joints, shall be locked and soldered.
2. Jointing of stainless steel over 0.45 mm (0.018 inch) thick shall be done by lapping, riveting and soldering.
3. Joints shall conform to following requirements:
    a. Flat-lock joints shall finish not less than 19 mm (3/4 inch) wide.
    b. Lap joints subject to stress shall finish not less than 25 mm (one inch) wide and shall be soldered and riveted.
    c. Unsoldered lap joints shall finish not less than 100 mm (4 inches) wide.
4. Flat and lap joints shall be made in direction of flow.
5. Edges of nonreinforced elastomeric sheeting and polyethylene coated copper shall be jointed by lapping not less than 100 mm (4 inches) in the direction of flow and cementing with asphalt roof cement or sealant as required by the manufacturer's printed instructions.
6. Soldering:
    a. Pre tin both mating surfaces with solder for a width not less than 38 mm (1 1/2 inches) of uncoated copper, stainless steel, and copper clad stainless steel.
    b. Treat in accordance with metal producers recommendations other sheet metal required to be soldered.
    c. Completely remove acid and flux after soldering is completed.

B. Expansion and Contraction Joints:

1. Fabricate in accordance with the Architectural Sheet Metal Manual recommendations for expansion and contraction of sheet metal work in continuous runs.
2. Space joints as shown or as specified.
3. Space expansion and contraction joints for stainless steel at intervals not exceeding 7200 mm (24 feet).
4. Space expansion and contraction joints for aluminum at intervals not exceeding 5400 mm (18 feet).
5. Fabricate slip-type or loose locked joints and fill with sealant unless otherwise specified.
6. Fabricate joint covers of same thickness material as sheet metal served.

C. Cleats:

1. Fabricate cleats to secure flashings and sheet metal work over 300 mm (12 inches) wide and where specified.

2. Provide cleats for maximum spacing of 300 mm (12 inch) centers unless specified otherwise.
3. Form cleats of same metal and weights or thickness as the sheet metal being installed unless specified otherwise.
4. Fabricate cleats from 50 mm (2 inch) wide strip. Form end with not less than 19 mm (3/4 inch) wide loose lock to item for anchorage. Form other end of length to receive nails free of item to be anchored and end edge to be folded over and cover nail heads.

D. Edge Strips or Continuous Cleats:
1. Fabricate continuous edge strips where shown and specified to secure loose edges of the sheet metal work.
2. Except as otherwise specified, fabricate edge strips of minimum 0.6 mm (0.024 inch) thick stainless steel or 1.25 mm (0.050 inch) thick aluminum.
3. Use material compatible with sheet metal to be secured by the edge strip.
4. Fabricate in 3000 mm (10 feet) maximum lengths with not less than 19 mm (3/4 inch) loose lock into metal secured by edge strip.
5. Fabricate Strips for fascia anchorage to extend below the supporting wood construction to form a drip and to allow the flashing to be hooked over the lower edge at least 19 mm (3/4-inch).
6. Fabricate anchor edge maximum width of 75 mm (3 inches) or of sufficient width to provide adequate bearing area to insure a rigid installation using 0.8 mm (0.031 inch) thick stainless steel or 1.6 mm (0.0625 inch) thick aluminum.

E. Drips:
1. Form drips at lower edge of sheet metal counter-flashings (cap flashings), fascias, gravel stops, wall copings, by folding edge back 13 mm (1/2 inch) and bending out 45 degrees from vertical to carry water away from the wall.
2. Form drip to provide hook to engage cleat or edge strip for fastening for not less than 19 mm (3/4 inch) loose lock where shown.

F. Edges:
1. Finish exposed edges of flashing with a 6 mm (1/4 inch) hem formed by folding edge of flashing back on itself when not hooked to edge strip or cleat.
2. All metal roof edges shall meet requirements of IBC, current edition.

G. Metal Options:
1. Where options are permitted for different metals use only one metal throughout.
2. Stainless steel may be used in concealed locations for fasteners of other metals exposed to view.

2.5 FINISHES

A. Use same finish on adjacent metal or components and exposed metal surfaces unless specified or shown otherwise.

B. In accordance with NAAMM Metal Finishes Manual AMP 500, unless otherwise specified.

C. Finish exposed metal surfaces as follows, unless specified otherwise:

1. Stainless Steel: Finish No. 2B or 2D.
2. Aluminum:
    a. Colored Finish: AA-C22A42 (anodized) or AA-C22A44 (electrolytically deposited metallic compound) medium matte, integrally colored coating, Class 1 Architectural, 18 mm (0.7 mils) thick. Dyes will not be accepted.
    b. Fluorocarbon Finish: AAMA 620, high performance organic coating.
3. Steel and Galvanized Steel:
    a. Finish painted under Section 09 91 00, PAINTING unless specified as prefinished item.
    b. Manufacturer's finish:
        1) Baked on prime coat over a phosphate coating.
        2) Baked-on prime and finish coat over a phosphate coating.
        3) Fluorocarbon Finish: AAMA 621, high performance organic coating.

2.6 THROUGH-WALL FLASHINGS

A. Form through-wall flashing to provide a mechanical bond or key against lateral movement in all directions. Install a sheet having 2 mm (1/16 inch) deep transverse channels spaced four to every 25 mm (one inch), or ribbed diagonal pattern, or having other deformation unless specified otherwise.

1. Fabricate in not less than 2400 mm (8 feet) lengths; 3000 mm (10 feet) maximum lengths.
2. Fabricate so keying nests at overlaps.

B. Sill Flashing and Lintel Flashing:

1. Use stainless steel or nonreinforced elastomeric sheeting.
2. Fabricate flashing at ends with folded corners to turn up 5 mm (3/16 inch) in first vertical masonry joint beyond masonry opening.
3. Turn up back edge as shown.
4. Form exposed portion with drip as specified or receiver.

2.7 HANGING GUTTERS

A. Fabricate gutters of not less than the following:

1. 0.6mm (0.025 inch) thick aluminum.

B. Fabricate hanging gutters in sections not less than 2400 mm (8 feet) long, except at ends of runs where shorter lengths are required.

C. Building side of gutter shall be not less than 38 mm (1 1/2 inches) higher than exterior side.

D. Gutter Bead: Stiffen outer edge of gutter by folding edge over approximately 19 mm (3/4 inch) toward roof and down approximately19 mm (3/4 inch) unless shown otherwise.

E. Gutter Spacers:

1. Fabricate of same material and thickness as gutter.
2. Fabricate 25 mm (one inch) wide strap and fasten to gutters not over 900 mm (36 inches) on center.
3. Turn back edge up 25 mm (one inch) and lap front edge over gutter bead.
4. Rivet and solder to gutter except rivet and seal to aluminum.

F. Outlet Tubes:

1. Form outlet tubes to connect gutters to conductors of same metal and thickness as gutters extend into the conductor 75 mm (3 inch). Flange upper end of outlet tube 13 mm (1/2 inch).
2. Lock and solder longitudinal seam except use sealant in lieu of solder with aluminum.
3. Seal aluminum tube to gutter and rivet to gutter.
4. Fabricate basket strainers of same material as gutters.

G. Gutter Brackets:

1. Fabricate of same metal as gutter. Use the following:
   a. 6 by 25 mm (1/4 by 1 inch) aluminum.
2. Fabricate to gutter profile.
3. Drill two 5 mm (3/16 inch) diameter holes in anchor leg for countersunk flat head screws.

2.8 CONDUCTORS (DOWNSPOUTS)

A. Fabricate conductors of same metal and thickness as gutters in sections approximately 3000 mm (10 feet) long [with 19 mm (3/4 inch) wide flat locked seams].

1. Fabricate open face channel shape with hemmed longitudinal edges.

B. Fabricate elbows by mitering, riveting, and soldering except seal aluminum in lieu of solder. Lap upper section to the inside of the lower piece.

C. Fabricate conductor brackets or hangers of same material as conductor, 2 mm (1/16 inch) thick by 25 mm (one inch) minimum width. Form to support conductors 25 mm (one inch) from wall surface in accordance with Architectural Sheet Metal Manual for rectangular and round shapes.

D. Conductor Heads:

1. Fabricate of same material as conductor.
2. Fabricate conductor heads to not less than 250 mm (10 inch) wide by 200 mm (8 inch) deep by 200 mm (8 inches) from front to back.
3. Form front and side edges channel shape not less than 13 mm (1/2 inch) wide flanges with edge hemmed.

4. Slope bottom to sleeve to conductor or downspout at not less than 60 degree angle.
5. Extend wall edge not less than 25 mm (one inch) above front edge.
6. Solder joints for water tight assembly.
7. Fabricate outlet tube or sleeve at bottom not less than 50 mm (2 inches) long to insert into conductor.

2.9 REGLETS

A. Fabricate reglets of one of the following materials:
   1. Stainless steel, not less than 0.3 mm (0.012 inch) thick.
   2. Plastic coated extruded aluminum, not less than 1.4 mm (0.055 inch) thick prefilled with butyl rubber sealer and complete with plastic wedges inserted at 1000 mm (40 inches) on centers.
   3. Plastic, ASTM D1784, Type II, not less than 2 mm (0.075 inch) thick.

B. Fill open-type reglets with fiberboard or other suitable separator, to prevent crushing of the slot during installation.

C. Bend edges of reglets for setting into concrete to an angle of not less than 45 degrees, and make wide enough to provide firm anchorage in the concrete.

D. Fabricate reglets for building into horizontal masonry mortar joints not less than 19 mm (3/4 inch) deep, nor more than 25 mm (one inch) deep.

E. Fabricate mitered corners, fittings, and special shapes as may be required by details.

F. Reglets for concrete may be formed to receive flashing and have a 10 mm (3/8 inch), 45 degree snap lock.

2.10 SCUPPERS

A. Fabricate scuppers with minimum of 100 mm (4 inch) wide flange.

B. Provide flange at top on through wall scupper to extend to top of base flashing.

C. Fabricate exterior wall side to project not less than 13 mm (1/2 inch) beyond face of wall with drip at bottom outlet edge.

D. Fabricate exterior wall flange for through wall scupper not less than 25 mm (one inch) wide on top and sides with edges hemmed.

E. Fabricate gravel stop bar of 25 mm x 25 mm (one by one inch) angle strip soldered to bottom of scupper.

F. Fabricate scupper not less than 200 mm (8 inch) wide and not less than 125 mm (5 inch) high for through wall scupper.

G. Solder joints watertight.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install flashing and sheet metal items as shown in Sheet Metal and Air Conditioning Contractors National Association, Inc., publication, ARCHITECTURAL SHEET METAL MANUAL, except as otherwise shown or specified.
2. Apply Sealant as specified in Section 07 92 00, JOINT SEALANTS.
3. Apply sheet metal and other flashing material to surfaces which are smooth, sound, clean, dry and free from defects that might affect the application.
4. Remove projections which would puncture the materials and fill holes and depressions with material compatible with the substrate. Cover holes or cracks in wood wider than 6 mm (1/4 inch) with sheet metal compatible with the roofing and flashing material used.
5. Coordinate with masonry work for the application of a skim coat of mortar to surfaces of unit masonry to receive flashing material before the application of flashing.
6. Confine direct nailing of sheet metal to strips 300 mm (12 inch) or less wide. Nail flashing along one edge only. Space nail not over 100 mm (4 inches) on center unless specified otherwise.
7. Install bolts, rivets, and screws where indicated, specified, or required in accordance with the SMACNA Sheet Metal Manual. Space rivets at 75 mm (3 inch) on centers in two rows in a staggered position. Use neoprene washers under fastener heads when fastener head is exposed.
8. Coordinate with roofing work for the installation of metal base flashings and other metal items having roof flanges for anchorage and watertight installation.
9. Nail continuous cleats on 75 mm (3 inch) on centers in two rows in a staggered position.
10. Nail individual cleats with two nails and bend end tab over nail heads. Lock other end of cleat into hemmed edge.
11. Install flashings in conjunction with other trades so that flashings are inserted in other materials and joined together to provide a water tight installation.
12. Where required to prevent galvanic action between dissimilar metal isolate the contact areas of dissimilar metal with sheet lead, waterproof building paper, or a coat of bituminous paint.
13. Isolate aluminum in contact with dissimilar metals others than stainless steel, white bronze or other metal compatible with aluminum by:
    a. Paint dissimilar metal with a prime coat of zinc-chromate or other suitable primer, followed by two coats of aluminum paint.
    b. Paint dissimilar metal with a coat of bituminous paint.
    c. Apply an approved caulking material between aluminum and dissimilar metal.

14. Paint aluminum in contact with or built into mortar, concrete, plaster, or other masonry materials with a coat of bituminous paint.
15. Paint aluminum in contact with absorptive materials that may become repeatedly wet with two coats of bituminous paint or two coats of aluminum paint.

3.2 THROUGH-WALL FLASHING

A. General:
1. Install continuous through-wall flashing between top of concrete foundation walls and bottom of masonry building walls; under masonry, concrete, and elsewhere as shown.
2. Where exposed portions are used as a counterflashings, lap base flashings at least 100 mm (4 inches) and use thickness of metal as specified for exposed locations.
3. Exposed edge of flashing may be formed as a receiver for two piece counter flashing as specified.
4. Terminate exterior edge beyond face of wall approximately 6 mm (1/4 inch) with drip edge where not part of counter flashing.
5. Turn back edge up 6 mm (1/4 inch) unless noted otherwise where flashing terminates in mortar joint or hollow masonry unit joint.
6. Under copings terminate both edges beyond face of wall approximately 6 mm (1/4 inch) with drip edge.
7. Lap end joints at least two corrugations, but not less than 100 mm (4 inches). Seal laps with sealant.
8. Where dowels, reinforcing bars and fastening devices penetrate flashing, seal penetration with sealing compound. Sealing compound is specified in Section 07 92 00, JOINT SEALANTS.
9. Where ends of flashing terminate turn ends up 25 mm (1 inch) and fold corners to form dam extending to wall face in vertical mortar or veneer joint.
10. When flashing terminates in reglet extend flashing full depth into reglet and secure with lead or plastic wedges spaced 150 mm (6 inch) on center.

B. Flashing at Top of Concrete Foundation Walls Where concrete is exposed. Turn up not less than 200 mm (8 inch) high and into masonry backup mortar joint or reglet in concrete backup as specified.

C. Lintel Flashing when not part of shelf angle flashing:
1. Install flashing full length of lintel to nearest vertical joint in masonry over veneer.
2. Turn ends up 25 mm (one inch) and fold corners to form dam and extend end to face of wall.
3. Turn back edge up to top of lintel; terminate back edge as specified for back-up wall.

D. Sill Flashing:

1. Install flashing to extend not less than 100 mm (4 inch) beyond ends of sill into vertical joint of masonry or veneer.
2. Turn back edge up to terminate under frame.
3. Turn ends up 25 mm (one inch) and fold corners to form dam and extend to face of wall.

E. Flashing at Masonry Copings:

1. Install flashing with drips on both wall faces unless shown otherwise.
2. Form penetration openings to fit tight against dowel or other item with edge turned up. Seal penetrations with sealant.

3.3 REGLETS

A. Install reglets in a manner to provide a watertight installation.

B. Locate reglets not less than 225 mm (9 inch) nor more than 400 mm (16 inch) above roofing, and not less than 125 mm (5 inch) nor more than 325 mm (13 inch) above cant strip.

C. Butt and align end joints or each section of reglet and securely hold in position until concrete or mortar are hardened:

1. Coordinate reglets for anchorage into concrete with formwork construction.
2. Coordinate reglets for masonry to locate horizontally into mortar joints.

3.4 COPINGS

A. General:

1. On walls topped with a wood plank, install a continuous edge strip on the front and rear edge of the plank. Lock the coping to the edge strip with a 19 mm (3/4 inch) loose lock seam.
2. Install ends adjoining existing construction so as to form space for installation of sealants. Sealant is specified in Section 07 92 00, JOINT SEALANTS.

B. Aluminum Coping:

1. Install with 6 mm (1/4 inch) joint between ends of coping sections.
2. Install joint covers, centered at each joint, and securely lock in place.

C. Prefinished galvanized steel Copings:

1. Join ends of sheets at intervals of 9600 mm (32 feet) by a 38 mm (1 1/2 inch) loose locked expansion joint filled with sealant or mastic.
2. At straight runs between 7200 mm (24 feet) and 19200 mm (64 feet) locate expansion joint at center.

3.5 HANGING GUTTERS

A. Hang gutters with high points equidistant from downspouts. Slope at not less than 1:200 (1/16 inch per foot).

B. Lap joints, except for expansion joints, at least 25 mm (one inch) in the direction of flow. Rivet and seal or solder lapped joints.

C. Support gutters in brackets spaced not more than 600 mm (24 inch) on centers, brackets attached to facial or wood nailer by at least two screws or nails.
   1. For aluminum gutters use aluminum brackets or stainless steel brackets.
   2. Use brass or stainless steel screws.

D. Secure brackets to gutters in such a manner as to allow free movement of gutter due to expansion and contraction.

E. Outlet Tubes: Set bracket strainers loosely into gutter outlet tubes.

3.6 CONDUCTORS (DOWNSPOUTS)

A. Where scuppers discharge into downspouts install conductor head to receive discharge with back edge up behind drip edge of scupper. Fasten and seal joint. Sleeve conductors to gutter outlet tubes and fasten joint and joints between sections.

B. Set conductors plumb and clear of wall, and anchor to wall with two anchor straps, located near top and bottom of each section of conductor. Strap at top shall be fixed to downspout, intermediate straps and strap at bottom shall be slotted to allow not less than 13 mm (1/2 inch) movement for each 3000 mm (10 feet) of downspout.

C. Install elbows, offsets and shoes where shown and required. Slope not less than 45 degrees.

- - - E N D - - -

SECTION 07 84 00
FIRESTOPPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide UL or equivalent approved firestopping system for the closures of openings in walls, floors, and roof decks against penetration of flame, heat, and smoke or gases in fire resistant rated construction.

B. Provide UL or equivalent approved firestopping system for the closure of openings in walls against penetration of gases or smoke in smoke partitions.

1.2 RELATED WORK

A. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS: Sustainable Design Requirements.

B. Section 07 92 00, JOINT SEALANTS: Sealants and application.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Sustainable Design Submittals, as described below:

1. Volatile organic compounds per volume as specified in PART 2 - PRODUCTS.

C. Installer qualifications.

D. Inspector qualifications.

E. Manufacturers literature, data, and installation instructions for types of firestopping and smoke stopping used.

F. List of FM, UL, or WH classification number of systems installed.

G. Certified laboratory test reports for ASTM E814 tests for systems not listed by FM, UL, or WH proposed for use.

H. Submit certificates from manufacturer attesting that firestopping materials comply with the specified requirements.

1.4 DELIVERY AND STORAGE

A. Deliver materials in their original unopened containers with manufacturer’s name and product identification.

B. Store in a location providing protection from damage and exposure to the elements.

1.5 QUALITY ASSURANCE

A. FM, UL, or WH or other approved laboratory tested products will be acceptable.

B. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991 or been evaluated by UL and found to comply with UL’s “Qualified Firestop Contractor Program Requirements.” Submit qualification data.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

B. ASTM International (ASTM):

E84-20 ..... Surface Burning Characteristics of Building Materials

E699-16 ..... Standard Specification for Agencies Involved in Testing, Quality Assurance, and Evaluating of Manufactured Building Components

E814-13a(2017)..... Fire Tests of Penetration Firestop Systems

E2174-20a ..... Standard Practice for On-Site Inspection of Installed Firestop Systems

E2393-20 ..... Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers

C. FM Global (FM):

Annual Issue Approval Guide Building Materials

4991-13..... Approval of Firestop Contractors

D. Underwriters Laboratories, Inc. (UL):

Annual Issue Building Materials Directory

E. Annual Issue Fire Resistance Directory

723-Edition 11(2018).... Standard for Test for Surface Burning Characteristics of Building Materials

1479-04(2015)..... Fire Tests of Penetration Firestops

F. Intertek Testing Services - Warnock Hersey (ITS-WH):

Annual Issue Certification Listings

G. Environmental Protection Agency (EPA):

40 CFR 59(2014)..... National Volatile Organic Compound Emission Standards for Consumer and Commercial Products

PART 2 - PRODUCTS

2.1 FIRESTOP SYSTEMS

A. Provide either factory built (Firestop Devices) or field erected (through-Penetration Firestop Systems) to form a specific building system maintaining required integrity of the fire barrier and stop the passage of gases or smoke. Firestop systems to accommodate building movements without impairing their integrity.

B. Through-penetration firestop systems and firestop devices tested in accordance with ASTM E814 or UL 1479 using the "F" or "T" rating to maintain the same rating and integrity as the fire barrier being sealed. "T" ratings are not required for penetrations smaller than or equal to 101 mm (4 inches) nominal pipe or 0.01 square meter (16 square inches) in overall cross sectional area.

C. Firestop sealants used for firestopping or smoke sealing to have the following properties:
   1. Contain no flammable or toxic solvents.
   2. Release no dangerous or flammable out gassing during the drying or curing of products.
   3. Water-resistant after drying or curing and unaffected by high humidity, condensation or transient water exposure.
   4. When installed in exposed areas, capable of being sanded and finished with similar surface treatments as used on the surrounding wall or floor surface.
   5. VOC Content: Firestopping sealants and sealant primers to comply with the following limits for VOC content when calculated according to 40 CFR 59, (EPA Method 24):
      a. Sealants: 250 g/L.
      b. Sealant Primers for Nonporous Substrates: 250 g/L.
      c. Sealant Primers for Porous Substrates: 775 g/L.

D. Firestopping system or devices used for penetrations by glass pipe, plastic pipe or conduits, unenclosed cables, or other non-metallic materials to have following properties:
   1. Classified for use with the particular type of penetrating material used.
   2. Penetrations containing loose electrical cables, computer data cables, and communications cables protected using firestopping systems that allow unrestricted cable changes without damage to the seal.

E. Maximum flame spread of 25 and smoke development of 50 when tested in accordance with ASTM E84 or UL 723. Material to be an approved firestopping material as listed in UL Fire Resistance Directory or by a nationally recognized testing laboratory.

F. FM, UL, or WH rated or tested by an approved laboratory in accordance with ASTM E814.

G. Materials to be nontoxic and noncarcinogen at all stages of application or during fire conditions and to not contain hazardous chemicals. Provide firestop material that is free from Ethylene Glycol, PCB, MEK, and asbestos.

H. For firestopping exposed to view, traffic, moisture, and physical damage, provide products that do not deteriorate when exposed to these conditions.
   1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
   2. For floor penetrations with annular spaces exceeding 101 mm (4 inches) or more in width and exposed to possible loading and traffic, provide firestop systems capable of supporting the floor loads involved either by installing floor plates or by other means acceptable to the firestop manufacturer.
   3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

2.2 SMOKE STOPPING IN SMOKE PARTITIONS

A. Provide silicone sealant in smoke partitions as specified in Section 07 92 00, JOINT SEALANTS.

B. Provide mineral fiber filler and bond breaker behind sealant.

C. Sealants to have a maximum flame spread of 25 and smoke developed of 50 when tested in accordance with ASTM E84.

D. When used in exposed areas capable of being sanded and finished with similar surface treatments as used on the surrounding wall or floor surface.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Submit product data and installation instructions, as required by article, submittals, after an on-site examination of areas to receive firestopping.

B. Examine substrates and conditions with installer present for compliance with requirements for opening configuration, penetrating items, substrates, and other conditions affecting performance of firestopping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove dirt, grease, oil, laitance and form-release agents from concrete, loose materials, or other substances that prevent adherence and bonding or application of the firestopping or smoke stopping materials.

B. Remove insulation on insulated pipe for a distance of 150 mm (6 inches) on each side of the fire rated assembly prior to applying the firestopping materials unless the firestopping materials are tested and approved for use on insulated pipes.

C. Prime substrates where required by joint firestopping system manufacturer using that manufacturer’s recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

D. Masking Tape: Apply masking tape to prevent firestopping from contacting adjoining surfaces that will remain exposed upon completion of work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestopping materials. Remove tape as soon as it is possible to do so without disturbing seal of firestopping with substrates.

3.3 INSTALLATION

A. Do not begin firestopping work until the specified material data and installation instructions of the proposed firestopping systems have been submitted and approved.

B. Install firestopping systems with smoke stopping in accordance with FM, UL, WH, or other approved system details and installation instructions.

C. Install smoke stopping seals in smoke partitions.

3.4 CLEAN-UP

A. As work on each floor is completed, remove materials, litter, and debris.

B. Clean up spills of liquid type materials.

C. Clean off excess fill materials and sealants adjacent to openings and joints as work progresses by methods and with cleaning materials approved by manufacturers of firestopping products and of products in which opening and joints occur.

D. Protect firestopping during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they 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 firestopping immediately and install new materials to provide firestopping complying with specified requirements.

3.5 INSPECTIONS AND ACCEPTANCE OF WORK

A. Do not conceal or enclose firestop assemblies until inspection is complete and approved by the Contracting Officer Representative (COR).

B. Furnish service of approved inspector to inspect firestopping in accordance with ASTM E2393 and ASTM E2174 for firestop inspection, and document inspection results. Submit written reports indicating locations of and types of penetrations and type of firestopping used at each location; type is to be recorded by UL listed printed numbers.

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SECTION 07 92 00
JOINT SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section covers interior and exterior sealant and their application, wherever required for complete installation of building materials or systems.

1.2 RELATED WORK (INCLUDING BUT NOT LIMITED TO THE FOLLOWING)

A. Sustainable Design Requirements: Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.

B. Sealing of Site Work Concrete Paving: Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS.

C. Masonry Control and Expansion Joint: Section 04 20 00, UNIT MASONRY.

D. Firestopping Penetrations: Section 07 84 00, FIRESTOPPING.

E. Mechanical Work: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer with a minimum of three (3) years' experience and who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.

B. Source Limitations: Obtain each type of joint sealant through one (1) source from a single manufacturer.

C. Product Testing: Obtain test results from a qualified testing agency based on testing current sealant formulations within a 12-month period.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021.
2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C920, and where applicable, to other standard test methods.
3. Test elastomeric joint sealants according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C920 for adhesion and cohesion under cyclic movement, adhesion-in peel, and indentation hardness.
4. Test other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.

D. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to joint substrates according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

1. Locate test joints as directed by COR.
2. Conduct field tests for each application indicated below:

a. Each type of elastomeric sealant and joint substrate indicated.
b. Each type of non-elastomeric sealant and joint substrate indicated.

3. Notify COR seven (7) days in advance of dates and times when test joints will be erected.

1.4 CERTIFICATION

A. Contractor is to submit to the COR written certification that joints are of the proper size and design, that the materials supplied are compatible with adjacent materials and backing, that the materials will properly perform to provide permanent watertight, airtight or vapor tight seals (as applicable), and that materials supplied meet specified performance requirements.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Sustainable Design Submittals, as described below:

1. Volatile organic compounds per volume as specified in PART 2 - PRODUCTS.

C. Installer qualifications.

D. Contractor certification.

E. Manufacturer's installation instructions for each product used.

F. Cured samples of exposed sealants for each color.

G. Manufacturer's Literature and Data:

1. Primers
2. Sealing compound, each type, including compatibility when different sealants are in contact with each other.

H. Manufacturer warranty.

1.6 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not proceed with installation of joint sealants under following conditions:
   a. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4 degrees C (40 degrees F).
   b. When joint substrates are wet.

B. Joint-Width Conditions:

1. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

C. Joint-Substrate Conditions:

1. Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.7 DELIVERY, HANDLING, AND STORAGE

A. Deliver materials in manufacturers' original unopened containers, with brand names, date of manufacture, shelf life, and material designation clearly marked thereon.

B. Carefully handle and store to prevent inclusion of foreign materials.

C. Do not subject to sustained temperatures exceeding 32 degrees C (90 degrees F) or less than 5 degrees C (40 degrees F).

1.8 DEFINITIONS

A. Definitions of terms in accordance with ASTM C717 and as specified.

B. Backing Rod: A type of sealant backing.

C. Bond Breakers: A type of sealant backing.

D. Filler: A sealant backing used behind a back-up rod.

1.9 WARRANTY

A. Construction Warranty: Comply with FAR clause 52.246-21 "Warranty of Construction".

B. Manufacturer Warranty: Manufacturer shall warranty their sealant for a minimum of five (5) years from the date of installation and final acceptance by the Government. Submit manufacturer warranty.

1.10 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.

B. ASTM International (ASTM):

C509-06 ..... Elastomeric Cellular Preformed Gasket and Sealing Material
C612-14 ..... Mineral Fiber Block and Board Thermal Insulation
C717-14a ..... Standard Terminology of Building Seals and Sealants
C734-06(R2012)..... Test Method for Low-Temperature Flexibility of Latex Sealants after Artificial Weathering
C794-10 ..... Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
C919-12. ..... Use of Sealants in Acoustical Applications.
C920-14a ..... Elastomeric Joint Sealants.
C1021-08(R2014)..... Laboratories Engaged in Testing of Building Sealants
C1193-13 ..... Standard Guide for Use of Joint Sealants.
C1248-08(R2012)..... Test Method for Staining of Porous Substrate by Joint Sealants
C1330-02(R2013)..... Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants
C1521-13 ..... Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints
D217-10 ..... Test Methods for Cone Penetration of Lubricating Grease
D1056-14 ..... Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
E84-09 ..... Surface Burning Characteristics of Building Materials

C. Sealant, Waterproofing and Restoration Institute (SWRI).

The Professionals' Guide

D. Environmental Protection Agency (EPA):

40 CFR 59(2014)..... National Volatile Organic Compound Emission Standards for Consumer and Commercial Products

PART 2 - PRODUCTS

2.1 SEALANTS

A. Exterior Sealants:

1. Vertical surfaces, provide non-staining ASTM C920, Type S or M, Grade NS, Class 25, Use NT.
2. Horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T.
3. Provide location(s) of exterior sealant as follows:
   a. Joints formed where frames and subsills of windows, doors, louvers, and vents adjoin masonry, concrete, or metal frames. Provide sealant at exterior surfaces of exterior wall penetrations.
   b. Metal to metal.
   c. Masonry to masonry or stone.
   d. Masonry expansion and control joints.
   e. Wood to masonry.
   f. Masonry joints where shelf angles occur.
   g. Voids where items penetrate exterior walls.
   h. Metal reglets, where flashing is inserted into masonry joints, and where flashing is penetrated by coping dowels.

B. Floor Joint Sealant:

1. ASTM C920, Type S or M, Grade P, Class 25, Use T.
2. Provide location(s) of floor joint sealant as follows.
   a. Seats of metal thresholds exterior doors.
   b. Control and expansion joints in floors, slabs, ceramic tile, and walkways.

C. Interior Sealants:

3.1 VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system are to comply with the following limits for VOC content when calculated according to 40 CFR 59, (EPA Method 24):
   a. Architectural Sealants: 250 g/L.
   b. Sealant Primers for Nonporous Substrates: 250 g/L.
   c. Sealant Primers for Porous Substrates: 775 g/L.

3.2 Vertical and Horizontal Surfaces: ASTM C920, Type S or M, Grade NS, Class 25, Use NT.

3.3 Provide location(s) of interior sealant as follows:

a. Typical narrow joint 6 mm, (1/4 inch) or less at walls and adjacent components.
b. Perimeter of doors, windows, access panels which adjoin concrete or masonry surfaces.
c. Interior surfaces of exterior wall penetrations.
d. Joints at masonry walls and columns, piers, concrete walls or exterior walls.
e. Exposed isolation joints at top of full height walls.
f. Joints formed where nonplanar tile surfaces meet.
g. Joints formed between tile floors and tile base cove; joints between tile and dissimilar materials; joints occurring where substrates change.
h. Behind escutcheon plates at valve pipe penetrations.

D. Acoustical Sealant:
1. Conforming to ASTM C919; flame spread of 25 or less; and a smoke developed rating of 50 or less when tested in accordance with ASTM E84. Acoustical sealant have a consistency of 250 to 310 when tested in accordance with ASTM D217; remain flexible and adhesive after 500 hours of accelerated weathering as specified in ASTM C734; and be non-staining.
2. Provide location(s) of acoustical sealant as follows:
a. Exposed acoustical joint at sound rated partitions.
b. Concealed acoustic joints at sound rated partitions.
c. Joints where item pass-through sound rated partitions.

2.2 COLOR

A. Sealants used with exposed masonry are to match color of mortar joints.
B. Sealants used with unpainted concrete are to match color of adjacent concrete.
C. Color of sealants for other locations to be light gray or aluminum, unless otherwise indicated in construction documents.

2.3 JOINT SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
B. Cylindrical Sealant Backings: ASTM C1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
1. Type C: Closed-cell material with a surface skin.
C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D1056 or synthetic rubber (ASTM C509), nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 32 degrees C (minus 26 degrees F). Provide products with low compression set and of size and shape to provide a

secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.

D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.4 FILLER

A. Mineral fiberboard: ASTM C612, Class 1.

B. Thickness same as joint width.

C. Depth to fill void completely behind back-up rod.

2.5 PRIMER

A. As recommended by manufacturer of caulking or sealant material.

B. Stain free type.

2.6 CLEANERS-NON POROUS SURFACES

A. Chemical cleaners compatible with sealant and acceptable to manufacturer of sealants and sealant backing material. Cleaners to be free of oily residues and other substances capable of staining or harming joint substrates and adjacent non-porous surfaces and formulated to promote adhesion of sealant and substrates.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect substrate surface for bond breaker contamination and unsound materials at adherent faces of sealant.

B. Coordinate for repair and resolution of unsound substrate materials.

C. Inspect for uniform joint widths and that dimensions are within tolerance established by sealant manufacturer.

3.2 PREPARATIONS

A. Prepare joints in accordance with manufacturer's instructions and SWRI (The Professionals' Guide).

B. Clean surfaces of joint to receive caulking or sealants leaving joint dry to the touch, free from frost, moisture, grease, oil, wax, lacquer paint, or other foreign matter that would tend to destroy or impair adhesion.

1. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants.
2. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include but are not limited to the following:

a. Concrete.
b. Masonry.
c. Unglazed surfaces of ceramic tile.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous surfaces include but are not limited to the following:
   a. Metal.
   b. Glass.
   c. Porcelain enamel.
   d. Glazed surfaces of ceramic tile.

C. Do not cut or damage joint edges.

D. Apply non-staining masking tape to face of surfaces adjacent to joints before applying primers, caulking, or sealing compounds.
1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Apply primer to sides of joints wherever required by compound manufacturer's printed instructions or as indicated by pre-construction joint sealant substrate test.
1. Apply primer prior to installation of back-up rod or bond breaker tape.
2. Use brush or other approved means that will reach all parts of joints. Avoid application to or spillage onto adjacent substrate surfaces.

3.3 BACKING INSTALLATION

A. Install backing material, to form joints enclosed on three sides as required for specified depth of sealant.

B. Where deep joints occur, install filler to fill space behind the backing rod and position the rod at proper depth.

C. Cut fillers installed by others to proper depth for installation of backing rod and sealants.

D. Install backing rod, without puncturing the material, to a uniform depth, within plus or minus 3 mm (1/8 inch) for sealant depths specified.

E. Where space for backing rod does not exist, install bond breaker tape strip at bottom (or back) of joint so sealant bonds only to two opposing surfaces.

3.4 SEALANT DEPTHS AND GEOMETRY

A. At widths up to 6 mm (1/4 inch), sealant depth equal to width.

B. At widths over 6 mm (1/4 inch), sealant depth 1/2 of width up to 13 mm (1/2 inch) maximum depth at center of joint with sealant thickness at center of joint approximately 1/2 of depth at adhesion surface.

3.5 INSTALLATION

A. General:

1. Apply sealants and caulking only when ambient temperature is between
2. 5 degrees C and 38 degrees C (40 degrees and 100 degrees F).
3. Do not install polysulfide base sealants where sealant may be exposed to fumes from bituminous materials, or where water vapor in continuous contact with cementitious materials may be present.
4. Do not install sealant type listed by manufacture as not suitable for use in locations specified.
5. Apply caulking and sealing compound in accordance with manufacturer's printed instructions.
6. Avoid dropping or smearing compound on adjacent surfaces.
7. Fill joints solidly with compound and finish compound smooth.
8. Tool exposed joints to form smooth and uniform beds, with slightly concave surface conforming to joint configuration per Figure 5A in ASTM C1193 unless shown or specified otherwise in construction documents. Remove masking tape immediately after tooling of sealant and before sealant face starts to “skin” over. Remove any excess sealant from adjacent surfaces of joint, leaving the working in a clean finished condition.
9. Finish paving or floor joints flush unless joint is otherwise detailed.
10. Apply compounds with nozzle size to fit joint width.
11. Test sealants for compatibility with each other and substrate. Use only compatible sealant. Submit test reports.
12. Replace sealant which is damaged during construction process.

B. For application of sealants, follow requirements of ASTM C1193 unless specified otherwise. Take all necessary steps to prevent three-sided adhesion of sealants.

C. Interior Sealants: Where gypsum board partitions are of sound rated, fire rated, or smoke barrier construction, follow requirements of ASTM C919 only to seal all cut-outs and intersections with the adjoining construction unless specified otherwise.

1. Apply a 6 mm (1/4 inch) minimum bead of sealant each side of runners (tracks), including those used at partition intersections with dissimilar wall construction.
2. Coordinate with application of gypsum board to install sealant immediately prior to application of gypsum board.
3. Partition intersections: Seal edges of face layer of gypsum board abutting intersecting partitions, before taping and finishing or application of veneer plaster-joint reinforcing.

4. Openings: Apply a 6 mm (1/4 inch) bead of sealant around all cutouts to seal openings of electrical boxes, ducts, pipes and similar penetrations. To seal electrical boxes, seal sides and backs.
5. Control Joints: Before control joints are installed, apply sealant in back of control joint to reduce flanking path for sound through control joint.

3.6 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field-test joint-sealant adhesion to joint substrates 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.
   1. Extent of Testing: Test completed elastomeric sealant joints as follows:
      a. Perform 10 tests for first 305 m (1000 feet) of joint length for each type of elastomeric sealant and joint substrate.
      b. Perform one test for each 305 m (1000 feet) of joint length thereafter or one test per each floor per elevation.

B. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field adhesion test log.

C. Inspect tested joints and report on following:
   1. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate.
   2. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
   3. Whether sealants filled joint cavities and are free from voids.
   4. Whether sealant dimensions and configurations comply with specified requirements.

D. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.

E. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.

F. Evaluation of Field-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.

3.7 CLEANING:

A. Fresh compound accidentally smeared on adjoining surfaces: Scrape off immediately and rub clean with a solvent as recommended by manufacturer of the adjacent material or if not otherwise indicated by the caulking or sealant manufacturer.

B. Leave adjacent surfaces in a clean and unstained condition.

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SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hollow metal doors hung in hollow metal frames at exterior locations.

1.2 RELATED WORK

A. Section 08 71 00, DOOR HARDWARE: Door Hardware.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American National Standard Institute (ANSI):

A250.8-2014 ..... Standard Steel Doors and Frames

C. ASTM International (ASTM):

A240/A240M-15b..... Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A653/A653M-15..... Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip

A1008/A1008M-15..... Steel, Sheet, Cold-Rolled, Carbon, Structural, High Strength Low Alloy and High Strength Low Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

D. Master Painters Institute (MPI):

No. 18 ..... Primer, Zinc Rich, Organic

E. National Association of Architectural Metal Manufacturers (NAAMM):

AMP 500-06..... Metal Finishes Manual

F. Department of Veterans Affairs

VA Physical Security and Resiliency Design Manual October 1, 2020

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:

1. Show size, configuration, and fabrication and installation details.

C. Manufacturer's Literature and Data:

1. Description of each product.
2. Include schedule showing each door and frame requirements for openings.
3. Installation instructions.

D. Qualifications: Substantiate qualifications comply with specifications.

1. Manufacturer.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Regularly manufactures specified products.
   2. Manufactured specified products with satisfactory service on five similar installations for minimum five years.

1.6 DELIVERY

A. Deliver products in manufacturer's original sealed packaging.
B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, production run number, and manufacture date.
C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

A. Store products indoors in dry, weathertight facility.
B. Protect products from damage during handling and construction operations.

1.8 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design hollow metal doors and frames complying with specified performance:
   1. Thermal Transmittance: 0.700 U-value, maximum at exterior doors.

2.2 MATERIALS

A. Stainless Steel: ASTM A240/A240M; Type 304.
B. Sheet Steel: ASTM A1008/A1008M, cold-rolled.
C. Galvanized Sheet Steel: ASTM A653.

2.3 PRODUCTS - GENERAL

A. Provide hollow metal doors and frames from one manufacturer.

2.4 HOLLOW METAL DOORS

A. Hollow Metal Doors: ANSI A250.8; 44 mm (1-3/4 inches) thick.
   1. Interior Doors: Level 3 and Physical Performance Level A, extra-heavy duty; Model 2, seamless.
   2. Exterior Doors: Level 3 and Physical Performance Level A, extra-heavy duty; Model 2, seamless.

B. Door Faces:
   1. Interior Doors: Stainless steel, type 316, No.4 Brushed Satin.
   2. Exterior Doors: Galvanized sheet steel minimum Z180 or ZF180 (G60 or A60) coating.

3. Door Cores:
   4. Interior/Exterior Doors: Polystyrene or polyurethane.

2.5 HOLLOW METAL FRAMES

A. Hollow Metal Frames: ANSI A250.8; face welded. See drawings for sizes and designs.
   1. Frames: Level 3 Hollow Metal or Stainless steel.

B. Frame Materials:
   1. Interior Frames: Stainless steel, type 316, No.4 Brushed Satin.
   2. Exterior Frames: Galvanized sheet steel minimum Z180 or ZF180 (G60 or A60) coating.

2.6 FABRICATION

A. Hardware Preparation: ANSI A250.8; for hardware specified in Section 08 71 00, DOOR HARDWARE.

B. Hollow Metal Door Fabrication:
   1. Close top edge of exterior doors flush and seal to prevent water intrusion.
   2. Fill spaces between vertical steel stiffeners with insulation.

C. Hollow Metal Frame Fabrication:
   1. Fasten mortar guards to back of hardware reinforcements.
   2. Frame Anchors:
      a. Floor anchors:
         1) Provide continuous 1 mm (0.042 inch) thick steel rough bucks drilled for floor fasteners and frame anchor screws for sill sections.
         2) Space floor bolts 50 mm (24 inches) on center.
      b. Jamb anchors:
         1) Place anchors on jambs:
            a) Near top and bottom of each frame.
            b) At intermediate points at maximum 600 mm (24 inches) spacing.
         2) Form jamb anchors from steel minimum 1 mm (0.042 inch) thick.
         3) Anchors for frames set in prepared openings:
            a) Steel pipe spacers 6 mm (1/4 inch) inside diameter, welded to plate reinforcing at jamb stops, or hat shaped formed strap spacers 50 mm (2 inches) wide, welded to jamb near stop.
            b) Drill jamb stop and strap spacers for 6 mm (1/4 inch) flat head bolts to pass through frame and spacers.
         4) Modify frame anchors to fit special frame and wall construction.
         5) Provide special anchors where shown on drawings and where required to suit application.

2.7 FINISHES

A. Steel and Galvanized Steel: ANSI A250.8; shop primed.

B. Stainless Steel: NAAMM AMP 500; No. 4 polished finish.

C. Finish exposed surfaces after fabrication.

2.8 ACCESSORIES

A. Primers: ANSI A250.8.

B. Barrier Coating: ASTM D1187/D1187M.

C. Welding Materials: AWS D1.1/D1.1M, type to suit application.

D. Clips Connecting Members and Sleeves: Match door faces.

E. Fasteners: stainless steel.

1. Masonry and Concrete: Expansion bolts and power actuated drive pins.

F. Anchors: Galvanized steel.

G. Galvanizing Repair Paint: MPI No. 18.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing construction and completed work from damage.

C. Apply barrier coating to metal surfaces in contact with cementitious materials to minimum 0.7 mm (30 mils) dry film thickness.

3.2 INSTALLATION - GENERAL

A. Install products according to manufacturer's instructions and approved submittal drawings.

1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.

3.3 FRAME INSTALLATION

A. Plumb, align, and brace frames until permanent anchors are set.

B. Floor Anchors:

1. Anchor frame jambs to floor with two expansion bolts.
   a) Use 6 mm (1/4 inch) diameter bolts.
2. Power actuated drive pins are acceptable to secure frame anchors to concrete floors.

C. Jamb Anchors:

1. Prepared Masonry and Concrete Openings:
   a) Direct Securement: 6 mm (1/4 inch) diameter expansion bolts through spacers.
   b) Subframe or Rough Buck Securement:
      1) 6 mm (1/4 inch) diameter expansion bolts on 600 mm (24 inch) centers.
      2) Power activated drive pins on 600 mm (24 inches) centers.

D. Touch up damaged factory finishes.

1. Repair galvanized surfaces with galvanized repair paint.
2. Repair painted surfaces with touch up primer.

3.4 DOOR INSTALLATION

A. Install doors plumb and level.

B. Adjust doors for smooth operation.

C. Touch up damaged factory finishes.

1. Repair galvanized surfaces with galvanized repair paint.
2. Repair painted surfaces with touch up primer.

3.5 CLEANING

A. Clean exposed door and frame surfaces. Remove contaminants and stains.

3.6 PROTECTION

A. Protect doors and frames from construction operations.

B. Remove protective materials immediately before acceptance.

C. Repair damage.

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SECTION 08 71 00
DOOR HARDWARE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Door hardware and related items necessary for complete installation and operation of doors.

1.2 RELATED WORK

A. Caulking: Section 07 92 00 JOINT SEALANTS.

B. Application of Hardware: Section 08 11 13, HOLLOW METAL DOORS AND FRAMES.

C. Painting: Section 09 91 00, PAINTING.

1.3 GENERAL

A. All hardware shall comply with ABAAS, (Architectural Barriers Act Accessibility Standard) unless specified otherwise.

B. Hardware for application on metal and wood doors and frames shall be made to standard templates. Furnish templates to the fabricator of these items in sufficient time so as not to delay the construction.

C. The following items shall be of the same manufacturer, except as otherwise specified:

1. Mortise locksets.
2. Hinges for hollow metal doors.

1.4 WARRANTY

A. Subject to the terms of FAR Clause 52.246-21, except that the Warranty period shall be two years in lieu of one year for all items except as noted below:

1. Locks, latchsets, and panic hardware: 5 years.
2. Door closers and continuous hinges: 10 years.

1.5 MAINTENANCE MANUALS

A. In accordance with Section 01 00 00, GENERAL REQUIREMENTS Article titled "INSTRUCTIONS", furnish maintenance manuals and instructions on all door hardware. Provide installation instructions with the submittal documentation.

1.6 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submit final copy of the final approved schedules to VAMC Locksmith as record copies (VISN Locksmith if the VAMC does not have a locksmith).

C. Hardware Schedule: AHC certified hardware consultant to prepare and submit hardware schedule in the following form:

Hardware Item	Qty	Size	Reference Publ. Type #	Finish	Mfr. Name & Catalog No.	Key Control Symbols	UL Mark (if fire rated / listed)	ANSI/BHMA Finish Desig.

D. Samples and Manufacturers' Literature:
   1. Samples: All hardware items (proposed for the project) that have not been previously approved by Builders Hardware Manufacturers Association shall be submitted for approval. Tag and mark all items with manufacturer's name, catalog number and project number.
   2. Samples are not required for hardware listed in the specifications by manufacturer's catalog number, if the contractor proposes to use the manufacturer's product specified.

E. Certificate of Compliance and Test Reports: Submit certificates that hardware conforms to the requirements specified herein. Certificates shall be accompanied by copies of reports as referenced. The testing shall have been conducted either in the manufacturer's plant and certified by an independent testing laboratory or conducted in an independent laboratory, within four years of submittal of reports for approval.

1.7 DELIVERY AND MARKING

A. Deliver items of hardware to job site in their original containers, complete with necessary appurtenances including screws, keys, and instructions. Tag one of each different item of hardware and deliver to COR for reference purposes. Tag shall identify items by Project Specification number and manufacturer's catalog number. These items shall remain on file in COR's office until all other similar items have been installed in project, at which time the COR will deliver items on file to Contractor for installation in predetermined locations on the project.

1.8 INSTRUCTIONS

A. Hardware Set Symbols on Drawings: Except for protective plates, door stops, mutes, thresholds and the like specified herein, hardware requirements for each door are indicated on drawings by symbols. Symbols for hardware sets consist of letters (e.g., "HW") followed by a number. Each number designates a set of hardware items applicable to a door type.

B. Keying: All cylinders shall be keyed into existing Grand Master Key System. Provide removable core cylinders that are removable only with a special key or tool without disassembly of knob or lockset. Cylinders shall match building standard. Keying information shall be furnished at a later date by the COR.

1.9 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. In text, hardware items are referred to by series, types, etc., listed in such specifications and standards, except as otherwise specified.

B. ASTM International(ASTM):

E2180-18 ..... Standard Test Method for Determining the Activity of Incorporated Antimicrobial Agent(s) In Polymeric or Hydrophobic Materials

C. American National Standards Institute/Builders Hardware Manufacturers Association (ANSI/BHMA):

A156.1-06 ..... Butts and Hinges
A156.2-03 ..... Bored and Pre-assembled Locks and Latches
A156.5-14 ..... Cylinders and Input Devices for Locks.
A156.6-05 ..... Architectural Door Trim
A156.8-05 ..... Door Controls-Overhead Stops and Holders
A156.16-08 ..... Auxiliary Hardware
A156.18-06 ..... Materials and Finishes
A156.22-05 ..... Door Gasketing and Edge Seal Systems
A156.28-07 ..... Master Keying Systems
A156.30-03 ..... High Security Cylinders
A156.36-10 ..... Auxiliary Locks
A250.8-03 ..... Standard Steel Doors and Frames

PART 2 - PRODUCTS

2.1 BUTT HINGES

A. ANSI A156.1. Provide only three-knuckle hinges, except five-knuckle where the required hinge type is not available in a three-knuckle version (e.g., some types of swing-clear hinges). The following types of butt hinges shall be used for the types of doors listed, except where otherwise specified:

1. Exterior Doors: Type A2112/A5112 for doors 900 mm (3 feet) wide or less. Hinges for exterior outswing doors shall have non-removable pins.

B. Provide quantity and size of hinges per door leaf as follows:

1. Doors up to 1210 mm (4 feet) high: 2 hinges.
2. Doors 1210 mm (4 feet) to 2260 mm (7 feet 5 inches) high: 3 hinges minimum.
3. Doors up to 900 mm (3 feet) wide, standard weight: 114 mm x 114 mm (4-1/2 inches x 4-1/2 inches) hinges.
4. Provide heavy-weight hinges where specified.

2.2 DOOR CLOSING DEVICES

A. Closing devices shall be products of one manufacturer.

B. OVERHEAD CLOSERS

1. Conform to ANSI A156.4, Grade 1.
2. Closers shall conform to the following:
   a. The closer shall have minimum 50 percent adjustable closing force over minimum value for that closer and have adjustable hydraulic back check effective between 60 degrees and 85 degrees of door opening.
   b. Where specified, closer shall have hold-open feature.

c. Size Requirements: Provide multi-size closers, sizes 1 through 6, except where multi-size closer is not available for the required application.
d. Material of closer body shall be forged or cast.
e. Arm and brackets for closers shall be steel, malleable iron or high strength ductile cast iron.
f. Where closers are exposed to the exterior or are mounted in rooms that experience high humidity, provide closer body and arm assembly of stainless steel material.
g. Closers shall have full size metal cover; plastic covers will not be accepted.
h. Closers shall have adjustable hydraulic back-check, separate valves for closing and latching speed, adjustable back-check positioning valve, and adjustable delayed action valve.
i. Provide closers with any accessories required for the mounting application, including (but not limited to) drop plates, special soffit plates, spacers for heavy-duty parallel arm fifth screws, bull-nose or other regular arm brackets, longer or shorter arm assemblies, and special factory templating. Provide special arms, drop plates, and templating as needed to allow mounting at doors with overhead stops and/or holders.
j. Provide parallel arm closers with heavy duty rigid arm.
k. Where closers are to be installed on the push side of the door, provide parallel arm type except where conditions require use of top jamb arm.
l. All closers shall have a 1 ½" (38mm) minimum piston diameter.

2.3 LOCKS AND LATCHES

A. Conform to ANSI A156.2. Locks and latches for doors 45 mm (1-3/4 inch) thick or over shall have beveled fronts. Lock cylinders shall match building standard. Cylinders for all locksets shall be removable core type. Cylinders shall be furnished with construction removable cores and construction master keys. Cylinder shall be removable by special key or tool. Construct all cores so that they will be interchangeable into the core housings of all mortise locks, rim locks, cylindrical locks, and any other type lock included in the Great Grand Master Key System. Disassembly of lever or lockset shall not be required to remove core from lockset. Provide temporary keying device or construction core to allow opening and closing during construction and prior to the installation of final cores.

B. In addition to above requirements, locks and latches shall comply with following requirements:
1. Auxiliary locks shall be as specified under hardware sets and conform to ANSI A156.36.

2.4 KEYS

A. Stamp all keys with change number and key set symbol. Furnish keys in quantities as follows:

Locks/Keys	**Quantity**
Cylinder locks	2 keys each

2.5 THRESHOLDS

A. Conform to ANSI A156.21, mill finish extruded aluminum, except as otherwise specified. In existing construction, thresholds shall be installed in a bed of sealant with ¼-20 stainless steel machine screws and expansion shields. In new construction, embed aluminum anchors coated with epoxy in concrete to secure thresholds. Furnish thresholds for the full width of the openings.

B. At exterior doors and any interior doors exposed to moisture, provide threshold with non-slip abrasive finish.

C. Provide with miter returns where threshold extends more than 12 mm (0.5 inch) beyond face of frame.

2.6 WEATHERSTRIPS (FOR EXTERIOR DOORS)

A. Conform to ANSI A156.22. Air leakage shall not to exceed 0.50 CFM per foot of crack length ($0.000774 m^3/s/m$).

2.7 FINISHES

A. Exposed surfaces of hardware shall have ANSI A156.18, finishes as specified below. Finishes on all hinges, pivots, closers, thresholds, etc., shall be as specified below under "Miscellaneous Finishes." For field painting (final coat) of ferrous hardware, see Section 09 91 00, PAINTING.

1. 626 or 630: All surfaces on exterior and interior of buildings, except where other finishes are specified.
2. Miscellaneous Finishes:
    m. Hinges --exterior doors: 626 or 630.
    n. Door Closers: Factory applied paint finish. Dull or Satin Aluminum color.
    o. Other primed steel hardware: 600.

B. Hardware Finishes for Existing Buildings: U.S. Standard finishes shall match finishes of hardware in (similar) existing spaces.

2.8 BASE METALS

A. Apply specified U.S. Standard finishes on different base metals as following:

Finish	Base Metal
652	Steel
626	Brass or bronze
630	Stainless steel

PART 3 - EXECUTION

3.1 HARDWARE HEIGHTS

A. For existing buildings locate hardware on doors at heights to match existing hardware. The Contractor shall visit the site, verify location of existing hardware and submit locations to VA COR for approval.

B. Hardware Heights from Finished Floor:

1. Deadlocks centerline of strike 1219 mm (48 inches).
2. Locate other hardware at standard commercial heights.

3.2 INSTALLATION

A. Hinge Size Requirements:

Door Thickness	Door Width	Hinge Height
45 mm (1-3/4 inch)	900 mm (3 feet) and less	113 mm (4-1/2 inches)
45 mm (1-3/4 inch)	Over 900 mm (3 feet) but not more than 1200 mm (4 feet)	125 mm (5 inches)

B. Hinge leaves shall be sufficiently wide to allow doors to swing clear of door frame trim and surrounding conditions.

C. Hinges Required Per Door:

Door Description	Number butts
Doors 1500 mm (5 ft) or less in height	2 butts
Doors over 1500 mm (5 ft) high and not over 2280 mm (7 ft 6 in) high	3 butts

D. Fastenings: Suitable size and type and shall harmonize with hardware as to material and finish. Provide machine screws and lead expansion shields to secure hardware to concrete, ceramic or quarry floor tile, or solid masonry. Fiber or rawl plugs and adhesives are not permitted. All fastenings exposed to weather shall be of nonferrous metal.

E. After locks have been installed; show in presence of COR that keys operate their respective locks in accordance with keying requirements. (All keys, Master Key level and above shall be sent Registered Mail to the Medical Center Director along with the bitting list. Also a copy of the invoice shall be sent to the COR for his records.) Installation of locks which do not meet specified keying requirements shall be considered sufficient justification for rejection and replacement of all locks installed on project.

3.3 FINAL INSPECTION

A. Installer to provide letter to COR that upon completion, installer has visited the Project and has accomplished the following:

1. Re-adjust hardware.

2. Evaluate maintenance procedures and recommend changes or additions, and instruct VA personnel.
3. Identify items that have deteriorated or failed.
4. Submit written report identifying problems.

3.4 DEMONSTRATION

A. Demonstrate efficacy of mechanical hardware systems, including adjustment and maintenance procedures, to satisfaction of COR and VA Locksmith.

3.5 HARDWARE SETS

A. Following sets of hardware correspond to hardware symbols shown on drawings. Only those hardware sets that are shown on drawings will be required. Disregard hardware sets listed in specifications but not shown on drawings.

B. The numbers shown in the following sets come from BHMA standards.

HW-1A

Each Door to Have:	NON-RATED
Hinges	QUANTITY & TYPE AS REQUIRED
1 Latchset	F01
1 Closer	C02011/C02021
1 Set Seals	R0Y164

HW-E0

Each Door to Have:	NON-RATED
Hinges	QUANTITY & TYPE AS REQUIRED
1 Double-Sided Deadbolt Lock	
2 Key Cylinders	TYPE AS REQUIRED
1 Set Weatherstripping	
1 Drip	R0Y976

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SECTION 08 90 00
LOUVERS AND VENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies fixed wall louvers and wall vents.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Shop Drawings:

1. Each type, showing material, finish, size of members, method of assembly, and installation and anchorage details.

C. Manufacturer's Literature and Data:

1. Each type of louver and vent.

D. Color samples.

1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. The Master Painters Institute (MPI):
Approved Product List – Updated Monthly

C. ASTM International (ASTM):

A240/A240M-20..... Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A653/A653M-20..... Steel Sheet Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot Dip Process

A1008/A1008M-20..... Steel, Sheet, Carbon, Cold Rolled, Structural, and High Strength Low-Alloy with Improved Formability

B209-14 ..... Aluminum and Aluminum Alloy, Sheet and Plate

B209M-14 ..... Aluminum and Aluminum Alloy, Sheet and Plate (Metric)

B221-14 ..... Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

B221M-13 ..... Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes (Metric)

D1187/D1187M-97(2018) Asphalt-Base Emulsions for Use as Protective Coatings for Metal

D. National Association of Architectural Metal Manufacturers (NAAMM):

AMP 500-06..... Metal Finishes Manual

E. National Fire Protection Association (NFPA):

90A-15 ..... Installation of Air Conditioning and Ventilating Systems

F. American Architectural Manufacturers Association (AAMA):

2605-13..... High Performance Organic Coatings on Architectural Extrusions and Panels

G. Air Movement and Control Association, Inc. (AMCA):

500-L-07 ..... Testing Louvers

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum, Extruded: ASTM B221M (B221).

B. Stainless Steel: ASTM A240/A240M, Type 302B.

C. Galvanized Steel Sheet: ASTM A653/A653M; G90 min.

D. Carbon Steel and Sheet: ASTM A1008/A1008M (interior use louvers only).

E. Aluminum, Plate and Sheet: ASTM B209M (B209); alloy 3003 or 5005 with temper as required for forming.

F. Fasteners: Fasteners for securing louvers and wall vents to adjoining construction, except as otherwise specified or indicated in construction documents, to be toggle or expansion bolts of size and type as required for each specific type of installation and service condition.

1. Where type, size, or spacing of fasteners is not shown or specified, submit shop drawings showing proposed fasteners, and method of installation.
2. Fasteners for louvers, louver frames, and wire guards to be of stainless steel or aluminum with same finish as louvers.
3. Fasteners for louvers, louver frames and wire guards within mental health areas to be non-removable/tamper-proof type.

G. Inorganic Zinc Primer: MPI No. 19.

H. Bituminous Coating: ASTM D1187/D1187M; cold applied asphalt mastic emulsion.

2.2 EXTERIOR WALL LOUVERS

A. General:

1. Provide fixed type louvers of size and design shown.
2. Heads, sills and jamb sections are to have formed caulking slots or be designed to retain caulking. Head sections are to have exterior drip lip, and sill sections an integral water stop.
3. Furnish louvers with sill extension or separate sill as shown.
4. Frame is to be mechanically fastened or welded construction with welds dressed smooth and flush.

B. Performance Characteristics:

1. Weather louvers are to have a minimum of 50 percent free area.

C. Aluminum Louvers:

1. General: Frames, blades, sills, and mullions (sliding interlocking type); 2 mm (0.078-inch) thick extruded 6063-T5 or –T52 aluminum. Blades to be standard type and have reinforcing bosses.
2. Louvers, fixed: Make frame sizes 13 mm (1/2-inch) smaller than openings. Single louvers frames are not to exceed 1676 mm (66 inches) wide. When openings exceed 1676 mm (66 inches), provide twin louvers separated by mullion members.

D. Stainless Steel Louvers: Form stainless steel louvers using 1.6 mm (0.063-inch) thick sheet for frames, blades, sills and mullions.

E. Provide louver with fixed 45 degree standard blades with water baffle. Make overall frame size 13 mm (1/2-inch) less than opening, unless otherwise indicated in construction documents.

F. Single louver sections are not to exceed 1676 mm (66 inches) in width. For openings larger than 1676 mm (66 inches) wide, provide multiple sections not larger than 1676 mm (66 inches) wide separated by mullions.

2.3 CLOSURE ANGLES AND CLOSURE PLATES

A. Fabricate from 2 mm (0.078-inch) thick stainless steel or aluminum.

B. Provide continuous closure angles and closure plates on inside head, jambs, and sill of exterior wall louvers.

C. Secure angles and plates to louver frames with screws, and to masonry or concrete with fasteners as indicated in construction documents.

2.4 WIRE GUARDS

A. Provide wire guards on outside of all exterior louvers, except on exhaust air louvers.

B. Fabricate frames from 2 mm (0.078-inch) thick extruded or sheet aluminum or 1.5 mm (0.059-inch) thick stainless steel designed to retain wire mesh.

C. Wire mesh to be woven from not less than 1.6 mm (0.063-inch) diameter aluminum wire or 1.3 mm (0.05-inch) diameter stainless steel wire in 13 mm (1/2-inch) square mesh.

D. Miter corners and join by concealed corner clips or locks extending not less than 57 mm (2-1/4 inches) into rails and stiles. Equip wire guards over 1219 mm (4 feet) in height with a mid-rail constructed as specified for frame components.

E. Fasten frames to outside of louvers with aluminum or stainless steel devices of same finish as louvers designed to allow removal and replacement without damage to the wire guard or the louver.

2.5 FINISH

A. In accordance with NAAMM Metal Finishes Manual: AMP 500-505

B. Aluminum Louvers:

1. Anodized finish

a. AA-M10C22A41, Chemically etched medium matte, with clear anodic coating, Class I Architectural, 0.17 mm (0.7 mils) thick.

C. Stainless Steel: Mechanical finish No. 4 in accordance with NAAMM Metal Finishes Manual.

D. Steel: Surfaces of steel work, for which no other finish is specified, are to be cleaned free from scale, rust, oil and grease, and then given a light colored prime paint after fabrication, except ferrous metals concealed in finished work. Paint all contact surfaces of assembled work (except welded contact surfaces) with an additional shop coat of similar paint.

2.6 PROTECTION

A. Provide protection for aluminum against galvanic action wherever dissimilar materials are in contact, by painting the contact surfaces of the dissimilar material with a heavy coat of bituminous coating (complete coverage), or by separating the contact surfaces with a performed synthetic rubber tape having pressure sensitive adhesive coating on one side.

B. Isolate the aluminum from plaster, concrete, and masonry by coating aluminum with zinc-chromate primer.

C. Protect finished surfaces from damage during fabrication, erection, and after completion of the work. Strippable plastic coating on finish is not approved.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set work accurately, in alignment and where indicated in construction documents. Install plumb, level, free of rack and twist, and set parallel or perpendicular as required to line and plane of surface.

B. Furnish setting drawings and instructions for installation of anchors and for the positioning of items having anchors to be built into masonry construction. Provide temporary bracing for such items until masonry is set.

C. Provide anchoring devices and fasteners as shown and as necessary for securing louvers to building construction as specified. Power actuated drive pins may be used, except for removal items and where members would be deformed or substrate damaged by their use.

3.2 CLEANING AND ADJUSTING

A. After installation, all exposed prefinished and plated items and all items fabricated from stainless steel and aluminum are to be cleaned as recommended by the manufacturer and protected from damage until completion of the project.

B. All movable parts, including hardware, are to be cleaned and adjusted to operate as designed without binding or deformation of the members, so as to be centered in the opening of frame, and where applicable, to have all contact surfaces fit tight and even without forcing or warping the components.

C. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Contracting Officer Representative (COR) damaged units and replace with new units.

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SECTION 09 22 16
NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies steel studs wall systems, ceiling or soffit suspended or furred framing, wall furring, fasteners, and accessories for the screw attachment of gypsum board, plaster bases or other building boards.

1.2 RELATED WORK

A. Section 09 29 00, GYPSUM BOARD.

1.3 TERMINOLOGY

A. Description of terms shall be in accordance with ASTM C754, ASTM C11, ASTM C841 and as specified.

B. Thickness of steel specified is the minimum bare (uncoated) steel thickness.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Literature and Data:

1. Studs, runners and accessories.
2. Hanger inserts.
3. Channels (Rolled steel).
4. Furring channels.
5. Screws, clips and other fasteners.

C. Shop Drawings:

1. Typical ceiling suspension system.
2. Typical metal stud and furring construction system including details around openings and corner details.
3. Typical fire rated assembly and column fireproofing showing details of construction same as that used in fire rating test.

D. Test Results: Fire rating test designation, each fire rating required for each assembly.

1.5 DELIVERY, IDENTIFICATION, HANDLING AND STORAGE

A. In accordance with the requirements of ASTM C754.

1.6 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society For Testing And Materials (ASTM)

A641-09 ..... Zinc-Coated (Galvanized) Carbon Steel Wire

A653/653M-11 ..... Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
C11-10 ..... Terminology Relating to Gypsum and Related Building Materials and Systems
C635-07 ..... Manufacture, Performance, and Testing of Metal Suspension System for Acoustical Tile and Lay-in Panel Ceilings
C636-08 ..... Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels
C645-09 ..... Non-Structural Steel Framing Members
C754-11 ..... Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
C841-03(R2008)..... Installation of Interior Lathing and Furring
C954-10 ..... Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
E580-11 ..... Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Moderate Seismic Restraint.

PART 2 - PRODUCTS

2.1 PROTECTIVE COATING

A. Galvanize steel studs, runners (track), rigid (hat section) furring channels, "Z" shaped furring channels, and resilient furring channels, with coating designation of G40 or equivalent.

2.2 STEEL STUDS AND RUNNERS (TRACK)

A. ASTM C645, modified for thickness specified and sizes as shown.
   1. Use C 645 steel, 0.75 mm (0.0296-inch) minimum base-metal (30 mil).
   2. Runners same thickness as studs.
   3. Exception: Members that can show certified third party testing with gypsum board in accordance with ICC ES AC86 (Approved May 2012) need not meet the minimum thickness limitation or minimum section properties set forth in ASTM C 645. The submission of an evaluation report is acceptable to show conformance to this requirement. Use C 645 steel, 0.48mm (0.019 inch) minimum base-metal (19 mil).

B. Provide not less than two cutouts in web of each stud, approximately 300 mm (12 inches) from each end, and intermediate cutouts on approximately 600 mm (24-inch) centers.

C. Doubled studs for openings and studs for supporting concrete backer-board.

D. Studs 3600 mm (12 feet) or less in length shall be in one piece.

2.3 FURRING CHANNELS

A. Rigid furring channels (hat shape): ASTM C645.

B. Rolled Steel Channels: ASTM C754, cold rolled; or, ASTM C841, cold rolled.

2.4 FASTENERS, CLIPS, AND OTHER METAL ACCESSORIES

A. ASTM C754, except as otherwise specified.

B. For fire rated construction: Type and size same as used in fire rating test.

C. Fasteners for steel studs thicker than 0.84 mm (0.033-inch) thick. Use ASTM C954 steel drill screws of size and type recommended by the manufacturer of the material being fastened.

D. Clips: ASTM C841 (paragraph 6.11), manufacturer's standard items. Clips used in lieu of tie wire shall have holding power equivalent to that provided by the tie wire for the specific application.

E. Tie Wire and Hanger Wire:

1. ASTM A641, soft temper, Class 1 coating.
2. Gage (diameter) as specified in ASTM C754 or ASTM C841.

F. Power Actuated Fasteners: Type and size as recommended by the manufacturer of the material being fastened.

2.5 SUSPENDED CEILING SYSTEM FOR GYPSUM BOARD (OPTION)

A. Conform to ASTM C635, heavy duty, with not less than 35 mm (1-3/8 inch) wide knurled capped flange face designed for screw attachment of gypsum board.

B. Wall track channel with 35 mm (1-3/8 inch) wide flange.

PART 3 - EXECUTION

3.1 INSTALLATION CRITERIA

A. Where fire rated construction is required for walls, partitions, columns, beams and floor-ceiling assemblies, the construction shall be same as that used in fire rating test.

B. Construction requirements for fire rated assemblies and materials shall be as shown and specified, the provisions of the Scope paragraph (1.2) of ASTM C754 and ASTM C841 regarding details of construction shall not apply.

3.2 INSTALLING STUDS

A. Install studs in accordance with ASTM C754, except as otherwise shown or specified.

B. Space studs not more than 610 mm (24 inches) on center.

C. Cut studs 6 mm to 9 mm (1/4 to 3/8-inch) less than floor to underside of structure overhead when extended to underside of structure overhead.

D. Extend studs to underside of structure overhead for fire rated partitions.

E. Openings:

1. Frame jambs of openings in stud partitions and furring with two studs placed back to back or as shown.
2. Fasten back to back studs together with 9 mm (3/8-inch) long Type S pan head screws at not less than 600 mm (two feet) on center, staggered along webs.

3. Studs fastened flange to flange shall have splice plates on both sides approximately 50 X 75 mm (2 by 3 inches) screwed to each stud with two screws in each stud. Locate splice plates at 600 mm (24 inches) on center between runner tracks.

F. Fastening Studs:
1. Fasten studs located adjacent to partition intersections, corners and studs at jambs of openings to flange of runner tracks with two screws through each end of each stud and flange of runner.
2. Do not fasten studs to top runner track when studs extend to underside of structure overhead.

G. Form control joint, with double studs spaced 13 mm (1/2-inch) apart.

3.3 INSTALLING FURRED AND SUSPENDED CEILINGS OR SOFFITS

A. Install furred and suspended ceilings or soffits in accordance with ASTM C754 or ASTM C841 except as otherwise specified or shown for screw attached gypsum board ceilings and for plaster ceilings or soffits.
1. Space framing at 400 mm (16-inch) centers for metal lath anchorage.
2. Space framing at 600 mm (24-inch) centers for gypsum board anchorage.

B. Existing concrete construction exposed:
1. Use power actuated fasteners either eye pin, threaded studs or drive pins for type of hanger attachment required.
2. Install fasteners at approximate mid height of concrete beams or joists. Do not install in bottom of beams or joists.

C. Installing suspended ceiling system for gypsum board (ASTM C635 Option):
1. Install only for ceilings to receive screw attached gypsum board.
2. Install in accordance with ASTM C636.
a. Install main runners spaced 1200 mm (48 inches) on center.
b. Install 1200 mm (four foot) tees not over 600 mm (24 inches) on center; locate for edge support of gypsum board.
c. Install wall track channel at perimeter.

3.4 TOLERANCES

A. Fastening surface for application of subsequent materials shall not vary more than 3 mm (1/8-inch) from the layout line.

B. Plumb and align vertical members within 3 mm (1/8-inch.)

C. Level or align ceilings within 3 mm (1/8-inch.)

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SECTION 09 29 00
GYPSUM BOARD

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies installation and finishing of gypsum board.

1.2 RELATED WORK

A. Installation of steel framing members for walls, partitions, furring, soffits, and ceilings: Section 09 22 16, NON-STRUCTURAL METAL FRAMING.

B. Sealants: Section 07 92 00, JOINT SEALANTS.

1.3 TERMINOLOGY

A. Definitions and description of terms shall be in accordance with ASTM C11, C840, and as specified.

B. "Yoked": Gypsum board cut out for opening with no joint at the opening (along door jamb or above the door).

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Literature and Data:

1. Cornerbead and edge trim.
2. Finishing materials.
3. Laminating adhesive.
4. Gypsum board, each type.

C. Shop Drawings:

1. Typical gypsum board installation, showing corner details, edge trim details and the like.
2. Typical fire rated assembly and column fireproofing, indicating details of construction same as that used in fire rating test.

D. Samples:

1. Cornerbead.
2. Edge trim.
3. Control joints.

E. Test Results:

1. Fire rating test, each fire rating required for each assembly.

F. Certificates: Certify that gypsum board types and joint treating materials do not contain asbestos material.

1.5 DELIVERY, IDENTIFICATION, HANDLING AND STORAGE

A. In accordance with the requirements of ASTM C840.

1.6 ENVIRONMENTAL CONDITIONS

A. In accordance with the requirements of ASTM C840.

1.7 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society for Testing And Materials (ASTM):

C11-15 ..... Terminology Relating to Gypsum and Related Building Materials and Systems

C475-15 ..... Joint Compound and Joint Tape for Finishing Gypsum Board

C840-13 ..... Application and Finishing of Gypsum Board

C919-12 ..... Sealants in Acoustical Applications

C954-15 ..... Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases to Steel Stud from 0.033 in. (0.84mm) to 0.112 in. (2.84mm) in thickness

C1002-14 ..... Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs

C1047-14 ..... Accessories for Gypsum Wallboard and Gypsum Veneer Base

C1396-14 ..... Gypsum Board

C. Underwriters Laboratories Inc. (UL):

Latest Edition ..... Fire Resistance Directory

D. Inchcape Testing Services (ITS):

Latest Editions ..... Certification Listings

PART 2 - PRODUCTS

2.1 GYPSUM BOARD

A. Gypsum Board: ASTM C1396, Type X, 16 mm (5/8 inch) thick unless shown otherwise.

B. Water Resistant Gypsum Backing Board: ASTM C1178, Type X, 16 mm (5/8 inch) thick.

C. Paper facings shall contain 100 percent post-consumer recycled paper content.

2.2 ACCESSORIES

A. ASTM C1047, except form of 0.39 mm (0.015 inch) thick zinc coated steel sheet or rigid PVC plastic.

B. Flanges not less than 22 mm (7/8 inch) wide with punchouts or deformations as required to provide compound bond.

2.3 FASTENERS

A. ASTM C1002 and ASTM C840, except as otherwise specified.

B. ASTM C954, for steel studs thicker than 0.04 mm (0.33 inch).

C. Select screws of size and type recommended by the manufacturer of the material being fastened.

D. For fire rated construction, type and size same as used in fire rating test.

E. Clips: Zinc-coated (galvanized) steel; gypsum board manufacturer's standard items.

2.4 FINISHING MATERIALS AND LAMINATING ADHESIVE

A. ASTM C475 and ASTM C840. Free of antifreeze, vinyl adhesives, preservatives, biocides and other VOC. Adhesive shall contain a maximum VOC content of 50 g/l.

PART 3 - EXECUTION

3.1 GYPSUM BOARD HEIGHTS

A. Extend all layers of gypsum board from floor to underside of structure overhead.

3.2 INSTALLING GYPSUM BOARD

A. Coordinate installation of gypsum board with other trades and related work.

B. Install gypsum board in accordance with ASTM C840, except as otherwise specified.

C. Moisture and Mold–Resistant Assemblies: Provide and install moisture and mold-resistant glass mat gypsum wallboard products with moisture-resistant surfaces complying with ASTM C1658 where shown and in locations which might be subject to moisture exposure during construction.

D. Use gypsum boards in maximum practical lengths to minimize number of end joints.

E. Bring gypsum board into contact, but do not force into place.

F. Ceilings:

1. For single-ply construction, use perpendicular application.
2. For two-ply assembles:
    a. Use perpendicular application.
    b. Apply face ply of gypsum board so that joints of face ply do not occur at joints of base ply with joints over framing members.

G. Walls (Except Shaft Walls):

1. When gypsum board is installed parallel to framing members, space fasteners 300 mm (12 inches) on center in field of the board, and 200 mm (8 inches) on center along edges.
2. When gypsum board is installed perpendicular to framing members, space fasteners 300 mm (12 inches) on center in field and along edges.
3. Stagger screws on abutting edges or ends.
4. For single-ply construction, apply gypsum board with long dimension either parallel or perpendicular to framing members as required to minimize number of joints except gypsum board shall be applied vertically over "Z" furring channels.
5. For two-ply gypsum board assemblies, apply base ply of gypsum board to assure minimum number of joints in face layer. Apply face ply of wallboard to base ply so that joints of face ply do not occur at joints of base ply with joints over framing members.
6. For three-ply gypsum board assemblies, apply plies in same manner as for two-ply assemblies, except that heads of fasteners need only be driven flush with surface for first

and second plies. Apply third ply of wallboard in same manner as second ply of two-ply assembly, except use fasteners of sufficient length enough to have the same penetration into framing members as required for two-ply assemblies.

7. No offset in exposed face of walls and partitions will be permitted because of single-ply and two-ply or three-ply application requirements.
    a. Fasten face layer with screw, of sufficient length to secure to framing, spaced 300 mm (12 inches) on center around perimeter, and 400 mm (16 inches) on center in the field.
8. Control Joints ASTM C840 and as follows:
    a. Locate at both side jambs of openings if gypsum board is not "yoked". Use one system throughout.
    b. Not required for wall lengths less than 9000 mm (30 feet).
    c. Extend control joints the full height of the wall or length of soffit/ceiling membrane.

H. Fire and Smoke Partitions:
1. Cut gypsum board for a space approximately 3 mm to 6 mm (1/8 to 1/4 inch) wide around partition perimeter.
2. Coordinate for application of caulking or sealants to space prior to taping and finishing.

I. Electrical and Telecommunications Boxes:
1. Seal annular spaces between electrical and telecommunications receptacle boxes and gypsum board partitions.

J. Accessories:
1. Set accessories plumb, level and true to line, neatly mitered at corners and intersections, and securely attach to supporting surfaces as specified.
2. Install in one piece, without the limits of the longest commercially available lengths.
3. Corner Beads:
    a. Install at all vertical and horizontal external corners and where shown.
    b. Use screws only. Do not use crimping tool.
4. Edge Trim (casings Beads):
    a. At both sides of expansion and control joints unless shown otherwise.
    b. Where gypsum board terminates against dissimilar materials and at perimeter of openings, except where covered by flanges, casings or permanently built-in equipment.
    c. Where gypsum board surfaces of non-load bearing assemblies abut load bearing members.
    d. Where shown.

3.3 FINISHING OF GYPSUM BOARD

A. Finish joints, edges, corners, and fastener heads in accordance with ASTM C840. Use Level 4 finish for al finished areas open to public view.

B. Before proceeding with installation of finishing materials, assure the following:

1. Gypsum board is fastened and held close to framing or furring.
2. Fastening heads in gypsum board are slightly below surface in dimple formed by driving tool.

C. Finish joints, fasteners, and all openings, including openings around penetrations, on that part of the gypsum board extending above suspended ceilings to seal surface of non decorated, fire rated gypsum board construction. After the installation of hanger rods, hanger wires, supports, equipment, conduits, piping and similar work, seal remaining openings and maintain the integrity of the fire rated construction. Sanding is not required of non decorated surfaces.

3.4 REPAIRS

A. After taping and finishing has been completed, and before decoration, repair all damaged and defective work, including nondecorated surfaces.

B. Patch holes or openings 13 mm (1/2 inch) or less in diameter, or equivalent size, with a setting type finishing compound or patching plaster.

C. Repair holes or openings over 13 mm (1/2 inch) diameter, or equivalent size, with 16 mm (5/8 inch) thick gypsum board secured in such a manner as to provide solid substrate equivalent to undamaged surface.

D. Tape and refinish scratched, abraded or damaged finish surfaces including cracks and joints in non decorated surface to provide smoke tight construction fire protection equivalent to the fire rated construction and STC equivalent to the sound rated construction.

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SECTION 09 30 13
CERAMIC/PORCELAIN TILING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies interior ceramic tile, waterproofing membranes for thin-set applications, and crack isolation membranes.

1.2 RELATED WORK

A. Section 07 92 00, JOINT SEALANTS: Sealing of Joints.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Sustainable Design Submittals as described below:

1. Volatile organic compounds per volume as specified in PART 2 - PRODUCTS.

C. Samples:

1. Base tile, each type, each color, each size.
2. Wall (or wainscot) tile, each color, size and pattern.
3. Trim shapes, bullnose cap and cove including bullnose cap and base pieces at internal and external corners of vertical surfaces, each type, color, and size.

D. Product Data:

1. Ceramic tile, marked to show each type, size, and shape required.
2. Chemical resistant mortar and grout (epoxy and furan).
3. Dry-set portland cement mortar and grout.
4. Elastomeric membrane and bond coat.
5. Latex-portland cement mortar and grout.
6. Commercial portland cement grout.
7. Organic adhesive.

E. Installer Qualifications:

1. Submit letter stating installer’s experience.

1.4 DELIVERY AND STORAGE

A. Deliver materials in containers with labels legible and intact and grade-seals unbroken.

B. Store material to prevent damage or contamination.

1.5 QUALITY ASSURANCE

A. Installers to be from a company specializing in performing installation of products specified and have a minimum of three (3) years’ experience.

B. Each type and color of tile to be provided from a single source.

C. Each type and color of mortar, adhesive, and grout to be provided from the same source.

1.6 WARRANTY

A. Construction Warranty: Comply with FAR clause 52.246-21, “Warranty of Construction”.

1.7 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in text by basic designation only.

B. American National Standards Institute (ANSI):

A10.20-06(R2016) ..... Safe Operating Practices for Tile, Terrazzo and Marble Work

A108/A118/A136.1:2019 Installation of Ceramic Tile

A108.01-18 ..... Subsurfaces and Preparations by Other Trades

A108.02-19 ..... Materials, Environmental, and Workmanship

A108.1B-17..... Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar

A108.1C-17..... Contractors Option; Installation of Ceramic Tile in the Wet-Set method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar

A108.4-09 ..... Ceramic Tile with Organic Adhesives or Water Cleanable Tile-Setting Epoxy Adhesive

A108.5-10 ..... Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar

A108.9-10 ..... Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout

A108.10-17 ..... Grout in Tilework

A108.13-16 ..... Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone

A118.1-19 ..... Dry-Set Portland Cement Mortar

A118.3-13 ..... Chemical Resistant, Water Cleanable Tile-Setting and –Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive

A118.4-19 ..... Modified Dry-Set Cement Mortar

A118.7-1 ..... High Performance Cement Grouts for Tile Installation

A118.8-16 ..... Modified Epoxy Emulsion Mortar/ Grout

A118.10-14 ..... Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation

A118.15-19 ..... Improved Modified Dry-Set Cement Mortar

A136.1-13 ..... Organic Adhesives for Installation of Ceramic Tile

A137.1-17 ..... American National Standard Specifications for Ceramic Tile

C. ASTM International (ASTM):

C109/C109M-20b ..... Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch. or [50-mm] Cube Specimens)

C348-20 ..... Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars

C979/C979M-16 ..... Pigments for Integrally Colored Concrete

C1027-19 ..... Test Method for Determining Visible Abrasion Resistance of Glazed Ceramic Tile

C1127/C1127M-15 ..... Standard Guide for Use of High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane with an Integral Wearing Surface

D. Code of Federal Regulation (CFR):

40 CFR 59 ..... Determination of Volatile Matter Content, Water Content, Density Volume Solids, and Weight Solids of Surface Coating

E. Tile Council of North America, Inc. (TCNA):

Handbook for Ceramic Tile Installation (2020)G. TCNA DCOF AcuTest-2012,Dynamic Coefficient of Friction Test

PART 2 - PRODUCTS

2.1 TILE

A. Comply with ANSI A137.1, Standard Grade, except as modified:

1. Inspection procedures listed under the Appendix of ANSI A137.1.
2. Abrasion Resistance Classification:
   a) Tested in accordance with values listed in Table 1, ASTM C1027.
   b) Class IV, 6000 revolutions.
3. Factory Blending: For tile with color variations, within the ranges selected during sample submittals blend tile in the factory and package so tile units taken from one (1) package show the same range in colors as those taken from other packages and match approved samples.
4. Factory-Applied Temporary Protective Coating:
   a) Protect exposed face surfaces (top surface) of tile against adherence of mortar and grout by pre-coating with a continuous film of hot applied petroleum paraffin wax.
   b) Do not coat unexposed tile surfaces.
   c) Pre-wax tiles set or grouted with furan or epoxy or latex modified mortars.

B. Glazed Wall Tile: Cushion edges, glazing.

C. Trim Shapes:

1. Conform to applicable requirements of adjoining floor and wall tile.
2. Use trim shapes sizes conforming to size of adjoining field wall tile including existing spaces unless detailed on construction documents or specified otherwise.

3. Internal and External Corners:
   a) Square internal and external corner joints are not acceptable.
   b) External corners including edges: Use bullnose shapes.
   c) Internal corners: Use cove shapes.
   d) Base to floor internal corners: Use special shapes providing integral cove vertical and horizontal joint.
   e) Base to floor external corners: Use special shapes providing bullnose vertical edge with integral cove horizontal joint. Use stop at bottom of openings having bullnose return to wall.
   f) Wall top edge internal corners: Use special shapes providing integral cove vertical joint with bullnose top edge.
   g) Wall top edge external corners: Use special shapes providing bullnose vertical and horizontal joint edge.
   h) For glazed wall tile installed in portland cement mortar setting bed, use cove and bullnose shapes as applicable. When ceramic mosaic wall and base tile is required, use C Series cove and bullnose shapes.
   i) For glazed wall tile installed in dry-set portland cement mortar, latex-portland cement mortar, and organic adhesive (thin set methods), use cove and surface bullnose shapes as applicable.
   j) Provide cove and bullnose shapes where indicated in construction documents and required to complete tile work.

2.2 SETTING MATERIALS OR BOND COATS

A. Conform to TCNA Handbook for Ceramic Tile Installation.

B. Latex-Portland Cement Mortar: ANSI A118.4.
   1. For wall applications, provide non-sagging, latex-portland cement mortar complying with ANSI A118.4.
   2. Prepackaged Dry-Mortar Mix: Factory-prepared mixture of portland cement; dry, redispersible, ethylene vinyl acetate additive; and other ingredients to which only water needs to be added at Project site.

C. Dry-Set Portland Cement Mortar: ANSI A118.1. For wall applications, provide non-sagging, latex-portland cement mortar complying with ANSI A118.1.

D. Organic Adhesives: ANSI A136.1, Type 1.

E. Elastomeric Waterproofing Membrane and Bond Coat:
   1. TCNA F122-14 (on ground concrete) and TCNA F112A-14 (above ground concrete).
   2. ANSI A118.10.
   3. One component polyurethane, liquid applied material having the following additional physical properties:

a) Hardness: Shore "A" between 40-60.
b) Elongation: Between 300-600 percent.
c) Tensile strength: Between .27 - .41 Newton per square millimeter (40-60 pounds per square inch gauge).
d) No volatile compounds (VOC).

4. Coal tar modified urethanes are not acceptable.

2.3 GROUTING MATERIALS

A. Coloring Pigments:
1. Pure mineral pigments, lime proof and nonfading, complying with ASTM C979/C979M.
2. Coloring pigments may only be added to grout by the manufacturer.
3. Job colored grout is not acceptable.
4. Use is required in Commercial Portland Cement Grout, Dry-Set Grout, and Latex-Portland Cement Grout.

B. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59 (EPA Method 24).
1. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 60 and 100 degrees C (140 and 212 degrees F), respectively, and certified by manufacturer for intended use.

2.4 PATCHING AND LEVELING COMPOUND

A. Portland cement base, polymer-modified, self-leveling compound, manufactured specifically for resurfacing and leveling concrete floors. Products containing gypsum are not acceptable.

B. Provide a patching and leveling compound with the following minimum physical properties:
1. Compressive strength - 25 MPa (3500 psig) per ASTM C109/C109M.
2. Flexural strength - 7 MPa (1000 psig) per ASTM C348 (28 day value).
3. Tensile strength – 4.1 MPa (600 psi) per ANSI 118.7.
4. Density – 1.9.

C. Capable of being applied in layers up to 38 mm (1-1/2 inches) thick without fillers and up to 101 mm (4 inches) thick with fillers, being brought to a feather edge, and being trowelled to a smooth finish.

D. Primers, fillers, and reinforcement as required by manufacturer for application and substrate condition.

E. Ready for use in 48 hours after application.

2.5 WATER

A. Clean, potable and free from salts and other injurious elements to mortar and grout materials.

2.6 CLEANING COMPOUNDS

A. Specifically designed for cleaning masonry and concrete and which will not prevent bond of subsequent tile setting materials including patching and leveling compounds and elastomeric waterproofing membrane and coat.

B. Materials containing acid or caustic Material are not acceptable.

PART 3 - EXECUTION

3.1 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperature of work areas at not less than 16 degrees C (60 degrees F), without interruption, for not less than 24 hours before installation and not less than three (3) days after installation.

B. Maintain higher temperatures for a longer period of time where required by manufacturer's recommendation and ANSI Specifications for installation.

C. Do not install tile when the temperature is above 38 degrees C (100 degrees F).

D. Do not install materials when the temperature of the substrate is below 16 degrees C (60 degrees F).

E. Do not allow temperature to fall below 10 degrees C (50 degrees F) after third day of completion of tile work.

3.2 ALLOWABLE TOLERANCE

A. Variation in Plane of Wall Surfaces:

1. Not more than 6 mm in 2438 mm (1/4 inch in 8 feet) from required plane where portland cement mortar setting bed is used.
2. Not more than 3 mm in 2438 mm (1/8 inch in 8 feet) where dry-set or latex-portland cement mortar or organic adhesive setting materials is used.

3.3 SURFACE PREPARATION

A. Cleaning New Concrete or Masonry:

1. Chip out loose material, clean off all oil, grease dirt, adhesives, curing compounds, and other deterrents to bonding by mechanical method, or by using products specifically designed for cleaning concrete and masonry.
2. Use self-contained power blast cleaning systems to remove curing compounds and steel trowel finish from concrete slabs where ceramic tile will be installed directly on concrete surface with thin-set materials.
3. Steam cleaning or the use of acids and solvents for cleaning will not be permitted.

B. Patching and Leveling:

1. Apply patching and leveling compound to concrete and masonry wall surfaces that are out of required plane.
2. Apply leveling coats of material compatible with wall surface and tile setting material to wall surfaces, other than concrete and masonry that are out of required plane.

C. Walls:
   1. Apply patching and leveling compound to concrete and masonry surfaces that are out of required plane.
   2. Apply leveling coats of material compatible with wall surface and tile setting material to wall surfaces, other than concrete and masonry that are out of required plane.

D. Existing Floors and Walls:
   1. Remove existing composition floor finishes and adhesive. Prepare surface by grinding, chipping, self-contained power blast cleaning or other suitable mechanical methods to completely expose uncontaminated concrete or masonry surfaces. Follow safety requirements of ANSI A10.20.

3.4 CERAMIC TILE – GENERAL

A. Comply with ANSI A108/A118/A136 series of tile installation standards applicable to methods of installation and TCNA Installation Guidelines.

B. Setting Beds or Bond Coats:
   1. Set wall tile installed over concrete or masonry in dry-set portland cement mortar, or latex-portland cement mortar, ANSI 108.1B and TCNA System W211-14, W221-14 or W222-14.

C. Workmanship:
   1. Lay out tile work so that no tile less than one-half full size is used. Make all cuts on the outer edge of the field. Align new tile work scheduled for existing spaces to the existing tile work unless specified otherwise.
   2. Set tile firmly in place with finish surfaces in true planes. Align tile flush with adjacent tile unless shown otherwise on construction documents.
   3. Form intersections and returns accurately.
   4. Cut and drill tile neatly without marring surface.
   5. Cut edges of tile abutting penetrations, finish, or built-in items:
      a) Fit tile closely around electrical outlets, piping, fixtures and fittings, so that plates, escutcheons, collars and flanges will overlap cut edge of tile.
      b) Seal tile joints water tight as specified in Section 07 92 00, JOINT SEALANTS, around electrical outlets, piping fixtures and fittings before cover plates and escutcheons are set in place.
   6. Completed work is to be free from hollow sounding areas and loose, cracked, or defective tile.
   7. Remove and reset tiles that are out of plane or misaligned.
   8. Walls:
      a) Cover walls and partitions, including furred areas, from floor to nominal wainscot heights as indicated in construction documents with tile.

b) Finish wall surfaces behind and at sides of casework and equipment, except those units mounted in wall recesses, with same tile as scheduled for room proper.

9. Joints:
   a) Keep all joints in line, straight, level, perpendicular and of even width unless shown otherwise on construction documents.
   b) Make joints 2 mm (1/16 inch) wide for glazed wall tile and mosaic tile work.
10. Back Buttering: For installations indicated below, obtain 100 percent mortar coverage by complying with applicable special requirements for back buttering of tile in referenced ANSI A108/A118/A136 series of tile installation standards:
    a) Tile wall installations in wet areas.

3.5 THIN SET CERAMIC AND PORCELAIN TILE INSTALLED WITH DRY-SET PORTLAND CEMENT AND LATEX-PORTLAND CEMENT MORTAR

A. Installation of Tile: ANSI A108.1B, except as specified otherwise.

3.6 THIN SET CERAMIC AND PORCELAIN TILE INSTALLED WITH ORGANIC ADHESIVE

A. Installation of Tile: ANSI A108.4.

3.7 CERAMIC AND PORCELAIN TILE INSTALLED WITH ELASTOMERIC BOND COAT

A. Surface Preparation: Prepare surfaces as specified.

B. Installation of Elastomeric Membrane: ANSI A108.10 and F122A-14 (above-ground concrete).
   1. Prime surfaces, where required, in accordance with manufacturer's instructions.
   2. Install first coat of membrane material in accordance with manufacturer's instructions, in thickness of 0.76 to 1.3 mm (30 to 50 mils).
   3. Extend material over flashing rings.
   4. When material has set, recoat areas with a second coat of elastomeric membrane material for a total thickness of 1.3 to 1.9 mm (50 to 75 mils).
   5. After curing test for leaks with 25 mm (1 inch) of water for 24 hours.

C. Installation of Tile in Elastomeric Membrane:
   1. Spread no more material than can be covered with tile before material starts to set.
   2. Apply tile in second coat of elastomeric membrane material in accordance with the coating manufacturer's instructions in lieu at aggregate surfacing specified in ASTM C1127. Do not install top coat over tile.

3.8 GROUTING

A. Grout Type and Location:
   1. Grout for glazed wall and base tile: water cleanable epoxy grout.

B. Workmanship:
   1. Install and cure grout in accordance with the applicable standard.
   2. Water-Cleanable Epoxy Grout: ANSI A118.3.

3.9 MOVEMENT JOINTS

A. Prepare tile expansion, isolation, construction and contraction joints for installation of sealant. Refer to Section 07 92 00, JOINT SEALANTS.

B. TCNA details EJ 171-14.

C. At expansion joints, rake out joint full depth of tile and setting bed and mortar bed. Do not cut waterproof or isolation membrane.

3.10 CLEANING

A. Thoroughly sponge and wash tile. Polish glazed surfaces with clean dry cloths.

B. Methods and materials used are not permitted to damage or impair appearance of tile surfaces.

C. The use of acid or acid cleaners on glazed tile surfaces is prohibited.

D. Clean tile grouted with epoxy and tile set in elastomeric bond coat as recommended by the manufacturer of the grout and bond coat.

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SECTION 09 91 00
PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the painting and finishing as shown on the construction documents and/or specified herein, including, but not limited to, the following:

1. Prime coats which may be applied in shop under other sections.
2. Prime painting unprimed surfaces to be painted under this Section.
3. Painting items furnished with a prime coat of paint, including touching up of or repairing of abraded, damaged or rusted prime coats applied by others.
4. Painting ferrous metal (except stainless steel) exposed to view.
5. Painting galvanized ferrous metals exposed to view.
6. Painting interior concrete block exposed to view.
7. Painting gypsum drywall exposed to view.
8. Painting pipes, pipe coverings, conduit, ducts, insulation, hangers, supports and other mechanical and electrical items and equipment exposed to view.
9. Painting includes shellacs, coatings specified, and striping or markers and identity markings.
10. Incidental painting and touching up as required to produce proper finish for painted surfaces, including touching up of factory finished items.
11. Painting of any surface not specifically mentioned to be painted herein or on construction documents, but for which painting is obviously necessary to complete the job, or work which comes within the intent of these specifications, is to be included as though specified.

1.2 RELATED WORK

A. Section 01 35 26, SAFETY REQUIREMENTS: Activity Hazard Analysis.

B. Section 01 81 13, SUSTAINABLE CONSTUCTION REQUIREMENTS: Sustainable Design Requirements.

C. Division 05 METALS: Shop prime painting of steel and ferrous metals.

D. Division 08 OPENINGS: Shop prime painting of steel and ferrous metals.

E. Division 23 HEATING; VENTILATION AND AIR-CONDITIONING: Shop prime painting of steel and ferrous metals.

F. Division 26 ELECTRICAL: Shop prime painting of steel and ferrous metals.

G. Division 27 COMMUNICATIONS: Shop prime painting of steel and ferrous metals.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Sustainable Design Submittals as described below:

1. Volatile organic compounds per volume as specified in Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.

C. Manufacturer's Literature and Data:

1. Before work is started, or sample panels are prepared, submit manufacturer's literature and technical data, the current Master Painters Institute (MPI) "Approved Product List" indicating brand label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use subsequent MPI "Approved Product List", however, only one (1) list may be used for the entire contract and each coating system is to be from a single manufacturer. All coats on a particular substrate must be from a single manufacturer. No variation from the MPI "Approved Product List" where applicable is acceptable.

D. Sample Panels:

1. After painters' materials have been approved and before work is started, submit sample panels showing each type of finish and color specified.
2. Panels to Show Color: Composition board, 100 x 250 mm (4 x 10 inch).
3. Attach labels to panel stating the following:
    a. Federal Specification Number or manufacturers name and product number of paints used.
    b. Product type and color.
    c. Name of project.
4. Strips showing not less than 50 mm (2 inch) wide strips of undercoats and 100 mm (4 inch) wide strip of finish coat.

E. Sample of identity markers if used.

F. Manufacturers' Certificates indicating compliance with specified requirements:

1. Manufacturer's paint substituted for Federal Specification paints meets or exceeds performance of paint specified.
2. Intumescent clear coating or fire-retardant paint.

1.4 DELIVERY AND STORAGE

A. Deliver materials to site in manufacturer's sealed container marked to show following:

1. Name of manufacturer.
2. Product type.
3. Batch number.
4. Instructions for use.
5. Safety precautions.

B. In addition to manufacturer's label, provide a label legibly printed as following:

1. Federal Specification Number, where applicable, and name of material.
2. Surface upon which material is to be applied.

3. Specify Coat Types: Prime; body; finish; etc.

C. Maintain space for storage, and handling of painting materials and equipment in a ventilated, neat and orderly condition to prevent spontaneous combustion from occurring or igniting adjacent items.

D. Store materials at site at least 24 hours before using, at a temperature between 7 and 30 degrees C (45 and 85 degrees F).

1.5 QUALITY ASSURANCE

A. Paint Coordination: Provide finish coats which are compatible with the prime paints used. Review other Sections of these specifications in which prime paints are to be provided to ensure compatibility of the total coatings system for the various substrates. Upon request from other subcontractors, furnish information on the characteristics of the finish materials proposed to be used, to ensure that compatible prime coats are used. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify the Contracting Officer Representative (COR) in writing of any anticipated problems using the coating systems as specified with substrates primed by others.

1.6 REGULATORY REQUIREMENTS

A. Paint materials are to conform to the restrictions of the local Environmental and Toxic Control jurisdiction.

1. Volatile Organic Compounds (VOC) Emissions Requirements: Field-applied paints and coatings that are inside the waterproofing system to not exceed limits of authorities having jurisdiction:
   a. 10g/L for interior latex paints/primers.
   b. 50g/L for exterior latex paints/primers.
2. Lead-Base Paint:
   a. Comply with Section 410 of the Lead-Based Paint Poisoning Prevention Act, as amended, and with implementing regulations promulgated by Secretary of Housing and Urban Development.
   b. Regulations concerning prohibition against use of lead-based paint in federal and federally assisted construction, or rehabilitation of residential structures are set forth in Subpart F, Title 24, Code of Federal Regulations, Department of Housing and Urban Development.
   c. Do not use coatings having a lead content over 0.06 percent by weight of non-volatile content.
3. Asbestos: Provide materials that do not contain asbestos.
4. Chromate, Cadmium, Mercury, and Silica: Provide materials that do not contain zinc-chromate, strontium-chromate, Cadmium, mercury or mercury compounds or free crystalline silica.

5. Human Carcinogens: Provide materials that do not contain any of the ACGIH-BKLT and ACGHI-DOC confirmed or suspected human carcinogens.
6. Use high performance acrylic paints in place of alkyd paints.

1.7 SAFETY AND HEALTH

A. Apply paint materials using safety methods and equipment in accordance with the following:
1. Comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis (AHA) as specified in Section 01 35 26, SAFETY REQUIREMENTS. The AHA is to include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

B. Safety Methods Used During Paint Application: Comply with the requirements of SSPC PA Guide 10.

C. Toxic Materials: To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:
1. The applicable manufacturer's Material Safety Data Sheets (MSDS) or local regulation.
2. 29 CFR 1910.1000.
3. ACHIH-BKLT and ACGHI-DOC, threshold limit values.

1.8 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

B. American Conference of Governmental Industrial Hygienists (ACGIH):

ACGIH TLV-BKLT-2012 Threshold Limit Values (TLV) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs)

ACGIH TLV-DOC-2012 Documentation of Threshold Limit Values and Biological Exposure Indices, (Seventh Edition)

C. ASME International (ASME):

A13.1-07(R2013) ..... Scheme for the Identification of Piping Systems

D. Commercial Item Description (CID):

A-A-1272A ..... Plaster Gypsum (Spackling Compound)

E. Federal Specifications (Fed Spec):

TT-P-1411A ..... Paint, Copolymer-Resin, Cementitious (For Waterproofing Concrete and Masonry Walls) (CEP)

F. Master Painters Institute (MPI):

4 ..... Interior/ Exterior Latex Block Filler

9 ..... Exterior Alkyd Enamel MPI Gloss Level 6

11 ..... Exterior Latex, Semi-Gloss

22 ..... High Heat Resistant Coating

45 ..... Interior Primer Sealer
46 ..... Interior Enamel Undercoat
47 ..... Interior Alkyd, Semi-Gloss, MPI Gloss Level 5
50 ..... Interior Latex Primer Sealer
94 ..... Exterior Alkyd, Semi-Gloss
95 ..... Fast Drying Metal Primer
99 ..... Sealer, Water-based, for Concrete Floors
134 ..... Galvanized Water Based Primer
138 ..... Interior High Performance Latex, MPI Gloss Level 2
139 ..... Interior High Performance Latex, MPI Gloss Level 3
141 ..... Interior High Performance Latex (SG) MPI Gloss Level 5

G. Society for Protective Coatings (SSPC):
SSPC SP 1-82(R2004). Solvent Cleaning
SSPC SP 2-82(R2004). Hand Tool Cleaning
SSPC SP 3-28(R2004). Power Tool Cleaning
SSPC SP 10/NACE No.2 Near-White Blast Cleaning
SSPC PA Guide 10 ..... Guide to Safety and Health Requirements

H. U.S. National Archives and Records Administration (NARA):
29 CFR 1910.1000 ..... Air Contaminants

I. Underwriter's Laboratory (UL)

PART 2 - PRODUCTS

2.1 MATERIALS

A. Conform to the coating specifications and standards referenced in PART 3. Submit manufacturer's technical data sheets for specified coatings and solvents.

2.2 PAINT PROPERTIES

A. Use ready-mixed (including colors), except two component epoxies, polyurethanes, polyesters, paints having metallic powders packaged separately and paints requiring specified additives.

B. Where no requirements are given in the referenced specifications for primers, use primers with pigment and vehicle, compatible with substrate and finish coats specified.

C. Provide undercoat paint produced by the same manufacturer as the finish coats. Use only thinners approved by the paint manufacturer and use only to recommended limits.

D. VOC Content: For field applications that are inside the weatherproofing system, paints and coating to comply with VOC content limits of authorities having jurisdiction and the VOC content limits listed in Section 01 81 13, SUSTAINABLE DESIGN REQUIREMENTS.

2.3 PLASTIC TAPE

A. Pigmented vinyl plastic film in colors as specified.

B. Pressure sensitive adhesive back.

C. Widths as specified.

2.4 BIOBASED CONTENT

A. Paint products shall comply with following bio-based standards for biobased materials:

Material Type	Percent by Weight
Interior Paint	20 percent biobased material
Interior Paint- Oil Based and Solvent Alkyd	67 percent biobased material
Exterior Paint	20 percent biobased material
Wood & Concrete Stain	39 percent biobased content
Polyurethane Coatings	25 percent biobased content
Water Tank Coatings	59 percent biobased content
Wood & Concrete Sealer- Membrane Concrete Sealers	11 percent biobased content
Wood & Concrete Sealer- Penetrating Liquid	79 percent biobased content

B. The minimum-content standards are based on the weight (not the volume) of the material.

PART 3 - EXECUTION

3.1 JOB CONDITIONS

A. Safety: Observe required safety regulations and manufacturer's warning and instructions for storage, handling and application of painting materials.

1. Take necessary precautions to protect personnel and property from hazards due to falls, injuries, toxic fumes, fire, explosion, or other harm.
2. Deposit soiled cleaning rags and waste materials in metal containers approved for that purpose. Dispose of such items off the site at end of each day’s work.

B. Atmospheric and Surface Conditions:

1. Do not apply coating when air or substrate conditions are:
   a. Less than 3 degrees C (5 degrees F) above dew point.
   b. Below 10 degrees C (50 degrees F) or over 35 degrees C (95 degrees F), unless specifically pre-approved by the COR and the product manufacturer. Under no circumstances are application conditions to exceed manufacturer recommendations.
   c. When the relative humidity exceeds 85 percent; or to damp or wet surfaces; unless otherwise permitted by the paint manufacturer’s printed instructions.
2. Maintain interior temperatures until paint dries hard.
3. Do no exterior painting when it is windy and dusty.
4. Do not paint in direct sunlight or on surfaces that the sun will warm.
5. Apply only on clean, dry and frost-free surfaces except as follows:

a. Apply water thinned acrylic and cementitious paints to damp (not wet) surfaces only when allowed by manufacturer's printed instructions.
b. Concrete and masonry when permitted by manufacturer’s recommendations, dampen surfaces to which water thinned acrylic and cementitious paints are applied with a fine mist of water on hot dry days to prevent excessive suction and to cool surface.

3.2 INSPECTION

A. Examine the areas and conditions where painting and finishing are to be applied and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.3 GENERAL WORKMANSHIP REQUIREMENTS

A. Application may be by brush or roller. Spray application only upon acceptance from the COR in writing.
B. Furnish to the COR a painting schedule indicating when the respective coats of paint for the various areas and surfaces will be completed. This schedule is to be kept current as the job progresses.
C. Protect work at all times. Protect all adjacent work and materials by suitable covering or other method during progress of work. Upon completion of the work, remove all paint and varnish spots from floors, glass and other surfaces. Remove from the premises all rubbish and accumulated materials of whatever nature not caused by others and leave work in a clean condition.
D. Remove and protect hardware, accessories, device plates, lighting fixtures, and factory finished work, and similar items, or provide in place protection. Upon completion of each space, carefully replace all removed items by workmen skilled in the trades involved.
E. When indicated to be painted, remove electrical panel box covers and doors before painting walls. Paint separately and re-install after all paint is dry.
F. Materials are to be applied under adequate illumination, evenly spread and flowed on smoothly to avoid runs, sags, holidays, brush marks, air bubbles and excessive roller stipple.
G. Apply materials with a coverage to hide substrate completely. When color, stain, dirt or undercoats show through final coat of paint, the surface is to be covered by additional coats until the paint film is of uniform finish, color, appearance and coverage, at no additional cost to the Government.
H. All coats are to be dry to manufacturer’s recommendations before applying succeeding coats.

3.4 SURFACE PREPARATION

A. General
1. The Contractor shall be held wholly responsible for the finished appearance and satisfactory completion of painting work. Properly prepare all surfaces to receive paint, which includes cleaning, sanding, and touching-up of all prime coats applied under other Sections of the

work. Broom clean all spaces before painting is started. All surfaces to be painted or finished are to be completely dry, clean and smooth.

2. See other sections of specifications for specified surface conditions and prime coat.
3. Perform preparation and cleaning procedures in strict accordance with the paint manufacturer's instructions and as herein specified, for each particular substrate condition.
4. Clean surfaces before applying paint or surface treatments with materials and methods compatible with substrate and specified finish. Remove any residue remaining from cleaning agents used. Do not use solvents, acid, or steam on concrete and masonry. Schedule the cleaning and painting so that dust and other contaminants from the cleaning process will not fall in wet, newly painted surfaces.
5. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   a. Concrete: 12 percent.
   b. Masonry (Clay and CMU's): 12 percent.
   c. Gypsum Board: 12 percent.

B. Ferrous Metals:

1. Remove oil, grease, soil, drawing and cutting compounds, flux and other detrimental foreign matter in accordance with SSPC-SP 1 (Solvent Cleaning).
2. Remove loose mill scale, rust, and paint, by hand or power tool cleaning, as defined in SSPC-SP 2 (Hand Tool Cleaning) and SSPC-SP 3 (Power Tool Cleaning).
3. Fill dents, holes and similar voids and depressions in flat exposed surfaces of hollow steel doors and frames, access panels, and similar items specified to have semi-gloss or gloss finish with TT-F-322D (Filler, Two-Component Type, For Dents, Small Holes and Blow-Holes). Finish flush with adjacent surfaces.
   a. Fill flat head countersunk screws used for permanent anchors.
   b. Do not fill screws of item intended for removal such as glazing beads.
4. Spot prime abraded and damaged areas in shop prime coat which expose bare metal with same type of paint used for prime coat. Feather edge of spot prime to produce smooth finish coat.
5. Spot prime abraded and damaged areas which expose bare metal of factory finished items with paint as recommended by manufacturer of item.

C. Zinc-Coated (Galvanized) Metal, Surfaces Specified Painted:

1. Clean surfaces to remove grease, oil and other deterrents to paint adhesion in accordance with SSPC-SP 1 (Solvent Cleaning).
2. Spot coat abraded and damaged areas of zinc-coating which expose base metal on hot-dip zinc-coated items with MPI 18 (Organic Zinc Rich Coating). Prime or spot prime with MPI

134 (Waterborne Galvanized Primer) or MPI 135 (Non-Cementitious Galvanized Primer) depending on finish coat compatibility.

D. Masonry, Concrete, Cement Board, Cement Plaster and Stucco:
   1. Clean and remove dust, dirt, oil, grease efflorescence, form release agents, laitance, and other deterrents to paint adhesion.
   2. Use emulsion type cleaning agents to remove oil, grease, paint and similar products. Use of solvents, acid, or steam is not permitted.
   3. Remove loose mortar in masonry work.
   4. Replace mortar and fill open joints, holes, cracks and depressions with new mortar specified in Section 04 05 13, MASONRY MORTARING and Section 04 05 16, MASONRY GROUTING. Do not fill weep holes. Finish to match adjacent surfaces.
   5. Neutralize Concrete floors to be painted by washing with a solution of 1.4 Kg (3 pounds) of zinc sulfate crystals to 3.8 L (1 gallon) of water, allow to dry three (3) days and brush thoroughly free of crystals.
   6. Repair broken and spalled concrete edges with concrete patching compound to match adjacent surfaces as specified in Division 03, CONCRETE Sections. Remove projections to level of adjacent surface by grinding or similar methods.

E. Gypsum Plaster and Gypsum Board:
   1. Remove efflorescence, loose and chalking plaster or finishing materials.
   2. Remove dust, dirt, and other deterrents to paint adhesion.
   3. Fill holes, cracks, and other depressions with CID-A-A-1272A finished flush with adjacent surface, with texture to match texture of adjacent surface. Patch holes over 25 mm (1-inch) in diameter as specified in Section for plaster or gypsum board.

3.5 PAINT PREPARATION

A. Thoroughly mix painting materials to ensure uniformity of color, complete dispersion of pigment and uniform composition.

B. Do not thin unless necessary for application and when finish paint is used for body and prime coats. Use materials and quantities for thinning as specified in manufacturer's printed instructions.

C. Remove paint skins, then strain paint through commercial paint strainer to remove lumps and other particles.

D. Mix two (2) component and two (2) part paint and those requiring additives in such a manner as to uniformly blend as specified in manufacturer's printed instructions unless specified otherwise.

E. For tinting required to produce exact shades specified, use color pigment recommended by the paint manufacturer.

3.6 APPLICATION

A. Start of surface preparation or painting will be construed as acceptance of the surface as satisfactory for the application of materials.

B. Unless otherwise specified, apply paint in three (3) coats; prime, body, and finish. When two (2) coats applied to prime coat are the same, first coat applied over primer is body coat and second coat is finish coat.

C. Apply each coat evenly and cover substrate completely.

D. Allow not less than 48 hours between application of succeeding coats, except as allowed by manufacturer's printed instructions, and approved by COR.

E. Apply by brush or roller. Spray application for existing occupied spaces only upon approval by acceptance from COR in writing.

1. Apply painting materials specifically required by manufacturer to be applied by spraying.
2. In existing occupied spaces, where paint is applied by spray, mask or enclose with polyethylene, or similar air tight material with edges and seams continuously sealed including items specified in “Building and Structural Work Field Painting”; “Work not Painted”; motors, controls, telephone, and electrical equipment, fronts of sterilizes and other recessed equipment and similar prefinished items.

F. Do not paint in closed position operable items such as access doors and panels, window sashes, overhead doors, and similar items except overhead roll-up doors and shutters.

3.7 PRIME PAINTING

A. After surface preparation, prime surfaces before application of body and finish coats, except as otherwise specified.

B. Spot prime and apply body coat to damaged and abraded painted surfaces before applying succeeding coats.

C. Additional field applied prime coats over shop or factory applied prime coats are not required except for exterior exposed steel apply an additional prime coat.

D. Metals except boilers, incinerator stacks, and engine exhaust pipes:

1. Steel and iron: MPI 95 (Fast Drying Metal Primer).
2. Zinc-coated steel and iron: MPI 134 (Waterborne Galvanized Primer).
3. Machinery not factory finished: MPI 9 (Exterior Alkyd Enamel).

E. Gypsum Board and Plaster:

1. Primer: MPI 50 (Interior Latex Primer Sealer), except use MPI 45 (Interior Primer Sealer) or MPI 46 (Interior Enamel Undercoat) in bathrooms.

F. Concrete Masonry Units except glazed or integrally colored and decorative units:

1. MPI 4 (Block Filler) on interior surfaces.
2. Prime exterior surface as specified for exterior finishes.

G. Concrete Floors: MPI 99 (Water-based Acrylic Curing and Sealing Compound).

3.8 EXTERIOR FINISHES

A. Steel and Ferrous Metal:
   1. Two (2) coats of MPI 94 (Exterior Alkyd, Semi-Gloss) on exposed surfaces.
B. Machinery without factory finish except for primer: One (1) coat MPI 9 (Exterior Alkyd Enamel).
C. Concrete Masonry Units, Concrete:
   1. General:
      a. Mix as specified in manufacturer's printed directions.
      b. Do not mix more paint than can be used within four (4) hours after mixing. Discard paint that has started to set.
      c. Dampen warm surfaces above 24 degrees C (75 degrees F) with fine mist of water before application of paint. Do not leave free water on surface.
      d. Cure paint with a fine mist of water as specified in manufacturer's printed instructions.
   2. Use two (2) coats of TT-P-1411 (Paint, Co-polymer-Resin, Cementitious), unless specified otherwise.

3.9 INTERIOR FINISHES

A. Apply following finish coats over prime coats in spaces or on surfaces specified.
B. Metal Work:
   1. Apply to exposed surfaces.
   2. Omit body and finish coats on surfaces concealed after installation except electrical conduit containing conductors over 600 volts.
   3. Ferrous Metal, Galvanized Metal, and Other Metals Scheduled:
      a. Apply two (2) coats of MPI 47 (Interior Alkyd, Semi-Gloss) unless specified otherwise.
      b. Machinery: One (1) coat MPI 9 (Exterior Alkyd Enamel).
C. Gypsum Board and Plaster:
   1. Two (2) coats of MPI 138 (Interior High Performance Latex, MPI Gloss Level 2), unless otherwise indicated.
   2. One (1) coat of MPI 45 (Interior Primer Sealer) or MPI 46 (Interior Enamel Undercoat) plus one (1) coat of MPI 141 (Interior High Performance Latex, MPI Gloss level 5) at bathroom ceilings.
D. Masonry and Concrete Walls:
   1. Over MPI 4 (Interior/Exterior Latex Block Filler) on CMU surfaces.
   2. Two (2) coats of MPI 139 (Interior High Performance Latex, MPI Gloss Level 3), unless otherwise indicated.
   3. Two (2) coats of MPI 141 (Interior High Performance Latex MPI Gloss Level 5) at bathrooms.

3.10 REFINISHING EXISTING PAINTED SURFACES

A. Clean, patch and repair existing surfaces as specified under “Surface Preparation”. No “telegraphing” of lines, ridges, flakes, etc., through new surfacing is permitted. Where this occurs, sand smooth and re-finish until surface meets with COR’s approval.

B. Remove and reinstall items as specified under “General Workmanship Requirements”.

C. Remove existing finishes or apply separation coats to prevent non compatible coatings from having contact.

D. Patched or Replaced Areas in Surfaces and Components: Apply spot prime and body coats as specified for new work to repaired areas or replaced components.

E. Except where scheduled for complete painting apply finish coat over plane surface to nearest break in plane, such as corner, reveal, or frame.

F. Refinish areas as specified for new work to match adjoining work unless specified or scheduled otherwise.

G. Sand or dull glossy surfaces prior to painting.

H. Sand existing coatings to a feather edge so that transition between new and existing finish will not show in finished work.

3.11 PAINT COLOR

A. Color and gloss of finish coats is to match existing finishes, unless noted otherwise.

B. For additional requirements regarding color see Articles, “REFINISHING EXISTING PAINTED SURFACE” and “MECHANICAL AND ELECTRICAL FIELD PAINTING SCHEDULE”.

C. Coat Colors:

1. Color of priming coat: Lighter than body coat.
2. Color of body coat: Lighter than finish coat.
3. Color prime and body coats to not show through the finish coat and to mask surface imperfections or contrasts.

3.12 MECHANICAL AND ELECTRICAL WORK FIELD PAINTING SCHEDULE

A. Where mechanical and electrical systems are modified to accomplish work, modified portions of the system shall be field painted.

B. Field painting of mechanical and electrical consists of cleaning, touching-up abraded shop prime coats, and applying prime, body and finish coats to materials and equipment if not factory finished in space scheduled to be finished.

C. Paint various systems specified in Division 21 – FIRE SUPPRESSION, Division 22 - PLUMBING, Division 23 – HEATING, VENTILATION AND AIR-CONDITIONING, Division 26 - ELECTRICAL, Division 27 - COMMUNICATIONS, and Division 28 – ELECTRONIC SAFETY AND SECURITY.

D. Paint after tests have been completed.

E. Omit prime coat from factory prime-coated items.

F. Omit field painting of items specified in “BUILDING AND STRUCTURAL WORK FIELD PAINTING”; “Building and Structural Work not Painted”.

G. Color:
   1. Paint items having no color specified below or in other Sections to match surrounding surfaces.
   2. Paint items not specified in other Section according to the following:
      a. White: Exterior unfinished surfaces of enameled plumbing fixtures. Insulation coverings on condensate tanks and condensate piping.
      b. Gray: Heating, ventilating, air conditioning and refrigeration equipment (except as required to match surrounding surfaces), and water and sewage treatment equipment and sewage ejection equipment.
      c. Aluminum Color: Ferrous metal in connection with steam generation system (bare piping, fittings, hangers, supports, valves, traps and miscellaneous iron work in contact with pipe).
      d. Federal Safety Red: Exposed fire protection piping, electrical conducts containing fire alarm control wiring, and fire alarm equipment.
      e. Federal Safety Orange: Entire lengths of electrical conduits containing feeders 600 volts or more.

H. Apply paint systems on properly prepared and primed surface as follows:
   1. Exterior Locations:
      a. Apply two (2) coats MPI 94 (Exterior Alkyd, Semi-gloss) to the following ferrous metal items:
         1) Vent and exhaust pipes with temperatures under 94 degrees C(201 degrees F), exposed piping and similar items.
      b. Apply two (2) coats of MPI 11 (Exterior Latex, Semi-Gloss) to galvanized and zinc-copper alloy metal.
      c. Apply one (1) coat of MPI 22 (High Heat Resistant Coating), 650 degrees C (1200 degrees F) to engine generator exhaust.
   2. Interior Locations:
      a. Apply two (2) coats of MPI 47 (Interior Alkyd, Semi-Gloss) to following items:
         1) Metal under 94 degrees C (201 degrees F) of items such as bare piping, fittings, hangers and supports.
         2) Equipment and systems such as hinged covers and frames for control cabinets and boxes, cast-iron radiators, electric conduits and panel boards.
         3) Heating, ventilating, air conditioning, plumbing equipment, and machinery having shop prime coat and not factory finished.

b. Apply two (2) coats of MPI 22 (High Heat Resistant Coating) to ferrous metal surface over 94 degrees K (290 degrees F) of following items:
   1) Steam line flanges, bare pipe, fittings, valves, hangers and supports over 94 degrees K (290 degrees F).
   2) Engine generator exhaust piping and muffler.
c. Paint electrical conduits containing cables rated 600 volts or more using two (2) coats of MPI 9 (Exterior Alkyd Enamel) in the Federal Safety Orange color in exposed and concealed spaces full length of conduit.

3. Other exposed locations:
   a. Cloth jackets of insulation of ducts and pipes in connection with plumbing, air conditioning, ventilating refrigeration and heating systems: One (1) coat of MPI 50 (Interior Latex Primer Sealer) and one (1) coat of MPI 11 (Exterior Latex Semi-Gloss.

3.13 BUILDING AND STRUCTURAL WORK FIELD PAINTING

A. Painting and finishing of interior and exterior work except as specified here-in-after.
   1. Painting and finishing of new work is specified within this Section. New work is to match existing adjacent finishes, except as otherwise specified.
   2. Painting of disturbed, damaged and repaired or patched surfaces when entire space is not scheduled for complete repainting or refinishing.
   3. Painting of ferrous metal and galvanized metal.
   4. Identity painting and safety painting.

B. Building and Structural Work not Painted:
   1. Prefinished items:
      a. Casework, doors, metal panels, and similar items specified factory finished under other sections.
      b. Factory finished equipment and pre-engineered metal building components such as metal roof and wall panels.
   2. Finished surfaces:
      a. Hardware except ferrous metal.
      b. Anodized aluminum, stainless steel, chromium plating, copper, and brass, except as otherwise specified.
      c. Signs, fixtures, and other similar items integrally finished.
   3. Concealed surfaces:
      a. Inside pipe basements, crawl spaces, pipe tunnels, above ceilings, except as otherwise specified.
      b. Inside walls or other spaces behind access doors or panels.
      c. Surfaces concealed behind permanently installed casework and equipment.
   4. Moving and operating parts:

a. Shafts, chains, gears, mechanical and electrical operators, linkages, and sprinkler heads, and sensing devices.
b. Tracks for overhead or coiling doors, shutters, and grilles.

5. Labels:
   a. Code required label, such as Underwriters Laboratories Inc., Intertek Testing Service or Factory Mutual Research Corporation.
   b. Identification plates, instruction plates, performance rating, and nomenclature.
6. Galvanized metal:
   a. Exterior chain link fence and gates, corrugated metal areaways, and gratings.
   b. Except where specifically specified to be painted.
7. Metal safety treads and nosings.
8. Gaskets.
9. Concrete curbs, gutters, pavements, retaining walls, exterior exposed foundations walls and interior walls in pipe basements.
10. Face brick.
11. Structural steel encased in concrete, masonry, or other enclosure.
12. Structural steel to receive intumescent paint.
13. Ceilings, walls, and columns in pipe basements.

3.14 IDENTITY PAINTING SCHEDULE

A. Identify designated service with labels to match existing where exposed piping, piping above removable ceilings, piping in accessible pipe spaces, and piping behind access panels are modified to complete the work on.

1. Legend may be identified using snap-on coil plastic markers or by paint stencil applications.
2. Apply legends adjacent to changes in direction, on branches, where pipes pass through walls or floors, adjacent to operating accessories such as valves, regulators, strainers and cleanouts a minimum of 12.2 M (40 feet) apart on straight runs of piping. Identification next to plumbing fixtures is not required.
3. Locate Legends clearly visible from operating position.
4. Use arrow to indicate direction of flow using black stencil paint.
5. Identify pipe contents with sufficient additional details such as temperature, pressure, and contents to identify possible hazard. Insert working pressure shown on construction documents where asterisk appears for High, Medium, and Low Pressure designations as follows:
   a. High Pressure - 414 kPa (60 psig) and above.
   b. Medium Pressure - 104 to 413 kPa (15 to 59 psig).
   c. Low Pressure - 103 kPa (14 psig) and below.
   d. Add Fuel oil grade numbers.

6. Electrical Conduits containing feeders over 600 volts, paint legends using 50 mm (2 inch) high black numbers and letters, showing the voltage class rating. Provide legends where conduits pass through walls and floors and at maximum 6096 mm (20 foot) intervals in between. Use labels with yellow background with black border and words Danger High Voltage Class, (5000, 15000, or 25000).
7. See Sections for methods of identification, legends, and abbreviations of the following:
    a. Conduits containing high voltage feeders over 600 volts: Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS and Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.

B. Fire and Smoke Partitions:
1. Identify partitions above ceilings on both sides of partitions except within shafts in letters not less than 64 mm (2 1/2 inches) high.
2. Stenciled message: "SMOKE BARRIER" or, "FIRE BARRIER" as applicable.
3. Locate not more than 6096 mm (20 feet) on center on corridor sides of partitions, and with a least one (1) message per room on room side of partition.
4. Use semi-gloss paint of color that contrasts with color of substrate.

C. Identify columns in pipe basements and interstitial space:
1. Apply stenciled number and letters to correspond with grid numbering and lettering indicated on construction documents.
2. Paint numbers and letters 101 mm (4 inches) high, locate 45 mm (18 inches) below overhead structural slab.
3. Apply on four (4) sides of interior columns and on inside face only of exterior wall columns.
4. Color:
    a. Use black on concrete columns.
    b. Use white or contrasting color on steel columns.

3.15 PROTECTION CLEAN UP, AND TOUCH-UP

A. Protect work from paint droppings and spattering by use of masking, drop cloths, removal of items or by other approved methods.

B. Upon completion, clean paint from hardware, glass and other surfaces and items not required to be painted of paint drops or smears.

C. Before final inspection, touch-up or refinished in a manner to produce solid even color and finish texture, free from defects in work which was damaged or discolored.

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SECTION 09 96 56
EPOXY COATINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes the coating of concrete surfaces with a high-build, protective, solvent-free, colored epoxy coating.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 35 26, SAFETY REQUIREMENTS.

C. Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

D. Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT.

E. Section 03 30 00, CAST-IN-PLACE CONCRETE:.

F. Section 03 41 33, PRECAST STRUCTURAL PRETENSIONED CONCRETE.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Literature and Data:

1. Description of each product to be provided.
2. Application and installation instructions.
3. Maintenance Instructions: Submit manufacturer's written instructions for recommended maintenance practices.
4. Material safety Data Sheets (MSDS).

C. Qualification Data: For Installer.

D. Shop Drawings: Include plans, sections, and component details.

1.4 QUALITY ASSURANCE

A. Manufacturing qualifications: The manufacturer of the specified product shall be ISO 9001 certified and have in existence a recognized ongoing quality assurance program independently audited on a regular basis.

B. Contractor qualifications: Contractor shall be qualified in the field of concrete repair and protection with five (5) or more documented years of experience.

1. Contractor shall maintain qualified personnel who have received product training by a manufacturer's representative.

C. Source Limitations:

1. Obtain primary resinous flooring materials including primers, resins, hardening agents, grouting coats and finish or sealing coats from a single manufacturer.
2. Provide secondary materials, including patching and fill material, joint sealant, and repair material of type and from source recommended by manufacturer of primary materials.

D. Install materials in accordance with all safety and weather conditions required by manufacturer or as modified by applicable rules and regulations of local, state and federal authorities having jurisdiction. Consult Material Safety Data Sheets for complete handling recommendations.

1.5 DELIVERY, STORAGE, AND HANDLING

A. All materials must be delivered in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers. Damaged material must be removed from the site immediately.

B. Keep containers sealed until ready for use.

C. Store all materials off the ground and protect materials from damage and contamination in storage or delivery, including moisture, heat, cold, direct sunlight, etc.

D. Maintain temperature of storage area between 60 and 80 degrees F (15 and 26 degrees C).

E. Do not use materials beyond manufacturer's shelf life limits.

F. Package materials in factory pre-weighed and in single, easy to manage batches sized for ease of handling and mixing proportions from entire package or packages. No On site weighing or volumetric measurements are allowed.

G. Condition the specified product as recommended by the manufacturer.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring applications.

1. Do not apply material if it is raining or snowing or if such conditions appear to be imminent.
2. Minimum application temperature: 40 degrees fahrenheit and rising.

B. Protection: Take precautions to avoid damage to any surface near the work zone due to mixing and handling of the specified material.

1.7 WARRANTY

A. Work subject to the terms of the Article "Warranty of Construction" FAR clause 52.246-21.

B. Provide a written warranty from the manufacturer against defects of materials for a period of one (1) year, beginning with date of substantial completion of the project.

1.8 APPLICABLE PUBLICATIONS

A. The publication listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. ASTM Standard C722-04 (2012), "Standard Specification for Chemical-Resistant Monolithic Floor Surfacings," ASTM International, West Conshohocken, PA, 2006, DOI: 10.1520/C0722-04R12, www.astm.org.

1. Specification covers the requirements for aggregate-filled, resin-based, monolithic surfacings for use over concrete.

C. ASTM International(ASTM):

C307-18 ..... Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings

C413-18 ..... Absorption of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

C531-18 ..... Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

C579-18 ..... Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

C580-18 ..... Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

D638-14 ..... Tensile Properties of Plastics

D1308-02(2013) ..... Effect of Household Chemicals on Clear and Pigmented Organic Finishes

D2240-15e1 ..... Rubber Property—Durometer Hardness

D2794-93(2019) ..... Resistance of Organic Coatings to the Effects of Rapid Deformation Impact

D4060-19 ..... Abrasion Resistance of Organic Coatings by the Taber Abraser

D4259-18 ..... Abrading Concrete to alter the surface profile of the concrete and to remove foreign materials and weak surface laitance

D7234-19 ..... Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers

E96/E96M-16 ..... Water Vapor Transmission of Materials

F1869-16a ..... Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

F2170-19a ..... Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. High-build, protective, corrosion-resistant, solvent-free, colored epoxy coating.

B. System Components: Verify specific requirements as systems vary by manufacturer. Verify mortar base product, build up layers of broadcast systems will not be accepted. Verify compatibility with substrate. Use manufacturer’s standard components, compatible with each other.

2.2 MATERIALS

A. Epoxy resin adhesive binder:
   1. Component A shall be a modified epoxy resin of the epichlorohydrin bisphenol A type containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.
   2. Component B shall be primarily a reaction product of a selected amine blend with an epoxy resin of the epichlorohydrin bisphenol A type containing suitable viscosity control agents, pigments and accelerators.
   3. The ratio of Component A: Component B shall be 1:1 by volume.
   4. The material shall not contain asbestos.

B. Aggregate for the epoxy resin broadcast shall be an oven-dried, 20-40 gradation sand, as approved by the Engineer.

C. SikaGard 62: Manufactured by Sika Corporation, 1682 Marion Williamsport Road, Marion, Ohio is considered to conform to the requirements of the specification.

D. Crack Isolation Membrane: Type recommended or produced by manufacturer of resinous flooring for conditions as specified.

E. Patching and Fill Material: Resinous product of or approved by resinous coating manufacturer for application indicated. Resinous based materials only. Cementitous or single component product are not expectable.

2.3 PERFORMANCE CRITERIA:

A. Properties of the mixed epoxy resin adhesive binder:
   1. Pot Life: 35-40 minutes (60 gram mass)
   2. Tack-Free Time to Touch (4-7 mil): Approximately 4 hours
   3. Initial Viscosity (Brookfield Viscometer, Spindle #3; Speed 100) 2200-3400 cps
   4. Color: gray

B. Properties of the mixed neat epoxy resin adhesive binder:
   1. Bond Strength (ASTM C-882) Hardened Concrete to Hardened Concrete
      a. 2 day (dry cure): 2,000 psi (13.79 MPa)
      b. 14 day (moist cure): 1,500 psi (10.34 MPa)
   2. Water Absorption (ASTM D-570) at 7 days: 0.1% max., 2 hour boil (24 hour immersion)
   3. Elongation (ASTM D-638) at 14 days: 5%
   4. Abrasion Coefficient (ASTM D-968) at 14 days: 40 1/mil min.
   5. Abrasion (Taber Abrader) at 14 days:
      a. Weight Loss: 0.7 gm max. (H-22 wheel; 1,000 gm weight; 1,000 cycles)
   6. Adhesion (ASTM D-3359) at 14 days: Adhesion classification 4A min.
   7. The epoxy resin adhesive binder shall be approved by the United States Department of Agriculture.

C. Properties of the epoxy resin broadcast (epoxy resin/ aggregate = 1/1.7 by volume):

1. Compressive Properties (ASTM D-695) at 28 days
   a. Compressive Strength: 9,000 psi (62 MPa)
   b. Modulus of Elasticity: 700,000 psi (4,826 MPa)
2. Tensile Properties (ASTM D-638) at 14 days
   a. Tensile Strength: 3,000 psi (21 MPa)
   b. Elongation at Break: 0.4%
3. Flexural Properties (ASTM D-790) at 14 days
   a. Flexural Strength (Modulus of Rupture): 5,000 psi (34.5 MPa)
   b. Tangent Modulus of Elasticity in Bending: 1.0×10^6 psi
4. Abrasion (Taber Abrader) at 7 days:
   a. Weight Loss: 1.5 gm max. (H-22 wheel; 1,000 gm weight; 1,000 cycles)
   b. Weight Loss: 11.0 gm max. (H-22 wheel; 1,000 gm weight; 8,000 cycles)

PART 3 – EXECUTION

3.1 SURFACE PREPARATION

A. Substrate must be clean, sound and free of surface contaminants. Remove dust, laitance, grease, oils, curing compounds, form release agents and all foreign particles by mechanical means. Substrate shall be in accordance with ICRI Guideline No. 03732 for coatings.

B. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written recommendations.

C. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

D. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written recommendations. Allowances should be included for flooring manufacturer recommended joint fill material, and concrete crack treatment.

3.2 MIXING AND APPLICATION

A. Mixing the epoxy resin adhesive binder:
   1. To minimize color differences, blend two complete Component B's together. Use only one of the blended Component B's to mix with a Component A. After the first Component B had been used, blend the second Component B with a new Component B and repeat the above procedure for the entire application.
   2. Premix each component. Proportion equal parts by volume of Component A and Component B into a clean, dry mixing pail. Mix thoroughly for three minutes min. with a jiffy paddle on a low speed (400-600 rpm) drill. Mix only that quantity of material that can be used within its pot life (25-40 minutes at 73F).

B. Placement Procedure: Prime the prepared substrate with the mixed epoxy resin adhesive binder with brushes, rollers or brooms. Do not over prime or puddle. Coverage should be 300 sq ft/gal min.

C. Apply the epoxy resin adhesive with a 3/16 in. x 3/16 in. notched squeegee while the primer is still tacky. Allow the binder to self-level and then slowly broadcast an oven-dried sand in such a manner that the sand drops vertically into the binder. Broadcast lightly making several passes, allowing the binder to bleed through the sand before the next pass. Cover completely with sand before the binder becomes tack-free. Estimate oven-dried sand quantity required to broadcast to excess at 2 lbs./sq. ft. Remove excess aggregate when the broadcast overlay has reached sufficient cure as to not be damaged.

D. Top coat the surface with the epoxy resin adhesive using a roller or flat rubber squeegee. Do not apply the top coat too heavy as to lose the slip resistant surface texture. Coverage will typically be 160 sq. ft./ gal. When applying the top coat, never stop the application until the entire surface has been sealed, if possible. If impossible, always discontinue at an edge, corner or joint. Never let a previously coated film dry, always top coat into a wet film. Always apply the top coat at a 45º angle to an edge, corner or joint.

E. Adhere to all limitations and cautions for the epoxy resin adhesive binder in the manufacturers current printed literature.

F. Discontinue Resinous floor system at vertical and horizontal contraction and expansion joints by installing backer rod and compatible sealant after coating installation is completed. Provide sealant type recommended by manufacturer for traffic conditions and chemical exposures to be encountered.

3.3 CURING, PROTECTION, AND CLEANING

A. The uncured epoxy resin adhesive can be cleaned from tools with an approved solvent. The cured epoxy resin adhesive can only be removed mechanically.

B. Leave work and work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

C. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.

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SECTION 10 26 00
WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies corner guards and door/door frame protectors and high impact wall covering.

1.2 RELATED WORK

A. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS: Sustainable Design Requirements.

1.3 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Manufacturer with a minimum of three (3) years’ experience in providing items of type specified.
   1. Obtain wall and door protection from single manufacturer.

B. Installer’s Qualifications: Installers are to have a minimum of three (3) years’ experience in the installation of units required for this project.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Shop Drawings: show design and installation details.

C. Manufacturer's Literature and Data:
   1. Corner Guards.
   2. High Impact Wall covering.

D. Test Report: Showing that resilient material complies with specified fire and safety code requirements.

E. Manufacturer’s warranty.

1.5 DELIVERY AND STORAGE

A. Deliver materials to the site in original sealed packages or containers marked with the name and brand, or trademark of the manufacturer.

B. Protect from damage from handling and construction operations before, during and after installation.

C. Store in a dry environment of approximately 21 degrees C (70 degrees F) for at least 48 hours prior to installation.

1.6 WARRANTY

A. Construction Warranty: Comply with FAR clause 52.246-21 “Warranty of Construction”.

B. Manufacturer Warranty: Manufacturer shall warranty their wall protection for a minimum of five (5) years from date of installation and final acceptance by the Government. Submit manufacturer warranty.

1.7 APPLICABLE PUBLICATIONS

A. publications listed below form a part of this specification to extent referenced. publications are referenced in text by basic designation only.

B. ASTM International (ASTM):

A240/A240M-20..... Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and For General Applications

D256-10(2018) ..... Determining the Izod Pendulum Impact Resistance of Plastics

D635-18 ..... Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

E84-20 ..... Surface Burning Characteristics of Building Materials

C. Code of Federal Regulation (CFR):

40 CFR 59(2020) Subpart D National Volatile Organic Compound Emission Standards for Architectural Coatings

D. The National Association of Architectural Metal Manufacturers (NAAMM):

AMP 500-06..... Metal Finishes Manual

E. SAE International (SAE):

J 1545-2014-10 ..... Instrumental Color Difference Measurement for Exterior Finishes, Textiles and Colored Trim.

F. Underwriters Laboratories Inc. (UL):

Annual Issue..... Building Materials Directory

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless Steel: A240/A240M, Type 304.

B. Resilient Material:

1. Provide resilient material consisting of high impact resistant extruded acrylic vinyl, polyvinyl chloride, or injection molded thermal plastic conforming to the following:
2. Minimum impact resistance of 960.8 N-m/m (18 feet-pounds/square inch) when tested in accordance with ASTM D256 (Izod impact, feet-pounds per inch notched).
3. Class 1 fire rating when tested in accordance with ASTM E84, having a maximum flame spread of 25 and a smoke developed rating of 450 or less.
4. Rated self-extinguishing when tested in accordance with ASTM D635.
5. Provide material labeled and tested by Underwriters Laboratories or other approved independent testing laboratory.
6. Provide integral color with colored components matched in accordance with SAE J 1545 to within plus or minus 1.0 on the CIE-LCH scales.

2.2 CORNER GUARDS

A. Fabricate stainless steel corner guards of 1.27 mm (.05 inch) thick material conforming to ASTM A240/A240M, Type 304. Install corner guards from floor to ceiling. Form corner guard with 1-1/2” x 1-1/2” wings.

2.3 HIGH IMPACT WALL COVERING

A. Provide wall covering/panels consisting of high impact rigid acrylic vinyl or polyvinyl chloride resilient material.

B. Panel sizes to be 1.21 x 2.42 meter (4 x 8 feet).

C. Submit fire rating and extinguishing test results for resilient material.

D. Submit statements attesting that the items comply with specified fire and safety code requirements.

E. Rigid Vinyl Acrylic Wall Covering: Wall covering thickness to be 1.02 mm (0.040 inch).

F. Provide adhesive as recommended by the wall covering manufacturer. Provide adhesive with VOC content of 250 g/L or less when calculated according to 40 CFR 59, (EPA Method 24).

2.4 FASTENERS AND ANCHORS

A. Provide fasteners and anchors as required for each specific type of installation.

B. Where type, size, spacing or method of fastening is not shown or specified in construction documents, submit shop drawings showing proposed installation details.

2.5 FINISH

A. Stainless Steel: In accordance with NAAMM AMP 500 finish Number 4.

B. Resilient Material: Embossed textures and color in accordance with SAE J1545.

PART 3 - INSTALLATION

3.1 STAINLESS STEEL CORNER GUARDS

A. Mount guards on external corners of interior walls, partitions, soffits, and columns as shown on construction documents.

B. Where corner guards are installed on gypsum board, clean surface and anchor guards with a neoprene solvent-type contact adhesive specifically manufactured for use on gypsum board construction. Remove excess adhesive from around edge of guard and allow curing undisturbed for 24 hours.

3.2 HIGH IMPACT WALL COVERING

A. Surfaces to receive protection to be clean, smooth and free of obstructions.

B. Apply with adhesive in controlled environment according to manufacturer’s recommendations.

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SECTION 11 13 13
LOADING DOCK BUMPERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies loading dock bumpers of molded rubber with attachment frame.

1.2 RELATED WORK

A. Placement of loading dock bumper frame anchors: Section 03 30 00, CAST-IN-PLACE CONCRETE.

B. Sealants: Section 07 92 00, JOINT SEALANTS.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Literature and Data:

1. Unit dimensions.
2. Details of construction.
3. Method of anchorage.
4. Installation instructions.

C. Shop Drawings:

1. Layout and anchor locations.

1.4 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society for Testing And Materials (ASTM):

D624-00 ..... Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers

D2632-01 ..... Standard Test Method for Rubber Property--Resilience by Vertical Rebound

1.5 WARRANTY

A. Provide manufacturer's 5-year warranty unless otherwise specified.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Loading Dock Bumpers: Fabric reinforced rubber pads, ozone resistant, laminated and compressed in position using two galvanized steel rods with threaded ends, washers, and nuts between 3 inch high by 2-1/2 inch wide by 1/4-inch-thick galvanized steel angle end plates.

1. Projection From Wall: 4-1/2 inches, minimum.
2. Vertical Height: 10 inches.

3. Width: Longest sections possible, placed end-to-end to achieve layout.
4. Profile: Rectangular.

2.2 ACCESSORIES

A. Attachment Hardware: 3/4 inches diameter galvanized bolts with expansion shields.

B. Touch-up Primer: Zinc rich type.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that anchor placement is acceptable.

B. Do not begin installation until substrates have been properly prepared.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install dock bumpers in accordance with manufacturer's instructions.

B. Set plumb and level.

C. Secure angled end frames to concrete; refer to Section 03 30 00 for additional information.

D. Weld angled end frames to steel dock frame, and touch up welds with primer.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

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SECTION 23 05 11
COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 23, HEATING, VENTILATING, AND AIR CONDITIONING (HVAC).

B. Definitions:

1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
2. Exterior: Piping, ductwork, and equipment exposed to weather be it temperature, humidity, precipitation, wind, or solar radiation.

C. Abbreviations/Acronyms:

ac: Alternating Current
AC: Air Conditioning
ACU: Air Conditioning Unit
ACR: Air Conditioning and Refrigeration
AI: Analog Input
AISI: American Iron and Steel Institute
AO: Analog Output
ASJ: All Service Jacket
AWG: American Wire Gauge

BACnet: Building Automation and Control Networking Protocol
BAg: Silver-Copper-Zinc Brazing Alloy
BAS: Building Automation System
BCuP: Silver-Copper-Phosphorus Brazing Alloy
bhp: Brake Horsepower
Btu: British Thermal Unit
Btu/h: British Thermal Unit Per Hour

CDA: Copper Development Association
C: Celsius
CD: Compact Disk
CFM: Cubic Foot Per Minute
CH: Chilled Water Supply
CHR: Chilled Water Return
CLR: Color
CO: Carbon Monoxide
COR: Contracting Officer's Representative
CPD: Condensate Pump Discharge
CPM: Cycles Per Minute
CPVC: Chlorinated Polyvinyl Chloride
CRS: Corrosion Resistant Steel
CTPD: Condensate Transfer Pump Discharge
CTPS: Condensate Transfer Pump Suction
CW: Cold Water
CWP: Cold Working Pressure
CxA: Commissioning Agent

dB: Decibels
dB(A): Decibels (A weighted)
DDC: Direct Digital Control
DI: Digital Input
DO: Digital Output
DVD: Digital Video Disc
DN: Diameter Nominal
DWV: Drainage, Waste and Vent

EPDM: Ethylene Propylene Diene Monomer
EPT: Ethylene Propylene Terpolymer
ETO: Ethylene Oxide
F: Fahrenheit
FAR: Federal Acquisition Regulations
FD: Floor Drain
FED: Federal
FG: Fiberglass
FGR: Flue Gas Recirculation
FOS: Fuel Oil Supply
FOR: Fuel Oil Return
FSK: Foil-Scrim-Kraft facing
FWPD: Feedwater Pump Discharge
FWPS: Feedwater Pump Suction

GC: Chilled Glycol Water Supply
GCR: Chilled Glycol Water Return
GH: Hot Glycol Water Heating Supply
GHR: Hot Glycol Water Heating Return
gpm: Gallons Per Minute

HDPE: High Density Polyethylene
Hg: Mercury
HOA: Hands-Off-Automatic

hp: Horsepower
HPS: High Pressure Steam (414 kPa (60 psig) and above)
HPR: High Pressure Steam Condensate Return
HW: Hot Water
HWH: Hot Water Heating Supply
HWHR: Hot Water Heating Return
Hz: Hertz

ID: Inside Diameter
IPS: Iron Pipe Size

kg: Kilogram
klb: 1000 lb
kPa: Kilopascal

lb: Pound
lb/hr: Pounds Per Hour
L/s: Liters Per Second
L/min: Liters Per Minute
LPS: Low Pressure Steam (103 kPa (15 psig) and below)
LPR: Low Pressure Steam Condensate Gravity Return

MAWP: Maximum Allowable Working Pressure
MAX: Maximum
MBtu/h: 1000 Btu/h
MBtu: 1000 Btu
MED: Medical
m: Meter
MFG: Manufacturer
mg: Milligram
mg/L: Milligrams Per Liter
MIN: Minimum
MJ: Megajoules
ml: Milliliter
mm: Millimeter
MPS: Medium Pressure Steam (110 kPa (16 psig) through 414 kPa (60 psig))
MPR: Medium Pressure Steam Condensate Return
MW: Megawatt

NC: Normally Closed
NF: Oil Free Dry (Nitrogen)
Nm: Newton Meter
NO: Normally Open
NOx: Nitrous Oxide
NPT: National Pipe Thread
NPS: Nominal Pipe Size

OD: Outside Diameter
OSD: Open Sight Drain
OS&Y: Outside Stem and Yoke

PC: Pumped Condensate
PID: Proportional-Integral-Differential
PLC: Programmable Logic Controllers
PP: Polypropylene
PPE: Personal Protection Equipment
ppb: Parts Per Billion
ppm: Parts Per Million
PRV: Pressure Reducing Valve \
PSIA: Pounds Per Square Inch Absolute
psig: Pounds Per Square Inch Gauge
PTFE: Polytetrafluoroethylene
PVC: Polyvinyl Chloride
PVDC: Polyvinylidene Chloride Vapor Retarder Jacketing, White
PVDF: Polyvinylidene Fluoride

R: Pump Recirculation
rad: Radians
RH: Relative Humidity
RO: Reverse Osmosis
rms: Root Mean Square
RPM: Revolutions Per Minute
RS: Refrigerant Suction
RTD: Resistance Temperature Detectors
RTRF: Reinforced Thermosetting Resin Fittings
RTRP: Reinforced Thermosetting Resin Pipe

SCFM: Standard Cubic Feet Per Minute
SPEC: Specification
SPS: Sterile Processing Services
STD: Standard
SDR: Standard Dimension Ratio
SUS: Saybolt Universal Second
SW: Soft water
SWP: Steam Working Pressure

TAB: Testing, Adjusting, and Balancing
TDH: Total Dynamic Head
TEFC: Totally Enclosed Fan-Cooled
TFE: Tetrafluoroethylene
THERM: 100,000 Btu
THHN: Thermoplastic High-Heat Resistant Nylon Coated Wire
THWN: Thermoplastic Heat & Water-Resistant Nylon Coated Wire
T/P: Temperature and Pressure

USDA: U.S. Department of Agriculture

V: Volt
VAC: Vacuum
VA: Veterans Administration
VAC: Voltage in Alternating Current
VA CFM: VA Construction & Facilities Management

VA CFM CSS: VA Construction & Facilities Management, Consulting Support Service
VAMC: Veterans Administration Medical Center
VHA OCAMES: Veterans Health Administration – Office of Capital Asset Management Engineering and Support
VR: Vacuum condensate return
WCB: Wrought Carbon Steel, Grade B
WG: Water Gauge or Water Column
WOG: Water, Oil, Gas

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.
B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
D. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
E. Section 05 50 00, METAL FABRICATIONS.
F. Section 07 84 00, FIRESTOPPING.
G. Section 07 92 00, JOINT SEALANTS.
H. Section 09 91 00, PAINTING.
I. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
J. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
K. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
L. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
M. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
N. Section 23 21 13, HYDRONIC PIPING.
O. Section 23 21 23, HYDRONIC PUMPS.
P. Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING.
Q. Section 23 25 00, HVAC WATER TREATMENT.
R. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
S. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.

1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standard will govern.
B. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
430-2020..... Performance Rating of Central Station Air-Handling Unit Supply Fans
C. Air Movement and Control Association (AMCA):
410-1996..... Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans

D. American Society of Mechanical Engineers (ASME):
B31.1-2020 ..... Power Piping
B31.9-2020 ..... Building Services Piping
ASME Boiler and Pressure Vessel Code:
BPVC Section IX-2021 Welding, Brazing, and Fusing Qualifications

E. American Society for Testing and Materials (ASTM):
A36/A36M-2019..... Standard Specification for Carbon Structural Steel
A575-1996(2020)..... Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades

F. International Code Council, (ICC):
IMC-2018 ..... International Mechanical Code

G. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
SP-58-2018..... Pipe Hangers and Supports-Materials, Design, Manufacture, Selection, Application, and Installation
SP-127-2014a ..... Bracing for Piping Systems: Seismic–Wind–Dynamic Design, Selection, and Application

H. Military Specifications (MIL):
MIL-P-21035B-2021 ..... Paint High Zinc Dust Content, Galvanizing Repair (Metric)

I. National Fire Protection Association (NFPA):
54-2018..... National Fuel Gas Code
70-2020..... National Electrical Code (NEC)
101-2021..... Life Safety Code

1.4 SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Information and material submitted under this section shall be marked “SUBMITTED UNDER SECTION 23 05 11, COMMON WORK RESULTS FOR HVAC”, with applicable paragraph identification.

C. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements, and all equipment that requires regular maintenance, calibration, etc are accessable from the floor or permanent work platform. It is the Contractor’s responsibility to ensure all submittals meet the VA specifications and requirements and it is assumed by the VA that all submittals do meet the VA specifications unless the Contractor has requested a variance in writing and approved by COR prior to the submittal. If at any time during the project it is found that any item does not meet the VA specifications and there was no variance approval the Contractor shall correct at no additional cost or time to the Government even if a submittal was approved.

D. If equipment is submitted which differs in arrangement from that shown, provide documentation proving equivalent performance, design standards and drawings that show the rearrangement of all associated systems. Additionally, any impacts on ancillary equipment or services such as foundations, piping, and electrical shall be the Contractor's responsibility to design, supply, and install at no additional cost or time to the Government. VA approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.

E. Prior to submitting shop drawings for approval, Contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed contract documents, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.

F. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together. Coordinate and properly integrate materials and equipment to provide a completely compatible and efficient installation.

G. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity. Submit under the pertinent section rather than under this section.

1. Submit electric motor data and variable speed drive data with the driven equipment.
2. Equipment and materials identification.
3. Fire-stopping materials.
4. Hangers, inserts, supports and bracing. Provide complete stress analysis for variable spring and constant support hangers.
5. Wall, floor, and ceiling plates.

H. HVAC Maintenance Data and Operating Instructions:

1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, paragraph INSTRUCTIONS for systems and equipment.
2. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
    a. Include complete list indicating all components of the systems.
    b. Include complete diagrams of the internal wiring for each item of equipment.
    c. Diagrams shall have their terminals identified to facilitate installation, operation, and maintenance.

I. Provide copies of approved HVAC equipment submittals to the TAB and Commissioning Subcontractor.

1.5 QUALITY ASSURANCE

A. Mechanical, electrical, and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional HVAC.

B. Flow Rate Tolerance for HVAC Equipment: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

C. Equipment Vibration Tolerance:

1. Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT. Equipment shall be factory-balanced to this tolerance and re-balanced onsite, as necessary.
2. After HVAC air balance work is completed and permanent drive sheaves are in place, perform field mechanical balancing and adjustments required to meet the specified vibration tolerance.

D. Products Criteria:

1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions and/or additional requirements.
2. Refer to all other sections for quality assurance requirements for systems and equipment specified therein.
3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
4. The products and execution of work specified in Division 23 sections shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments shall be enforced, along with requirements of local utility companies. The most stringent requirements of these specifications, local codes, or utility company requirements shall always apply. Any conflicts shall be brought to the attention of the COR.

5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be of the same manufacturer and model number, or if different models are required they shall be of the same manufacturer and identical to the greatest extent possible (i.e., same model series).
6. Assembled Units: Performance and warranty of all components that make up an assembled unit shall be the responsibility of the manufacturer of the completed assembly.
7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
8. Use of asbestos products or equipment or materials containing asbestos is prohibited.

E. HVAC Equipment Service Providers: Service providers shall be authorized and trained by the manufacturers of the equipment supplied. These providers shall be capable of responding onsite and provide acceptable service to restore equipment operations within 4 hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shutdown of equipment; or within 24 hours in a non-emergency. Submit names, mail and e-mail addresses and phone numbers of service personnel and companies providing service under these conditions for (as applicable to the project): fans, air handling units, chillers, cooling towers, control systems, pumps, critical instrumentation, computer workstation and programming.

F. HVAC Mechanical Systems Welding: Before any welding is performed, Contractor shall submit a certificate certifying that welders comply with the following requirements:
1. HVAC mechanical systems welding shall meet ASME BPVC Section IX. Provide proof of current certification.
2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
3. Certify that each welder and welding operator has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
4. All welds shall be stamped according to the provisions of the AWS or ASME as required herein and by the associated code.

G. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the COR with submittals. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material and removal by the Contractor and no additional cost or time to the Government.

H. Execution (Installation, Construction) Quality:

1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract documents to the COR for resolution. Provide written hard copies and computer files on CD or DVD of manufacturer’s installation instructions to the COR with submittals prior to commencing installation of any item. Installation of the item will not be allowed to proceed until the recommendations are received and approved by the VA. Failure to furnish these recommendations is a cause for rejection of the material.
2. All items that require access, such as for operating, cleaning, servicing, maintenance, and calibration, shall be easily and safely accessible by persons standing at floor level, or standing on permanent platforms, without the use of portable ladders. Examples of these items include, but are not limited to, all types of valves, filters and strainers, transmitters, control devices. Prior to commencing installation work, refer conflicts between this requirement and contract documents to the COR for resolution. Failure of the Contractor to resolve, or point out any issues will result in the Contractor correcting at no additional cost or time to the Government.
3. Complete coordination/shop drawings shall be required in accordance with paragraph SUBMITTALS. Construction work shall not start on any system until the coordination/shop drawings have been approved by VA.
4. Workmanship/craftsmanship will be of the highest quality and standards. The VA reserves the right to reject any work based on poor quality of workmanship this work shall be removed and done again at no additional cost or time to the Government.

I. Upon request by Government, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with current telephone numbers and e-mail addresses.

J. Guaranty: Warranty of Construction, FAR Clause 52.246-21.

K. Bio-Based Materials: For products designated by the USDA’s Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specification section. For more information regarding the product categories covered by the Bio-Preferred Program, visit http://www.biopreferred.gov.

L. Refer to Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for additional sustainable design requirements.

1.6 DELIVERY, STORAGE AND HANDLING

A. Protection of Equipment:

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the

Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage or theft.

2. Repair damaged equipment in first class, new operating condition and appearance; or, replace same as determined and directed by the COR. Such repair or replacement shall be at no additional cost or time to the Government.
3. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.
5. Protect plastic piping and tanks from ultraviolet light (sunlight).

B. Cleanliness of Piping and Equipment Systems:

1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Government.
4. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.7 AS-BUILT DOCUMENTATION

A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.

B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

C. The installing Contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing Contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:

1. Red-lined, hand-marked drawings are to be provided, with one paper copy and a scanned PDF version of the hand-marked drawings provided on CD or DVD.

D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.

E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

1.8 JOB CONDITIONS – WORK IN EXISTING BUILDING

A. Building Operation: Government employees will be continuously operating and managing all facilities, including temporary facilities that serve the VAMC.

B. Maintenance of Service: Schedule all work to permit continuous service as required by the VAMC.

C. Steam and Condensate Service Interruptions: Limited steam and condensate service interruptions, as required for interconnections of new and existing systems, will be permitted by the COR during periods when the demands are not critical to the operation of the VAMC. These non-critical periods are limited to between 8 pm and 5 am in the appropriate off-season (if applicable). Provide at least 10 working days advance notice to the COR. The request shall include a detailed plan on the proposed shutdown and the intended work to be done along with manpower levels. All equipment and materials shall be onsite and verified with plan 5 days prior to the shutdown or it will need to be rescheduled.

D. Phasing of Work: Contractor shall submit a complete detailed phasing plan/schedule with manpower levels prior to commencing work. The phasing plan shall be detailed enough to provide milestones in the process that can be verified.

E. Building Working Environment: Maintain the architectural and structural integrity of the building and the working environment at all times. Maintain the interior of building at 18 degrees C (65 degrees F) minimum. Limit the opening of doors, windows or other access openings to brief periods as necessary for rigging purposes. Storm water or ground water leakage is prohibited. Provide daily clean-up of construction and demolition debris on all floor

surfaces and on all equipment being operated by VA. Maintain all egress routes and safety systems/devices.

F. Acceptance of Work for Government Operation: As new equipment, systems and facilities are made available for operation and these items are deemed of beneficial use to the Government, inspections will be made and tests will be performed. Based on the inspections, a list of contract deficiencies will be issued to the Contractor. After correction of deficiencies as necessary for beneficial use, the Contracting Officer will process necessary acceptance and the equipment will then be under the control and operation of Government personnel.

PART 2 - PRODUCTS

2.1 FACTORY ASSEMBLED PRODUCTS

A. Provide maximum standardization of components to reduce spare part requirements.

B. Performance and warranty of all components that make up an assembled unit shall be the responsibility of the manufacturer of the completed assembly.

1. All components of an assembled unit need not be products of same manufacturer.
2. Constituent parts that are alike shall be products of a single manufacturer.
3. Components shall be compatible with each other and with the total assembly for intended service.
4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

C. Equipment and components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a nameplate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

D. Major items of equipment, which serve the same function, shall be the same make and model. Exceptions must be approved by the VA, but may be permitted if performance requirements cannot be met.

2.2 COMPATIBILITY OF RELATED EQUIPMENT

A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational plant that conforms to contract requirements.

2.3 LIFTING ATTACHMENTS

A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

2.4 ELECTRIC MOTORS

A. All material and equipment furnished, and installation methods shall conform to the requirements of Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT; and, Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection, and operation of the systems. Provide special energy efficient premium efficiency type motors as scheduled.

2.5 VARIABLE SPEED MOTOR CONTROLLERS

A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS for specifications.

B. Coordinate variable speed motor controller communication protocol with VA requirements.

C. Motors shall be premium efficiency type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.

D. Controller shall not add any current or voltage transients to the input ac power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the ac power system.

2.6 EQUIPMENT AND MATERIALS IDENTIFICATION

A. Use symbols, nomenclature and equipment numbers specified, shown in the contract documents, and shown in the maintenance manuals. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section 09 91 00, PAINTING.

B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 5 mm (3/16 inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.

C. Control Items: Label all instrumentation, temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.

D. Valve Tags and Lists:

1. HVAC and Mechanical Rooms: Provide for all valves.
2. Valve Tags: Engraved black filled numbers and letters not less than 13 mm (1/2 inch) high for number designation, and not less than 6 mm (1/4 inch) for service designation on 19-gauge 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.

3. Valve Lists: Typed or printed plastic coated card(s), sized 216 mm (8-1/2 inches) by 279 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
4. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color-coded thumb tack in ceiling.

2.7 FIRESTOPPING

A. Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping and ductwork. Refer to Section 23 07 11, HVAC AND BOILER PLANT INSULATION, for firestop pipe and duct insulation.

2.8 GALVANIZED REPAIR COMPOUND

A. Mil-P-21035B, paint form.

2.9 HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

A. Vibration Isolators: Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

B. Pipe Supports: Comply with MSS SP-58. Type Numbers specified refer to this standard. For selection and application comply with MSS SP-58. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting requirements.

C. Attachment to Concrete Building Construction:
1. Self-Drilling Expansion Shields and Machine Bolt Expansion Anchors: Permitted in concrete not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
2. Power-Driven Fasteners: Permitted in existing concrete or masonry not less than 100 mm (4 inches) thick when approved by the COR for each job condition.

D. Attachment to Steel Building Construction:
1. Welded Attachment: MSS SP-58, Type 22.
2. Beam Clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 C-clamp shall be used for individual copper tubing up to 22 mm (7/8 inch) outside diameter.

E. Attachment to Existing Structure: Support from existing floor/roof frame.

F. Attachment to Wood Construction: Wood screws or lag bolts.

G. Hanger Rods: Hot-rolled steel, ASTM A36/A36M or ASTM A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 38 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.

H. Hangers Supporting Multiple Pipes (Trapeze Hangers): Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 by 41 mm (1-5/8 by 1-5/8 inches), 2.7 mm (12

gauge), designed to accept special spring held, hardened steel nuts. Trapeze hangers are prohibited for use for steam supply and condensate piping.

1. Allowable Hanger Load: Manufacturers rating less 91 kg (200 pounds).
2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4 inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 13 mm (1/2 inch) galvanized steel bands, or preinsulated calcium silicate shield for insulated piping at each hanger.

I. Supports for Piping Systems:

1. Select hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC AND BOILER PLANT INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or preinsulated calcium silicate shields. Provide Type 40 insulation shield or preinsulated calcium silicate shield at all other types of supports and hangers including those for preinsulated piping.
2. Piping Systems Except High and Medium Pressure Steam (MSS SP-58):
    a. Standard Clevis Hanger: Type 1; provide locknut.
    b. Riser Clamps: Type 8.
    c. Wall Brackets: Types 31, 32 or 33.
    d. Roller Supports: Type 41, 43, 44 and 46.
    e. Saddle Support: Type 36, 37 or 38.
    f. Turnbuckle: Types 13 or 15. Preinsulate.
    g. U-bolt Clamp: Type 24.
    h. Copper Tube:
        1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with non-adhesive isolation tape to prevent electrolysis.
        2) For vertical runs use epoxy painted or plastic-coated riser clamps.
        3) For Supporting Tube to Strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
        4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.
    i. Supports for Plastic Piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.
3. High and Medium Pressure Steam (MSS SP-58):
    a. Provide eye rod or Type 17 eye nut near the upper attachment.
    b. Piping 50 mm (2 inches) and Greater: Type 43 roller hanger.
4. Convertor and Expansion Tank Hangers: May be Type 1 sized for the shell diameter. Insulation where required will cover the hangers.

J. Pre-Insulated Calcium Silicate Shields:
   1. Provide 360-degree water resistant high density 965 kPa (140 psig) compressive strength calcium silicate shields encased in galvanized metal.
   2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
   3. Shield thickness shall match the pipe insulation.
   4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
      a. Shields for supporting chilled or cold water shall have insulation that extends a minimum of 25 mm (1 inch) past the sheet metal. Provide for an adequate vapor barrier in chilled lines.
      b. The pre-insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS SP-58. To support the load, the shields may have one or more of the following features: structural inserts 4138 kPa (600 psig) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36/A36M) wear plates welded to the bottom sheet metal jacket.
   5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.

2.10 PIPE PENETRATIONS

A. To prevent accidental liquid spills from passing to a lower level, provide the following:
   1. For Drilled Penetrations: Provide 38 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.

B. Penetrations through beams or ribs are prohibited but may be installed in concrete beam flanges. Any deviation from these requirements shall receive prior approval of COR.

C. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

2.11 SPECIAL TOOLS AND LUBRICANTS

A. Furnish, and turn over to the COR, tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.

C. Refrigerant Tools: Provide system charging/Evacuation equipment, gauges, fittings, and tools required for maintenance of furnished equipment.

D. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the COR.

E. Lubricants: A minimum of 0.95 L (1 quart) of oil, and 0.45 kg (1 pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

2.12 WALL, FLOOR AND CEILING PLATES

A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.

B. Thickness: Not less than 2.4 mm (3/32 inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025 inch) for up to 75 mm (3 inch pipe), 0.89 mm (0.035 inch) for larger pipe.

C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

2.13 ASBESTOS

A. Materials containing asbestos are prohibited.

PART 3 - EXECUTION

3.1 GENERAL

A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

3.2 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to, all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gauges and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown in the contract documents.

C. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.

D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.

E. Cutting Holes:

1. Cut holes through concrete and masonry by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill is prohibited, except as permitted by COR where working area space is limited.

2. Locate holes to avoid interference with structural members such as slabs, columns, ribs, beams or reinforcing. Holes shall be laid out in advance and drilling done only after approval by COR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to COR for approval.
3. Do not penetrate membrane waterproofing.

F. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but shall be provided.

G. Electrical Interconnection of Instrumentation or Controls: This generally not shown but shall be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Devices shall be located so they are easily accessible for testing, maintenance, calibration, etc. The COR has the final determination on what is accessible and what is not. Comply with NFPA 70.

H. Protection and Cleaning:
1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the COR. Damaged or defective items in the opinion of the COR, shall be replaced.
2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

I. Concrete and Grout: Use concrete and non-shrink grout 20 MPa (3000 psig) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

J. Install gauges, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gauges to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

K. Install steam piping expansion joints as per manufacturer’s recommendations.

L. Work in Existing Building:
1. Perform as specified in paragraphs OPERATIONS AND STORAGE AREAS, paragraph ALTERATIONS, and paragraph RESTORATION of the Section 01 00 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).

2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, paragraph OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will least interfere with normal operation of the facility.

M. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and data/telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints. Installation of piping, ductwork, leak protection apparatus or other installations foreign to the electrical installation shall not be located in the space equal to the width and depth of the equipment and extending from to a height of 1.8 m (6 feet) above the equipment or to ceiling structure, whichever is lower (NFPA 70).

N. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance or inspections, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost or time to the Government.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to motors, fans, pumps, belt guards, transformers, high voltage lines, conduit and raceways, piping, hot surfaces, and ductwork. The COR has final determination on whether an installation meets this requirement or not.

3.3 TEMPORARY PIPING AND EQUIPMENT

A. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment, ducts, and piping.

B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of paragraph ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING apply.

C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining in service.

3.4 RIGGING

A. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.

B. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.

C. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on

structures shall be Contractor's full responsibility. Upon request, the Government will check structure adequacy and advise Contractor of recommended restrictions.

D. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.

E. Follow approved rigging plan.

F. Restore building to original condition upon completion of rigging work.

3.5 PIPE AND EQUIPMENT SUPPORTS

A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels designed by a structural engineer, secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the COR.

B. Use of chain pipe supports; wire or strap hangers; wood for blocking, stays and bracing; and hangers suspended from piping above are prohibited. Replace or thoroughly clean rusty products and paint with zinc primer.

C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 13 mm (1/2 inch) clearance between pipe or piping covering and adjacent work.

D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP-58. Provide additional supports at valves, strainers, inline pumps and other heavy components. Provide a support within one foot of each elbow.

E. HVAC Vertical Pipe Supports:

1. Up to 152 mm (6 inch pipe), 9 m (30 feet) long, bolt riser clamps to the pipe below couplings, or welded to the pipe and rests supports securely on the building structure.
2. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.

F. Overhead Supports:

1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
3. Tubing and capillary systems shall be supported in channel troughs.

G. Floor Supports:

1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems

shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.

2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Structural contract documents shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.

3.6 MECHANICAL DEMOLITION

A. Rigging access, other than indicated in the contract documents, shall be provided by the Contractor after approval for structural integrity by the COR. Such access shall be provided without additional cost or time to the Government. Where work is in an operating plant, provide approved protection from dust and debris at all times for the safety of plant personnel and maintenance of plant operation and environment of the plant.

B. In an operating facility, maintain the operation, cleanliness and safety. Government personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Debris accumulated in the area to the detriment of plant operation is prohibited. Perform all flame cutting to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. Perform all work in accordance with recognized fire protection standards. Inspection will be made by personnel of the VAMC, and Contractor shall follow all directives of the COR with regard to rigging, safety, fire safety, and maintenance of operations.

C. Unless specified otherwise, all piping, wiring, conduit, and other devices associated with the equipment not re-used in the new work shall be completely removed from Government property per Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT. This includes all concrete pads, pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. All openings shall be sealed after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with contract documents where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the contract documents of the other disciplines in the project for additional facilities to be demolished or handled.

D. All indicated valves including gate, globe, ball, butterfly and check, all pressure gauges and thermometers with wells shall remain Government property and shall be removed and

delivered to COR and stored as directed. The Contractor shall remove all other material and equipment, devices and demolition debris under these contract documents. Such material shall be removed from Government property expeditiously and shall not be allowed to accumulate.

3.7 CLEANING AND PAINTING

A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.

B. In addition, the following special conditions apply:

1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.
2. The following material and equipment shall not be painted:
    a. Motors, controllers, control switches, and safety switches.
    b. Control and interlock devices.
    c. Regulators.
    d. Pressure reducing valves.
    e. Control valves and thermostatic elements.
    f. Lubrication devices and grease fittings.
    g. Copper, brass, aluminum, stainless-steel and bronze surfaces.
    h. Valve stems and rotating shafts.
    i. Pressure gauges and thermometers.
    j. Glass.
    k. Nameplates.
3. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.
4. Pumps, fans, motors, steel and cast-iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same paint type and color as utilized by the pump and fan manufacturer.
5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats. This may include painting exposed metals where hangers were removed or where equipment was moved or removed.
6. Paint shall withstand the following temperatures without peeling or discoloration:
    a. Condensate and Feedwater: 38 degrees C (100 degrees F) on insulation jacket surface and 121 degrees C (250 degrees F) on metal pipe surface.

b. Steam: 52 degrees C (125 degrees F) on insulation jacket surface and 190 degrees C (374 degrees F) on metal pipe surface.

7. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this.
8. Lead based paints are prohibited.

3.8 IDENTIFICATION SIGNS

A. Where existing identification signs cannot be reused to to damage or removal, provide laminated plastic signs, with engraved lettering not less than 5 mm (3/16 inch) high, designating functions, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.

B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance.

C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

3.9 MOTOR AND DRIVES

A. Alignment of Direct-Connect Drives: Securely mount motor in accurate alignment so that shafts are per coupling manufacturer’s tolerances when both motor and driven machine are operating at normal temperatures.

3.10 LUBRICATION

A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. Field-check all devices for proper lubrication.

B. All devices and equipment shall be equipped with required lubrication fittings or devices. A minimum of 0.95 liter (1 quart) of oil and 0.45 kg (1 pound) of grease of manufacturer's recommended grade and type for each different application shall be provided; also provide 12 grease sticks for lubricated plug valves. Deliver all materials to COR in unopened containers that are properly identified as to application.

C. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

D. All lubrication points shall be extended to one side of the equipment.

3.11 STARTUP, TEMPORARY OPERATION AND TESTING

A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.

C. Startup of equipment shall be performed as described in equipment specifications. Vibration within specified tolerance shall be verified prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, paragraph TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

3.12 OPERATING AND PERFORMANCE TESTS

A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS paragraph TESTS, and in individual Division 23 sections and submit the test reports and records to the COR.

B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost or time to the Government.

C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then conduct such performance tests and finalize control settings for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work. Rescheduling of these tests shall be requested in writing to COR for approval.

D. No adjustments shall be made during the acceptance inspection. All adjustments shall have been made by this point.

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SECTION 23 05 12
GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the installation and connection of motors for HVAC and steam generation equipment.

B. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

D. Section 23 21 23, HYDRONIC PUMPS.

E. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standards will govern.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

90.1-2019..... Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

C. Institute of Electrical and Electronics Engineers (IEEE):

112-2017..... Standard Test Procedure for Polyphase Induction Motors and Generators

D. National Electrical Manufacturers Association (NEMA):

MG 1-2016 (R2019)..... Motors and Generators

MG 2–2014..... Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

250-2020..... Enclosures for Electrical Equipment (1000 Volts Maximum)

E. National Fire Protection Association (NFPA):

70-2020..... National Electrical Code (NEC)

1.4 SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Information and material submitted under this section shall be marked “SUBMITTED UNDER SECTION 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT”, with applicable paragraph identification.

C. Certification: Two weeks prior to final inspection, unless otherwise noted, certification shall be submitted to the COR stating that the motors have been properly applied, installed, adjusted, lubricated, and tested.

1.5 AS-BUILT DOCUMENTATION

A. Comply with requirements in Paragraph “AS-BUILT DOCUMENTATION” in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

PART 2 - PRODUCTS

2.1 MOTORS

A. All material furnished and installation methods shall conform to the requirements of Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide premium efficiency type motors. Unless otherwise specified for a particular application, use electric motors with the following requirements.

B. Special Requirements:

1. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
    a. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
    b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
    c. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.

C. Additional requirements for specific motors, as indicated in the other sections listed in Article, RELATED SECTIONS shall also apply.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motors in accordance with manufacturer’s recommendations, the NEC, NEMA, as shown in the contract documents and/or as required by other sections of these specifications.

B. If in the substantiated evaluation of the COR, the installation fails to meet the requirements of the construction documents with respect to function and maintainability, an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

3.2 FIELD TESTS

A. Perform an electric insulation resistance Test using a megohmmeter on all motors after installation, before startup. All shall test free from grounds.

B. Perform Load test in accordance with IEEE 112, Test Method B, to determine freedom from electrical or mechanical defects and compliance with performance data.

C. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.

D. All test data shall be complied into a report form for each motor and provided to the contracting officer or their representative.

3.3 STARTUP AND TESTING

A. The COR will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR. Provide a minimum of 7 days prior notice.

B. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

C. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.

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SECTION 23 05 41
NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the tolerance and vibration isolation for HVAC work.

B. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA and SAMPLES.

C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

D. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

E. Section 23 21 23, HYDRONIC PUMPS.

F. Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING.

1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standards will govern.

B. American Society of Civil Engineers (ASCE):

ASCE 7-2016..... Minimum Design Loads for Buildings and Other Structures

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

Handbook-2019 ..... ASHRAE Handbook – HVAC Applications

Handbook-2021 ..... ASHRAE Handbook - Fundamentals, Chapter 8, Sound and Vibration

D. American Society for Testing and Materials (ASTM):

A123/A123M-2017..... Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A307-2021 ..... Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength

D2240-2015(R2021)..... Standard Test Method for Rubber Property - Durometer Hardness

E. International Code Council (ICC):

IBC-2018..... International Building Code

F. Manufacturers Standardization Society (MSS):

SP-58-2018..... Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation

G. Occupational Safety and Health Administration (OSHA):

29 CFR 1910.95 ..... Occupational Noise Exposure

I. Department of Veterans Affairs (VA):
PG-18-10-2017(R2021) HVAC Design Manual

1.4 SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Information and material submitted under this section shall be marked “SUBMITTED UNDER SECTION 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT”, with applicable paragraph identification.

C. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.

1. Vibration isolators:
   a. Floor mountings
   b. Hangers

D. Isolator manufacturer shall furnish with submittal load calculations for selection of isolators, including supplemental bases, based on lowest operating speed of equipment supported.

1.5 QUALITY ASSURANCE

A. Bio-Based Materials: For products designated by the USDA’s Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit http://www.biopreferred.gov.

B. Allowable Vibration Tolerances for Rotating, Non-reciprocating Equipment: Not to exceed a self-excited vibration maximum velocity of 5 mm per second (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal, and axial directions or measured at equipment mounting feet if bearings are concealed. Measurements for internally isolated fans and motors may be made at the mounting feet.

1.6 AS-BUILT DOCUMENTATION

A. Comply with requirements in paragraph AS-BUILT DOCUMENTATION of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Type of isolator, base, and minimum static deflection shall be as required for each specific equipment application as recommended by isolator or equipment manufacturer. Refer to ASHRAE Handbook - HVAC Applications Chapter 49, Noise and Vibration Control, Table 47 for selection guide for Vibration Isolation.

B. Elastomeric isolators shall comply with ASTM D2240 and be oil resistant neoprene with a maximum stiffness of 60 durometer and have a straight-line deflection curve.

C. Uniform Loading: Select and locate isolators to produce uniform loading and deflection even when equipment weight is not evenly distributed.

D. Color code isolators by type and size for easy identification of capacity.

2.2 VIBRATION ISOLATORS

A. Floor Mountings:

1. Double Deflection Neoprene (Type N): Shall include neoprene covered steel support plated (top and bottom), friction pads, and necessary bolt holes.
2. Spring Isolators (Type S): Shall be free-standing, laterally stable and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.
3. Spring Isolators with Vertical Limit Stops (Type SP): Similar to spring isolators noted above, except include a vertical limit stop to limit upward travel if weight is removed and also to reduce movement and spring extension due to wind loads. Provide clearance around restraining bolts to prevent mechanical short circuiting. Isolators shall have a minimum seismic rating of one G.
4. Pads (Type D), Washers (Type W), and Bushings (Type L): Pads shall be natural rubber or neoprene waffle, neoprene and steel waffle, or reinforced duck and neoprene. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).

B. Hangers: Shall be combination neoprene and springs unless otherwise noted and shall allow for expansion of pipe.

1. Combination Neoprene and Spring (Type H): Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
2. Hanger supports for piping 50 mm (2 inches) and greater shall have a pointer and scale deflection indicator.

PART 3 - EXECUTION

3.1 INSTALLATION

A. If an installation is unsatisfactory to the COR, the contractor shall correct the installation at no additional cost or time to the Government.

B. Vibration Isolation:

1. No metal-to-metal contact will be permitted between fixed and floating parts.

2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports with a deflection equal to that used on the corresponding equipment.
3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling, and bolting.
4. Provide heat shields where elastomers are subject to temperatures over 38 degrees C (l00 degrees F).
5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.
6. Non-rotating equipment such as heat exchangers and convertors shall be mounted on isolation units having the same static deflection as the isolation hangers or support of the pipe connected to the equipment.

C. Inspection and Adjustments: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.

3.2 ADJUSTING

A. Adjust vibration isolators after piping systems are filled and equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Torque anchor bolts according to equipment manufacturer's recommendations to resist seismic forces.

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SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

A. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

B. Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems. TAB includes the following:

1. Planning systematic TAB procedures.
2. Design Review Report.
3. Systems Inspection Report.
4. Systems Readiness Report.
5. Balancing air and water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
6. Vibration and sound measurements.
7. Recording and reporting results.

C. Definitions:

1. Basic TAB used in this Section: Chapter 39, "Testing, Adjusting and Balancing" of ASHRAE Handbook "HVAC Applications".
2. TAB: Testing, Adjusting and Balancing; the process of checking and adjusting HVAC systems to meet design objectives.
3. AABC: Associated Air Balance Council.
4. NEBB: National Environmental Balancing Bureau.
5. TABB: Testing Adjusting and Balancing Bureau.
6. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.
7. Hydronic Systems: Includes chilled water, condenser water, heating hot water, and glycol-water systems.
8. Air Systems: Includes all outside air, supply air, return air, exhaust air and relief air systems.
9. Flow Rate Tolerance: The allowable percentage variation, minus to plus, of actual flow rate from values (design) in the contract documents.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

D. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

E. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.

F. Section 23 21 13, HYDRONIC PIPING.

G. Section 23 21 23, HYDRONIC PUMPS.

1.3 APPLICABLE PUBLICATIONS

A. The following publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standards will govern.

B. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):

2019..... ASHRAE Handbook – HVAC Applications, Chapter 39, Testing, Adjusting, and Balancing and Chapter 49, Noise and Vibration Control

C. Associated Air Balance Council (AABC):

2016..... National Standards for Total System Balance, 7th Edition

D. National Environmental Balancing Bureau (NEBB):

2019..... Procedural Standard for Testing, Adjusting, and Balancing of Environmental Systems, 9th Edition

2015..... Procedural Standard for the Measurement of Sound and Vibration, 2nd Edition

E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

2002..... HVAC Systems Testing, Adjusting and Balancing, 3rd Edition

2003..... TAB Procedural Guide 1st Edition

1.4 SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Information and material submitted under this section shall be marked “SUBMITTED UNDER SECTION 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC”, with applicable paragraph identification.

C. Submit names and qualifications of TAB agency and TAB Specialists within 60 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment.

D. For use by the COR staff, submit one complete set of applicable AABC, NEBB or TABB publications that will be the basis of TAB work.

E. Submit the following for review and approval:

1. Design Review Report within 90 days for conventional design projects after the system layout on air and water side is completed by the Contractor.
2. Systems inspection report on equipment and installation for conformance with design.
3. Systems Readiness Report.

4. Intermediate and Final TAB reports covering flow balance and adjustments, performance tests, vibration tests and sound tests.
5. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.

F. Prior to request for Final or Partial Final inspection, submit completed Test and Balance report for the area with noted critical paths.

1.5 QUALITY ASSURANCE

A. Refer to paragraphs QUALITY ASSURANCE and SUBMITTALS, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

B. Qualifications:

1. TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.
2. The TAB agency shall be either a certified member of AABC, NEBB, or TABB to perform TAB service for HVAC, water balancing and vibrations testing of equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the COR and submit another qualified TAB firm for approval. Any agency that has been the subject of disciplinary action by either the AABC, TABB or NEBB within the five (5) years preceding Contract Award shall not be eligible to perform any work related to the TAB. All work performed in this Section and in other related Sections by the TAB agency shall be considered invalid if the TAB agency loses its certification prior to Contract completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.
3. TAB Specialist: The TAB Specialist shall be either a member of AABC or TABB or an experienced technician of the Agency certified by NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the COR and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five (5) years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and shall be performed by an approved successor.
4. TAB Specialist shall be identified by the General Contractor within sixty (60) days after the Notice to Proceed. The TAB Specialist will be coordinating, scheduling, and reporting

all TAB work and related activities and will provide necessary information as required by the COR. The responsibilities shall specifically include:

a. Directly supervising all TAB work.
b. Sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC, TABB or NEBB.
c. Following all TAB work through its satisfactory completion.
d. Providing final markings of settings of all HVAC adjustment devices.

5. All TAB technicians performing actual TAB work shall be experienced and shall have done satisfactory work on a minimum of three (3) projects comparable in size and complexity to this project. Qualifications shall be certified by the TAB agency in writing. The lead technician shall be certified by AABC, TABB or NEBB.

C. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards, TABB/SMACNA International Standards, or by NEBB Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for test and balance purpose. All equipment shall remain in calibration, or be re-calibrated if certification expires, during the TAB procedures.

D. TAB Criteria:

1. One or more of the applicable AABC, NEBB, TABB or SMACNA publications, supplemented by Chapter 39, "Testing, Adjusting and Balancing" of ASHRAE Handbook "HVAC Applications" and requirements stated herein shall be the basis for planning, procedures, and reports.
2. Flow Rate Tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow Chapter 39, "Testing, Adjusting and Balancing" of ASHRAE Handbook "HVAC Applications" as a guideline.
    a. Fans, cubic meters/min (cubic feet per minute): Minus 5 percent to plus 10 percent.
    b. Heating Hot Water Pumps and Hot Water Coils: Minus 5 percent to plus 5 percent.
    c. Chilled Water and Condenser Water Pumps: Minus 5 percent to plus 5 percent.
3. Systems shall be adjusted for energy efficient operation as described in PART 3.
4. Typical TAB procedures shall be demonstrated to the COR for all fans and 1 hydronic system (pumps and 3 coils) as follows:
    a. When field TAB work begins.
    b. During each partial final inspection and the final inspection for the project if requested by VA.

PART 2 - PRODUCTS

2.1 INSULATION REPAIR MATERIAL

A. See Section 23 07 11, HVAC and BOILER PLANT INSULATION. Provide for repair of insulation removed or damaged for TAB work.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to TAB Criteria in Paragraph QUALITY ASSURANCE.

B. Obtain applicable contract documents and copies of approved submittals for HVAC equipment and automatic control systems.

3.2 DESIGN REVIEW REPORT

A. The TAB Specialist shall review the contract documents and advise the COR of any design deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

3.3 SYSTEMS INSPECTION REPORT

A. Inspect equipment and installation for conformance with design.

B. The inspection and report shall be done after hydronic and other equipment is onsite and piping installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.

C. Reports: Follow checklist format developed by AABC, NEBB or SMACNA (TABB), supplemented by narrative comments, with emphasis on air-handling units and fans. Check for conformance with submittals. Verify that diffuser and register sizes are correct. Check air terminal unit installation including their duct sizes and routing.

3.4 SYSTEM READINESS REPORT

A. The TAB Contractor shall measure existing air and water flow rates associated with existing systems utilized to serve renovated areas as indicated in the contract documents. Submit report of findings to COR.

B. Inspect each system to ensure that it is complete including installation and operation of controls. Submit report to COR in standard format and forms prepared and/or approved by the COR.

C. Verify that all items such as ductwork piping, dampers, valves, ports, terminals, connectors, etc., that are required for TAB are installed. Provide a report to the COR.

3.5 TAB REPORTS

A. Submit an intermediate report for 50 percent of systems and equipment tested and balanced to establish satisfactory test results.

B. The TAB Contractor shall provide raw data immediately in writing to the COR if there is a problem in achieving intended results before submitting a formal report.

C. If over 20 percent of readings in the intermediate report fall outside the acceptable range, the TAB report shall be considered invalid and all contract TAB work shall be repeated after engineering and construction have been evaluated and re-submitted for approval at no additional cost to the owner.

D. Do not proceed with the remaining systems until intermediate report is approved by the COR.

3.6 TAB PROCEDURES

A. TAB shall be performed in accordance with the requirement of the Standard under which TAB agency is certified by either AABC, TABB or NEBB. Balancing shall be done proportionally to all applicable systems.

1. At least one hydronic balancing valve shall be 100 percent open per hydronic system.

B. General: During TAB all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.

C. Coordinate TAB procedures with existing systems and any phased construction completion requirements for the project. Provide TAB reports for pre-construction water flow rate and for each phase of the project prior to partial final inspections of each phase of the project. Return existing areas outside the work area to pre-constructed conditions.

D. Allow 30 days' time in construction schedule for TAB and submission of all reports for an organized and timely correction of deficiencies.

E. Water Balance and Equipment Test: Include circulating pumps, convertors, coils, coolers and condensers:

3.7 VIBRATION TESTING

A. Furnish instruments and perform vibration measurements as specified in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT. Field vibration balancing is specified in Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Provide measurements for all rotating HVAC equipment of 373 watts (1/2 horsepower) and larger, including pumps, fans and motors.

B. Record initial measurements for each unit of equipment on test forms and submit a report to the COR. Where vibration readings exceed the allowable tolerance Contractor shall be directed to correct the problem. The TAB agency shall verify that the corrections are done and submit a final report to the COR.

3.8 MARKING OF SETTINGS

A. Following approval of TAB Final Report, the setting of all HVAC adjustment devices including valves, splitters and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time. Style and colors used for markings shall be coordinated with the COR.

3.9 PHASING

A. Phased Projects: Testing and Balancing Work to follow project with areas shall be completed per the project phasing. Upon completion of the project all areas shall have been tested and balanced per the contract documents.

B. Existing Areas: Systems that serve areas outside of the project scope shall not be adversely affected. Measure existing parameters where shown to document system capacity.

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SECTION 23 07 11
HVAC AND BOILER PLANT INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Field applied insulation for thermal efficiency and condensation control for
   1. HVAC piping and equipment.
   2. Re-insulation of HVAC piping and equipment and boiler plant piping.

B. Definitions
   1. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
   2. ASJ: All service jacket, white finish facing or jacket.
   3. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
   4. Cold: Equipment, ductwork or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.
   5. Concealed: Ductwork and piping above ceilings and in chases, interstitial space, and pipe spaces.
   6. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical and electrical equipment rooms or exposed to outdoor weather. Chases and pipe basements are not considered finished areas.
   7. Hot: HVAC equipment or piping handling media above 41 degrees C (105 degrees F); piping media and equipment 32 to 230 degrees C(90 to 450 degrees F).
   8. Density: kg/m^3 - kilograms per cubic meter (Pcf - pounds per cubic foot).
   9. Runouts: Branch pipe connections up to 25-mm (one-inch) nominal size to fan coil units or reheat coils for terminal units.
   10. Thermal conductance: Heat flow rate through materials.
      a. Flat surface: Watt per square meter (BTU per hour per square foot).
      b. Pipe or Cylinder: Watt per square meter (BTU per hour per linear foot).
   11. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).
   12. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). For the purpose of this specification, vapor retarders shall have a maximum published permeance of 0.1 perms and vapor barriers shall have a maximum published permeance of 0.001 perms.

1.2 RELATED WORK

A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Section 07 84 00, FIRESTOPPING.

C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

D. Section 23 21 13, HYDRONIC PIPING.

E. Section 23 22 13, STEAM and CONDENSATE HEATING PIPING

1.3 QUALITY ASSURANCE

A. Refer to article QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

B. Criteria:

1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4, parts of which are quoted as follows:

4.3.3.1 Pipe insulation and coverings, duct coverings, duct linings, vapor retarder facings, adhesives, fasteners, tapes, and supplementary materials added to air ducts, plenums, panels, and duct silencers used in duct systems, unless otherwise provided for in 4.3.3.1.1 or 4.3.3.1.2., shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

4.3.3.1.1 Where these products are to be applied with adhesives, they shall be tested with such adhesives applied, or the adhesives used shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when in the final dry state. *(See 4.2.4.2.)*

4.3.3.1.2 The flame spread and smoke developed index requirements of 4.3.3.1.1 shall not apply to air duct weatherproof coverings where they are located entirely outside of a building, do not penetrate a wall or roof, and do not create an exposure hazard.

4.3.3.3 Air duct, panel, and plenum coverings and linings, and pipe insulation and coverings shall not flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C 411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service.

4.3.3.3.1 In no case shall the test temperature be below 121°C (250°F).

4.3.3.4 Air duct coverings shall not extend through walls or floors that are required to be fire stopped or required to have a fire resistance rating, unless such coverings meet the requirements of 5.4.6.4.

4.3.10.2.6 Materials exposed to the airflow shall be noncombustible or limited combustible and have a maximum smoke developed index of 50 or comply with the following.

4.3.10.2.6.1 Electrical wires and cables and optical fiber cables shall be listed as noncombustible or limited combustible and have a maximum smoke developed index of 50 or shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

4.3.10.2.6.2 Pneumatic tubing for control systems shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 1820, Standard for Safety Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics.

4.3.10.2.6.4 Optical-fiber and communication raceways shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 2024, Standard for Safety Optical-Fiber Cable Raceway.

4.3.10.2.6.6 Supplementary materials for air distribution systems shall be permitted when complying with the provisions of 4.3.3.

5.4.6.4 Where air ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and where fire dampers are not required, the opening in the construction around the air duct shall be as follows:

(1) Not exceeding a 25.4 mm (1 in.) average clearance on all sides

(2) Filled solid with an approved material capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subjected to the time-temperature fire conditions required for fire barrier penetration as specified in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*

2. Test methods: ASTM E84, UL 723, or NFPA 255.
3. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.

C. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Shop Drawings:

1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.
   a. Insulation materials: Specify each type used and state surface burning characteristics.
   b. Insulation facings and jackets: Each type used. Make it clear that white finish will be furnished for exposed ductwork, casings and equipment.
   c. Insulation accessory materials: Each type used.
   d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.

e. Make reference to applicable specification paragraph numbers for coordination.

1.5 STORAGE AND HANDLING OF MATERIAL

A. Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

1.6 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.

B. Federal Specifications (Fed. Spec.):

L-P-535E (2)- 1999..... Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.

C. Military Specifications (Mil. Spec.):

MIL-A-3316C -1987 Adhesives, Fire-Resistant, Thermal Insulation

MIL-A-24179A (1)-2016 Adhesive, Flexible Unicellular-Plastic Thermal Insulation

MIL-C-19565C (1)- 2016 Coating Compounds, Thermal Insulation, Fire-and Water-Resistant, Vapor-Barrier

MIL-C-20079H-1987..... Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass

D. American Society for Testing and Materials (ASTM):

A167-99 2014 ..... Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

B209-2014 ..... Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

C411-2019..... Standard test method for Hot-Surface Performance of High-Temperature Thermal Insulation

C449-2019..... Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement

C533-2017..... Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation

C534-2017..... Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

C547-2017..... Standard Specification for Mineral Fiber pipe Insulation

C552-07..... Standard Specification for Cellular Glass Thermal Insulation

C553-2015..... Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

C585-2016 ..... Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System) R (1998)

C612-2014 ..... Standard Specification for Mineral Fiber Block and Board Thermal Insulation

C1126-2019 ..... Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation

C1136-2017 ..... Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation

D1668-97a 2017 ..... Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing

E84-2014 ..... Standard Test Method for Surface Burning Characteristics of Building Materials

E119-2007 ..... Standard Test Method for Fire Tests of Building Construction and Materials

E136-2019 ..... Standard Test Methods for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C (1380 F)

E. National Fire Protection Association (NFPA):

90A-2018 ..... Standard for the Installation of Air Conditioning and Ventilating Systems

96-2018..... Standards for Ventilation Control and Fire Protection of Commercial Cooking Operations

101-2018..... Life Safety Code

251-2014..... Standard methods of Tests of Fire Endurance of Building Construction Materials

255-2006..... Standard Method of tests of Surface Burning Characteristics of Building Materials

F. Underwriters Laboratories, Inc (UL):

723-2018..... UL Standard for Safety Test for Surface Burning Characteristics of Building Materials with Revision of 09/08

G. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS):

SP58-2018..... Pipe Hangers and Supports Materials, Design, and Manufacture

PART 2 - PRODUCTS

2.1 MINERAL FIBER OR FIBER GLASS

A. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1, k = 0.037 (0.26) at 24 degrees C (75 degrees F), for use at temperatures up to 230 degrees C (450 degrees F) with an all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.

2.2 FLEXIBLE ELASTOMERIC CELLULAR THERMAL

A. ASTM C177, C518, k = 0.039 (0.27) at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for temperatures from minus 4 degrees C (40 degrees F) to 93 degrees C (200 degrees F). No jacket required.

2.3 CALCIUM SILICATE

A. Preformed pipe Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.

B. Premolded Pipe Fitting Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.

C. Equipment Insulation: ASTM C533, Type I and Type II

D. Characteristics:

Insulation Characteristics		
ITEMS	**TYPE I**	**TYPE II**
Temperature, maximum degrees C (degrees F)	649 (1200)	927 (1700)
Density (dry), Kg/m^3 (lb/ ft3)	232 (14.5)	288 (18)
Thermal conductivity: Min W/ m K (Btu in/h ft^2 degrees F)@ mean temperature of 93 degrees C (200 degrees F)	0.059 (0.41)	0.078 (0.540)
Surface burning characteristics: Flame spread Index, Maximum	0	0
Smoke Density index, Maximum	0	0

2.4 INSULATION FACINGS AND JACKETS

A. Vapor Retarder, higher strength with low water permeance $\underline{=}$ 0.02 or less perm rating, Beach puncture 50 units for insulation facing on exposed ductwork, casings and equipment, and for pipe insulation jackets. Facings and jackets shall be all service type (ASJ) or PVDC Vapor Retarder jacketing.

B. ASJ jacket shall be white kraft bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 50 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75 mm (3 inch) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.

C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: Foil-Scrim-Kraft (FSK) or PVDC vapor retarder jacketing type for concealed ductwork and equipment.

D. Field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping and ductwork as well as on interior piping and ductwork exposed to outdoor air (i.e.; piping in ventilated (not air conditioned) spaces, etc.) in high humidity areas conveying fluids below ambient temperature. The vapor barrier jacket shall

consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.

E. Glass Cloth Jackets: Presized, minimum 0.18 kg per square meter (7.8 ounces per square yard), 2000 kPa (300 psig) bursting strength with integral vapor retarder where required or specified. Weather proof if utilized for outside service.

F. Factory composite materials may be used provided that they have been tested and certified by the manufacturer.

G. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be polyvinyl chloride (PVC) conforming to Fed Spec L-P-335, composition A, Type II Grade GU, and Type III, minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape.

H. Aluminum Jacket-Piping systems and circular breeching and stacks: ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.6 mm (0.024) inch minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel bands shall be installed on all circumferential joints. Bands shall be 13 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.

2.5 REMOVABLE INSULATION JACKETS

A. Insulation and Jacket:

1. Non-Asbestos Glass mat, type E needled fiber.
2. Temperature maximum of 450°F, Maximum water vapor transmission of 0.00 perm, and maximum moisture absorption of 0.2 percent by volume.
3. Jacket Material: Silicon/fiberglass and LFP 2109 pure PTFE.
4. Construction: One piece jacket body with three-ply braided pure Teflon or Kevlar thread and insulation sewn as part of jacket. Belt fastened.

2.6 PIPE COVERING PROTECTION SADDLES

A. Cold pipe support: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass or high density Polyisocyanurate insulation of the same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m^3 (3.0 pcf).

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
Up through 125 (5)	150 (6) long
150 (6)	150 (6) long

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
200 (8), 250 (10), 300 (12)	225 (9) long
350 (14), 400 (16)	300 (12) long
450 through 600 (18 through 24)	350 (14) long

B. Warm or hot pipe supports: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be high density Polyisocyanurate (for temperatures up to 149 degrees C [300 degrees F]), cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m^3 (3.0 pcf).

2.7 ADHESIVE, MASTIC, CEMENT

A. Mil. Spec. MIL-A-3316, Class 1: Jacket and lap adhesive and protective finish coating for insulation.

B. Mil. Spec. MIL-A-3316, Class 2: Adhesive for laps and for adhering insulation to metal surfaces.

C. Mil. Spec. MIL-A-24179, Type II Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.

D. Mil. Spec. MIL-C-19565, Type I: Protective finish for outdoor use.

E. Mil. Spec. MIL-C-19565, Type I or Type II: Vapor barrier compound for indoor use.

F. ASTM C449: Mineral fiber hydraulic-setting thermal insulating and finishing cement.

G. Other: Insulation manufacturers' published recommendations.

2.8 MECHANICAL FASTENERS

A. Pins, anchors: Welded pins, or metal or nylon anchors with galvanized steel-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.

B. Staples: Outward clinching galvanized steel.

C. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.

D. Bands: 13 mm (0.5 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

2.9 REINFORCEMENT AND FINISHES

A. Glass fabric, open weave: ASTM D1668, Type III (resin treated) and Type I (asphalt treated).

B. Glass fiber fitting tape: Mil. Spec MIL-C-20079, Type II, Class 1.

C. Tape for Flexible Elastomeric Cellular Insulation: As recommended by the insulation manufacturer.

D. Hexagonal wire netting: 25 mm (one inch) mesh, 0.85 mm thick (22 gage) galvanized steel.

E. Corner beads: 50 mm (2 inch) by 50 mm (2 inch), 0.55 mm thick (26 gage) galvanized steel; or, 25 mm (1 inch) by 25 mm (1 inch), 0.47 mm thick (28 gage) aluminum angle adhered to 50 mm (2 inch) by 50 mm (2 inch) Kraft paper.

F. PVC fitting cover: Fed. Spec L-P-535, Composition A, 11-86 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 4 degrees C (40 degrees F) to 121 degrees C (250 degrees F). Below 4 degrees C (40 degrees F) and above 121 degrees C (250 degrees F). Provide double layer insert. Provide color matching vapor barrier pressure sensitive tape.

2.10 FIRESTOPPING MATERIAL

A. Other than pipe and duct insulation, refer to Section 07 84 00 FIRESTOPPING.

2.11 FLAME AND SMOKE

A. Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications. See paragraph 1.3 "Quality Assurance".

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Required pressure tests of duct and piping joints and connections shall be completed and the work approved by the COR for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.

B. Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories), and duct systems. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.

C. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor retarder over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).

D. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.

E. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.

F. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.

G. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.

H. Insulate PRVs, flow meters, and steam traps.

I. HVAC work not to be insulated:
   1. Exhaust air ducts and plenums, and ventilation exhaust air shafts.
   2. Equipment: Expansion tanks, flash tanks, hot water pumps, steam condensate pumps.
   3. In hot piping: Unions, flexible connectors, control valves, PRVs, safety valves and discharge vent piping, vacuum breakers, thermostatic vent valves, steam traps 20 mm (3/4 inch) and smaller, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 75 mm (3 inches) of uninsulated items.

J. Work not to be insulated (NI), or if insulated, the insulation shall be removal jacket type (RJ):
   1. Pipes, valves and fittings:
      a. Gas fuel (NI)
      b. Compressed Air (NI)
      c. Flowmeter sensing piping and blowdown (NI)
   2. Equipment:
      a. Pumps-inlet to outlet(NI)
      b. Safety valves(NI)
      c. Water meters(NI)
      d. Chemical feeders(NI)
      e. All nameplates (NI)
   3. Specialties:
      a. Pressure reducing valves(RJ)
      b. Control valves-water and steam(NI)
      c. Level sensors-piping, valves and blowdown(NI)
      d. Back pressure regulators-oil and steam(NI)
      e. Strainers under 65 mm (2-1/2 inch) pipe size(RJ)
      f. Expansion bellows(RJ)
      g. Flexible connectors(RJ)
      h. Ball joints except piping between joints (NI)

K. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.

L. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting. Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.

M. Firestop Pipe and Duct insulation:
   1. Provide firestopping insulation at fire and smoke barriers through penetrations. Fire stopping insulation shall be UL listed as defines in Section 07 84 00, FIRESTOPPING.
   2. Pipe and duct penetrations requiring fire stop insulation including, but not limited to the following:
      a. Pipe risers through floors
      b. Pipe or duct chase walls and floors
      c. Fire barriers

N. Provide vapor barrier jackets over insulation as follows:
   1. All piping and ductwork exposed to outdoor weather.
   2. All interior piping conveying fluids exposed to outdoor air (i.e. in ventilated (not air conditioned) spaces, etc.) below ambient air temperature in high humidity areas.

O. Provide metal jackets over insulation as follows:
   1. All piping and ducts exposed to outdoor weather.
   2. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.

3.2 INSULATION INSTALLATION

A. Molded Mineral Fiber Pipe and Tubing Covering:
   1. Fit insulation to pipe or duct, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.
   2. Contractor's options for fitting, flange and valve insulation:
      a. Insulating and finishing cement for sizes less than 100 mm (4 inches) operating at surface temperature of 16 degrees C (61 degrees F) or more.
      b. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts. Provide two insert layers for pipe temperatures below 4 degrees C (40 degrees F), or above 121 degrees C (250 degrees F). Secure first layer of insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.
      c. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place. For hot piping finish with a smoothing coat of finishing cement. For cold

fittings, 16 degrees C (60 degrees F) or less, vapor seal with a layer of glass fitting tape imbedded between two 2 mm (1/16 inch) coats of vapor barrier mastic.

d. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).

3. Nominal thickness in millimeters and inches specified in the schedule at the end of this section.

B. Flexible Elastomeric Cellular Thermal Insulation:

1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions and finish with two coats of weather resistant finish as recommended by the insulation manufacturer.
2. Pipe and tubing insulation:
   a. Use proper size material. Do not stretch or strain insulation.
   b. To avoid undue compression of insulation, provide cork stoppers or wood inserts at supports as recommended by the insulation manufacturer. Insulation shields are specified under Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
   c. Where possible, slip insulation over the pipe or tubing prior to connection, and seal the butt joints with adhesive. Where the slip-on technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, may be employed. Make changes from mineral fiber insulation in a straight run of pipe, not at a fitting. Seal joint with tape.
3. Apply sheet insulation to flat or large curved surfaces with 100 percent adhesive coverage. For fittings and large pipe, apply adhesive to seams only.
4. Pipe insulation: nominal thickness in millimeters (inches as specified in the schedule at the end of this section.
5. Minimum 20 mm (0.75 inch) thick insulation for pneumatic control lines for a minimum distance of 6 m (20 feet) from discharge side of the refrigerated dryer.

C. Calcium Silicate:

1. Minimum thickness in millimeter (inches) specified in the schedule at the end of this section for piping other than in boiler plant. See paragraphs 3.3 through 3.7 for Boiler Plant Applications.
2. Engine Exhaust Insulation for Emergency Generator and Diesel Driven Fire Pump: Type II, Class D, 65 mm (2 1/2 inch) nominal thickness. Cover exhaust completely from engine through roof or wall construction, including muffler. Secure with 16 AWG galvanized annealed wire or 0.38 x 12 mm 0.015 x 1/2 IN wide galvanized bands on 300 mm 12 IN maximum centers. Anchor wire and bands to welded pins, clips or angles. Apply 25 mm 1 IN hex galvanized wire over insulation. Fill voids with 6 mm 1/4 IN insulating cement.

3. ETO Exhaust (High Temperature): Type II, class D, 65 mm (2.5 inches) nominal thickness. Cover duct for entire length. Provide sheet aluminum jacket for all exterior ductwork.

3.3 PIPE INSULATION SCHEDULE

A. Provide insulation for piping systems as scheduled below:

Insulation Wall Thickness Millimeters (Inches)					
		Nominal Pipe Size Millimeters (Inches)			
Operating Temperature Range/Service	Insulation Material	<25 (1)	25 – 32 (1 – 1¼)	38 – 75 (1½ - 3)	100 (4) and Above
	Insulation Wall Thickness Millimeters (Inches)				
122-177 degrees C (251-350 degrees F) (HPS, MPS)	Mineral Fiber (Above ground piping only)	75 (3)	100 (4)	113 (4.5)	113 (4.5)
93-260 degrees C (200-500 degrees F) (HPS, HPR)	Calcium Silicate	100 (4)	125 (5)	150 (6)	150 (6)
100-121 degrees C (212-250 degrees F) (HPR, MPR, LPS, vent piping from PRV Safety Valves, Condensate receivers and flash tanks)	Mineral Fiber (Above ground piping only)	62 (2.5)	62 (2.5)	75 (3.0)	75 (3.0)
38-94 degrees C (100-200 degrees F) (LPR, PC, HWH, HWHR, GH and GHR)	Mineral Fiber (Above ground piping only)	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	----	----
4-16 degrees C (40-60 degrees F) (CH, CHR, GC, GCR and RS for DX refrigeration)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)

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SECTION 23 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Water piping to connect HVAC equipment, including the following:
   1. Chilled water, condenser water, heating hot water and drain piping.
   2. Extension of domestic water make-up piping for HVAC systems.
   3. Glycol-water piping.

B. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.

D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

E. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

F. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.

G. Section 23 21 23, HYDRONIC PUMPS.

H. Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING.

I. Section 23 25 00, HVAC WATER TREATMENT.

1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standard will govern.

B. American Society of Mechanical Engineers (ASME):

B1.20.1-2013 ..... Pipe Threads, General Purpose, Inch

B16.3-2016 ..... Malleable Iron Threaded Fittings: Classes 150 and 300

B16.4-2016 ..... Gray Iron Threaded Fittings: (Classes 125 and 250)

B16.5-2020 ..... Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard

B16.9-2018 ..... Factory Made Wrought Buttwelding Fittings

B16.11-2016 ..... Forged Fittings, Socket-Welding and Threaded

B16.18-2018 ..... Cast Copper Alloy Solder Joint Pressure Fittings

B16.22-2018 ..... Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings

B16.24-2016 ..... Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500

B16.39-2019 ..... Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300
B16.42-2016 ..... Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300
B31.9-2020 ..... Building Services Piping
B40.100-2013 ..... Pressure Gauges and Gauge Attachments
ASME Boiler and Pressure Vessel Code (BPVC):
BPVC Section VIII-2021 Rules for Construction of Pressure Vessels, Division 1

C. American Society for Testing and Materials (ASTM):
A47/A47M-1999(R2018)e1 Standard Specification for Ferritic Malleable Iron Castings
A53/A53M-2020..... Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A106/A106M-2019a..... Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
A126-2004(R2019) ..... Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
A183-2014(R2020) ..... Standard Specification for Carbon Steel Track Bolts and Nuts
A216/A216M-2021..... Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
A307-2021 ..... Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
A536-1984(R2019e1) ... Standard Specification for Ductile Iron Castings
B62-2017 ..... Standard Specification for Composition Bronze or Ounce Metal Castings
B88-2020 ..... Standard Specification for Seamless Copper Water Tube

D. American Welding Society (AWS):
B2.1/B2.1M-2014..... Specification for Welding Procedure and Performance Qualification

E. Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry, Inc.:
SP-67-2017..... Butterfly Valves
SP-70-2011..... Gray Iron Gate Valves, Flanged and Threaded Ends
SP-71-2018..... Gray Iron Swing Check Valves, Flanged and Threaded Ends
SP-80-2019..... Bronze Gate, Globe, Angle, and Check Valves
SP-85-2011..... Gray Iron Globe and Angle Valves, Flanged and Threaded Ends
SP-110-2010..... Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
SP-125-2018..... Check Valves: Gray Iron and Ductile Iron, In-line, Spring-Loaded, Center-Guided

F. National Fire Protection Association (NFPA):
70-2020..... National Electrical Code (NEC)

G. Tubular Exchanger Manufacturers Association (TEMA):
TEMA Standards 2019 . 10th Edition

1.4 SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Information and material submitted under this section shall be marked “SUBMITTED UNDER SECTION 23 21 13, HYDRONIC PIPING”, with applicable paragraph identification.

C. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
1. Pipe and equipment supports.
2. Pipe and tubing, with specification, class or type, and schedule.
3. Pipe fittings, including miscellaneous adapters and special fittings.
4. Flanges, gaskets and bolting.
5. Couplings and fittings.
6. Valves of all types.
7. Strainers.
8. Flexible connectors for water service.
9. Pipe alignment guides.
10. All specified hydronic system components.

D. Submit the welder’s qualifications in the form of a current (less than 1-year old) and formal certificate.

E. Coordination Drawings: Refer to paragraph, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

F. As-Built Piping Diagrams: For modifications to piping required to complete the work, provide drawings as follows for chilled water, condenser water, and heating hot water system and other piping systems and equipment.
1. 1 complete set of reproducible drawings.
2. 1 complete set of drawings in electronic pdf format.

G. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
1. Include complete list indicating all components of the systems.

1.5 QUALITY ASSURANCE

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC, which includes welding qualifications.

B. Submit prior to welding of steel piping a certificate of Welder’s certification. The certificate shall be current and not more than 1-year old.

C. All couplings, fittings, valves, and specialties shall be the products of a single manufacturer.
   1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

D. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit http://www.biopreferred.gov.

E. Refer to Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for additional sustainable design requirements.

1.6 AS-BUILT DOCUMENTATION

A. Comply with requirements in paragraph AS-BUILT DOCUMENTATION of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

1.7 SPARE PARTS

A. For mechanical pressed sealed fittings provide tools required for each pipe size used at the facility.

PART 2 - PRODUCTS

2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES

A. Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

2.2 PIPE AND TUBING

A. Chilled Water, Condenser Water, Heating Hot Water, and Glycol-Water, and Vent Piping:
   1. Steel: ASTM A53/A53M Grade B, seamless or ERW, Schedule 40.
   2. Copper Water Tube Option: ASTM B88, Type K or L, hard drawn.

B. Extension of Domestic Water Make-up Piping: ASTM B88, Type K or L, hard drawn copper tubing.

C. Cooling Coil Condensate Drain Piping:
   1. Copper water tube, ASTM B88, Type M for runouts and Type L for mains.

D. Chemical Feed Piping for Condenser Water Treatment: CPVC, Schedule 80, ASTM F441/F441M.

E. Pipe supports, including insulation shields, for aboveground piping: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

2.3 FITTINGS FOR STEEL PIPE

A. 50 mm (2 inches) and Smaller: Screwed or welded joints.
   1. Butt Welding: ASME B16.9 with same wall thickness as connecting piping.
   2. Forged Steel, Socket Welding or Threaded: ASME B16.11.

3. Screwed: 150-pound malleable iron, ASME B16.3. 125-pound cast-iron, ASME B16.4, may be used in lieu of malleable iron. Bushing reduction of a single pipe size, or use of close nipples, is prohibited.
4. Unions: ASME B16.39.
5. Water Hose Connection Adapter: Brass, pipe thread to 19 mm (3/4 inch) garden hose thread, with hose cap nut.

B. 63 mm (2-1/2 inches) and Larger: Welded or flanged joints.
1. Butt Welding Fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
2. Welding Flanges and Bolting: ASME B16.5:
a. Water Service: Weld neck or slip-on, plain face, with 3.2 mm (1/8 inch) thick full-face neoprene gasket suitable for 104 degrees C (220 degrees F).
1) Contractor's Option: Convoluted, cold formed 150-pound steel flanges, with Teflon gaskets, may be used for water service.
b. Flange Bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.

C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets shall be used for branch connections up to 1 pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 shall be used for drain, vent, and gauge connections.

2.4 FITTINGS FOR COPPER TUBING

A. Joints:
1. Solder Joints: Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.
2. Mechanically Formed Tee Connection In Water and Drain Piping: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than 3 times the thickness of tube wall. Adjustable collaring device shall ensure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting.

B. Bronze Flanges and Flanged Fittings: ASME B16.24.

C. Fittings: ASME B16.18 cast copper or ASME B16.22 solder wrought copper.

2.5 DIELECTRIC FITTINGS

A. Provide where copper tubing and ferrous metal pipe are joined.

B. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.

C. 63 mm (2-1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42. Dielectric gasket material shall be compatible with hydronic medium.

D. Temperature Rating: 99 degrees C (210 degrees F).

E. Contractor's Option: On pipe sizes 50 mm (2 inch) and smaller, screwed end brass ball valves or dielectric nipples may be used in lieu of dielectric unions.

2.6 SCREWED JOINTS

A. Pipe Thread: ASME B1.20.1.

B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

2.7 VALVES

A. Asbestos packing is prohibited.

B. All valves of the same type shall be products of a single manufacturer.

C. Provide chain operators for valves 152 mm (6 inches) and larger when the centerline is located 2.4 m (8 feet) or more above the floor or operating platform.

D. Shut-Off Valves:

1. Ball Valves (Pipe Sizes 50 mm (2 inch) and Smaller): MSS SP-110, screwed or solder connections, brass or bronze body with chrome-plated ball with full port and Teflon seat at 2758 kPa (400 psig) working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation.
2. Butterfly Valves (Pipe Sizes 63 mm (2-1/2 inch) and Larger): Provide stem extension to allow 50 mm (2 inches) of pipe insulation without interfering with valve operation. MSS SP-67, flange lug type rated 1200 kPa (175 psig) working pressure at 93 degrees C (200 degrees F). Valves shall be ANSI Leakage Class VI and rated for bubble tight shut-off to full valve pressure rating. Valve shall be rated for dead end service and bi-directional flow capability to full rated pressure. Butterfly valves are prohibited for direct buried pipe applications.
    a. Body: Cast-iron, ASTM A126, Class B. Malleable iron, ASTM A47/A47M electro-plated, or ductile iron, ASTM A536, Grade 65-45-12 electro-plated.
    b. Trim: Bronze, aluminum bronze, or 300 series stainless-steel disc, bronze bearings, 316 stainless-steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.
3. Gate Valves:
    a. 50 mm (2 inches) and Smaller: MSS SP-80, Bronze, 1034 kPa (150 psig), wedge disc, rising stem, union bonnet.
    b. 63 mm (2-1/2 inches) and Larger: Flanged, outside screw and yoke. MSS SP-70, iron body, bronze mounted, 860 kPa (125 psig) wedge disc.
4. Field Interchangeable Actuators: Valves for balancing service shall have adjustable memory stop to limit open position.

a. Valves 152 mm (6 inches) and Smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.
b. Valves 203 mm (8 inches) and Larger: Enclosed worm gear with handwheel, and where required, chain-wheel operator.

E. Globe and Angle Valves:
1. Globe Valves:
a. 50 mm (2 inches) and Smaller: MSS SP-80, bronze, 1034 kPa (150 psig) Globe valves shall be union bonnet with metal plug type disc.
b. 63 mm (2-1/2 inches) and Larger: 860 kPa (125 psig), flanged, iron body, bronze trim, MSS SP-85 for globe valves.
2. Angle Valves:
a. 50 mm (2 inches) and Smaller: MSS SP-80, bronze, 1034 kPa (150 psig) Angle valves shall be union bonnet with metal plug type disc.
b. 63 mm (2-1/2 inches) and Larger: 860 kPa (125 psig), flanged, iron body, bronze trim, MSS SP-85 for angle.

F. Check Valves:
1. Swing Check Valves:
a. 50 mm (2 inches) and Smaller: MSS SP-80, bronze, 1034 kPa (150 psig), 45-degree swing disc.
b. 63 mm (2-1/2 inches) and Larger: 860 kPa (125 psig), flanged, iron body, bronze trim, MSS SP-71 for check valves.
2. Non-Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut-off. Provide where check valves are shown in chilled water and hot water piping. Check valves incorporating a balancing feature may be used.
a. Body: MSS SP-125 cast-iron, ASTM A126, Class B, or steel, ASTM A216/A216M, Class WCB, or ductile iron, ASTM 536, flanged or wafer type.
b. Seat, Disc and Spring: 18-8 stainless-steel, or bronze, ASTM B62. Seats may be elastomer material.

G. Water Flow Balancing Valves: For flow regulation. Provide separate isolation valve.. Valves shall be sized to provide the needed pressure drop in the middle of their throttling range.
1. Ball or Globe style valve.
2. A dual-purpose flow balancing valve and adjustable flow meter, with bronze or cast-iron body, calibrated position pointer, valved pressure taps or quick disconnects with integral check valves and preformed polyurethane insulating enclosure.
3. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.

H. Automatic Balancing Control Valves: Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of 28 to 393 kPa (4 to 57 psig). Provide standard pressure taps and 4 sets of capacity charts. Valves shall be line size and be one of the following designs:

1. Gray iron ASTM A126 or brass body rated 1200 kPa (175 psig) at 93 degrees C (200 degrees F), with stainless-steel piston and spring.
2. Brass or ferrous body designed for 2070 kPa (300 psig) service at 121 degrees C (250 degrees F), with corrosion resistant, tamper proof, self-cleaning piston/spring assembly that is easily removable for inspection or replacement.
3. Combination assemblies containing ball type shut-off valves, unions, flow regulators, strainers with blowdown valves and pressure temperature ports shall be acceptable.

2.8 STRAINERS

A. Basket or Y Type.

1. Screens: Bronze, Monel metal or 18-8 stainless-steel, free area not less than 2-1/2 times pipe area, with perforations as follows: 1.1 mm (0.045 inch) diameter perforations for 100 mm (4 inches) and larger: 3.2 mm (1/8 inch) diameter perforations.

B. Suction Diffusers: Specified in Section 23 21 23, HYDRONIC PUMPS.

2.9 FLEXIBLE CONNECTORS FOR WATER SERVICE

A. Flanged Spool Connector:

1. Single arch or multiple arch type. Tube and cover shall be constructed of chlorobutyl elastomer with full faced integral flanges to provide a tight seal without gaskets. Connectors shall be internally reinforced with high strength synthetic fibers impregnated with rubber or synthetic compounds as recommended by connector manufacturer, and steel reinforcing rings.
2. Working pressures and temperatures shall be as follows:
   a. Connector sizes 50 mm to 100 mm (2 inches to 4 inches), 1137 kPa (165 psig) at 121 degrees C (250 degrees F).
   b. Connector sizes 127 mm to 305 mm (5 inches to 12 inches), 965 kPa (140 psig) at 121 degrees C (250 degrees F).
3. Provide ductile iron retaining rings and control units.

B. Braided Hose: Corrugated-metal inner hose and braided outer shell.

1. Piping Up To 50 mm (2 inches): Bronze hoses and single-braid bronze sheaths with 3102 kPa at 21 degrees C (450 psig at 70 degrees F) and 2344 kPa at 232 degrees C (340 psig at 450 degrees F) ratings.
2. Piping From 65 mm (2-1/2 inches) To 100 mm (4 inches): Stainless-steel hoses and single-braid, stainless-steel sheaths with 2070 kPa at 21 degrees C (300 psig at 70 degrees F) and 1550 kPa at 232 degrees C (225 psig at 450 degrees F) ratings.

3. Piping From 150 mm (6 inches) and Above: Stainless-steel hoses and single-braid, stainless-steel sheaths with 1380 kPa at 21 degrees C (200 psig at 70 degrees F) and 1000 kPa at 315 degrees C (145 psig at 600 degrees F) ratings.

2.10 HYDRONIC SYSTEM COMPONENTS

A. Where removal and reinstallation is required to complete the work, take care to protect existing components for reinstallation.

2.11 WATER FILTERS AND POT CHEMICAL FEEDERS

A. See Section 23 25 00, HVAC WATER TREATMENT, paragraph, CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS.

2.12 FIRESTOPPING MATERIAL

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

PART 3 - EXECUTION

3.1 INSTALLATION

A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

B. The contract documents show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost or time to the Government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location in the contract documents shall be altered by contractor where necessary to avoid interferences and clearance difficulties.

C. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.

D. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Install heat exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.

E. Install piping generally parallel to walls and column center lines, unless shown otherwise in the contract documents. Space piping, including insulation, to provide 25 mm (1 inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope drain piping down in the direction of flow not less than 25 mm (1 inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.

F. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally, locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown in the contract documents. Install butterfly valves

with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.

G. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted in the contract documents.

H. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.

I. Provide manual or automatic air vent at all piping system high points and drain valves at all low points. Install piping to floor drains from all automatic air vents.

J. Connect piping to equipment as shown in the contract documents. Install components furnished by others such as:

1. Water treatment pot feeders and condenser water treatment systems.
2. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.

K. Thermometer Wells: In pipes 63 mm (2-1/2 inches) and smaller increase the pipe size to provide free area equal to the upstream pipe area.

L. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC AND BOILER PLANT INSULATION.

M. Where copper piping is connected to steel piping, provide dielectric connections.

3.2 PIPE JOINTS

A. Welded: Beveling, spacing and other details shall conform to ASME B31.9 and AWS B2.1/B2.1M. See Welder’s qualification requirements in paragraph QUALITY ASSURANCE of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

B. Screwed: Threads shall conform to ASME B1.20.1; joint compound shall be applied to male threads only and joints made up so no more than 3 threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.

C. 125 Pound Cast-Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast-iron flange.

D. Solvent Welded Joints: As recommended by the manufacturer.

3.3 EXPANSION JOINTS (BELLOWS AND SLIP TYPE)

A. Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown. A professional engineer shall verify in writing that anchors and guides are properly designed for forces and moments which will be imposed.

B. Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.

C. Preparation for Service: Remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.

D. Access: Expansion joints shall be located in readily accessible space. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding.

3.4 LEAK TESTING ABOVEGROUND PIPING

A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the COR. Tests shall be either of those below, or a combination, as approved by the COR.

B. An operating test at design pressure, and for hot systems, design maximum temperature.

C. A hydrostatic test at 1.5 times design pressure. For water systems, the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Isolate equipment where necessary to avoid excessive pressure on mechanical seals and safety devices.

3.5 FLUSHING AND CLEANING PIPING SYSTEMS

A. Water Piping: Clean systems as recommended by the suppliers of chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.

B. Initial Flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 1.8 m/s (5.9 f/s), if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the COR.

C. Cleaning: Using products supplied in Section 23 25 00, HVAC WATER TREATMENT, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is

"clean" and where dead-end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 1.8 m/s (5.9 f/s). Circulate each section for not less than 4 hours. Blow-down all strainers or remove and clean as frequently as necessary. Drain and prepare for final flushing.

D. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

3.6 WATER TREATMENT

A. Install water treatment equipment and provide water treatment system piping.

B. Close and fill system as soon as possible after final flushing to minimize corrosion.

C. Charge systems with chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.

D. Utilize this activity, by arrangement with the COR, for instructing VA operating personnel.

3.7 STARTUP AND TESTING

A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.

C. Adjust red set hand on pressure gauges to normal working pressure.

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SECTION 23 21 23
HYDRONIC PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Hydronic pumps for heating, ventilating and air conditioning.

B. Definitions:

1. Capacity: Liters per second (L/s) (Gallons per minute (gpm)) of the fluid pumped.
2. Head: Total dynamic head in kPa (feet) of the fluid pumped.
3. Flat head-capacity curve: Where the shutoff head is less than 1.16 times the head at the best efficiency point.

C. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

D. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.

E. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

F. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

G. Section 23 21 13, HYDRONIC PIPING.

1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur, these specifications and the VHA standard will govern.

B. American Society of Mechanical Engineers (ASME):

B16.1-2020 ..... Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250

C. American Society for Testing and Materials (ASTM):

A48/48M-2003(R2021) . Standard Specification for Gray Iron Castings

B62-2017 ..... Standard Specification for Composition Bronze or Ounce Metal Castings

1.4 SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Information and material submitted under this section shall be marked “SUBMITTED UNDER SECTION 23 21 23, HYDRONIC PUMPS”, with applicable paragraph identification.

C. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.

1. Pumps and accessories.

D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity, and NPSHR-capacity for each pump. Identify pump and show fluid pumped, pump speed and curves plotted from zero flow to maximum for the impeller being furnished and at least the maximum diameter impeller that can be used with the casing.

E. Complete operating and maintenance manuals including technical data sheets, information for ordering replacement parts, and troubleshooting guide:

1. Include complete list indicating all components of the systems.

1.5 QUALITY ASSURANCE

A. Design Criteria:

1. Pump sizes, capacities, pressures, operating characteristics and efficiency shall be as scheduled.
2. Head-capacity curves shall slope up to maximum head at shut-off. Select pumps near the midrange of the curve, so the design capacity falls to the left of the best efficiency point, to allow a cushion for the usual drift to the right in operation, without approaching the pump curve end point and possible cavitation and unstable operation. Select pumps for open systems so that required net positive suction head (NPSHR) does not exceed the net positive head available (NPSHA). Provide pumps with non-overloading motors.
3. Pump Driver: Furnish with pump. Size shall be non-overloading at any point on the head-capacity curve, including in a parallel or series pumping installation with one pump in operation.
4. Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard and other accessories specified. Statically and dynamically balance all rotating parts.
5. Furnish each pump and motor with a nameplate giving the manufacturers name, serial number of pump, capacity in gpm and head in feet at design condition, horsepower, voltage, frequency, speed and full load current and motor efficiency. Name plates shall be visible when pumps are insulated.
6. Test all pumps before shipment. The manufacturer shall certify all pump ratings.
7. After completion of balancing, provide replacement of impellers or trim impellers to provide specified flow at actual pumping head, as installed.

B. Allowable Vibration Tolerance for Pump Units: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

1.6 AS-BUILT DOCUMENTATION

A. Comply with requirements in paragraph AS-BUILT DOCUMENTATION of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

1.7 SPARE MATERIALS

A. Furnish one spare seal and casing gasket for each pump to the COR.

PART 2 - PRODUCTS

2.1 PUMPS

A. General:

1. Provide pumps that will operate continuously without overheating bearings or motors at every condition of operation on the pump curve, or produce noise audible outside the room or space in which installed.
2. Provide pumps of size, type and capacity as indicated, complete with electric motor and drive assembly, unless otherwise indicated. Design pump casings for the indicated working pressure and factory test at 1-1/2 times the designed pressure.
3. Provide pumps of the same type, the product of a single manufacturer, with pump parts of the same size and type interchangeable.
4. General Construction Requirements:
   a. Balance: Rotating parts, statically and dynamically.
   b. Construction: To permit servicing without breaking piping or motor connections.
   c. Pump Motors: Provide high efficiency motors, inverter duty for variable speed service. Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
   d. Heating pumps shall be suitable for handling water or glycol to 107 degrees C (225 degrees F).
   e. Provide coupling guards that meet OSHA requirements.
   f. Pump Connections: Flanged.
   g. Pump shall be factory tested.
   h. Performance: As scheduled in the contract documents.
5. Variable Speed Pumps:
   a. The pumps shall be the type shown in the contract documents and specified herein.
   b. Variable Speed Motor Controllers: Existing to remain.
   c. Pump operation and speed control shall be as shown in the contract documents.

PART 3 - EXECUTION

3.1 INSTALLATION

A. If an installation is unsatisfactory to the COR, the contractor shall correct the installation at no additional cost or time to the Government.

B. Follow manufacturer's written instructions for pump mounting and startup. Access/Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.

C. Coordinate location of thermometer and pressure gauges as per Section 23 21 13, HYDRONIC PIPING.

3.2 STARTUP AND TESTING

A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.

C. Verify that the piping system has been flushed, cleaned and filled.

D. Lubricate pumps before startup.

E. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition.

F. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.

G. Field modifications to the bearings and or impeller (including trimming) are prohibited. If the pump does not meet the specified vibration tolerance, send the pump back to the manufacturer for a replacement pump. All modifications to the pump shall be performed at the factory.

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SECTION 23 22 13
STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Steam, condensate, and vent piping inside buildings.

B. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.

D. Section 09 91 00, PAINTING.

E. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

F. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

G. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.

H. Section 23 25 00, HVAC WATER TREATMENT.

1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standards shall govern.

B. American Society of Mechanical Engineers (ASME):

B1.20.1-2013 ..... Pipe Threads, General Purpose (Inch)

B16.5-2020 ..... Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard

B16.9-2018 ..... Factory Made Wrought Buttwelding Fittings

B16.11-2016 ..... Forged Fittings, Socket-Welding and Threaded

B16.42-2016 ..... Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300

B31.9-2020 ..... Building Services Piping

B40.100-2013 ..... Pressure Gauges and Gauge Attachments

ASME Boiler and Pressure Vessel Code (BPVC) -

BPVC Section II-2021 ..... Materials

BPVC Section VIII-2021..... Rules for Construction of Pressure Vessels, Division 1

BPVC Section IX-2021..... Welding, Brazing, and Fusing Qualifications

C. American Society for Testing and Materials (ASTM):

A53/A53M-2020..... Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A106/A106M-2019a..... Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
A216/A216M-2018..... Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
A285/A285M-2017..... Standard Specification for Pressure Vessel Plates, Carbon Steel, Low-and Intermediate-Tensile Strength
A307-2014e1 ..... Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
A516/A516M-2017..... Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
A536-1984(2019)e1..... Standard Specification for Ductile Iron Castings
B62-2017 ..... Standard Specification for Composition Bronze or Ounce Metal Castings

D. American Welding Society (AWS):
B2.1/B2.1M-2014..... Specification for Welding Procedure and Performance Qualifications
Z49.1-2012 ..... Safety in Welding and Cutting and Allied Processes

E. Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry, Inc.:
SP-80-2019..... Bronze Gate, Globe, Angle, and Check Valves

F. Military Specifications (Mil. Spec.):
MIL-DTL-901E-2017..... Shock Tests, H.I. (High Impact) Shipboard Machinery, Equipment, and Systems

G. National Board of Boiler and Pressure Vessel Inspectors (NB):
Relieving Capacities of Safety Valves and Relief Valves

H. Tubular Exchanger Manufacturers Association (TEMA):
TEMA Standards-2019 . 10th Edition

1.4 SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Information and material submitted under this section shall be marked “SUBMITTED UNDER SECTION 23 22 13, STEAM AND CONDENSATE HEATING PIPING”, with applicable paragraph identification.

C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.

1. Pipe and equipment supports.
2. Pipe and tubing, with specification, class or type, and schedule.
3. Pipe fittings, including miscellaneous adapters and special fittings.

4. Flanges, gaskets and bolting.
5. Valves of all types.
6. Pipe alignment guides.
7. Expansion joints.
8. Expansion compensators.
9. Flexible ball joints: Catalog sheets, performance charts, schematic drawings, specifications and installation instructions.
10. All specified steam system components.

D. Coordination Drawings: Refer to paragraph, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

E. As-Built Piping Diagrams: For modifications to piping required to complete the work, provide drawing as follows for steam and steam condensate piping and other central plant equipment.
1. One set of reproducible drawings.
2. 1 set of electronic pdf drawings.

F. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
1. Include complete list indicating all components of the systems.

1.5 QUALITY ASSURANCE

A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC, which includes welding qualifications.

B. The products and execution of work specified in this section shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments shall be enforced, along with requirements of local utility companies. The most stringent requirements of these specifications, local codes, or utility company requirements shall always apply. Any conflicts shall be brought to the attention of the COR.

C. Welding Qualifications: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME BPVC Section IX, AWS Z49.1 and AWS B2.1/B2.1M.
2. Comply with provisions in ASME B31.9.
3. Certify that each welder and welding operator has passed AWS qualification tests for welding processes involved and that certification is current and recent. Submit documentation to the COR.
4. All welds shall be stamped according to the provisions of the American Welding Society.

D. ASME Compliance: Comply with ASME B31.1 for materials, products, and installation. Safety valves and pressure vessels shall bear appropriate ASME labels.

1.6 AS-BUILT DOCUMENTATION

A. Comply with requirements in paragraph AS-BUILT DOCUMENTATION of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

PART 2 - PRODUCTS

2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES

A. Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

2.2 PIPE AND TUBING

A. Steam Piping: Steel, ASTM A53/A53M, Grade B, seamless or ERW; ASTM A106/A106M Grade B, seamless; Schedule 40.

B. Steam Condensate and Pumped Condensate Piping: Steel, ASTM A53/A53M, Grade B, seamless or ERW; or ASTM A106/A106M Grade B, seamless, Schedule 80.

C. Vent Piping: Steel, ASTM A53/A53M, Grade B, seamless or ERW; ASTM A106/A106M Grade B, seamless; Schedule 40, galvanized.

2.3 FITTINGS FOR STEEL PIPE

A. 50 mm (2 inches) and Smaller: Screwed or welded.

1. Cast iron fittings or piping is prohibited for steam and steam condensate piping. Bushing reduction or use of close nipples is prohibited.
2. Forged steel, socket welding or threaded: ASME B16.11, 13,790 kPa (2000 psig) class with ASME B1.20.1 threads. Use Schedule 80 pipe and fittings for threaded joints. Lubricant or sealant shall be oil and graphite, or other compound approved for the intended service.
3. Unions: Forged steel, 13,790 kPa (2000 psig) class or 20,685 kPa (3000 psig) class on piping 50 mm (2 inches) and less.
4. Steam line drip station and strainer quick-couple blowdown hose connection: Straight through, plug and socket, screw or cam locking type for 15 mm (1/2 inch) ID hose. No integral shut-off is required.

B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints.

1. Cast iron fittings or piping is prohibited for steam and steam condensate piping.
2. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
3. Welding flanges and bolting: ASME B16.5:
    a. Steam service: Weld neck or slip-on, raised face, with non-asbestos gasket. Non-asbestos gasket shall either be stainless steel spiral wound strip with flexible graphite filler or compressed inorganic fiber with nitrile binder rated for saturated and superheated steam service 400 degrees C (750 degrees F) and 10,342 kPa (1500 psig).
    b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.

C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gauge connections.

2.4 DIELECTRIC FITTINGS

A. Provide where dissimilar metal pipe are joined.

B. 50 mm (2 inches) and Smaller: Threaded dielectric union.

C. 65 mm (2-1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.

D. Temperature Rating, 121 degrees C (250 degrees F) for steam condensate and as required for steam service.

E. Contractor's option: On pipe sizes 50 mm (2 inches) and smaller, screwed end steel gate valves or dielectric nipples may be used in lieu of dielectric unions.

2.5 VALVES

A. Asbestos packing is prohibited.

B. All valves of the same type shall be products of a single manufacturer.

C. Provide chain operators for valves 150 mm (6 inches) and larger when the centerline is located 2.1 meter (7 feet) or greater above the floor or operating platform.

D. Shut-Off Valves:

1. Gate Valves:

a. 50 mm (2 inches) and smaller: Forged steel body, rated for 1380 kPa (200 psig) saturated steam, 2758 kPa (400 psig) WOG, bronze wedges and Monel or stainless-steel seats, threaded ends, rising stem, and union bonnet.

b. 65 mm (2-1/2 inches) and larger: Flanged, outside screw and yoke.

1) High pressure steam 110 kPa (16 psig) and above system: Cast steel body, ASTM A216/A216M grade WCB, 1035 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel solid disc and seats. Provide 25 mm (1 inch) factory installed bypass with globe valve on valves 100 mm (4 inches) and larger.

2) All other services: Forged steel body, Class B, rated for 850 kPa (123 psig) saturated steam, 1380 kPa (200 psig) WOG, bronze or bronze face wedge and seats, 850 kPa (123 psig) ASME flanged ends, OS&Y, rising stem, bolted bonnet, and renewable seat rings.

E. Globe and Angle Valves:

1. Globe Valves:

a. 50 mm (2 inches) and smaller: Forged steel body, rated for 1380 kPa (200 psig) saturated steam, 2758 kPa (400 psig) WOG, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, and renewable seat rings.

b. 65 mm (2-1/2 inches) and larger:
1) Globe valves for high pressure steam 110 kPa (16 psig): Cast steel body, ASTM A216/A216M grade WCB, flanged, OS&Y, 1035 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
2) All other services: Steel body, rated for 850 kPa (123 psig) saturated steam, 1380 kPa (200 psig) WOG, bronze or bronze-faced disc (Teflon or composition facing permitted) and seat, 850 kPa (123 psig) ASME flanged ends, OS&Y, rising stem, bolted bonnet, and renewable seat rings.

2. Angle Valves:
a. 50 mm (2 inches) and smaller: Cast steel 1035 kPa (150 psig), union bonnet with metal plug type disc.
b. 65 mm (2-1/2 inches) and larger:
1) Angle valves for high pressure steam 110 kPa (16 psig): Cast steel body, ASTM A216/A216M grade WCB, flanged, OS&Y, 1035 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
2) All other services: 861 kPa (125 psig), flanged, cast steel body, and bronze trim.

F. Swing Check Valves:
1. 50 mm (2 inches) and smaller: Cast steel, 1035 kPa (150 psig), 45-degree swing disc.
2. 65 mm (2-1/2 inches) and Larger:
a. Check valves for high pressure steam 110 kPa (16 psig) and above system: Cast steel body, ASTM A216/A216M grade WCB, flanged, OS&Y, 1035 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
b. All other services: 861 kPa (125 psig), flanged, cast steel body, and bronze trim.

2.6 PIPE ALIGNMENT

A. Guides: Provide factory-built guides along the pipe line to permit axial movement only and to restrain lateral and angular movement. Guides shall be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed in the contract documents.

2.7 EXPANSION JOINTS

A. Factory built devices, inserted in the pipe lines, designed to absorb axial cyclical pipe movement which results from thermal expansion and contraction. This includes factory-built or field-fabricated guides located along the pipe lines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.

B. Minimum Service Requirements:
   1. Pressure Containment:
      a. Steam Service 35-200 kPa (5-29 psig): Rated 345 kPa (50 psig) at 148 degrees C (298 degrees F).
      b. Steam Service 214-850 kPa (31-123 psig): Rated 1035 kPa (150 psig) at 186 degrees C (366 degrees F).
      c. Steam Service 869-1035 kPa (126-150 psig): Rated 1380 kPa (200 psig) at 194 degrees C (381 degrees F).
      d. Condensate Service: Rated 690 kPa (100 psig) at 154 degrees C (309 degrees F).
   2. Number of Full Reverse Cycles without failure: Minimum 1000.
   3. Movement: As shown on contract documents plus recommended safety factor of manufacturer.

C. Manufacturing Quality Assurance: Conform to Expansion Joints Manufacturers Association Standards.

D. Bellows - Internally Pressurized Type:
   1. Multiple corrugations of Type 304 or Type A240-321 stainless steel.
   2. Internal stainless-steel sleeve entire length of bellows.
   3. External cast iron equalizing rings for services exceeding 345 kPa (50 psig).
   4. Welded ends.
   5. Design shall conform to standards of EJMA and ASME B31.1.
   6. External tie rods designed to withstand pressure thrust force upon anchor failure if one or both anchors for the joint are at change in direction of pipeline.
   7. Integral external cover.

E. Bellows - Externally Pressurized Type:
   1. Multiple corrugations of Type 304 stainless steel.
   2. Internal and external guide integral with joint.
   3. Design for external pressurization of bellows to eliminate squirm.
   4. Welded ends.
   5. Conform to the standards of EJMA and ASME B31.1.
   6. Threaded connection at bottom, 25 mm (1 inch) minimum, for drain or drip point.
   7. Integral external cover and internal sleeve.

F. Expansion Joint Identification: Provide stamped brass or stainless-steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and temperature, date of manufacture, and identifying the expansion joint by the identification number in the contract documents.

2.8 FLEXIBLE BALL JOINTS

A. Design and Fabrication: One-piece component construction, fabricated from steel with welded ends, designed for a working steam pressure of 1725 kPa (250 psig) and a temperature of 232 degrees C (450 degrees F). Each joint shall provide for 360 degrees rotation in addition to a minimum angular flexible movement of 30 degrees for sizes 6 mm (1/4 inch) to 150 mm (6 inch) inclusive, and 15 degrees for sizes 65 mm (2-1/2 inches) to 762 mm (30 inches). Joints through 355 mm (14 inches) shall have forged pressure retaining members, while size 406 mm (16 inches) through 762 mm (30 inches) shall be of one-piece construction.

B. Material:

1. Cast or forged steel pressure containing parts and bolting in accordance with ASME BPVC Section II or ASME B31.1. Retainer may be ductile iron ASTM A536, Grade 65-45-12, or ASME BPVC Section II SA 515, Grade 70.
2. Gaskets: Steam pressure molded composition design for a temperature range of from minus 10 degrees C (50 degrees F) to plus 274 degrees C (525 degrees F).

C. Certificates: Submit qualifications of ball joints in accordance with the following test data:

1. Low pressure leakage test: 41 kPa (6 psig) saturated steam for 60 days.
2. Flex cycling: 800 Flex cycles at 3447 kPa (500 psig) saturated steam.
3. Thermal cycling: 100 saturated steam pressure cycles from atmospheric pressure to operating pressure and back to atmospheric pressure.
4. Environmental shock tests: Forward certificate from a recognized test laboratory, that ball joints of the type submitted has passed shock testing in accordance with Mil. Spec MIL-S-901.
5. Vibration: 170 hours on each of three mutually perpendicular axes at 25 to 125 Hz; 1.3 mm to 2.5 mm (0.05 inch to 0.10 inch) double amplitude on a single ball joint and 3 ball joint off set.

2.9 STEAM SYSTEM COMPONENTS

A. Where removal and reinstallation is required to complete the work, take care to protect existing components for reinstallation.

2.10 FIRESTOPPING MATERIAL

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

PART 3 - EXECUTION

3.1 GENERAL

A. If in the substantiated evaluation of the COR, the installation fails to meet the requirements of the construction documents with respect to function and maintainability, an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

B. The contract documents show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost or time to the Government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location in the contract documents shall be altered by contractor where necessary to avoid interferences and clearance difficulties.

C. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.

D. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Install convertors and other heat exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.

E. Install piping generally parallel to walls and column center lines, unless shown otherwise in the contract documents. Space piping, including insulation, to provide 25 mm (1 inch) minimum clearance between adjacent piping and another surface. Unless shown otherwise, slope steam, condensate and drain piping down in the direction of flow not less than 25 mm (1 inch) in 12 meter (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.

F. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally, locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown in the contract documents.

G. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted in the contract documents.

H. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.

I. Connect piping to equipment as shown in the contract documents. Install components furnished by others such as flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.

J. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC AND BOILER PLANT INSULATION.

K. Pipe vents to the exterior. Where a combined vent is provided, the cross-sectional area of the combined vent shall be equal to sum of individual vent areas. Slope vent piping 25 mm (1 inch) in 12 meter (40 feet) 0.25 percent in direction of flow. Provide a drip pan elbow on relief

valve outlets if the vent rises to prevent backpressure. Terminate vent minimum 300 mm (12 inches) above the roof or through the wall minimum 2.4 meter (8 feet) above grade with down turned elbow.

3.2 WELDING

A. The contractor is entirely responsible for the quality of the welding and shall:
   1. Conduct tests of the welding procedures used on the project, verify the suitability of the procedures used, verify that the welds made will meet the required tests, and also verify that the welding operators have the ability to make sound welds under standard conditions.
   2. Perform all welding operations required for construction and installation of the piping systems.

B. Beveling: Field bevels and shop bevels shall be done by mechanical means or by flame cutting. Where beveling is done by flame cutting, surfaces shall be thoroughly cleaned of scale and oxidation just prior to welding. Conform to specified standards.

C. Alignment: Provide approved welding method for joints on all pipes greater than 50 mm (2 inches) to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe.

D. Erection: Piping shall not be split, bent, flattened, or otherwise damaged before, during, or after installation. If the pipe temperature falls to 0 degrees C (32 degrees F) or lower, the pipe shall be heated to approximately 38 degrees C (100 degrees F) for a distance of 300 mm (1 foot) on each side of the weld before welding, and the weld shall be finished before the pipe cools to 0 degrees C (32 degrees F).

E. Non-Destructive Examination of Piping Welds:
   1. Perform radiographic examination of 50 percent of the first 10 welds made and 10 percent of all additional welds made. The COR reserves the right to identify individual welds for which the radiographic examination shall be performed. All welds shall be visually inspected by the COR. The VA reserves the right to require testing on additional welds up to 100 percent if greater than 25 percent of the examined welds fail the inspection.

F. Defective Welds: Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening are prohibited. Welders responsible for defective welds shall be requalified prior to resuming work on the project.

G. Electrodes: Electrodes shall be stored in a dry heated area and be kept free of moisture and dampness during the fabrication operations. Discard electrodes that have lost part of their coating.

3.3 PIPE JOINTS

A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1/B2.1M. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

B. Screwed: Threads shall conform to ASME B1.20.1; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.

C. 125 Pound Cast Steel Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast steel flange.

3.4 EXPANSION JOINTS (BELLOWS AND SLIP TYPE)

A. Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown. A professional engineer shall verify in writing that anchors and guides are properly designed for forces and moments which will be imposed.

B. Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.

C. Preparation for Service: Remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.

D. Access: Expansion joints shall be located in readily accessible space. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding packing.

3.5 STEAM TRAP PIPING

A. Install to permit gravity flow to the trap. Provide gravity flow (avoid lifting condensate) from the trap where modulating control valves are used. Support traps weighing over 11 kg (24 pounds) independently of connecting piping.

1. On pipe size 1-1/2 inch and greater a raised face flange is required to allow for removal of the steam trap without disturbing surrounding piping.
2. On pipe size less than 1-1/2inch raised face flanges or unions may be used to allow for removal of the traps.

3.6 LEAK TESTING

A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary to the satisfaction of the COR in accordance with the specified requirements. Testing shall be performed in accordance with the specification requirements.

B. An operating test at design pressure, and for hot systems, design maximum temperature.

C. A hydrostatic test at 1.5 times design pressure. For water systems, the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump

head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Avoid excessive pressure on mechanical seals and safety devices.

D. Prepare and submit test and inspection reports to the COR within 5 working days of test completion and prior to covering the pipe.

3.7 FLUSHING AND CLEANING PIPING SYSTEMS

A. Steam, Condensate and Vent Piping: The piping system shall be flushed clean prior to equipment connection. Cleaning includes pulling all strainer screens and cleaning all scale/dirt legs during startup operation. Contractor shall be responsible for damage caused by inadequately cleaned/flushed systems.

3.8 STARTUP AND TESTING

A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.

C. Adjust red set hand on pressure gauges to normal working pressure.

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SECTION 23 25 00
HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

B. This section specifies cleaning and treatment of circulating HVAC water systems, including the following.

1. Cleaning compounds.
2. Chemical treatment for closed loop heat transfer systems.
4. Glycol-water heat transfer systems.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

D. Section 23 21 13, HYDRONIC PIPING.

E. Section 23 22 13, STEAM and CONDENSATE HEATING PIPING.

1.3 APPLICABLE PUBLICATIONS

A. The publication listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standards will govern.

B. American Society for Testing and Materials (ASTM):

A666-2015 ..... Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

C. National Fire Protection Association (NFPA):

70-2020..... National Electric Code (NEC)

1.4 SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Information and material submitted under this section shall be marked “SUBMITTED UNDER SECTION 23 25 00, HVAC WATER TREATMENT”, with applicable paragraph identification.

C. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.

1. Cleaning compounds and recommended procedures for their use.
2. Chemical treatment for closed systems, including installation and operating instructions.
3. Glycol-water system materials, equipment, and installation.

D. Water analysis verification.

E. Materials Safety Data Sheet for all proposed chemical compounds, based on U.S. Department of Labor Form No. L5B-005-4.

F. Complete operating and maintenance manuals including technical data sheets, information for ordering replaceable parts, and troubleshooting guide:

1. Include complete list indicating all components of the systems.

1.5 QUALITY ASSURANCE

A. Refer to paragraph QUALITY ASSURANCE in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

B. Technical Services: Provide the services of an experienced water treatment chemical engineer or technical representative to direct flushing, cleaning, pre-treatment, training, debugging, and acceptance testing operations; direct and perform chemical limit control during construction period and monitor systems for a period of 12 months after acceptance, including not less than 6 service calls and written status reports. Emergency calls are not included. Minimum service during construction/startup shall be 6 hours.

C. Chemicals: Chemicals shall be non-toxic approved by local authorities and meeting applicable EPA requirements.

D. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specification section. For more information regarding the product categories covered by the Bio-Preferred Program, visit http://www.biopreferred.gov.

1.6 AS-BUILT DOCUMENTATION

A. Comply with requirements in paragraph AS-BUILT DOCUMENTATION of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

PART 2 - PRODUCTS

2.1 CLEANING COMPOUNDS

A. Alkaline phosphate or non-phosphate detergent/surfactant/specific to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals without deleterious effects.

B. All chemicals to be acceptable for discharge to sanitary sewer.

C. Refer to Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING, PART 3, for flushing and cleaning procedures.

2.2 CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS

A. Inhibitor: Provide sodium nitrite/borate, molybdate-based inhibitor or other approved compound suitable for make-up quality and make-up rate and which will cause or enhance

bacteria/corrosion problems or mechanical seal failure due to excessive total dissolved solids. Shot feed manually. Maintain inhibitor residual as determined by water treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.

B. pH Control: Inhibitor formulation shall include adequate buffer to maintain pH range of 8.0 to 10.5.

C. Performance: Protect various wetted, coupled, materials of construction including ferrous, red and yellow metals. Maintain system essentially free of scale, corrosion, and fouling. Corrosion rate of following metals shall not exceed specified mills per year penetration; ferrous, 0-2; brass, 0-1; copper, 0-1. Inhibitor shall be stable at equipment skin surface temperatures and bulk water temperatures of not less than 121 degrees C (250-degrees F) and 52-degrees C (125-degrees F) respectively. Heat exchanger fouling and capacity reduction shall not exceed that allowed by fouling factor 0.0005.

D. Pot Feeder: Bypass type, complete with necessary shutoff valves, drain and air release valves, and system connections, for introducing chemicals into system, cast-iron or steel tank with funnel or large opening on top for easy chemical addition. Feeders shall be 18.9 L (5 gallon) minimum capacity at 860 kPa (125 psig) minimum working pressure.

E. Side Stream Water Filter for Closed Loop Systems: Stainless-steel housing, and polypropylene filter media with stainless-steel core. Filter media shall be compatible with antifreeze and water treatment chemicals used in the system. Replaceable filter cartridges for sediment removal service with minimum 20 micrometer particulate at 98 percent efficiency for approximately 5 percent of system design flow rate. Filter cartridge shall have a maximum pressure drop of 13.8 kPa (2 psig) at design flow rate when clean, and maximum pressure drop of 172 kPa (25 psig) when dirty. A constant flow rate valve shall be provided in the piping to the filter. Inlet and outlet pressure gauges shall be provided to monitor filter condition.

2.3 GLYCOL-WATER SYSTEM

A. Propylene glycol shall be inhibited with 1.75 percent dipotassium phosphate. Do not use automotive antifreeze because the inhibitors used are not needed and can cause sludge precipitate that interferes with heat transfer.

B. Provide required amount of glycol to obtain the percent by volume for glycol-water systems as follows and to provide 1/2 tank reserve supply: 30 percent for chilled water system.

C. Pot Feeder Make-up Unit: Bypass type for chemical treatment, schedule 3.5 mm (10 gauge) heads, 19 mm (3/4 inch) system connections and large neck opening for chemical addition. Feeders shall be 18.9 L (5 gallon) minimum size.

2.4 EQUIPMENT AND MATERIALS IDENTIFICATION

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

PART 3 - EXECUTION

3.1 INSTALLATION

A. If an installation is unsatisfactory to the COR, the contractor shall correct the installation at no additional cost or time to the Government.

B. Delivery and Storage: Deliver all chemicals in manufacturer's sealed shipping containers. Store in designated space and protect from deleterious exposure and hazardous spills.

C. Install equipment furnished by the chemical treatment supplier and charge systems according to the manufacturer's instructions and as directed by the Technical Representative.

D. Refer to Section 23 21 13, HYDRONIC PIPING for chemical treatment piping, where required to be replaced to complete the work, installed as follows:

1. Provide a bypass line around water meters and bleed off piping assembly. Provide ball valves to allow for bypassing, isolation, and servicing of components.
2. Bleed off water piping with bleed off piping assembly shall be piped from pressure side of circulating water piping to a convenient drain. Bleed off connection to main circulating water piping shall be upstream of chemical injection nozzles.
3. Provide piping for the flow assembly piping to the main control panel and accessories.
    a. The inlet piping shall connect to the discharge side of the circulating water pump.
    b. The outlet piping shall connect to the water piping serving the cooling tower downstream of the heat source.
    c. Provide inlet Y-strainer and ball valves to isolate and service main control panel and accessories.
4. Install injection nozzles with corporation stops in the water piping serving the cooling tower downstream of the heat source.
5. Provide piping for corrosion monitor rack per manufacturer’s installation instructions. Provide ball valves to isolate and service rack.

E. Before adding cleaning chemical to the closed system, all air handling coils and fan coil units shall be isolated by closing the inlet and outlet valves and opening the bypass valves. This is done to prevent dirt and solids from lodging the coils.

F. Do not valve in or operate system pumps until after system has been cleaned.

G. After chemical cleaning is satisfactorily completed, open the inlet and outlet valves to each coil and close the bypass valves. Also, clean all strainers.

H. Perform tests and report results in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

I. After cleaning is complete, and water pH is acceptable to manufacturer of water treatment chemical, add manufacturer recommended amount of chemicals to systems.

3.2 STARTUP AND TESTING

A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.

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SECTION 26 05 11
REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section applies to all sections of Division 26.

B. This Project includes, but is not limited to:

1. Disconnection and removal of existing equipment, conduit, conductors, cabling, supports, and other electrical associated with removal, replacement, and/or repair of structural components.
2. Installation of removed electrical work, removal of temporary supports and wiring, and making final electrical connections to ensure continuity and proper operation of electrical equipment and devices affected by repair work.
3. Coordination with structural, architectural, and mechanical Work.
4. Field verification and tracing of electrical circuits and feeders, as required. Field verification by this contractor shall be performed to prepare for: electrical demolition; temporary support of electrical equipment, raceways, boxes, conductors, and devices; and installation of existing and new electrical as required. Furnish and install electrical systems, materials, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, conductors and cable, switchboards, switchgear, panelboards, motor control centers, generators, automatic transfer switches, and other items and arrangements for the specified items are shown on the drawings.

C. Conductor ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways sized per NEC. Aluminum conductors are prohibited.

1.2 MINIMUM REQUIREMENTS

A. The latest International Building Code (IBC), Underwriters Laboratories, Inc. (UL), Institute of Electrical and Electronics Engineers (IEEE), and National Fire Protection Association (NFPA) codes and standards are the minimum requirements for materials and installation.

B. The drawings and specifications shall govern in those instances where requirements are greater than those stated in the above codes and standards.

1.3 TEST STANDARDS

A. All materials and equipment shall be listed, labeled, or certified by a Nationally Recognized Testing Laboratory (NRTL) to meet Underwriters Laboratories, Inc. (UL), standards where test standards have been established. Materials and equipment which are not covered by UL standards will be accepted, providing that materials and equipment are listed, labeled, certified or otherwise determined to meet the safety requirements of a NRTL. Materials and equipment which no NRTL accepts, certifies, lists, labels, or determines to be safe, will be

considered if inspected or tested in accordance with national industrial standards, such as ANSI, NEMA, and NETA. Evidence of compliance shall include certified test reports and definitive shop drawings.

B. Definitions:

1. Listed: Materials and equipment included in a list published by an organization that is acceptable to the Authority Having Jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production or listed materials and equipment or periodic evaluation of services, and whose listing states that the materials and equipment either meets appropriate designated standards or has been tested and found suitable for a specified purpose.
2. Labeled: Materials and equipment to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the Authority Having Jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled materials and equipment, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
3. Certified: Materials and equipment which:
   a. Have been tested and found by a NRTL to meet nationally recognized standards or to be safe for use in a specified manner.
   b. Are periodically inspected by a NRTL.
   c. Bear a label, tag, or other record of certification.
4. Nationally Recognized Testing Laboratory: Testing laboratory which is recognized and approved by the Secretary of Labor in accordance with OSHA regulations.

1.4 APPLICABLE PUBLICATIONS

A. Applicable publications listed in all Sections of Division 26 shall be the latest issue, unless otherwise noted.

B. Products specified in all sections of Division 26 shall comply with the applicable publications listed in each section.

1.5 MANUFACTURED PRODUCTS

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, and for which replacement parts shall be available. Materials and equipment furnished shall be new, and shall have superior quality and freshness.

B. When more than one unit of the same class or type of materials and equipment is required, such units shall be the product of a single manufacturer.

C. Equipment Assemblies and Components:

1. Components of an assembled unit need not be products of the same manufacturer.

2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
3. Components shall be compatible with each other and with the total assembly for the intended service.
4. Constituent parts which are similar shall be the product of a single manufacturer.

D. Factory wiring and terminals shall be identified on the equipment being furnished and on all wiring diagrams.

E. When Factory Tests are specified, Factory Tests shall be performed in the factory by the equipment manufacturer, and witnessed by the contractor. In addition, the following requirements shall be complied with:

1. The Government shall have the option of witnessing factory tests. The Contractor shall notify the Government through the COR a minimum of thirty (30) days prior to the manufacturer's performing of the factory tests.
2. When factory tests are successful, contractor shall furnish four (4) copies of the equipment manufacturer's certified test reports to the COR fourteen (14) days prior to shipment of the equipment, and not more than ninety (90) days after completion of the factory tests.
3. When factory tests are not successful, factory tests shall be repeated in the factory by the equipment manufacturer, and witnessed by the Contractor. The Contractor shall be liable for all additional expenses for the Government to witness factory re-testing.

1.6 VARIATIONS FROM CONTRACT REQUIREMENTS

A. Where the Government or the Contractor requests variations from the contract requirements, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.7 MATERIALS AND EQUIPMENT PROTECTION

A. Materials and equipment shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold, freeze and rain.

1. Store materials and equipment indoors in clean dry space with uniform temperature to prevent condensation.
2. During installation, equipment shall be protected against entry of foreign matter, and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
3. Damaged equipment shall be repaired or replaced, as determined by the COR.
4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.

5. Damaged paint on equipment shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.8 WORK PERFORMANCE

A. All electrical work shall comply with requirements of the latest NFPA 70 (NEC), NFPA 70B, NFPA 70E, NFPA 99, NFPA 110, NFPA 780, OSHA Part 1910 subpart J – General Environmental Controls, OSHA Part 1910 subpart K – Medical and First Aid, and OSHA Part 1910 subpart S – Electrical, in addition to other references required by contract.

B. Job site safety and worker safety is the responsibility of the Contractor.

C. Electrical work shall be accomplished with all affected circuits or equipment de-energized. However, energized electrical work may be performed only for the non-destructive and non-invasive diagnostic testing(s), or when scheduled outage poses an imminent hazard to patient care, safety, or physical security. In such case, all aspects of energized electrical work, such as the availability of appropriate/correct personal protective equipment (PPE) and the use of PPE, shall comply with the latest NFPA 70E, as well as the following requirements:

1. Only Qualified Person(s) shall perform energized electrical work. Supervisor of Qualified Person(s) shall witness the work of its entirety to ensure compliance with safety requirements and approved work plan.
2. At least two weeks before initiating any energized electrical work, the Contractor and the Qualified Person(s) who is designated to perform the work shall visually inspect, verify and confirm that the work area and electrical equipment can safely accommodate the work involved.
3. At least two weeks before initiating any energized electrical work, the Contractor shall develop and submit a job specific work plan, and energized electrical work request to the COR, and Medical Center’s Chief Engineer or his/her designee. At the minimum, the work plan must include relevant information such as proposed work schedule, area of work, description of work, name(s) of Supervisor and Qualified Person(s) performing the work, equipment to be used, procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used, and exit pathways.
4. Energized electrical work shall begin only after the Contractor has obtained written approval of the work plan, and the energized electrical work request from the COR, and Medical Center’s Chief Engineer or his/her designee. The Contractor shall make these approved documents present and available at the time and place of energized electrical work.
5. Energized electrical work shall begin only after the Contractor has invited and received acknowledgment from the COR, and Medical Center’s Chief Engineer or his/her designee to witness the work.

D. For work that affects existing electrical systems, arrange, phase and perform work to assure minimal interference with normal functioning of the facility. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.

E. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.

F. Coordinate location of equipment and conduit with other trades to minimize interference.

1.9 EQUIPMENT INSTALLATION AND REQUIREMENTS

A. Equipment location shall be as close as practical to locations shown on the drawings.

B. Working spaces or working clearances shall comply with NEC's requirements, at a minimum.

C. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not readily accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
2. "Readily accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

D. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system, and obtain electric utility company approval for sizes and settings of these devices.

1.10 SUBMITTALS

A. Submit to the COR in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. The Government's approval shall be obtained for all materials and equipment before delivery to the job site. Delivery, storage or installation of materials and equipment which has not had prior approval will not be permitted.

C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings, test reports, certifications, samples, and other data necessary for the Government to ascertain that the proposed materials and equipment comply with drawing and specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify specific materials and equipment being submitted.

D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.

1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
3. Submit each section separately.

E. The submittals shall include the following:

1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, manuals, pictures, nameplate data, and test reports as required.
2. Elementary and interconnection wiring diagrams for communication and signal systems, control systems, and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
3. Parts list which shall include information for replacement parts and ordering instructions, as recommended by the equipment manufacturer.

F. Maintenance and Operation Manuals:

1. Submit as required for systems and equipment specified in the technical sections. Furnish in hardcover binders or an approved equivalent.
2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, material, equipment, building, name of Contractor, and contract name and number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the material or equipment.
3. Provide a table of contents and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
4. The manuals shall include:
    a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
    b. A control sequence describing start-up, operation, and shutdown.
    c. Description of the function of each principal item of equipment.
    d. Installation instructions.
    e. Safety precautions for operation and maintenance.
    f. Diagrams and illustrations.
    g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers.
    h. Performance data.

i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare and replacement parts, and name of servicing organization.

j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.

G. Approvals will be based on complete submission of shop drawings, manuals, test reports, certifications, and samples as applicable.

H. After approval and prior to installation, furnish the COR with one sample of each of the following:

1. A minimum 300 mm (12 inches) length of each type and size of wire and cable along with the tag from the coils or reels from which the sample was taken. The length of the sample shall be sufficient to show all markings provided by the manufacturer.
2. Each type of conduit coupling, bushing, and termination fitting.
3. Conduit hangers, clamps, and supports.
4. Each type of receptacle, toggle switch, lighting control sensor, outlet box, manual motor starter, device wall plate, engraved nameplate, wire and cable splicing and terminating material, and branch circuit single pole molded case circuit breaker.

1.11 SINGULAR NUMBER

A. Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.12 ACCEPTANCE CHECKS AND TESTS

A. The Contractor shall furnish the instruments, materials, and labor for tests.

B. Where systems are comprised of components specified in more than one section of Division 26, the Contractor shall coordinate the installation, testing, and adjustment of all components between various manufacturer’s representatives and technicians so that a complete, functional, and operational system is delivered to the Government.

C. When test results indicate any defects, the Contractor shall repair or replace the defective materials or equipment, and repeat the tests for the equipment. Repair, replacement, and re-testing shall be accomplished at no additional cost to the Government.

1.13 WARRANTY

A. All work performed and all equipment and material furnished under this Division shall be free from defects and shall remain so for a period of one year from the date of acceptance of the entire installation by the Contracting Officer for the Government.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

---END---

SECTION 26 05 12
ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electrical demolition.

1.2 RELATED REQUIREMENTS

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 02 41 00, DEMOLITION.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Demolition drawings are based on casual field observation and existing record documents.

B. Report discrepancies to COR before disturbing existing installation.

C. Beginning of demolition Work means installer accepts existing conditions.

3.2 PREPARATION

A. Review lockout/tagout (LOTO) requirements and procedures per Specification Section 01 00 00, GENERAL REQUIREMENTS.

B. Trace existing electrical circuits to determine panelboard and circuit numbers for all electrical devices, lighting fixtures, and electrical equipment in areas requiring demolition or temporary removal.

C. Disconnect electrical systems in or on walls, floors, and ceilings to be removed.

D. Coordinate utility service outages with COR per Specification Section 01 00 00, GENERAL REQUIREMENTS.

E. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

F. Coordinate demolition and construction phasing to ensure existing services in areas adjacent to work area are maintained throughout the Project.

G. Existing Electrical Service: Maintain existing system in service until new system or extension to existing system is complete and ready for to be placed in service. Disable system only to make switchovers and connections. Minimize outage duration.

1. Obtain permission from COR at least 15 days before partially or completely disabling system. See also Specifications Section 01 00 00, GENERAL REQUIREMENTS and 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS for additional requirements.

a. Contractor must submit a written request to the COR for permission of any downtime. Contractor can only proceed with the downtime after receipt of written approval from the Hospital Director through the COR.

2. Make temporary connections to maintain service in areas adjacent to work area.
3. Coordinate demolition and construction phasing to ensure existing services in areas adjacent to work area are maintained throughout the Project.
4. Provide temporary construction lighting in areas where existing lighting is de-energized and/or removed as part of construction work. Remove temporary lighting after new lighting is installed or after existing lighting is placed back in service.

H. Existing Fire Alarm System: Maintain existing system in service at all times, except for approved temporary outages. Disable system only to make switchovers and connections. Minimize outage duration.

1. Notify COR before partially or completely disabling system.
2. Notify local fire service.
3. Make notifications at least 15 days in advance.
4. Make temporary connections to maintain service in areas adjacent to work area.
5. Coordinate with the COR to implement a plan for protection of existing fire alarm devices during demolition and construction activities and for removal of device protection during times when there is no construction activity.
6. Disconnect existing devices affected by demolition and construction, provide temporary devices and cabling as necessary to protect areas during demolition and construction, and install existing devices in new ceilings in approximate locations that existing devices were located previously, and remove temporary devices and cabling after existing devices are installed. Field verify quantity of devices affected by structural, ceiling and wall demolition prior to bidding.

I. Existing Nurse Call System: There are no nurse call devices in areas of this Project, but there may be devices and equipment in other areas of the building. Maintain existing system in service at all times, except for approved temporary outages. Disable system only to make switchovers and connections. Minimize outage duration.

1. Notify COR before partially or completely disabling system.
2. Notify local VA biomedical department.
3. Make notifications at least 15 days in advance.
4. Make temporary connections to maintain service in areas adjacent to work area.

J. Existing Safety and Security System: Maintain existing system in service at all times, except for approved temporary outages. Disable system only to make switchovers and connections. Minimize outage duration.

1. Notify COR before partially or completely disabling system.

2. Notify local VA Security Department.
3. Make notifications at least 15 days in advance.
4. Make temporary connections to maintain service in areas adjacent to work area.

K. Public Address Speakers and System: Maintain existing system in service at all times, except for approved temporary outages. Provide temporary support of existing devices in ceilings that are to be demolished. Install existing devices and backboxes in new ceilings, remove temporary supports, and ensure devices are connected to existing system.

L. Existing wireless devices: Maintain existing system in service at all times, except for approved temporary outages. Disable system only to make switchovers and connections. Minimize outage duration.

1. Temporarily support and protect existing devices and cabling during demolition and construction.
2. Install existing devices in new or existing ceilings or structure, remove temporary supports, and ensure existing system is operational.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, relocate, and extend existing installations to accommodate structural repair work and new construction.

B. Salvage and maintain fire alarm devices for reinstallation in new construction. Turn over unused devices to Government.

C. Protect and maintain existing electrical, systems, and electronic safety and security circuits passing through areas of demolition and new construction.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

F. Disconnect and remove luminaires where indicated. Remove brackets, stems, hangers, and other accessories.

G. Repair adjacent construction and finishes damaged during demolition and extension work.

H. Provide temporary support of electrical equipment, raceways, lighting, and other electrical and communications systems to accommodate structural repair. Provide permanent support for electrical items after repairs are complete.

I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

K. Removal: Remove demolished material from the Project site.

L. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

M. Salvaged equipment: Remove and store. Clean, re-lamp, and reinstall if required, otherwise, turn over to owner at end of project.

N. Dispose of Fluorescent lamps, H.I.D. lamps, and ballasts containing PCB'S in accordance with the applicable laws pertaining to the disposal of hazardous waste.

3.4 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or that are to be reused.

- - - END - - -

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of the electrical conductors and cables for use in electrical systems rated 600 V and below, indicated as cable(s), conductor(s), wire, or wiring in this section.

1.2 RELATED WORK

A. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire-resistant rated construction.

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for conductors and cables.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
    a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    b. Submit the following data for approval:
        1) Electrical ratings and insulation type for each conductor and cable.
        2) Splicing materials and pulling lubricant.
2. Certifications: Two weeks prior to final inspection, submit the following.
    a. Certification by the manufacturer that the conductors and cables conform to the requirements of the drawings and specifications.
    b. Certification by the Contractor that the conductors and cables have been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.

B. American Society of Testing Material (ASTM):

D2301-10 ..... Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

D2304-18 ..... Test Method for Thermal Endurance of Rigid Electrical Insulating Materials

D3005-17 ..... Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

C. National Electrical Manufacturers Association (NEMA):

WC 70-21..... Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy

D. National Fire Protection Association (NFPA):

70-23..... National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):

44-18..... Thermoset-Insulated Wires and Cables

83-17..... Thermoplastic-Insulated Wires and Cables

467-13..... Grounding and Bonding Equipment

486A-486B-18 ..... Wire Connectors

486C-18 ..... Splicing Wire Connectors

486D-15 ..... Sealed Wire Connector Systems

486E-15 ..... Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

493-18..... Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables

514B-12 ..... Conduit, Tubing, and Cable Fittings

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Conductors and cables shall be in accordance with ASTM, NEMA, NFPA, UL, as specified herein, and as shown on the drawings.

B. Conductors shall be copper.

C. Single Conductor:

1. No. 12 AWG: Minimum size, except where smaller sizes are specified herein or shown on the drawings.
2. No. 8 AWG and larger: Stranded.

3. No. 10 AWG and smaller: Solid; except shall be stranded for final connection to motors, transformers, and vibrating equipment.
4. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.

D. Conductor Color Code:

1. No. 10 AWG and smaller: Solid color insulation or solid color coating.
2. No. 8 AWG and larger: Color-coded using one of the following methods:
   a. Solid color insulation or solid color coating.
   b. Stripes, bands, or hash marks of color specified.
   c. Color using 19 mm (0.75 inches) wide tape.
3. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
   a. Conductors shall be color-coded as follows:

208/120 V	Phase	480/277 V
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray *
* or white with colored (other than green) tracer.		

   b. Lighting circuit “switch legs” shall have pink color coding, and 3-way and 4-way switch “traveling wires” shall have purple color coding, that is unique and distinct from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC. Verify color coding in the field with the COR.
   c. Color code for isolated power system wiring shall be in accordance with the NEC.

2.2 SPLICES

A. Splices shall be in accordance with NEC and UL.

B. Above Ground Splices for No. 10 AWG and Smaller:

1. Solderless, screw-on, reusable pressure cable type, with integral insulation, approved for copper and aluminum conductors.
2. The integral insulator shall have a skirt to completely cover the stripped conductors.
3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.

C. Above Ground Splices for No. 8 AWG to No. 4/0 AWG:

1. Compression, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.

2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
3. Splice and insulation shall be product of the same manufacturer.
4. All bolts, nuts, and washers used with splices shall be zinc-plated or cadmium-plated steel.

D. Above Ground Splices for 250 kcmil and Larger:
1. Long barrel “butt-splice” or “sleeve” type compression connectors, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.
2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
3. Splice and insulation shall be product of the same manufacturer.

2.3 CONNECTORS AND TERMINATIONS

A. Mechanical type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.

B. Long barrel compression type of high conductivity and corrosion-resistant material, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.

C. All bolts, nuts, and washers used to connect connections and terminations to bus bars or other termination points shall be zinc-plated steel.

2.4 CONTROL WIRING

A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified herein, except that the minimum size shall be not less than No. 14 AWG, or as required by the control wiring equipment manufacturer.

B. Control wiring shall be sized such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

2.5 WIRE LUBRICATING COMPOUND

A. Lubricating compound shall be suitable for the wire insulation and conduit, and shall not harden or become adhesive.

B. Shall not be used on conductors for isolated power systems.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer’s instructions.

B. Install conductors in raceway systems.

C. Splice conductors only in outlet boxes, junction boxes, pullboxes, manholes, or handholes.

D. Conductors of different systems (e.g., 120 V and 277 V) shall not be installed in the same raceway.

E. For conductors installed in vertical raceways, provide conductor support (also known as cable support), to counter gravity pull on conductor weight. Conductor support shall be split-wedge conductor support type. Prior to installing the conductor support plug, remove all pulling compound from conductors where they pass through the conductor support body. After installing the conductor support plug, tap the conductor support plug firmly in the conductor support body.

F. In panelboards, cabinets, wireways, switches, enclosures, and equipment assemblies, neatly form, train, and tie the conductors with non-metallic “zip” ties.

G. For connections to motors, transformers, and vibrating equipment, stranded conductors shall be used only from the last fixed point of connection to the motors, transformers, or vibrating equipment.

H. Conductor Pulling:

1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling. Use lubricants approved for the cable.
2. Use nonmetallic pull ropes.
3. Attach pull ropes by means of either woven basket grips or pulling eyes attached directly to the conductors.
4. All conductors in a single conduit shall be pulled simultaneously.
5. Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.

I. Number of conductors for branch circuits shall not exceed more than three branch circuits in any one conduit.

J. When stripping stranded conductors, use a tool that does not damage the conductor or remove conductor strands.

3.2 SPLICE AND TERMINATION INSTALLATION

A. Splices and terminations shall be mechanically and electrically secure, and tightened to manufacturer’s published torque values using a torque screwdriver or wrench.

B. Where the Government determines that unsatisfactory splices or terminations have been installed, replace the splices or terminations at no additional cost to the Government.

3.3 CONDUCTOR IDENTIFICATION

A. When using colored tape to identify phase, neutral, and ground conductors larger than No. 8 AWG, apply tape in half-overlapping turns for a minimum of 75 mm (3 inches) from terminal points, and in junction boxes, pullboxes, and manholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where markings are covered by tape, apply tags to conductors, stating size and insulation type.

3.4 FEEDER CONDUCTOR IDENTIFICATION

A. In each interior pullbox, install brass tags on all feeder conductors to clearly designate their circuit identification and voltage. The tags shall be the embossed type, 40 mm (1-1/2 inches) in diameter and 40 mils thick. Attach tags with plastic ties.

3.5 EXISTING CONDUCTORS

A. Unless specifically indicated on the plans, existing conductors shall not be reused.

3.6 CONTROL WIRING INSTALLATION

A. Unless otherwise specified in other sections, install control wiring and connect to equipment to perform the required functions as specified or as shown on the drawings.

B. Install a separate power supply circuit for each system, except where otherwise shown on the drawings.

3.7 CONTROL WIRING IDENTIFICATION

A. Install a permanent wire marker on each wire at each termination.

B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.

C. Wire markers shall retain their markings after cleaning.

3.8 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests: Inspect physical condition.
2. Electrical tests:
    a. After installation but before connection to utilization devices, such as fixtures, motors, or appliances, test conductors phase-to-phase and phase-to-ground resistance with an insulation resistance tester. Existing conductors to be reused shall also be tested.
    b. Applied voltage shall be 500 V DC for 300 V rated cable, and 1000 V DC for 600 V rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300 V rated cable and 100 megohms for 600 V rated cable.
    c. Perform phase rotation test on all three-phase circuits.

---END---

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of grounding and bonding equipment, indicated as grounding equipment in this section.

B. “Grounding electrode system” refers to grounding electrode conductors and all electrodes required or allowed by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.

C. The terms “connect” and “bond” are used interchangeably in this section and have the same meaning.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Test Reports:
   a. Two weeks prior to the final inspection, submit ground resistance field test reports to the COR.
2. Certifications:
   a. Certification by the Contractor that the grounding equipment has been properly installed and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. American Society for Testing and Materials (ASTM):

B1-13 ..... Standard Specification for Hard-Drawn Copper Wire

B3-13(R2018) ..... Standard Specification for Soft or Annealed Copper Wire

B8-11(R2017) ..... Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

81-12..... IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements

D. National Fire Protection Association (NFPA):

70-23..... National Electrical Code (NEC)

70E-21 ..... National Electrical Safety Code

99-21..... Health Care Facilities

E. Underwriters Laboratories, Inc. (UL):

44-18 ..... Thermoset-Insulated Wires and Cables

83-17 ..... Thermoplastic-Insulated Wires and Cables

467-13 ..... Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment grounding conductors shall be insulated stranded copper, except that sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be identified per NEC.

B. Bonding conductors shall be bare stranded copper, except that sizes No. 10 AWG and smaller shall be bare solid copper. Bonding conductors shall be stranded for final connection to motors, transformers, and vibrating equipment.

C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.

D. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer’s instructions.

B. Equipment Grounding: Metallic piping, building structural steel, electrical enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

A. Make grounding connections, which are normally buried or otherwise inaccessible, by exothermic weld.

3.3 RACEWAY

A. Conduit Systems:

1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
2. Non-metallic conduit systems, except non-metallic feeder conduits that carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment, shall contain an equipment grounding conductor.
3. Metallic conduit that only contains a grounding conductor, and is provided for its mechanical protection, shall be bonded to that conductor at the entrance and exit from the conduit.
4. Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a equipment grounding conductor to the equipment ground bus.

B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders, and all branch circuits.

C. Boxes, Cabinets, Enclosures, and Panelboards:

1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
2. Provide lugs in each box and enclosure for equipment grounding conductor termination.

D. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.

E. Ground lighting fixtures to the equipment grounding conductor of the wiring system. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

F. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

3.4 CORROSION INHIBITORS

A. When making grounding and bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.5 ACCEPTANCE CHECKS AND TESTS

A. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized or connected to the electric utility

company ground system, and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall.

B. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

---END---

SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes, to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.

B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

1.2 RELATED WORK

A. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.

B. Section 09 91 00, PAINTING: Identification and painting of conduit and other devices.

C. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Product Data:
   a. Raceway types and sizes.
   b. Conduit bodies, connectors and fittings.
   c. Junction and pull boxes, types and sizes.
2. Certifications: Two weeks prior to final inspection, submit the following:
   a. Certification by the manufacturer that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment conform to the requirements of the drawings and specifications.
   b. Certification by the Contractor that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment have been properly installed.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. National Electrical Manufacturers Association (NEMA):

C80.1-20 ..... Electrical Rigid Steel Conduit

C80.3-20 ..... Steel Electrical Metal Tubing

C80.6-18 ..... Electrical Intermediate Metal Conduit

FB1-14 ..... Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

FB2.10-21 ..... Selection and Installation Guidelines for Fittings for use with Non-Flexible Conduit or Tubing (Rigid Metal Conduit, Intermediate Metallic Conduit, and Electrical Metallic Tubing)

FB2.20-21 ..... Selection and Installation Guidelines for Fittings for use with Flexible Electrical Conduit and Cable

TC-2-20..... Electrical Polyvinyl Chloride (PVC) Tubing and Conduit

TC-3-21..... PVC Fittings for Use with Rigid PVC Conduit and Tubing

C. National Fire Protection Association (NFPA):

70-23..... National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):

1-05..... Flexible Metal Conduit

5-16..... Surface Metal Raceway and Fittings

6-07..... Electrical Rigid Metal Conduit - Steel

50-15..... Enclosures for Electrical Equipment

360-13..... Liquid-Tight Flexible Steel Conduit

467-13..... Grounding and Bonding Equipment

514A-13 ..... Metallic Outlet Boxes

514B-12 ..... Conduit, Tubing, and Cable Fittings

514C-14 ..... Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers

651-11..... Schedule 40 and 80 Rigid PVC Conduit and Fittings

651A-11 ..... Type EB and A Rigid PVC Conduit and HDPE Conduit

797-07..... Electrical Metallic Tubing

1242-06..... Electrical Intermediate Metal Conduit - Steel

PART 2 - PRODUCTS

2.1 MATERIAL

A. Conduit Size: In accordance with the NEC, but not less than 13 mm (0.5-inch) unless otherwise shown. Where permitted by the NEC, 13 mm (0.5-inch) flexible conduit may be used for tap connections to recessed lighting fixtures.

B. Conduit:

1. Size: In accordance with the NEC, but not less than 13 mm (0.5-inch).
2. Conduit color:
   a. Power conduits: manufacturer's standard galvanized finish.
   b. Fire alarm and fire protection: Use EMT with integral red finish the entire length of the conduit run.
   c. Low-voltage (telecom/data, building automation): Use EMT with integral blue finish for the entire length of the run.Rigid Steel Conduit (RMC): Shall conform to UL 6 and NEMA C80.1.
3. Rigid Intermediate Steel Conduit (IMC): Shall conform to UL 1242 and NEMA C80.6.
4. Electrical Metallic Tubing (EMT): Shall conform to UL 797 and NEMA C80.3. Maximum size not to exceed 105 mm (4 inches) and shall be permitted only with cable rated 600 V or less.
5. Flexible Metal Conduit: Shall conform to UL 1.
6. Liquid-tight Flexible Metal Conduit: Shall conform to UL 360.
7. Plastic Conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).

C. Conduit Fittings:

1. Rigid Steel and Intermediate Metallic Conduit Fittings:
   a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
   b. Standard threaded couplings, locknuts, bushings, conduit bodies, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
   c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
   d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
   e. Erickson (Union-Type) and Set Screw Type Couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.

f. Sealing Fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.

2. Electrical Metallic Tubing Fittings:
   a. Fittings and conduit bodies shall meet the requirements of UL 514B, NEMA C80.3, and NEMA FB1.
   b. Only steel or malleable iron materials are acceptable.
   c. Set Screw Couplings and Connectors: Use setscrews of case-hardened steel with hex head and cup point, to firmly seat in wall of conduit for positive grounding. Connector shall have insulated throat.
   d. Indent-type connectors or couplings are prohibited.
   e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
3. Flexible Metal Conduit Fittings:
   a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
   b. Clamp-type, with insulated throat.
4. Liquid-tight Flexible Metal Conduit Fittings:
   a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
   b. Only steel or malleable iron materials are acceptable.
   c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
5. Plastic Conduit Fittings: Fittings shall meet the requirements of UL 514C and NEMA TC3.
6. Expansion and Deflection Couplings:
   a. Conform to UL 467 and UL 514B.
   b. Accommodate a 19 mm (0.75-inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
   c. Include internal flexible metal braid, sized to guarantee conduit ground continuity and a low-impedance path for fault currents, in accordance with UL 467 and the NEC tables for equipment grounding conductors.
   d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.

D. Conduit Supports:
1. Parts and Hardware: Zinc-coat or provide equivalent corrosion protection.
2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.

3. Multiple Conduit (Trapeze) Hangers: Not less than 38 mm x 38 mm (1.5 x 1.5 inches), 12-gauge steel, cold-formed, lipped channels; with not less than 9 mm (0.375-inch) diameter steel hanger rods.
4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.

E. Outlet, Junction, and Pull Boxes:
1. Comply with UL-50 and UL-514A.
2. Rustproof cast metal where required by the NEC or shown on drawings.
3. Sheet Metal Boxes: Galvanized steel, except where shown on drawings.

PART 3 - EXECUTION

3.1 PENETRATIONS

A. Cutting or Holes:
1. Cut holes in advance where they should be placed in the structural elements, such as ribs or beams. Obtain the approval of the COR prior to drilling through structural elements.
2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammers, impact electric, hand, or manual hammer-type drills are not allowed, except when permitted by the COR where working space is limited.

B. Firestop: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal the gap around conduit to render it watertight, as specified in Section 07 92 00, JOINT SEALANTS.

3.2 INSTALLATION, GENERAL

A. In accordance with NEC, NEMA, UL, as shown on drawings, and as specified herein.

B. Raceway systems used for Essential Electrical Systems (EES) shall be entirely independent of other raceway systems.

C. Install conduit as follows:
1. In complete mechanically and electrically continuous runs before pulling in cables or wires.
2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.
3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new conduits.

4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
5. Cut conduits square, ream, remove burrs, and draw up tight.
6. Independently support conduit at 2.4 M (8 feet) on centers with specified materials and as shown on drawings.
7. Do not use suspended ceilings, suspended ceiling supporting members, lighting fixtures, other conduits, cable tray, boxes, piping, or ducts to support conduits and conduit runs.
8. Support within 300 mm (12 inches) of changes of direction, and within 300 mm (12 inches) of each enclosure to which connected.
9. Close ends of empty conduits with plugs or caps at the rough-in stage until wires are pulled in, to prevent entry of debris.
10. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid steel and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
11. Conduit bodies shall only be used for changes in direction, and shall not contain splices.

D. Conduit Bends:
1. Make bends with standard conduit bending machines.
2. Conduit hickey may be used for slight offsets and for straightening stubbed out conduits.
3. Bending of conduits with a pipe tee or vise is prohibited.

E. Layout and Homeruns:
1. Install conduit with wiring, including homeruns, as shown on drawings.
2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted and approved by the COR.

3.3 CONCEALED WORK INSTALLATION

A. In Concrete:
1. Conduit: Rigid steel, IMC, or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel, or vapor barriers.
2. Do not install conduit through beams or columns.
3. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
   a. Conduit outside diameter larger than one-third of the slab thickness is prohibited.
   b. Space between conduits in slabs: Approximately six conduit diameters apart, and one conduit diameter at conduit crossings.
   c. Install conduits approximately in the center of the slab so that there will be a minimum of 19 mm (0.75-inch) of concrete around the conduits.

4. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to ensure low resistance ground continuity through the conduits. Tightening setscrews with pliers is prohibited.

B. Above Furred or Suspended Ceilings and in Walls:

1. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits in the same system is prohibited.
2. Align and run conduit parallel or perpendicular to the building lines.
3. Connect recessed lighting fixtures to conduit runs with maximum 1.8 M (6 feet) of flexible metal conduit extending from a junction box to the fixture.
4. Tightening set screws with pliers is prohibited.
5. For conduits running through metal studs, limit field cut holes to no more than 70% of web depth. Spacing between holes shall be at least 457 mm (18 inches). Cuts or notches in flanges or return lips shall not be permitted.

3.4 EXPOSED WORK INSTALLATION

A. Unless otherwise indicated on drawings, exposed conduit is only permitted in mechanical and electrical rooms.

B. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits in the system is prohibited.

C. Align and run conduit parallel or perpendicular to the building lines.

D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.

E. Support horizontal or vertical runs at not over 2.4 M (8 feet) intervals.

F. Painting:

1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.
2. Paint all conduits containing cables rated over 600 V safety orange. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color. In addition, paint legends, using 50 mm (2 inch) high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 6 M (20 feet) intervals in between.

3.5 CORROSIVE LOCATIONS (BUILDING 7 SALT ROOM)

A. Use plastic conduit only.

3.6 WET OR DAMP LOCATIONS

A. Use rigid steel or IMC conduits unless as shown on drawings.

B. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.

3.7 MOTORS AND VIBRATING EQUIPMENT

A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.

B. Use liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside airstream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water.

C. Provide a green equipment grounding conductor with flexible and liquid-tight flexible metal conduit.

3.8 EXPANSION JOINTS

A. Conduits 75 mm (3 inch) and larger that are secured to the building structure on opposite sides of a building expansion joint require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.

B. Provide conduits smaller than 75 mm (3 inch) with junction boxes on both sides of the expansion joint. Connect flexible metal conduits to junction boxes with sufficient slack to produce a 125 mm (5 inch) vertical drop midway between the ends of the flexible metal conduit. Flexible metal conduit shall have a green insulated copper bonding jumper installed. In lieu of this flexible metal conduit, expansion and deflection couplings as specified above are acceptable.

C. Install expansion and deflection couplings where where raceway passes across building expansion joints or where existing expansion and/or deflection couplings are found in areas requiring temporary electrical support or connection associated with structural repairs.

3.9 CONDUIT SUPPORTS

A. Safe working load shall not exceed one-quarter of proof test load of fastening devices.

B. Use pipe straps or individual conduit hangers for supporting individual conduits.

C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and an additional 90 kg (200 lbs). Attach each conduit with U-bolts or other approved fasteners.

D. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.

E. Fasteners and Supports in Solid Masonry and Concrete:

1. Steel expansion anchors not less than 6 mm (0.25-inch) bolt size and not less than 28 mm (1.125 inch) in embedment.
2. Power set fasteners not less than 6 mm (0.25-inch) diameter with depth of penetration not less than 75 mm (3 inch).
3. Use vibration and shock-resistant anchors and fasteners for attaching to concrete ceilings.

F. Hollow Masonry: Toggle bolts.

G. Bolts supported only by plaster or gypsum wallboard are not acceptable.

H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.

J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.

K. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.

L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.10 BOX INSTALLATION

A. Boxes for Concealed Conduits:

1. Flush-mounted.
2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.

B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations or where more than the equivalent of 4-90 degree bends are necessary.

C. Locate pullboxes so that covers are accessible and easily removed. Coordinate locations with piping and ductwork where installed above ceilings.

D. Remove only knockouts as required. Plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

E. Outlet boxes mounted back-to-back in the same wall are prohibited. A minimum 600 mm (24 inch) center-to-center lateral spacing shall be maintained between boxes.

F. Flush-mounted wall or ceiling boxes shall be installed with raised covers so that the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.

G. Minimum size of outlet boxes for ground fault circuit interrupter (GFCI) receptacles is 100 mm (4 inches) square x 55 mm (2.125 inches) deep, with device covers for the wall material and thickness involved.

H. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "ELECTRICAL PB No. 1."

I. On all existing and new branch circuit junction box covers where electrical circuit tracing is required as part of electrical work associated with structural repairs, identify the circuits with black permanent marker.

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SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of the interior lighting systems. The terms “lighting fixture,” “fixture,” and “luminaire” are used interchangeably.

1.2 RELATED WORK

A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Disposal of lamps.

B. Section 02 41 00, DEMOLITION: Removal and disposal of lamps and ballasts.

C. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

D. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.

E. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Shop Drawings:
    a. Submit the following information for each type of lighting fixture designated on the drawings, arranged in order of lighting fixture designation.
    b. Material and construction details, include information on housing and optics system.
    c. Physical dimensions and description.
    d. Wiring schematic and connection diagram.
    e. Installation details.
    f. Energy efficiency data.
    g. Photometric data based on laboratory tests complying with IES Lighting Measurements testing and calculation guides.
    h. Lamp data including lumen output (initial and mean), color rendition index (CRI), rated life (hours), and color temperature (degrees Kelvin).
    i. Ballast data including ballast type, starting method, ambient temperature, ballast factor, sound rating, system watts, and total harmonic distortion (THD).

j. For LED lighting fixtures, submit US DOE LED Lighting Facts label, and IES L70 rated life.

2. Manuals:
   a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
   b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
   a. Certification by the Contractor that the interior lighting systems have been properly installed and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. Environmental Protection Agency (EPA):
40 CFR 261-21 ..... Identification and Listing of Hazardous Waste

C. Federal Communications Commission (FCC):
CFR Title 47, Part 15.... Radio Frequency Devices
CFR Title 47, Part 18.... Industrial, Scientific, and Medical Equipment

D. Illuminating Engineering Society of North America (IESNA):
LM-79-19 ..... Electrical and Photometric Measurements of Solid-State Lighting Products
LM-80-21 ..... Measuring Lumen Maintenance of LED Light Sources
LM-82-19 ..... Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature
TM-15-20 ..... Luminaire Classification System for Outdoor Luminaires

E. Institute of Electrical and Electronic Engineers (IEEE):
C62.41-91(R1995)..... Surge Voltages in Low Voltage AC Power Circuits

F. International Code Council (ICC):
IBC-2021..... International Building Code

G. National Electrical Manufacturer's Association (NEMA):
SSL 1-16..... Electronic Drivers for LED Devices, Arrays, or Systems

H. National Fire Protection Association (NFPA):
70-23..... National Electrical Code (NEC)
101-21..... Life Safety Code

I. Underwriters Laboratories, Inc. (UL):

496-17..... Lampholders

844-12..... Luminaires for Use in Hazardous (Classified) Locations

924-16..... Emergency Lighting and Power Equipment

1598-21..... Standard for Safety Luminaires

2108-15..... ..... Standard for Safety Low-Voltage Lighting Systems

8750-15..... ..... Standard for Safety Light Emitting Diode (LED) Light Sources for Use in Lighting Products

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES

A. Shall be in accordance with NFPA, UL, as shown on drawings, and as specified.

B. Sheet Metal:

1. Shall be formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved), and parallel to each other as designed.
2. Wireways and fittings shall be free of burrs and sharp edges, and shall accommodate internal and branch circuit wiring without damage to the wiring.
3. When installed, any exposed fixture housing surface, trim frame, door frame, and lens frame shall be free of light leaks.
4. Hinged door frames shall operate smoothly without binding. Latches shall function easily by finger action without the use of tools.

C. Ballasts and lamps shall be serviceable while the fixture is in its normally installed position. Ballasts shall not be mounted to removable reflectors or wireway covers unless so specified.

D. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, aircraft cable, captive hinges, or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

E. Metal Finishes:

1. The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion-resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.
2. Interior light reflecting finishes shall be white with not less than 85 percent reflectances, except where otherwise shown on the drawing.
3. Exterior finishes shall be as shown on the drawings.

F. Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.

G. Lighting fixtures in hazardous areas shall be suitable for installation in Class and Division areas as defined in NFPA 70.

2.2 LED LIGHT FIXTURES

A. General:

1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
2. Operating temperature rating shall be between -40 degrees C (-40 degrees F) and 50 degrees C (120 degrees F).
3. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant.
4. LED drivers shall include the following features unless otherwise indicated:
   a. Minimum efficiency: 85% at full load.
   b. Starting Temperature: -40 degrees C (-40 degrees F).
   c. Minimum Operating Ambient Temperature: -20˚ C. (-4˚ F.)
   d. Input Voltage: 120 - 277V (±10%) at 60 Hz.
   e. Integral short circuit, open circuit, and overload protection.
   f. Power Factor: ≥ 0.95.
   g. Total Harmonic Distortion: ≤ 20%.
   h. Comply with FCC 47 CFR Part 15.
5. LED modules shall include the following features unless otherwise indicated:
   a. Comply with IES LM-79 and LM-80 requirements.
   b. Minimum CRI: 80 or higher. Minimum Color Fidelity Index (IES Rf): 80 or higher.
   c. Color temperature between 3500° - 5000°K.
   d. Minimum Rated Life: 50,000 hours per IES L70.
   e. Light output lumens as specified.

B. Vapor Tight Corrosion-Resistant LED Enclosed Fixture:

1. Housing, LED driver, and LED module shall be products of the same manufacturer.
2. Construction
   a. Cast-aluminum or fiberglass housing with corrosion-resistant paint in an industrial grey finish.
   b. Sealed gasket protects against moisture and dust.
3. Optics
   a. 600 lumen, 4000K CCT LEDs.
   b. Frosted glass diffuser provides even light distribution.
4. Lumen Maintenance
   a. LEDs will deliver 70% of their initial lumens at 50,000 hour average LED life.

5. Electrical
    a. 15 watt MVOLT driver operates on any line voltage from 120-277V
    b. Operating temperature -40oC to 40oC.
    c. 4kV surge protection standard.
6. Installation
    a. Mounts to ceiling or wall with surface mount junction box (included).
7. Listings
    a. UL Listed to U.S. and Canadian safety standards for wet locations.
    b. Tested in accordance with IESNA LM-79 and LM-80 standards.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the NEC, manufacturer's instructions, and as shown on the drawings or specified.

B. Align, mount, and level the lighting fixtures uniformly.

C. Lighting Fixture Supports:
    1) Shall provide support for all of the fixtures. Supports may be anchored to the structural slab.
    2) Shall maintain the fixture positions after cleaning and relamping.
    3) Surface mounted lighting fixtures:
        a. Fixtures mounted in open construction shall be secured directly to the building structure with approved bolting and clamping devices.
        b. Fixtures less than 6.8 kg (15 pounds) in weight and occupying less than 3715 sq cm (two square feet) of ceiling area may, when designed for the purpose, be supported directly from the outlet box when all the following conditions are met.
            1) Screws attaching the fixture to the outlet box pass through round holes (not key-hole slots) in the fixture body.
            2) The outlet box is supported vertically from the building structure.
            3) Outlet boxes for support of lighting fixtures (where permitted) shall be secured directly to the building structure with approved devices.

D. Furnish and install the new lamps as specified for all lighting fixtures installed under this project, and for all existing lighting fixtures reused under this project.

E. Bond lighting fixtures to the grounding system as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

F. At completion of project, replace all defective components of the lighting fixtures at no cost to the Government.

G. Dispose of lamps per requirements of Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT, and Section 02 41 00, DEMOLITION.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform the following:

1. Visual Inspection:
    a. Verify proper operation by operating the lighting controls.
    b. Visually inspect for damage to fixtures, lenses, reflectors, diffusers, and louvers. Clean fixtures, lenses, reflectors, diffusers, and louvers that have accumulated dust, dirt, or fingerprints during construction.
2. Electrical tests:
    a. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Government. Burn-in period to be 40 hours minimum, unless specifically recommended otherwise by the lamp manufacturer. Replace any lamps and ballasts which fail during burn-in.

3.3 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the lighting systems are in good operating condition and properly performing the intended function.

---END---

SECTION 27 05 11
REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes common requirements to communications installations and applies to all sections of Division 27.

B. This Project includes, but is not limited to:

1. Disconnection and removal of existing equipment, conduit, cabling, supports, and other communications associated with removal, replacement, and/or repair of structural components.
2. Installation of removed communications work, removal of temporary supports and wiring, and making final communications connections to ensure continuity and proper operation of equipment and devices affected by repair work.
3. Coordination with structural, architectural, and mechanical Work.
4. Field verification and tracing of communications cabling, as required. Field verification by this contractor shall be performed to prepare for: communications demolition; temporary support of communications equipment, raceways, boxes, conductors, and devices; and installation of existing and new communications as required. Furnish and install communications systems, materials, equipment, and accessories in accordance with the specifications and drawings.

C. Comply with VAAR 852.236.91 and FAR clause 52.236-21 in circumstance of a need for additional detail or conflict between drawings, specifications, reference standards or code.

1.2 REFERENCES

A. Definitions:

1. Bond: Permanent joining of metallic parts to form an electrically conductive path to ensure electrical continuity and capacity to safely conduct any currents likely to be imposed to earth ground.
2. Conduit: Includes all raceway types specified.
3. Conveniently Accessible: Capable of being reached without use of ladders, or without climbing or crawling under or over obstacles such as, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.
4. Effectively Grounded: Intentionally bonded to earth through connections of low impedance having current carrying capacity to prevent buildup of currents and voltages resulting in hazard to equipment or persons.
5. Electrical Supervision: Analyzing a system’s function and components (i.e. cable breaks / shorts, inoperative stations, lights, LEDs and states of change, from primary to backup)

on a 24/7/365 basis; provide aural and visual emergency notification signals to minimum two remote designated or accepted monitoring stations.

6. Grounding Electrode Conductor: (GEC) Conductor connected to earth grounding electrode.
7. Grounding Electrode System: Electrodes through which an effective connection to earth is established, including supplementary, communications system grounding electrodes and GEC.
8. Head End (HE): Equipment, hardware and software, or a master facility at originating point in a communications system designed for centralized communications control, signal processing, and distribution that acts as a common point of connection between equipment and devices connected to a network of interconnected equipment, possessing greatest authority for allowing information to be exchanged, with whom other equipment is subordinate.
9. Voice over Internet Protocol (VoIP): A telephone system in which voice signals are converted to packets and transmitted over LAN network using Transmission Control Protocol (TCP)/Internet Protocol (IP). VA'S VoIP is not listed or coded for life and public safety, critical, emergency or other protection functions. When VoIP system or equipment is provided instead of PBX system or equipment, each TR (STR) and DEMARC requires increased AC power provided to compensate for loss of PBX's telephone instrument line power; and, to compensate for absence of PBX's UPS capability.

1.3 APPLICABLE PUBLICATIONS

A. Applicability of Standards: Unless documents include more stringent requirements, applicable construction industry standards have same force and effect as if bound or copied directly into the documents to extent referenced. Such standards are made a part of these documents by reference.

1. Each entity engaged in construction must be familiar with industry standards applicable to its construction activity.
2. Obtain standards directly from publication source, where copies of standards are needed to perform a required construction activity.

B. Government Codes, Standards and Executive Orders: Refer to http://www.cfm.va.gov/TIL/cPro.asp:

1. Federal Communications Commission, (FCC) CFR, Title 47:

Part 47..... Chapter A, Paragraphs 6.1-6.23, Access to Telecommunications Service, Telecommunications Equipment and Customer Premises Equipment

Part 58..... Television Broadcast Service

Part 90..... Rules and Regulations, Appendix C

2. US Department of Agriculture, (Title 7, USC, Chapter 55, Sections 2201, 2202 & 2203:RUS 1755Telecommunications Standards and Specifications for Materials, Equipment and Construction:
   RUS Bull 1753F-401 Splicing Copper and Fiber Optic Cables (PC-2)
   RUS Bull 345-50 .... Trunk Carrier Systems (PE-60)
   RUS Bull 345-65 ... Shield Bonding Connectors (PE-65)
   RUS Bull 345-72 ... Filled Splice Closures (PE-74)
3. US Department of Commerce/National Institute of Standards Technology,(NIST):
   FIPS PUB 1-1..... Telecommunications Information Exchange
   FIPS PUB 100/1..... Interface between Data Terminal Equipment (DTE) Circuit Terminating Equipment for operation with Packet Switched Networks, or Between Two DTEs, by Dedicated Circuit
   FIPS PUB 140/2..... Telecommunications Information Security Algorithms
   FIPS PUB 143 ..... General Purpose 37 Position Interface between DTE and Data Circuit Terminating Equipment
   FIPS 160/2 ..... Electronic Data Interchange (EDI),
   FIPS 175 ..... Federal Building Standard for Telecommunications Pathway and Spaces
   FIPS 199 ..... Standards for Security Categorization of Federal Information and Information Systems
4. US Department of Defense, (DoD):
   MIL-STD-188-114 .. Electrical Characteristics of Digital Interface Circuits
   MIL-STD-188-115 .. Communications Timing and Synchronizations Subsystems
   MIL-C-28883 ..... Advanced Narrowband Digital Voice Terminals
   MIL-C-39012/21 ..... Connectors, Receptacle, Electrical, Coaxial, Radio Frequency, (Series BNC (Uncabled), Socket Contact, Jam Nut Mounted, Class 2)
5. US Department of Labor, (DoL) - Public Law 426-62 – CFR, Title 29, Part 1910, Chapter XVII - Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standards):
   Subpart 268..... Telecommunications
   Subpart 305..... Wiring Methods, Components, and Equipment for General Use
6. US Department of Veterans Affairs (VA): Office of Telecommunications (OI&T), MP-6, PART VIII, TELECOMMUNICATIONS, CHAPTER 5, AUDIO, RADIO AND TELEVISION (and COMSEC) COMMUNICATIONS SYSTEMS: Spectrum Management and COMSEC Service (SMCS), AHJ for:

a. CoG, “Continuance of Government” communications guidelines and compliance.
b. FAA, FCC, and US Department of Commerce National Telecommunications and Information Administration, “VA wide RF Co-ordination, Compliance and Licensing.”
c. Low Voltage Special Communications Systems “Design, Engineering, Construction Contract Specifications and Drawings Conformity, Proof of Performance Testing, VA Compliance and Life Safety Certifications for CFM and VA Facility Low Voltage Special Communications Projects (except Fire Alarm, Telephone and Data Systems).”

C. NRTL Standards: Refer to https://www.osha.gov/laws-regs/regulations/standardnumber/1926
1. Canadian Standards Association (CSA); same tests as presented by UL
2. Communications Certifications Laboratory (CEL); same tests as presented by UL.
3. Intertek Testing Services NA, Inc., (ITSNA), formerly Edison Testing Laboratory (ETL) same tests as presented by UL).
4. Underwriters Laboratory (UL):

1-2005 ..... Flexible Metal Conduit
6-2007 ..... Rigid Metal Conduit
44-010 ..... Thermoset-Insulated Wires and Cables
83-2008 ..... Thermoplastic-Insulated Wires and Cables
360-2013 ..... Liquid-Tight Flexible Steel Conduit
444-2008 ..... Communications Cables
467-2013 ..... Grounding and Bonding Equipment
486A-486B-2013 .... Wire Connectors
486C-2013 ..... Splicing Wire Connectors
486D-2005 ..... Sealed Wire Connector Systems
486E-2009..... Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
497/497A/497B/497C
497D/497E ..... Protectors for Paired Conductors/Communications Circuits/Data Communications and Fire Alarm Circuits/coaxial circuits/voltage protections/Antenna Lead In
510-2005 ..... Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
514A-2013..... Metallic Outlet Boxes
514B-2012..... Fittings for Cable and Conduit
514C-1996 ..... Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
651-2011 ..... Schedule 40 and 80 Rigid PVC Conduit
651A-2011..... Type EB and A Rigid PVC Conduit and HDPE Conduit
797-2007 ..... Electrical Metallic Tubing

1242-2006 ..... Intermediate Metal Conduit
1449-2006 ..... Standard for Transient Voltage Surge Suppressors
1479-2003 ..... Fire Tests of Through-Penetration Fire Stops
1861-2012 ..... Communication Circuit Accessories
1863-2013 ..... Standard for Safety, communications Circuits Accessories
2024-2011 ..... Standard for Optical Fiber Raceways
2024-2014 ..... Standard for Cable Routing Assemblies and Communications Raceways
2196-2001 ..... Standard for Test of Fire Resistive Cable
60950-1 ed. 2-2014 Information Technology Equipment Safety

D. Industry Standards:

1. Advanced Television Systems Committee (ATSC):
   A/53 Part 1: 2013 ... ATSC Digital Television Standard, Part 1, Digital Television System
   A/53 Part 2: 2011 ... ATSC Digital Television Standard, Part 2, RF/Transmission System Characteristics
   A/53 Part 3: 2013 ... ATSC Digital Television Standard, Part 3, Service Multiplex and Transport System Characteristics
   A/53 Part 4: 2009 ... ATSC Digital Television Standard, Part 4, MPEG-2 Video System Characteristics
   A/53 Part 5: 2014 ... ATSC Digital Television Standard, Part 5, AC-3 Audio System Characteristics
   A/53 Part 6: 2014 ... ATSC digital Television Standard, Part 6, Enhanced AC-3 Audio System Characteristics
2. American Institute of Architects (AIA): 2006 Guidelines for Design & Construction of Health Care Facilities.
3. American Society for Testing and Materials (ASTM):
   B1 (2001) ..... Standard Specification for Hard-Drawn Copper Wire
   B8 (2004) ..... Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
   D1557 (2012) ..... Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft3 (2,700 kN-m/m3)
   D2301 (2004) ..... Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape
   B258-02 (2008) ..... Standard Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors
   D709-01(2007) ..... Standard Specification for Laminated Thermosetting Materials

D4566 (2008) ..... Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable

4. Building Industry Consulting Service International(BICSI):

ANSI/BICSI 004-2012 ... Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities

ANSI/NECA/BICSI 568-2006 ..... Standard for Installing Commercial Building Telecommunications Cabling

NECA/BICSI 607-2011 . Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

ANSI/BICSI 005-2013 .. Electronic Safety and Security (ESS) System Design and Implementation Best Practices

5. Electronic Components Assemblies and Materials Association,(ECA).

ECA EIA/RS-270 (1973)Tools, Crimping, Solderless Wiring Devices – Recommended Procedures for User Certification

6. Insulated Cable Engineers Association (ICEA):

ANSI/ICEA S-80-576-2002 ..... Category 1 & 2 Individually Unshielded Twisted-Pair Indoor Cables for Use in Communications Wiring Systems

ANSI/ICEA S-84-608-2010 ..... Telecommunications Cable, Filled Polyolefin Insulated Copper Conductor, S-87-640(2011) Optical Fiber Outside Plant Communications Cable

ANSI/ICEA S-90-661-2012 ..... Category 3, 5, & 5e Individually Unshielded Twisted-Pair Indoor Cable for Use in General Purpose and LAN Communication Wiring Systems

S-98-688 (2012) ..... Broadband Twisted Pair Cable Aircore, Polyolefin Insulated, Copper Conductors

S-99-689 (2012) ..... Broadband Twisted Pair Cable Filled, Polyolefin Insulated, Copper Conductors

ICEA S-102-700 (2004)..... Category 6 Individually Unshielded Twisted Pair Indoor Cables (With or Without an Overall Shield) for use in Communications Wiring Systems Technical Requirements

7. Institute of Electrical and Electronics Engineers (IEEE):

IEEE C2-2012 ..... National Electrical Safety Code (NESC)

C62.41.2-2002/
Cor 1-2012 IEEE ... Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits 4)
C62.45-2002 ..... IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
81-2012 IEEE..... Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System
100-1992 ..... IEEE the New IEEE Standards Dictionary of Electrical and Electronics Terms
1100-2005 ..... IEEE Recommended Practice for Powering and Grounding Electronic Equipment

8. International Code Council:
AC193 (2014)..... Mechanical Anchors in Concrete Elements
9. National Electrical Manufacturers Association (NEMA):
NEMA 250 (2008) .. Enclosures for Electrical Equipment (1,000V Maximum)
ANSI C62.61 (1993) American National Standard for Gas Tube Surge Arresters on Wire Line Telephone Circuits
ANSI/NEMA FB 1 (2012)Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing EMT) and Cable
ANSI/NEMA OS 1 (2009)Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
TC 3 (2004)..... Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
10. National Fire Protection Association (NFPA):
70E-2015..... Standard for Electrical Safety in the Workplace
70-2014 ..... National Electrical Code (NEC)
72-2013 ..... National Fire Alarm Code
75-2013 ..... Standard for the Fire Protection of Information Technological Equipment
76-2012 ..... Recommended Practice for the Fire Protection of Telecommunications Facilities
77-2014 ..... Recommended Practice on Static Electricity
90A-2015..... Standard for the Installation of Air Conditioning and Ventilating Systems
99-2015 ..... Health Care Facilities Code
101-2015 ..... Life Safety Code
241 ..... Safeguarding construction, alternation and Demolition Operations

255-2006 ..... Standard Method of Test of Surface Burning Characteristics of Building Materials

262 - 2011 ..... Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces

1221-2013 ..... Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems

5000-2015 ..... Building Construction and Safety Code

11. Society for Protective Coatings (SSPC):
    SSPC SP 6/NACE No.3 (2007) Commercial Blast Cleaning
12. Society of Cable Telecommunications Engineers (SCTE):
    ANSI/SCTE 15 2006 Specification for Trunk, Feeder and Distribution Coaxial Cable
13. Telecommunications Industry Association (TIA):
    TIA-120 Series ..... Telecommunications Land Mobile communications (APCO/Project 25) (January 2014)
    TIA TSB-140 ..... Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems (2004)
    TIA-155 ..... Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T (2010)
    TIA TSB-162-A..... Telecommunications Cabling Guidelines for Wireless Access Points (2013)
    TIA/EIA-423-B ..... Electrical Characteristics of Unbalanced Voltage Digital Interface Circuits (2012)
    TIA-455-C..... General Requirements for Standard Test Procedures for Optical Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and other Fiber Optic Components (August 2014)
    TIA-455-53-A..... FOTP-53 Attenuation by Substitution Measurements for Multimode Graded-Index Optical Fibers in Fiber Assemblies (Long Length) (September 2001)
    TIA-455-61-A..... FOTP-61 Measurement of Fiber of Cable Attenuation Using an OTDR (July 2003)
    TIA-472D000-B ..... Fiber Optic Communications Cable for Outside Plant Use (July 2007)
    ANSI/TIA-492-B .... 62.5-µ Core Diameter/125-um Cladding Diameter Class 1a Graded-Index Multimode Optical Fibers (November 2009)
    ANSI/TIA-492AAAB-A 50-um Core Diameter/125-um Cladding Diameter Class IA Graded-Index Multimode Optically Optimized American Standard Fibers (November 2009

TIA-492CAAA..... Detail Specification for Class IVa Dispersion- Unshifted Single-Mode Optical Fibers (September 2002)

TIA-492E000 ..... Sectional Specification for Class IVd Nonzero- Dispersion Single-Mode Optical Fibers for the 1,550 nm Window (September 2002)

TIA-526-7-B..... Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant – OFSTP-7 (December 2008)

TIA-526.14-A..... Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant – SFSTP-14 (August 1998)

TIA-568 ..... Revision/Edition: C Commercial Building Telecommunications Cabling Standard Set: (TIA-568-C.0-2 Generic Telecommunications Cabling for Customer Premises (2012), TIA-568-C.1-1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements (2012), TIA-568-C.2 Commercial Building Telecommunications Cabling Standard—Part 2: Balanced Twisted Pair Cabling Components (2009), TIA-568-C.3-1 Optical Fiber Cabling Components Standard, (2011) AND TIA-568-C.4 Broadband Coaxial Cabling and Components Standard (2011) with addendums and erratas

TIA-569 ..... Revision/Edition C Telecommunications Pathways and Spaces (March 2013)

TIA-574 ..... Position Non-Synchronous Interface between Data Terminal equipment and Data Circuit Terminating Equipment Employing Serial Binary Interchange (May 2003)

TIA-598-D..... Optical Fiber Cable Color Coding (January 2005)

TIA-604-10-B..... Fiber Optic Connector Intermateablility Standard (August 2008)

ANSI/TIA-606-B ..... Administration Standard for Telecommunications Infrastructure (2012)

TIA-607-B..... Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises (January 2013)

TIA-613 ..... High Speed Serial Interface for Data Terminal Equipment and Data Circuit Terminal Equipment (September 2005)

ANSI/TIA-758-B ..... Customer-owned Outside Plant Telecommunications Infrastructure Standard (April 2012)

ANSI/TIA-854 ..... A Full Duplex Ethernet Specification for 1000 Mb/s (1000BASE-TX) Operating over Category 6 Balanced Twisted-Pair Cabling (2001)

ANSI/TIA-862-A ..... Building Automation Systems Cabling Standard (April 2011)

TIA-1152 ..... Requirements for Field Testing Instruments and Measurements for Balanced Twisted Pair Cabling (September 2009)

TIA-1179 ..... Healthcare Facility Telecommunications Infrastructure Standard (July 2010)

1.4 SINGULAR NUMBER

A. Where any device or part of equipment is referred in singular number (such as " rack"), reference applies to as many such devices as are required to complete installation.

1.5 RELATED WORK

A. Specification Order of Precedence: FAR Clause 52.236-21, VAAR Clause 852.236-71.

1. Field Cutting and Patching: Section 09 91 00, PAINTING.
2. Additional submittal requirements: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
3. Availability and source of references and standards specified in applicable publications: Section 01 42 19, REFERENCE STANDARDS.
4. Control of environmental pollution and damage for air, water, and land resources: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
5. Requirements for non-hazardous building construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
6. General requirements and procedures to comply with various federal mandates and U.S. Department of Veterans Affairs (VA) policies for sustainable design: Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
7. Closures of openings in walls, floors, and roof decks against penetration of flame, heat, and smoke or gases in fire resistant rated construction: Section 07 84 00, FIRESTOPPING.
8. Sealant and caulking materials and their application: Section 07 92 00, JOINT SEALANTS.
9. General electrical requirements that are common to more than one section of Division 26: Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
10. Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents: Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
11. Conduit and boxes: Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS.

1.6 ADMINISTRATIVE REQUIREMENTS

A. Assign a single communications project manager to serve as point of contact for Government, contractor, and design professional.

B. Be proactive in scheduling work.

1. Use of premises is restricted at times directed by COR.
2. Movement of materials: Unload materials and equipment delivered to site.
3. Coordinate installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
4. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of Work.
5. Initiate and maintain discussion regarding schedule for ceiling construction and install cables to meet that schedule.

C. Contact the Office of Telecommunications, Special Communications Team (005OP2H3) (202)461-5310 to have a Government-accepted Telecommunications COR assigned to project for telecommunications review, equipment and system approval and coordination with other VA personnel.

D. Communications Project Manager Responsibilities:
1. Assume responsibility for overall telecommunications system integration and coordination of work among trades, subcontractors, and authorized system installers.
2. Coordinate with related work indicated on drawings or specified.
3. Manage work related to telecommunications system installation in a manner approved by manufacturer.

1.7 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Provide parts list including quantity of spare parts.

C. Provide manufacturer product information. Government reserves the right to require a list of installations where products have been in operation.

D. Provide sustainable design submittals.

E. Furnish electronic certified test reports to COR prior to final inspection and not more than 90 days after completion of tests.

1.8 CLOSEOUT SUBMITTALS

A. Provide following closeout submittals prior to project closeout date:
1. Warranty certificate.
2. Evidence of compliance with requirements such as low voltage certificate of inspection.
3. Project record documents.

B. Record Wiring Diagrams:
1. Building Composite Floor Plans: Provide building floor plans showing work area outlet locations and configuration, types of jacks, distance for each cable, and cable routing locations.
2. Floor plans to include:

a. Final room numbers and actual backbone cabling and pathway locations and labeling.
b. Inputs and outputs of equipment identified according to labels installed on cables and equipment
c. Device locations with labels.
d. Conduit.
e. Head-end equipment.
f. Wiring diagram.
g. Labeling and administration documentation.

3. Submit Record Wiring Diagrams within five business days after final cable testing.
4. Deliver Record Wiring Diagrams as PDF files or other format as determined by COR.
5. Deliver complete set of electronic record wiring diagrams to COR on portable storage drive.

1.9 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Manufacturer must produce, as a principal product, the equipment and material specified for this project, and have manufactured item for at least three years.

B. Trade Contractor Qualifications: Trade contractor must have completed three or more installations of similar systems of comparable size and complexity with regards to coordinating, engineering, testing, certifying, supervising, training, and documentation. Identify these installations as a part of submittal.

C. Manufactured Products:
1. Comply with FAR clause 52.236-5 for material and workmanship.
2. When more than one unit of same class of equipment is required, units must be product of a single manufacturer.
3. Equipment Assemblies and Components:
a. Components of an assembled unit need not be products of same manufacturer.
b. Manufacturers of equipment assemblies, which include components made by others, to assume complete responsibility for final assembled unit.
c. Provide compatible components for assembly and intended service.
d. Constituent parts which are similar must be product of a single manufacturer.
4. Identify factory wiring on equipment being furnished and on wiring diagrams.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:
1. Government's approval of submittals must be obtained for equipment and material before delivery to job site.

2. Deliver and store materials to job site in OEM's original unopened containers, clearly labeled with OEM's name and equipment catalog numbers, model and serial identification numbers for COR to inventory cable, patch panels, and related equipment.

B. Storage and Handling Requirements:

1. Equipment and materials must be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
   a. Store and protect equipment in a manner that precludes damage or loss, including theft.
   b. Protect painted surfaces with factory installed removable heavy kraft paper, sheet vinyl or equivalent.
   c. Protect enclosures, equipment, controls, controllers, circuit protective devices, and other like items, against entry of foreign matter during installation; vacuum clean both inside and outside before testing and operating.

C. Coordinate storage.

1.11 FIELD CONDITIONS

A. Where variations from documents are requested in accordance with GENERAL CONDITIONS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, connecting work and related components must include additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

B. A contract adjustment or additional time will not be granted because of field conditions pursuant to FAR 52.236-2 and FAR 52.236-3; a contract adjustment or additional time will not be granted for additional work required for complete and usable construction and systems pursuant to FAR 52.246-12.

1.12 WARRANTY

A. Comply with FAR clause 52.246-21, except as follows:

1. Warranty material and equipment to be free from defects, workmanship, and remain so for a period of one year for Emergency Systems from date of final acceptance of system by Government; provide OEM’s equipment warranty document to COR.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Provide communications spaces and pathways conforming to TIA 569, at a minimum.

B. Modification to administrative issues requires written approvals from COR with concurrence from SMCS 005OP2H3, OEM, contractor, and local authorities.

2.2 WIRE LUBRICATING COMPOUND

A. Provide non-hardening or forming adhesive coating cable lubricants suitable for cable jacket material and raceway.

2.3 FIREPROOFING TAPE

A. Provide flexible, conformable fabric tape of organic composition and coated one side with flame-retardant elastomer.

B. Tape must be self-extinguishing and cannot support combustion; arc-proof and fireproof.

C. Tape cannot deteriorate when subjected to water, gases, salt water, sewage, or fungus; and tape must be resistant to sunlight and ultraviolet light.

D. Application must withstand a 200-ampere arc for minimum 30 seconds.

E. Securing Tape: Glass cloth electrical tape minimum 0.18 mm (7 mils) thick and 19 mm (3/4 inch) wide.

PART 3 - EXECUTION

3.1 PREPARATION

A. Penetrations and Sleeves:

1. Fill slots, sleeves and other openings in floors or walls if not used.
    a. Fill spaces in openings after installation of conduit or cable.
    b. Provide fill for floor penetrations to prevent passage of water, smoke, fire, and fumes.
    c. Provide fire resistant fill in rated floors and walls, to prevent passage of air, smoke and fumes.
2. Match and set sleeves flush with adjoining floor, ceiling, and wall finishes where raceways passing through openings are exposed in finished rooms.
3. Annular space between conduit and sleeve must be minimum 6 mm (1/4 inch).
4. Comply with requirements for firestopping, for sleeves through rated fire walls and smoke partitions.
5. Do not support piping risers or conduit on sleeves.
6. Identify unused sleeves and slots for future installation.
7. Provide core drilling if walls are poured or otherwise constructed without sleeves and wall penetration is required; do not penetrate structural members.

B. Core Drilling:

1. Avoid core drilling whenever possible.
2. Coordinate openings with other trades and utilities, and prevent damage to structural reinforcement.
3. Investigate existing conditions in vicinity of required opening prior to coring, including an x-ray of floor if determined necessary by competent person or COR.
4. Protect areas from damage.

C. Verification of In-Place Conditions:

1. Verify location, use and status of all material, equipment, and utilities that are specified, indicated, or determined necessary for removal.

a. Verify materials, equipment, and utilities to be removed are inactive, not required, or in use after completion of project.
b. Replace with equivalent any material, equipment and utilities that were removed by contractor that are required to be left in place.

2. Existing Utilities: Do not interrupt utilities serving facilities occupied by Government or others unless permitted under following conditions and then only after arranging to provide temporary utility services, according to requirements indicated:
a. Notify COR in writing at least 14 days in advance of proposed utility interruptions.
b. Do not proceed with utility interruptions without Government's written permission.

D. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs for floor, wall and ceiling mounting of equipment as required.

E. Provide steel supports and hardware for installation of hangers, anchors, guides, and other support hardware.

F. Obtain and analyze catalog data, weights, and other pertinent data required for coordination of equipment support provisions and installation.

G. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly that would void warranty.

3.2 INSTALLATION - GENERAL

A. Coordinate systems, equipment, and materials installation with other building components.

B. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings.

C. Conform to VAAR 852.236.91 arrangements indicated, recognizing that work may be shown in diagrammatic form or have been impracticable to detail all items because of variances in manufacturers' methods of achieving specified results.

D. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed in both exposed and un-exposed spaces.

E. Install equipment according to manufacturers' written instructions.

F. Install wiring and cabling between equipment and related devices.

G. Install cabling, wiring, and equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum interference of adjacent other installations.

H. Provide access panel or doors where units are concealed behind finished surfaces.

I. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for wiring, cabling, and equipment installations.

J. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom and access for service and maintenance as possible.

K. Install systems, materials, and equipment giving priority to systems required to be installed at a specified slope.

L. Avoid interference with structure and with work or other trades, preserving adequate headroom and clearing doors and passageways to satisfaction of COR and code requirements.

M. Install equipment and cabling to distribute equipment loads on building structural members provided for equipment support under other sections; install and support roof-mounted equipment on structural steel or roof curbs as appropriate.

N. Provide supplementary or miscellaneous items, appurtenances, devices and materials for a complete installation.

3.3 EQUIPMENT INSTALLATION

A. Locate equipment as close as practical to locations shown on drawings.

B. Note locations of equipment requiring access on record drawings.

C. Access and Access Panels: Verify access panel locations and construction with COR.

D. Inaccessible Equipment:

1. Where Government determines that contractor has installed equipment not conveniently accessible for operation and maintenance, equipment must be removed and reinstalled as directed and without additional cost to Government.

3.4 EQUIPMENT IDENTIFICATION

A. Install an identification sign which clearly indicates information required for use and maintenance of equipment.

B. Secure identification signs with screws.

3.5 CUTTING AND PATCHING

A. Perform cutting and patching according to contract general requirements and as follows:

1. Perform cutting, fitting, and patching of equipment and materials required to uncover existing infrastructure in order to provide access for correction of improperly installed existing or new work.
2. Remove and replace defective work.
3. Remove and replace non-conforming work.

B. Cut, remove, and legally dispose of selected equipment, components, and materials, including removal of material, equipment, devices, and other items indicated to be removed and items made obsolete by new work.

C. Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.

D. Protect adjacent installations during cutting and patching operations.

E. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

F. Patch finished surfaces and building components using new materials specified for original installation and experienced installers.

3.6 FIELD QUALITY CONTROL

A. Provide work according to VAAR 852.236.91 and FAR clause 52.236-5.

B. Provide minimum clearances and work required for compliance with NFPA 70, National Electrical Code (NEC), and manufacturers' instructions; comply with additional requirements indicated for access and clearances.

C. Verify all field conditions and dimensions that affect selection and provision of materials and equipment, and provide any disassembly, reassembly, relocation, demolition, cutting and patching required to provide work specified or indicated, including relocation and reinstallation of existing wiring and equipment.

1. Protect facility, equipment, and wiring from damage.

D. Submit written notice that:

1. Project has been inspected for compliance with documents.
2. Work has been completed in accordance with documents.

E. Non-Conforming Work: Conduct project acceptance inspections, final completion inspections, substantial completion inspections, and acceptance testing and demonstrations after verification of system operation and completeness by Contractor.

F. Acceptance Test:

1. Give COR fifteen working days written notice prior to date test is expected to begin; include expected duration of time for test in notification.
2. Test in the presence of the COR.
3. Test system utilizing accepted test equipment to certify proof of performance and Life and Public Safety compliance, FCC, NRTL, NFPA and OSHA compliance.
    a. Rate system as acceptable or unacceptable at conclusion of test; make only minor adjustments and connections required to show proof of performance.
        1) Demonstrate and verify that system complies with performance requirements under operating conditions.
        2) Failure of any part of system that precludes completion of system testing, and which cannot be repaired within four hours, terminates acceptance test of that portion of system.

G. Acceptance Test Procedure:

1. Physical and Mechanical Inspection: The test team representatives must tour major areas to determine system and sub-systems are completely and properly installed and are ready for acceptance testing.
2. Confirm that deficiencies reported during Interim Inspections and Pretesting are corrected prior to start of Acceptance Test.

3. Inventory system diagrams, record drawings, equipment manuals, pretest results.
4. Failure of system to meet installation requirements of specifications is grounds for terminating testing and to schedule re-testing.

H. Proof of Performance Certification:
1. If system is declared acceptable, AHJ (SMCS 005OP2H3) provides COR notice stating system processes to required operating standards and functions and is Government accepted for use by facility.
2. Validate items with COR needing to be provided to complete project contract (i.e. charts & diagrams, manuals, spare parts, system warranty documents executed, etc.). Once items have been provided, COR contacts FMS service chief to turn over system from CFM oversight for beneficial use by facility.
3. If system is declared unacceptable without conditions, rescheduled testing expenses are to be borne by contractor.

3.7 CLEANING

A. Remove debris, rubbish, waste material, tools, construction equipment, machinery and surplus materials from project site and clean work area, prior to final inspection and acceptance of work.
B. Put building and premises in neat and clean condition.
C. Remove debris on a daily basis.
D. Remove unused material, during progress of work.
E. Perform cleaning and washing required to provide acceptable appearance and operation of equipment to satisfaction of COR.
F. Clean exterior surface of all equipment, including concrete residue, dirt, and paint residue, after completion of project.
G. Perform final cleaning prior to project acceptance by COR.
H. Remove paint splatters and other spots, dirt, and debris; touch up scratches and mars of finish to match original finish.
I. Clean devices internally using methods and materials recommended by manufacturer.
J. Tighten wiring connectors, terminals, bus joints, and mountings, to include lugs, screws and bolts according to equipment manufacturer’s published torque tightening values for equipment connectors. In absence of published connection or terminal torque values, comply with torque values specified in UL 486A-486B.

3.8 PROTECTION

A. Maintain equipment and systems until final acceptance.
B. Ensure adequate protection of equipment and material during installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.

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SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section identifies common and general grounding and bonding requirements of communication installations and applies to all sections of Divisions 27.

1.2 RELATED WORK

A. Low voltage wiring: Section 27 10 00, CONTROL, COMMUNICATION, AND SIGNAL WIRING.

1.3 SUBMITTALS

A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

B. Closeout Submittals: In addition to Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS provide the following:

1. Certifications: Two weeks prior to final inspection, submit following to COR:
    a. Certification materials and installation is in accordance with construction documents.
    b. Certification complete installation has been installed and tested.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Grounding and Bonding Conductors:

1. Provide UL 83 insulated stranded copper equipment grounding conductors, with the exception of solid copper conductors for sizes 6 mm² (10 AWG) and smaller. Identify all grounding conductors with continuous green insulation color, except identify wire sizes 25 mm² (4 AWG) and larger per NEC.
2. Provide ASTM B8 bare stranded copper bonding conductors, with the exception of ASTM B1 solid bare copper for wire sizes 6 mm² (10 AWG) and smaller.

B. Ground Rods:

1. Copper clad steel, 19 mm (3/4-inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.
2. Provide quantity of rods required to obtain specified ground resistance.

C. Splices and Termination Components: Provide components meeting or exceeding UL 467 and clearly marked with manufacturer’s name, catalog number, and permitted conductor sizes.

D. Splice Case Ground Accessories: Provide splice case grounding and bonding accessories manufactured by splice case manufacturer when available. Otherwise, use 16 mm² (6 AWG) insulated ground wire with shield bonding connectors.

E. Irreversible Compression Lugs:

1. Electroplated tinned copper.
2. Two holes spaced on 15.8 mm (5/8 inch) or 25.4 mm (1 inch) centers.
3. Sized to fit the specific size conductor.
4. Listed as wire connectors.

F. Antioxidant Joint Compound: Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION AND REQUIREMENTS

A. Conduit Systems:
1. Bond ferrous metallic conduit to ground.
2. Bond grounding conductors installed in ferrous metallic conduit at both ends of conduit using grounding bushing with #6 AWG conductor.

B. Boxes, Cabinets, and Enclosures:
1. Bond each pull box, splice box, equipment cabinet, and other enclosures through which conductors pass (except for special grounding systems for intensive care units and other critical units shown) to ground.

C. Corrosion Inhibitors: Apply corrosion inhibitor for protecting connection between metals used to contact surfaces, when making ground and ground bonding connections.

D. Communications Cable Grounding:
1. Bond all metallic cable sheaths in multi-pair communications cables together at each splicing or terminating location to provide 100 percent metallic sheath continuity throughout communications distribution system.
2. Install a cable shield bonding connector with a screw stud connection for ground wire, at terminal points. Bond cable shield connector to ground.
3. Bond all metallic cable shields together within splice closures using cable shield bonding connectors or splice case manufacturer’s splice case grounding and bonding accessories. When an external ground connection is provided as part of splice closure, connect to an effective ground source and bond all other metallic components and equipment at that location.

E. Communications Cable Tray Systems:
1. Bond metallic structures of cable tray to provide 100 percent electrical continuity throughout cable tray systems.
2. Where metallic cable tray systems are mechanically discontinuous:
a. Install splice plates provided by cable tray manufacturer between cable tray sections so resistance across a bolted connection is 0.010 ohms or less, as verified by measuring across splice plate connection.

b. Install 16 mm² (6 AWG) bonding jumpers across each cable tray splice or junction where splice plates cannot be used.

3. Bond cable tray installed in same room as telecommunications grounding busbar to busbar.

3.2 FIELD QUALITY CONTROL

A. Perform tests per BICSI's Information Technology Systems Installation Methods Manual (ITSIMM), Recommended Testing Procedures and Criteria.

B. Perform two-point bond test using trained installers qualified to use test equipment.

C. Conduct continuity test to verify that metallic pathways in telecommunications spaces are bonded to TGB or TMGB.

D. Conduct electrical continuity test to verify that TMGB is effectively bonded to grounding electrode conductor.

E. Visually inspect to verify that screened and shielded cables are bonded to TGB or TMGB.

F. Perform a resistance test to ensure patch panel, rack and cabinet bonding connection resistance measures less than 5 Ohms to TGB or TMGB.

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SECTION 27 05 33
RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies conduit, fittings, and boxes to form complete, coordinated, raceway systems. Raceways are required for communications cabling unless shown or specified otherwise.

1.2 RELATED WORK

A. Sealing around penetrations to maintain integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.

B. Sealing around conduit penetrations through building envelope to prevent moisture migration into building: Section 07 92 00, JOINT SEALANTS.

C. Identification and painting of conduit and other devices: Section 09 91 00, PAINTING.

D. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

1.3 SUBMITTALS

A. In accordance with Section 27 50 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS, submit the following:

1. Size and location of splice boxes and pull boxes.
2. Layout of required conduit penetrations through structural elements.
3. Catalog cuts marked with specific item proposed and area of application identified.

B. Certification: Provide letter prior to final inspection, certifying material is in accordance with construction documents and properly installed.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Minimum Conduit Size: 19 mm (3/4 inch).

B. Conduit:

1. Rigid Galvanized Steel: Conform to UL 6, ANSI C80.1.
2. Rigid Intermediate Steel Conduit (IMC): Conform to UL 1242, ANSI C80.6.
3. Electrical Metallic Tubing (EMT):
    a. Maximum Size: 105 mm (4 inches).
    b. Install only for cable rated 600 volts or less.
    c. Conform to UL 797, ANSI C80.3.
4. Flexible Galvanized Steel Conduit: Conform to UL 1.
5. Liquid-tight Flexible Metal Conduit: Conform to UL 360.

6. Wireway, Approved “Basket”: Provide "Telecommunications Service” rated with approved length way partitions and cable straps to prevent wires and cables from changing from one partitioned pathway to another.

C. Conduit Fittings:

1. Rigid Galvanized Steel and Rigid Intermediate Steel Conduit Fittings:
   a. Provide fittings meeting requirements of UL 514B and ANSI/ NEMA FB 1.
   b. Sealing: Provide threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water and vapor. In concealed work, install sealing fittings in flush steel boxes with blank cover plates having same finishes as other electrical plates in room.
   c. Standard Threaded Couplings, Locknuts, Bushings, and Elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
   d. Locknuts: Bonding type with sharp edges for digging into metal wall of an enclosure.
   e. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into metallic body of fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
   f. Erickson (union-type) and Set Screw Type Couplings:
      1) Couplings listed for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete.
      2) Use set screws of case hardened steel with hex head and cup point to seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
   g. Provide OEM approved fittings.
2. Electrical Metallic Tubing Fittings:
   a. Conform to UL 514B and ANSI/ NEMA FB1; only steel or malleable iron materials are acceptable.
   b. Couplings and Connectors: Concrete tight and rain tight, with connectors having insulated throats.
      1) Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller.
      2) Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches).
      3) Use set screws of case-hardened steel with hex head and cup point to seat in wall of conduit for positive grounding.
   c. Indent type connectors or couplings are not permitted.
   d. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are not permitted.

e. Provide OEM approved fittings.

3. Flexible Steel Conduit Fittings:
   a. Conform to UL 514B; only steel or malleable iron materials are acceptable.
   b. Provide clamp type, with insulated throat.
   c. Provide OEM approved fittings.
4. Liquid-tight Flexible Metal Conduit Fittings:
   a. Conform to UL 514B and ANSI/ NEMA FB1; only steel or malleable iron materials are acceptable.
   b. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening.
   c. Provide connectors with insulated throats to prevent damage to cable jacket.
   d. Provide OEM approved fittings.
5. Expansion and Deflection Couplings:
   a. Conform to UL 467 and UL 514B.
   b. Accommodate 19 mm (3/4 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
   c. Include internal flexible metal braid sized to ensure conduit ground continuity and fault currents in accordance with UL 467, and NEC code tables for ground conductors.
   d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.
6. Wireway Fittings: As recommended by wireway OEM.

D. Conduit Supports:
1. Parts and Hardware: Provide zinc-coat or equivalent corrosion protection.
2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
3. Multiple Conduit (Trapeze) Hangers: Minimum 38 mm by 38 mm (1-1/2 by 1-1/2 inch), 2.78 mm (12 gage) steel, cold formed, lipped channels; with minimum 9 mm (3/8 inch) diameter steel hanger rods.
4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.

E. Outlet, Splice, and Pull Boxes:
1. Conform to UL-50 and UL-514A.
2. Cast metal where required by NEC or shown, and equipped with rustproof boxes.
3. Sheet Metal Boxes: Galvanized steel, except where otherwise shown.
4. Install flush mounted wall or ceiling boxes with raised covers so that front face of raised cover is flush with wall.

5. Install surface mounted wall or ceiling boxes with surface style flat or raised covers.

F. Wireways: Equip with hinged covers, except where removable covers are shown.

G. Cable Tray:

1. Provide wire basket type of sizes indicated; with all required splicing and mounting hardware.
2. Materials and Finishes:
   a. Electro-plated zinc galvanized (post plated) made from carbon steel and plated to ASTM B 633, Type III, SC-1.
   b. Remove soot, manufacturing residue/oils, or metallic particles after fabrication.
   c. Rounded edges and smooth surfaces.
3. Provide continuous welded top side wire to protect cable insulation and installers.
4. High strength steel wires formed into a 50 x 100 mm (2 inches by 4 inches) wire mesh pattern with intersecting wires welded together.
5. Wire Basket Sizes:
   a. Wire Diameter: 5 mm (0.195 inch) minimum on all mesh sections.
   b. Usable Loading Depth: 105 mm (4 inch), 150 mm (6 inches).
   c. Width: 300 mm (12 inches), 450 mm (18 inches), 600 mm (24 inches).
6. Fittings: Field-formed, from straight sections, in accordance with manufacturer's instructions.
7. Provide accessories to protect, support and install wire basket tray system.

H. Cable Duct: Equip with hinged covers, except where removable covers are accepted by COR.

I. Cable Duct Fittings: As recommended by cable duct OEM.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION AND REQUIREMENTS

A. Raceways typically required for cabling systems unless otherwise indicated:

System	Specification Section	Installed Method
Grounding	27 05 26	Conduit Not Required
Control, Communication and Signal Wiring	27 10 00	Complete Conduit Allowed in Non-Partitioned Cable Tray or Cable Ladders
Communications Structured Cabling		Conduit to Cable Tray Partitioned Cable Tray
Public Address and Mass Notification Systems		Complete conduit
Security and Telecommunications		Conduit to Cable Tray, Partitioned Cable Tray
Physical Access Control System		Conduit to Cable Tray Partitioned Cable Tray

System	Specification Section	Installed Method
Physical Access Control System and Database Management		Conduit to Cable Tray Partitioned Cable Tray
Video Surveillance		Complete Conduit
Fire Detection and Alarm		Complete Conduit

B. Penetrations:
   1. Cutting or Holes:
      a. Locate holes in advance of installation. Where they are proposed in structural sections, obtain approval of structural engineer and COR prior to drilling through structural sections.
      b. Make holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not permitted; COR may grant limited permission by request, in condition of limited working space.
      c. Fire Stop: Where conduits, wireways, and other communications raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING.
         1) Fill and seal clearances between raceways and openings with fire stop material.
         2) Install only retrofittable, non-hardening, and reusable firestop material that can be removed and reinstalled to seal around cables inside conduits.
      d. Waterproofing at Floor, Exterior Wall, and Roof Conduit Penetrations:
         1) Seal clearances around conduit and make watertight as specified in Section 07 92 00, JOINT SEALANTS or directed by waterproofing manufacturer.

C. Conduit Installation:
   1. Minimum conduit size of 19 mm (3/4 inch), but not less than size required for 40 percent fill.
   2. Install insulated bushings on all conduit ends.
   3. Install pull boxes after every 180 degrees of bends (two 90 degree bends). Size boxes per TIA 569.
   4. Extend vertical conduits/sleeves through floors minimum 75 mm (3 inches) above floor and minimum 75 mm (3 inches) below ceiling of floor below.
   5. Terminate conduit runs to and from a backboard in a closet or interstitial space at top or bottom of backboard. Install conduits to enter telecommunication rooms next to wall and flush with backboard.
   6. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections.

7. Seal empty conduits located in telecommunications rooms or on backboards with a standard non-hardening putty compound to prevent entrance of moisture and gases and to meet fire resistance requirements.
8. Minimum radius of communication conduit bends:

Sizes of Conduit Trade Size	Radius of Conduit Bends mm, Inches
3/4	150 (6)
1	230 (9)
1-1/4	350 (14)
1-1/2	430 (17)
2	525 (21)
2-1/2	635 (25)
3	775 (31)
3-1/2	900 (36)
4	1125 (45)

9. Provide pull wire in all empty conduits; sleeves through floor are exceptions.
10. Complete each entire conduit run installation before pulling in cables.
11. Flattened, dented, or deformed conduit is not permitted.
12. Ensure conduit installation does not encroach into ceiling height head room, walkways, or doorways.
13. Cut conduit square with a hacksaw, ream, remove burrs, and draw tight.
14. Install conduit mechanically continuous.
15. Independently support conduit at 2.44 m (8 feet) on center; do not use other supports (i.e., suspended ceilings, suspended ceiling supporting members, luminaires, conduits, mechanical piping, or mechanical ducts).
16. Support conduit within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.
17. Close ends of empty conduit with plugs or caps to prevent entry of debris, until cables are pulled in.
18. Attach conduits to cabinets, splice cases, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on inside of enclosure, made up wrench tight. Do not make conduit connections to box covers.
19. Unless otherwise indicated on drawings or specified herein, conceal conduits within finished walls, floors and ceilings.
20. Conduit Bends:
    a. Make bends with standard conduit bending machines; observe minimum bend radius for cable type and outside diameter.

b. Conduit hickey is permitted only for slight offsets, and for straightening stubbed conduits.
c. Bending of conduits with a pipe tee or vise is not permitted.

21. Layout and Homeruns - Deviations: Make only where necessary to avoid interferences and only after drawings showing proposed deviations have been submitted and approved by COR.

D. Concealed Work Installation:

1. In Concrete:
   a. Conduit: Rigid steel or IMC.
   b. Align and run conduit in direct lines.
   c. Do not install conduit through beams or columns.
   d. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
      1) Conduit outside diameter larger than 1/3 of slab thickness is prohibited.
      2) Space between Conduits in Slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
      3) Install conduits approximately in center of slab to ensure a minimum of 19 mm (3/4 inch) of concrete around conduits.
   e. Make couplings and connections watertight. Use thread compounds that are NRTL listed conductive type to ensure low resistance ground continuity through conduits. Tightening set screws with pliers is not permitted.

E. Furred or Suspended Ceilings and in Walls:

1. Rigid steel or IMC. Different type conduits mixed indiscriminately in same system is not permitted.
2. Align and run conduit parallel or perpendicular to building lines.
3. Tightening set screws with pliers is not permitted.

F. Exposed Work Installation:

1. Unless otherwise indicated on drawings, exposed conduit is only permitted in mechanical, electrical, and telecommunications rooms.
   a. Provide rigid steel or IMC.
   b. Different type of conduits mixed indiscriminately in system is not permitted.
2. Align and run conduit parallel or perpendicular to building lines.
3. Install horizontal runs close to ceiling or beams and secure with conduit straps.
4. Support horizontal or vertical runs at not over 2400 mm (96 inches) intervals.
5. Surface Metal Raceways: Use only where shown on drawings.
6. Painting:
   a. Paint exposed conduit as specified in Section 09 91 00, PAINTING.

b. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color.
c. Provide labels where conduits pass through walls and floors and at maximum 6000 mm (20 foot) intervals in between.

G. Expansion Joints:
1. Conduits 75 mm (3 inches) and larger, that are secured to building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install couplings in accordance with manufacturer's recommendations.
2. Provide conduits smaller than 75 mm (3 inches) with pull boxes on both sides of expansion joint. Connect conduits to expansion and deflection couplings as specified.
3. Install expansion and deflection couplings where shown.

H. Conduit Supports, Installation:
1. Select AC193 code listed mechanical anchors or fastening devices with safe working load not to exceed 1/4 of proof test load.
2. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.
3. Support multiple conduit runs with trapeze hangers. Use trapeze hangers designed to support a load equal or greater than sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds). Attach each conduit with U-bolts or other accepted fasteners.
4. Support conduit independent of pull boxes, luminaires, suspended ceiling components, angle supports, duct work, and similar items.
5. Fastenings and Supports in Solid Masonry and Concrete:
a. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing concrete.
b. Existing Construction:
1) Code AC193 listed wedge type steel expansion anchors minimum 6 mm (1/4 inch) bolt size and minimum 28 mm (1-1/8 inch) embedment.
2) Power set fasteners minimum 6 mm (1/4 inch) diameter with depth of penetration minimum 75 mm (3 inches).
3) Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
6. Fastening to Hollow Masonry: Toggle bolts are permitted.
7. Fastening to Metal Structures: Use machine screw fasteners or other devices designed and accepted for application.
8. Bolts supported only by plaster or gypsum wallboard are not acceptable.
9. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.

10. Do not support conduit from chain, wire, or perforated strap.
11. Spring steel type supports or fasteners are not permitted except horizontal and vertical supports/fasteners within walls.
12. Vertical Supports:
    a. Install riser clamps and supports for vertical conduit runs in accordance with NEC.
    b. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

I. Box Installation:
1. Boxes for Concealed Conduits:
    a. Flush mounted.
    b. Provide raised covers for boxes to suit wall or ceiling, construction and finish.
2. In addition to boxes shown, install additional boxes where needed to prevent damage to cables during pulling.
3. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
4. Stencil or install phenolic nameplates on covers of boxes identified on riser diagrams; for example "SIG-FA JB No. 1".
5. Outlet boxes mounted back-to-back in same wall are not permitted. A minimum 600 mm (24 inches) center-to-center lateral spacing must be maintained between boxes.

J. Flexible Nonmetallic Communications Raceway (Innerduct), Installation:
1. Install supports from building structure for horizontal runs at intervals not to exceed 900 mm (3 feet) and at each end.
2. Install supports from building structure for vertical runs at intervals not to exceed 1.2 m (4 feet) and at each side of joints.
3. Install only in accessible spaces not subject to physical damage or corrosive influences.
4. Make bends manually to assure internal diameter of tubing is not effectively reduced.
5. Extend each segment of innerduct minimum 300 mm (12 inches) beyond end of service conduit tie or cable tray. Restrain innerduct ends with wall mount clamps and seal when cable is installed.

3.2 TESTING

A. Examine fittings and locknuts for secureness.
B. Test RMC, IMC and EMT systems for electrical continuity.
C. Perform simple continuity test after cable installation.

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SECTION 27 10 00
CONTROL, COMMUNICATION, AND SIGNAL WIRING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes control, communication, and signal wiring for a comprehensive systems infrastructure.

B. This section applies to all sections of Divisions 27.

1.2 RELATED WORK

A. Sealing around penetrations to maintain integrity of time rated construction: Section 07 84 00, FIRESTOPPING.

B. General electrical requirements that are common to more than one section in Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

C. Conduits for cables and wiring: Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.

D. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

1.3 SUBMITTALS

A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

B. Provide conduit size requirements.

C. Closeout Submittals:

1. Furnish spare or unused wire and cable with appropriate connectors (female types) for installation in appropriate punch blocks, barrier strips, patch, or bulkhead connector panels.
2. Turn over unused and opened installation kit boxes, coaxial, fiber optic, and twisted pair cable reels, conduit, cable tray, cable duct bundles, wire rolls, physical installation hardware to COR.
3. Documentation: Include any item or quantity of items, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to completely and correctly provide system documentation required herein.

PART 2 - PRODUCTS

2.1 CONTROL WIRING

A. Provide control wiring large enough so voltage drop under in-rush conditions does not adversely affect operation of controls.

B. Provide cable meeting specifications for type of cable.

C. Remote Control Cable:

1. Multi-conductor with stranded conductors able to handle power and voltage required to control specified system equipment, from a remote location.
2. NRTL listed and pass VW-1 vertical wire flame test (UL 83) (formerly FR-1).
3. Color-coded Conductors: Combined multi-conductor and coaxial cables are acceptable for this installation, on condition system performance standards are met.
4. Technical Characteristics:
   a. Length: As required.
   b. Connectors: As required by system design.
   c. Size:
      1) 18 AWG, minimum, Outside.
      2) 20 AWG, minimum, Inside.
   d. Color Coding: Required, EIA industry standard.
   e. Bend Radius: 10 times cable outside diameter.
   f. Impedance: As required.
   g. Shield Coverage: As required by OEM specification.
   h. Attenuation:

Frequency in MHz	dB per 305 Meter (1,000 feet), maximum
0.7	5.2
1.0	6.5
4.0	14.0
8.0	19.0
16.0	26.0
20.0	29.0
25.0	33.0
31.0	36.0
50.0	52.0

D. Distribution System Signal Wires and Cables:
1. Provide in same manner, and use construction practices, as Fire Protective and other Emergency Systems identified and defined in NFPA 101, Life Safety Code, Chapters 7, 12, and 13, NFPA 70, National Electrical Code, Chapter 7, Special Conditions.
2. Provide system able to withstand adverse environmental conditions without deterioration, in their respective location.
3. Provide entering of each equipment enclosure, console, cabinet or rack in such a manner that all doors or access panels can be opened and closed without removal or disruption of cables.
4. Terminate on an item of equipment by direct connection.

2.2 COMMUNICATION AND SIGNAL WIRING

A. Provide communications and signal wiring conforming to recommendations of manufacturers of systems; provide not less than TIA Performance Category 5e.

B. Wiring shown is for typical systems; provide wiring as required for systems being provided.

C. Provide color-coded conductor insulation for multi-conductor cables.

D. Connectors:

1. Provide connectors for transmission lines, and signal extensions to maintain uninterupted continuity, ensure effective connection, and preserve uniform polarity between all points in system.
    a. Provide AC barrier strips with a protective cover to prevent accidental contact with wires carrying live AC current.
    b. Provide punch blocks for signal connection, not AC power. AC power twist-on wire connectors are not permitted for signal wire terminations.
2. Cables: Provide connectors designed for specific size cable and conductors being installed with OEM's approved installation tool. Typical system cable connectors include:
    a. Audio spade lug.
    b. Punch block.
    c. Wirewrap.

2.3 INSTALLATION KIT

A. Include connectors and terminals, labeling systems, audio spade lugs, barrier strips, punch blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, conduit, cable duct, cable tray, etc., required to accomplish a neat and secure installation.

B. Terminate conductors in a spade lug and barrier strip, wire wrap terminal or punch block, so there are no unfinished or unlabeled wire connections.

C. Minimum required installation sub-kits:

1. System Grounding:
    a. Provide required cable and installation hardware for effective ground path, including the following:
        1) Control Cable Shields.
        2) Data Cable Shields.
        3) Conduits.
        4) Cable Trays.
2. Wire and Cable: Provide connectors and terminals, punch blocks, tie wraps, hangers, clamps, labels, etc. required to accomplish termination in an orderly installation.
3. Conduit, Cable Duct, and Cable Tray: Provide conduit, duct, trays, junction boxes, back boxes, cover plates, feed through nipples, hangers, clamps, other hardware required to

accomplish a neat and secure conduit, cable duct, cable tray installation in accordance with NEC and documents.

4. Equipment Interface: Provide any items or quantity of equipment, cable, mounting hardware and materials to interface systems with identified sub-systems, according to OEM requirements and construction documents.
5. Labels: Provide any item or quantity of labels, tools, stencils, and materials to label each subsystem according to OEM requirements, as-installed drawings, and construction documents.

2.4 EXISTING WIRING

A. Reuse existing wiring only where indicated on plans and accepted by SMCS 005OP2H3.

B. Only existing wiring that conforms to specifications and applicable codes can be reused; existing wiring that does not meet these requirements cannot be reused and must be removed by contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install wiring in cable tray or raceway.
2. Seal cable entering a building from underground, between wire and conduit where cable exits conduit, with non-hardening approved compound.
3. Wire Pulling:
   a. Provide installation equipment that prevents cutting or abrasion of insulation during pulling of cables.
   b. Use ropes made of nonmetallic material for pulling feeders.
   c. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached to conductors, as accepted by COR.
   d. Pull multiple cables into a single conduit together.

B. Control, Communication and Signal Wiring Installation:

1. Unless otherwise specified in other sections, provide wiring and connect to equipment/devices to perform required functions as indicated.
2. Install separate cables for each system so that malfunctions in any system does not affect other systems, except where otherwise required.
3. Group wires and cables according to service (i.e. AC, grounds, signal, DC, control, etc.); DC, control and signal cables can be included with any group.
4. Form wires and cables to not change position in group throughout the conduit run. Bundle wires and cables in accepted signal duct, conduit, cable ducts, or cable trays neatly formed, tied off in 600 mm to 900 mm (24 inch to 36 inch) lengths to not change position in group throughout run.

5. Concealed splices are not allowed.
6. Separate, organize, bundle, and route wires or cables to restrict EMI, channel crosstalk, or feedback oscillation inside any enclosure.
7. Looking at any enclosure from the rear (wall mounted enclosures, junction, pull or interface boxes from the front), locate AC power, DC and speaker wires or cables on the left; coaxial, control, microphone and line level audio and data wires or cables, on the right.
8. Provide ties and fasteners that do not damage or distort wires or cables. Limit spacing between tied points to maximum 150 mm (6 inches).
9. Install wires or cables outside of buildings in conduit, secured to solid building structures.
10. Wires or cables must be specifically accepted, on a case by case basis, to be installed outside of conduit. Bundled wires or cables must be tied at minimum 460 mm (18 inches) intervals to a solid building structure; bundled wires or cables must have ultra violet protection and be waterproof (including all connections).
11. Laying wires or cables directly on roof tops, ladders, drooping down walls, walkways, floors, etc. is not permitted.
12. Wires or cables installed outside of conduit, cable trays, wireways, cable duct, etc.:
    a. Only when authorized, can wires or cables be identified and approved to be installed outside of conduit.
    b. Provide wire or cable rated plenum and OEM certified for use in air plenums.
    c. Provide wires and cables hidden, protected, fastened and tied at maximum 600 mm (24 inches) intervals, to building structure.
    d. Provide closer wire or cable fastening intervals to prevent sagging, maintain clearance above suspended ceilings.
    e. Remove unsightly wiring and cabling from view, and discourage tampering and vandalism.
    f. Sleeve and seal wire or cable runs, not installed in conduit, that penetrate outside building walls, supporting walls, and two hour fire barriers, with an approved fire retardant sealant.

C. AC Power:
1. Bond to ground contractor-installed equipment and identified Government-furnished equipment, to eliminate shock hazards and to minimize ground loops, common mode returns, noise pickup, crosstalk, etc. for total ground resistance of 0.1 Ohm or less.
2. Use of conduit, signal duct or cable trays as system or electrical ground is not permitted; use these items only for dissipation of internally generated static charges (not to be confused with externally generated lightning) that can be applied or generated outside mechanical and physical confines of system to earth ground. Discovery of improper

system grounding is grounds to declare system unacceptable and termination of all system acceptance testing.

3.2 EQUIPMENT IDENTIFICATION

A. Control, Communication and Signal System Identification:
   1. Install a permanent wire marker on each wire at each termination.
   2. Identify cables with numbers and letters on the labels corresponding to those on wiring diagrams used for installing systems.
   3. Install labels retaining their markings after cleaning.
   4. In each maintenance hole (manhole) and handhole, install embossed brass tags to identify system served and function.

B. Labeling:
   1. Industry Standard: ANSI/TIA-606-B.
   2. Print lettering for voice and data circuits using laser printers or thermal ink transfer process; handwritten labels are not acceptable.
   3. Cable and Wires (hereinafter referred to as “cable”): Label cables at both ends in accordance with industry standard. Provide permanent labels in contrasting colors. Identify cables matching system Record Wiring Diagrams.
   4. Equipment: Permanently labeled system equipment with contrasting plastic laminate or bakelite material. Label system equipment on face of unit corresponding to its source.
   5. Conduit, Cable Duct, and Cable Tray: Label conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 meters (10 ft.) identifying system. Label each enclosure according to this standard.
   6. Termination Hardware: Label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with industry standard and Record Wiring Diagrams.

3.3 TESTING

A. Minimum test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on cables in frequency ranges specified.

B. Tests required for data cable must be made to confirm operation of this cable at minimum 10 Mega (M) Hertz (Hz) full bandwidth, fully channel loaded and a Bit Error Rate of a minimum of 10-6 at maximum rate of speed.

C. Record changes (used pair, failed pair, etc.) in existing test records as change occurs.
   1. Verify location of existing test records with COR.

D. Test cables after installation and replace any defective cables.

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SECTION 31 20 00
EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This section specifies the requirements for furnishing all equipment, materials, labor, tools, and techniques for earthwork including, but not limited to, the following:

1. Site preparation.
2. Excavation.
3. Underpinning.
4. Filling and backfilling.
5. Grading.
6. Soil Disposal.
7. Clean Up.

1.2 DEFINITIONS

A. Unsuitable Materials:

1. Fills: Topsoil; frozen materials; construction materials and materials subject to decomposition; clods of clay and stones larger than 75 mm (3 inches); organic material, including silts, which are unstable; and inorganic materials, including silts, too wet to be stable and any material with a liquid limit and plasticity index exceeding 40 and 15 respectively. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction, as defined by ASTM D698 or D1557.
2. Existing Subgrade (Except Footing Subgrade): Same materials as 1.2.A.1, that are not capable of direct support of slabs, pavement, and similar items with possible exception of improvement by compaction, proofrolling, or similar methods.
3. Existing Subgrade (Footings Only): Same as paragraph 1, but no fill or backfill. If materials differ from design requirements, excavate to acceptable strata subject to COR's approval.

B. Building Earthwork: Earthwork operations required in area enclosed by a line located 1500 mm (5 feet) outside of principal building perimeter. It also includes earthwork required for auxiliary structures and buildings.

C. Site Earthwork: Earthwork operations required in area outside of a line located 1500 mm (5 feet) outside of principal building perimeter and within new construction area with exceptions noted above.

D. Degree of compaction: Degree of compaction is expressed as a percentage of maximum density obtained by laboratory test procedure. This percentage of maximum density is

obtained through use of data provided from results of field test procedures presented in ASTM D1556, ASTM D2167, and ASTM D6938.

E. Fill: Satisfactory soil materials used to raise existing grades. In the Construction Documents, the term “fill” means fill or backfill as appropriate.

F. Backfill: Soil materials or controlled low strength material used to fill an excavation.

G. Unauthorized excavation: Removal of materials beyond indicated sub-grade elevations or indicated lines and dimensions without written authorization by the COR. No payment will be made for unauthorized excavation or remedial work required to correct unauthorized excavation.

H. Authorized additional excavation: Removal of additional material authorized by the COR based on the determination by the Government’s soils testing agency that unsuitable bearing materials are encountered at required sub-grade elevations. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in work.

I. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular sub-base, drainage fill, or topsoil materials.

J. Structure: Buildings, foundations, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

K. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.

L. Drainage course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.

M. Sub-base Course: Layer placed between the sub-grade and base course for asphalt paving or layer placed between the sub-grade and a concrete pavement or walk.

N. Utilities include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

O. Debris: Debris includes all materials located within the designated work area not covered in the other definitions and shall include but not be limited to items like vehicles, equipment, appliances, building materials or remains thereof, tires, any solid or liquid chemicals or products stored or found in containers or spilled on the ground.

P. Contaminated soils: Soil that contains contaminates as defined and determined by the COR or the Government’s testing agency.

1.3 RELATED WORK

A. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 00, GENERAL REQUIREMENTS.

B. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article, PHYSICAL DATA.

C. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

D. Erosion Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

E. Site preparation: Section 02 41 00, DEMOLITION.

F. Foundation system requirements33, Helical Piers

G. Paving sub-grade requirements: Section 32 12 16, ASPHALT PAVING.

1.4 CLASSIFICATION OF EXCAVATION

A. Classified Excavation: Removal and disposal of all material not defined as Rock.

B. Rock Excavation:

1. Trenches and Pits: Removal and disposal of solid, homogenous, interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be excavated with a late-model, track-mounted hydraulic excavator; equipped with a 1050 mm (42 inch) wide, short-tip-radius rock bucket; rated at not less than 103 kW (138 hp) flywheel power with bucket-curling force of not less than 125 kN (28,090 lbf) and stick-crowd force of not less than 84.5 kN (19,000 lbf); measured according to SAE J-1179. Trenches in excess of 3000 mm (10 feet) wide and pits in excess of 9000 mm (30 feet) in either length or width are classified as open excavation.
2. Open Excavation: Removal and disposal of solid, homogenous, interlocking crystalline material firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be dislodged and excavated with a late-model, track-mounted loader; rated at not less than 157 kW (210 hp) flywheel power and developing a minimum of 216 kN (48,510 lbf) breakout force; measured according to SAE J-732.
3. Other types of materials classified as rock are unstratified masses, conglomerated deposits and boulders of rock material exceeding 0.76 m3 (1 cubic yard) for open excavation, or 0.57 m3 (3/4 cubic yard) for footing and trench excavation that cannot be removed by rock excavating equipment equivalent to the above in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted.
4. Blasting: Blasting is not permitted.
5. Definitions of rock and guidelines for equipment are presented for general information purposes only. The Contractor is expected to use the information presented in the Geotechnical Engineering Report to evaluate the extent and competency of the rock and to determine both quantity estimations and removal equipment and efforts.

1.5 MEASUREMENT AND PAYMENT FOR EXCAVATION

A. Measurement: The unit of measurement for excavation and borrow will be the cubic yard, computed by the average end area method from cross sections taken before and after the excavation and borrow operations, including the excavation for ditches, gutters, and channel changes, when the material is acceptably utilized or disposed of as herein specified.

Quantities should be computed by a Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS. The measurement will not include the volume of subgrade material or other material used for purposes other than directed. The volume of overburden stripped from borrow pits and the volume of excavation for ditches to drain borrow its, unless used as borrow material, will not be measured for payment. The measurement will not include the volume of any excavation performed prior to taking of elevations and measurements of the undisturbed grade.

1.6 MEASUREMENT AND PAYMENT FOR ROCK EXCAVATION

A. Measurement: Cross section and measure uncovered and separated materials, and compute quantities by Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS. Do not measure quantities beyond the following limits:

1. 600 mm (24 inches) from outside face of concrete work for which forms are required, except for footings.
2. 300 mm (12 inches) from outside of perimeter of formed footings.
3. 150 mm (6 inches) below bottom of pipe and not more than pipe diameter plus 600 mm (24 inches) in width for pipe trenches.
4. From outside dimensions of concrete work for which no forms are required (trenches, conduits, and similar items not requiring forms).

B. Payment: No separate payment shall be made for rock excavation quantities shown. Contract price and time will be adjusted for overruns or underruns in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.

1.7 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Rock Excavation Report:

1. Certification of rock quantities excavated.
2. Excavation method.
3. Labor.
4. Equipment.
5. Land Surveyor's or Civil Engineer's name and official registration stamp.
6. Plot plan showing elevation.

C. Furnish to COR:

1. Contactor shall furnish resumes with all personnel involved in the project including Project Manager, Superintendent, and on-site Engineer. Project Manager and Superintendent should have at least 3 years of experience on projects of similar size.

2. Soil samples.
   a. Classification in accordance with ASTM D2487 for each on-site or borrow soil material proposed for fill, backfill, engineered fill, or structural fill.
   b. Pre-excavation photographs in the vicinity of the existing structures to document existing site features, including surfaces finishes, cracks, or other structural blemishes that might be misconstrued as damage caused by earthwork operations.
3. Contractor shall submit procedure and location for disposal of unused satisfactory material. Proposed source of borrow material. Notification of encountering rock in the project. Advance notice on the opening of excavation or borrow areas. Advance notice on shoulder construction for rigid pavements.

1.8 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.

B. American Association of State Highway and Transportation Officials (AASHTO):

T99-10 ..... Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305 mm (12 inch) Drop

T180-10 ..... Standard Method of Test for Moisture-Density Relations of Soils using a 4.54 kg (10 lb) Rammer and a 457 mm (18 inch) Drop

C. American Society for Testing and Materials (ASTM):

C33-03 ..... Concrete Aggregate

D448-08 ..... Standard Classification for Sizes of Aggregate for Road and Bridge Construction

D698-07e1 ..... Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft. lbf/ft3 (600 kN m/m3))

D1140-00 ..... Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve

D1556-07 ..... Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method

D1557-09 ..... Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2700 kN m/m3))

D2167-08 ..... Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

D2487-11 ..... Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D2940-09 ..... Standard Specifications for Graded Aggregate Material for Bases or Subbases for Highways or Airports

D6938-10 ..... Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth

D. Society of Automotive Engineers (SAE):

J732-07 ..... Specification Definitions - Loaders

J1179-08 ..... Hydraulic Excavator and Backhoe Digging Forces

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide borrow soil material when sufficient satisfactory soil materials are not available from excavations.

B. Fills: Material in compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SC, and ML, or any combination of these groups; free of rock or gravel larger than 75 mm (3 inches) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Material approved from on site or off site sources having a minimum dry density of 1760 kg/m3 (110 pcf), a maximum Plasticity Index of 15, and a maximum Liquid Limit of 40.

C. Engineered Fill: Naturally or artificially graded mixture of compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SC, and ML, or any combination of these groups, or as approved by the Engineer or material with at least 90 percent passing a 37.5-mm (1 1/2-inch) sieve and not more than 12 percent passing a 75-µm (No. 200) sieve, per ASTM D2940;.

D. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100 percent passing a 25 mm (1 inch) sieve and not more than 8 percent passing a 75-µm (No. 200) sieve.

E. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 37.5 mm (1 1/2-inch) sieve and 0 to 5 percent passing a 2.36 mm (No. 8) sieve.

F. Granular Fill:

1. Under concrete slab, - granular fill shall consist of clean, poorly graded crushed rock, crushed gravel, or uncrushed gravel placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below. Fine aggregate grading shall conform to ASTM C 33 with a maximum of 3 percent by weight passing ASTM D 1140, 75 micrometers (No. 200) sieve, and no more than 2 percent by weight passing the 4.75 mm (No. 4) size sieve.

G. Requirements for Offsite Soils: Offsite soils brought in for use as backfill shall be tested for TPH, BTEX and full TCLP including ignitability, corrosivity and reactivity. Backfill shall contain less than 100 parts per million (ppm) of total hydrocarbons (TPH) and less than 10 ppm of the sum of Benzene, Toleune, Ethyl Benzene, and Xylene (BTEX) and shall not fail the TCLP

test. TPH concentrations shall be determined by using EPA 600/4-79/020 Method 418.1. BTEX concentrations shall be determined by using EPA SW-846.3-3a Method 5030/8020. TCLP shall be performed in accordance with EPA SW-846.3-3a Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site.

H. Buried Warning and Identification Tape: Polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inch minimum width, color coded as specific below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, “CAUTION, BURIED (intended service) LINE BELOW” or similar wording. Color and printing shall be permanent, Unaffected by moisture or soil. Warning tape color codes:

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone and Other Communications
Blue:	Water Systems
Green:	Sewer Systems
White:	Steam Systems
Gray:	Compressed Air

I. Warning Tape for Metallic Piping: Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of tape shall be 0.076 mm (0.003 inch). Tape shall have a minimum strength of 10.3 MPa (1500 psi) lengthwise, and 8.6 MPa (1250 psi) crosswise, with a maximum 350 percent elongation.

J. Detectable Warning Tape for Non-Metallic Piping: Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.102 mm (0.004 inch). Tape shall have a minimum strength of 10.3 MPa (1500 psi) lengthwise and 8.6 MPa (1250 psi) crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 0.9 m (3 feet) deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

K. Detection Wire for Non-Metallic Piping: Detection wire shall be Insulated single strand, solid copper with a minimum of 12 AWG.

PART 3 - EXECUTION

3.1 SITE PREPARATION

A. Clearing: Clear within limits of earthwork operations as shown. Work includes removal of trees, shrubs, fences, foundations, incidental structures, paving, debris, trash, and other obstructions. Remove materials from Medical Center.

B. Grubbing: Remove stumps and roots 75 mm (3 inch) and larger diameter. Undisturbed sound stumps, roots up to 75 mm (3 inch) diameter, and nonperishable solid objects a minimum of 900 mm (3 feet) below subgrade or finished embankment may be left. Cemetery Projects: do not leave material within burial profile up to 2400 mm (8 feet) below finished grade.

C. Trees and Shrubs: Trees and shrubs, not shown for removal, may be removed from areas within 4500 mm (15 feet) of new construction and 2250 mm (7.5 feet) of utility lines when removal is approved in advance by COR. Remove materials from Medical Center. Box, and otherwise protect from damage, existing trees and shrubs which are not shown to be removed in construction area. Immediately repair damage to existing trees and shrubs by trimming, cleaning and painting damaged areas, including roots, in accordance with standard industry horticultural practice for the geographic area and plant species. Do not store building materials closer to trees and shrubs, that are to remain, than farthest extension of their limbs.

D. Stripping Topsoil: Strip topsoil from within limits of earthwork operations as specified. Topsoil shall be a fertile, friable, natural topsoil of loamy character and characteristic of locality. Topsoil shall be capable of growing healthy horticultural crops of grasses. Stockpile topsoil and protect as directed by COR. Eliminate foreign materials, such as weeds, roots, stones, subsoil, frozen clods, and similar foreign materials larger than 0.014 m3 (1/2 cubic foot) in volume, from soil as it is stockpiled. Retain topsoil on station. Remove foreign materials larger than 50 mm (2 inches) in any dimension from topsoil used in final grading. Topsoil work, such as stripping, stockpiling, and similar topsoil work shall not, under any circumstances, be carried out when soil is wet so that the composition of the soil will be destroyed.

E. Concrete Slabs and Paving: Score deeply or saw cut to insure a neat, straight cut, sections of existing concrete slabs and paving to be removed where excavation or trenching occurs. Extend pavement section to be removed a minimum of 300 mm (12 inches) on each side of widest part of trench excavation and insure final score lines are approximately parallel unless otherwise indicated. Remove material from Medical Center.

F. Disposal: All materials removed from the property shall be disposed of at a legally approved site, for the specific materials, and all removals shall be in accordance with all applicable Federal, State and local regulations. No burning of materials is permitted onsite.

3.2 EXCAVATION

A. Shoring, Sheeting and Bracing: Shore, brace, or slope, its angle of repose or to an angle considered acceptable by the COR, banks of excavations to protect workmen, banks, adjacent paving, structures, and utilities.

1. Design of the temporary support of excavation system is the responsibility of the Contractor. The Contractor shall submit a Shoring and Sheeting plan for approval 15 days prior to starting work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Shoring, including sheet piling, shall be furnished and installed as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Shoring, bracing, and sheeting shall be removed as excavations are backfilled, in a manner to prevent caving.
2. Construction of the support of excavation system shall not interfere with the permanent structure and may begin only after a review by the COR.
3. Extend shoring and bracing to a minimum of 1500 mm (5 feet) below the bottom of excavation. Shore excavations that are carried below elevations of adjacent existing foundations.
4. If bearing material of any foundation is disturbed by excavating, improper shoring or removal of existing or temporary shoring, placing of backfill, and similar operations, the Contractor shall provide a concrete fill support under disturbed foundations, as directed by COR, at no additional cost to the Government. Do not remove shoring until permanent work in excavation has been inspected and approved by COR.
5. The Contractor is required to hire a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer shall be responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer shall update the excavation, sheeting and dewatering plans as construction progresses to reflect changing conditions and shall submit an updated plan if necessary. A written report shall be submitted, at least monthly, informing the Contractor and COR of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Geotechnical Engineer shall be available to meet with the COR at any time throughout the contract duration.

B. Excavation Drainage: Operate pumping equipment, and/or provide other materials, means and equipment as required to keep excavation free of water and subgrade dry, firm, and undisturbed until approval of permanent work has been received from COR. Approval by the COR is also required before placement of the permanent work on all subgrades. Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of

excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction.

C. Subgrade Protection: Protect subgrades from softening, undermining, washout, or damage by rain or water accumulation. Reroute surface water runoff from excavated areas and not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches. When subgrade for foundations has been disturbed by water, remove disturbed material to firm undisturbed material after water is brought under control. Replace disturbed subgrade in trenches with concrete or material approved by the COR.

D. Blasting: Blasting shall not be permitted.

E. Building Earthwork:

1. Excavation shall be accomplished as required by drawings and specifications.
2. Excavate foundation excavations to solid undisturbed subgrade.
3. Remove loose or soft materials to a solid bottom.
4. Fill excess cut under footings or foundations with 25 MPa (3000 psi) concrete poured separately from the footings.
5. Do not tamp earth for backfilling in footing bottoms, except as specified.
6. Slope grades to direct water away from excavations and to prevent ponding.
7. Capillary water barrier (granular fill) under concrete floor and area-way slabs on grade shall be placed directly on the subgrade and shall be compacted with a minimum of two passes of a hand-operated plate-type vibratory compactor.
8. Ensure that footing subgrades have been inspected and approved by the COR prior to concrete placement. Excavate to bottom of pile cap prior to placing or driving piles, unless authorized otherwise by the COR. Backfill and compact over excavations and changes in grade due to pile driving operations to 95 percent of ASTM D698 maximum density.

F. Site Earthwork: Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation. Excavation shall be accomplished as required by drawings and specifications. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 25 mm (1 inch). Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, complying with OSHA requirements, and for inspections. Remove subgrade materials that are determined by COR as unsuitable, and replace with acceptable material. Testing of the soil shall be performed by the VA Testing Laboratory. When unsuitable material is encountered and removed, contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES

and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable. Adjustments to be based on volume in cut section only.

1. Site Grading:
    a. Provide a smooth transition between adjacent existing grades and new grades.
    b. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
    c. Slope grades to direct water away from buildings and to prevent ponds from forming where not designed. Finish subgrades to required elevations within the following tolerances:
        1) Lawn or Unpaved Areas: Plus or minus 25 mm (1 inch).
        2) Walks: Plus or minus 25 mm (1 inch).
        3) Pavements: Plus or minus 13 mm (1 inch).
    d. Grading Inside Building Lines: Finish subgrade to a tolerance of 13 mm (1/2 inch) when tested with a 3000 mm (10 foot) straightedge.

3.3 UNDERPINNING

A. Design of the underpinning system is the responsibility of the Contractor and should be designed by a registered professional engineer and is subject to review and approval by the COR. Underpinning of existing building foundations, as indicated on structural drawings, or where excavation undermines existing foundations, shall be accomplished in the following manner:

1. Make general excavation for new construction, where new foundations are to be below existing foundations, to elevation of new foundations (or sized stone subbase), maintaining a 45 degree sloped berm.
2. For underpinning pits, underpin existing wall foundations by excavating 1200 mm (4 feet) wide pits to depth shown on drawings skipping 3 sections at any one time so as to maintain support for wall at all times.
3. Underpin intervening sections one at a time; no adjacent sections shall be underpinned until concrete in adjacent sections shall have reached 20 MPa (2500 psi) strength and have been dry packed with non-shrink grout to obtain positive bearing. Sheet and brace underpinning pits if soil will not stand on a vertical cut during this operation, or as required for safety of workmen. Repack any voids behind sheeting to prevent sloughing which could cause settlement of existing foundations. Contractor performing this portion of work shall have been prequalified by COR as having previously performed successfully this type of work or will demonstrate his capability for successfully performing this work. It shall be sole responsibility of the Contractor to guard against objectionable movement or settlement and to preserve integrity of existing structures.

4. The tip elevation of the underpinning pits shall be a minimum of 900 mm (3 feet) below the adjacent excavation elevation.
5. Subgrades at the tip of the underpinning pit shall be clean, dry, and free of debris and shall be observed by the COR prior to concrete placement.
6. Concrete shall not be free fall greater than 3000 mm (10 feet) into the pit.

3.4 FILLING AND BACKFILLING

A. General: Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation. For fill and backfill, use excavated materials and borrow meeting the criteria specified herein, as applicable. Borrow will be supplied at no additional cost to the Government. Do not use unsuitable excavated materials. Do not backfill until foundation walls have been completed above grade and adequately braced, waterproofing or dampproofing applied, foundation drainage, and pipes coming in contact with backfill have been installed and work inspected and approved by COR.

B. Placing: Place materials in horizontal layers not exceeding 200 mm (8 inches) in loose depth for material compacted by heavy compaction equipment, and not more than 100 mm (4 inches) in loose depth for material compacted by hand-operated tampers and then compacted. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure. Place no material on surfaces that are muddy, frozen, or contain frost.

C. Compaction: Compact with approved tamping rollers, sheepsfoot rollers, pneumatic tired rollers, steel wheeled rollers, vibrator compactors, or other approved equipment (hand or mechanized) well suited to soil being compacted. Do not operate mechanized vibratory compaction equipment within 3000 mm (10 feet) of new or existing building walls without prior approval of COR. Moisten or aerate material as necessary to provide moisture content that will readily facilitate obtaining specified compaction with equipment used. Backfill adjacent to any and all types of structures shall be placed and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials to prevent wedging action or eccentric loading upon or against the structure. Compact soil to not less than the following percentages of maximum dry density, according to ASTM D698 or ASTM D1557 as specified below:

1. Fills, Embankments, and Backfill
    a. Under proposed structures, building slabs, steps, and paved areas, scarify and recompact top 300 mm (12 inches) of existing subgrade and each layer of backfill or fill material in accordance with ASTM D6938, 95 percent.
    b. Curbs, curbs and gutters, ASTM D6938, 95 percent.

c. Under Sidewalks, scarify and recompact top 150 mm (6 inches) below subgrade and compact each layer of backfill or fill material in accordance with ASTM D6938, 95 percent.
d. Landscaped areas, top 400 mm (16 inches), ASTM D6938, 85 percent.
e. Landscaped areas, below 400 mm (16 inches) of finished grade, ASTM D6938, 90 percent.

2. Natural Ground (Cut or Existing)
a. Under building slabs, steps and paved areas, top 150 mm (6 inches), ASTM D6938, 95 percent.
b. Curbs, curbs and gutters, top 150 mm (6 inches), ASTM D6938, 95 percent.
c. Under sidewalks, top 150 mm (6 inches), ASTM D6938, 95 percent.

D. Borrow Material: Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from the borrow areas within the limits of the project site, selected by the Contractor or from approved private sources. Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling. Borrow material from approved sources on Government-controlled land may be obtained without payment of royalties. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon shall be considered related operations to the borrow excavation.

E. Opening and Drainage of Excavation and Borrow Pits: The Contractor shall notify the COR sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, borrow pits and other excavation areas shall be excavated providing adequate drainage. Overburden and other spoil material shall be transported to designated spoil areas or otherwise disposed of as directed. Borrow pits shall be neatly trimmed and drained after the excavation is completed. The Contractor shall ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.5 GRADING

A. General: Uniformly grade the areas within the limits of this section, including adjacent transition areas. Smooth the finished surface within specified tolerance. Provide uniform levels or slopes between points where elevations are indicated, or between such points and existing finished grades. Provide a smooth transition between abrupt changes in slope.

B. Cut rough or sloping rock to level beds for foundations. In pipe spaces or other unfinished areas, fill low spots and level off with coarse sand or fine gravel.

C. Slope backfill outside building away from building walls for a minimum distance of 1800 mm (6 feet).

D. Finish grade earth floors in pipe basements as shown to a level, uniform slope and leave clean.

E. Finished grade shall be at least 150 mm (6 inches) below bottom line of window or other building wall openings unless greater depth is shown.

F. Place crushed stone or gravel fill under concrete slabs on grade, tamped, and leveled. Thickness of fill shall be 150 mm (6 inches) unless otherwise shown.

G. Finish subgrade in a condition acceptable to COR at least one day in advance of paving operations. Maintain finished subgrade in a smooth and compacted condition until succeeding operation has been accomplished. Scarify, compact, and grade subgrade prior to further construction when approved compacted subgrade is disturbed by Contractor's subsequent operations or adverse weather.

H. Grading for Paved Areas: Provide final grades for both subgrade and base course to +/- 6 mm (0.25 inches) of indicated grades.

3.6 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIAL

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Medical Center property.

B. Place excess excavated materials suitable for fill and/or backfill off site until at which time fill can be used.

C. Remove from site and dispose of any excess excavated materials after all fill and backfill operations have been completed.

D. Segregate all excavated contaminated soil designated by the COR from all other excavated soils, and stockpile on site on two 0.15 mm (6 mil) polyethylene sheets with a polyethylene cover. A designated area shall be selected for this purpose. Dispose of excavated contaminated material in accordance with State and Local requirements.

3.7 CLEAN UP

A. Upon completion of earthwork operations, clean areas within contract limits, remove tools, and equipment. Provide site clear, clean, free of debris, and suitable for subsequent construction operations. Remove all debris, rubbish, and excess material from Medical Center Property.

----- E N D -----

SECTION 31 66 15
HELICAL FOUNDATIONS PILES (OR APPROVED EQUAL)

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Helical anchors used to support tension loads.

B. Helical piles used to support compression loads.

1.2 RELATED REQUIREMENTS

A. Section 31 20 00, EARTHWORK: Excavation.

1.3 PRICE AND PAYMENT PROCEDURES

A. Base bids on anchor/pile quantity and lengths as indicated.

B. If the actual number of installed anchors/piles or the total installed length differs, an adjustment to the Contract Sum will be made based on unit prices defined in the Agreement.

C. No additional payment will be made for withdrawn, damaged, rejected, or misplaced piles; for any portion of a pile remaining above the cut-off elevation; for backdriving; for cutting off piles, or for any cut off length of piles.

D. Quantity and length measurements will be determined by Installation Logs kept and submitted by Contractor and verified by Architect, based on the following:

1. Length: By the linear foot measured from point to existing site elevation or as otherwise indicated.
2. Test Anchors/Piles: Assume feet longer than longest designed length.

1.4 DEFINITIONS

A. Specific terms used in this section are defined below. Terms not defined below are defined in DFI TM-GLOS-1 first and then by common usage.

B. Extension Section: Helical foundation component installed between lead section and load transfer device.

C. Effective Torsional Resistance: Average installation torque typically taken over a distance equal to last three diameters of penetration of largest helix plate.

D. Geotechnical Capacity (or, Ultimate Soil Capacity): Maximum load resisted.

E. Lead Section: First helical foundation component installed in soil.

F. Limit State: Condition beyond which a helical foundation component is unfit for service.

1. Serviceability Limit State: Foundation no longer useful for its intended function.
2. Strength Limit State: Foundation is unsafe.

G. Loads: Forces or other actions that result from weight of all building materials, occupants and their possessions, environmental effects, differential movement, and restrained dimensional changes. Permanent loads are those loads in which variations over time are rare or of small magnitude. All other loads are variable loads (see also Nominal Load below).

H. Load Test: Procedure to test capacity and relation of load to movement.

I. Mechanical Strength: Maximum tension load resisted by structural elements of helical foundation.

J. Nominal Load: Magnitude of loads determined by Engineer, including dead load, live load and other imposed by building code requirements

K. Reveal: Distance along longitudinal axis from ground surface to end of last installed extension of a foundation.

L. Safety Factor: Ratio of ultimate pullout resistance to nominal load.

M. Ultimate Pullout Resistance: Limit state based on lesser of mechanical strength or geotechnical capacity and defined as point at which helical foundation can resist no additional load.

1.5 REFERENCE STANDARDS

A. AISC 360 - Specification for Structural Steel Buildings 2016.

B. ASTM A29/A29M - Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought 2020.

C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.

D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.

E. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes 2021a.

F. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel 2021, with Editorial Revision.

G. ASTM D1143/D1143M - Standard Test Methods for Deep Foundation Elements Under Static Axial Compressive Load 2020.

H. DFI TM-GLOS-1 - Deep Foundation Institute Technical Manual; Glossary of Foundation Terms 1981.

I. RCSC (HSBOLT) - Specification for Structural Joints Using High-Strength Bolts; Research Council on Structural Connections 2014, with Errata (2015).

J. SAE J429 - Mechanical and Material Requirements for Externally Threaded Fasteners 2014.

1.6 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation meeting: Conduct a preinstallation meeting at least one week prior to start of work of this section; require attendance by all affected installers.

1.7 SUBMITTALS

A. See Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, for submittal procedures.

B. Product Data: Product list, with manufacturer's model designations; published capacities for installed assemblies, including load transfer devices.

C. Design Data: Submit documentation of foundation design, signed and certified by foundation designer; include:
   1. Statement that proposed foundations meet specified design criteria.
   2. Nominal load on each foundation element.
   3. Maximum allowable installation torque of each selected product.
   4. Calculated theoretical geotechnical capacity.
   5. Minimum effective torsional resistance requirements.
   6. Minimum embedment lengths and such other site specific embedment depth requirements.
   7. Inclination angle and location tolerance requirements.
   8. Pre-tensioning requirements, if any.
   9. Submit not less than four weeks prior to start of foundation installation.

D. Designer's Qualification Statement.

E. Installer's Qualification Statement.

F. Surveyor's Qualification Statement.

G. Installation Logs:
   1. Submit a copy of the log of each individual foundation element within 1 week after installation is completed.
   2. Submit final copy of all installation logs within 3 weeks after completing all helical foundation work.

H. Field Test Reports.

I. Project Record Documents: After work is complete, submit certification from surveyor that installed foundation locations are as shown on drawings.

1.8 QUALITY ASSURANCE

A. Designer Qualifications: Experienced in design of helical foundations of the type involved on this project, as evidenced by:
   1. State registration/licensure as a professional engineer.
   2. Recognition by local authority having jurisdiction.
   3. List of three or more similar projects designed within the previous three years and names of project representatives who can verify such participation.
   4. Manufacturer's written recommendation.

B. Installer Qualifications: Experienced in installation of helical foundations of the type involved on this project, as evidenced by:
   1. Manufacturer's certificate of competency in installing helical piles.

2. List of three or more similar projects completed within the previous three years and names of representatives who can verify such participation.
3. Letter from manufacturer stating ability and intent to provide on-site supervision.
4. List of all safety violations lodged against installer within previous three years and current status/final resolutions thereof.

C. Surveyor Qualifications: Engineer or land surveyor licensed in the State in which the Project is located.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Helical Piles and Anchors:
1. Foundation Supportworks, Inc
www.foundationsupportworks.com/#sle.
2. Substitutions: See Section 01 6000 - Product Requirements

2.2 HELICAL FOUNDATION DESIGN CRITERIA

A. It is Contractor's responsibility to design, or obtain qualified design, of the helical foundations as indicated in Contract Documents.
1. Information necessary for design that is contained in Contract Documents includes:
a. Locations of foundation elements.
b. Nominal design load for each foundation element, including dead load, live load and other loads required by building codes.

B. Subsurface geotechnical data may be obtained from new geotechnical report.

C. Helical Foundation Elements: One or more helical deformed plates (helix plates) attached to a central shaft with a load transfer device for attachment to a structure; entire element resisting applied loads by soil pressure.
1. Design foundations to support/resist the nominal design loads shown on drawings in accordance with AISC 360 Allowable Stress Design method; RCSC (HSBOLT) Load and Resistance Factor Design method.
2. Select foundation elements based on allowable installation torque and calculated minimum embedment length; maximum embedment length, if any; and minimum effective torsional resistance.
3. Corrosion Service Life: 50 years, minimum.
4. Use solid square shaft helical anchors where subject to tension alone.
5. Use hollow, round shaft helical foundations where subject to compression only or to alternating tension and compression.

D. Helical Anchors:
1. Base design on published capacities that represent entire anchor including couplings and connections.

2. Safety Factor: 3 times ultimate pullout/bearing resistance, minimum.
3. Axial Deflection at Nominal Tension Load: As indicated on drawings.
4. Pre-tensioning of anchors is acceptable method of reducing deflection at service loads.

E. Helical Piles:
1. Design with pile shaft sections in direct contact with couplings and no coupling bolts or welds in load path
2. Safety Factor: 2 ;
3. Deflection: As indicated on drawings.
4. Fit Up Tolerance: 1/16 inch;

2.3 MATERIALS

A. All Components: Hot-dipped galvanized in accordance with ASTM A123/A123M; Manufacturer's standard coating;

B. Helical Anchors: Solid, square shaft of hot rolled, solid, Round-Cornered-Square (RCS), carbon steel bar complying with ASTM A29/A29M.
1. Size: 1-1/2 inch;
2. Torque Strength: 6,000 foot-pounds
3. Minimum Yield Strength: 90 kips per square inch;

C. Helical Anchors and Piles: Hollow, round shaft of structural steel tube or pipe (rolled) complying with ASTM A572/A572M.
1. Size: 2-7/8 inches; O.D. by 0.203 inch;
2. Torque Strength: 6,000 foot-pounds;
3. Minimum Yield Strength: 60 kips per square inch.

D. Helical Anchors and Piles: Hollow, round shaft of structural steel tube or pipe (welded or seamless) complying with ASTM A500/A500M.
1. Size: 2-7/8 inches O.D. by 0.276 inch wall thickness.
2. Torque Strength: 8,000 foot-pounds;
3. Minimum Yield Strength: 60 kips per square inch kips per square inch.

E. Helical Anchors and Piles: Hollow, round shaft of structural steel tube or pipe (rolled) complying with ASTM A572/A572M.
1. Size: 3-1/2 inches; O.D. by 0.313 inch wall thickness.
2. Torque Strength: 16,000 foot-pounds; or foot-pounds.
3. Minimum Yield Strength: 65 kips per square inch.

F. Helix Plates: Round steel plates formed into helical spiral on matching metal dies to true helical shape and uniform pitch; welded to central shaft with all plates tracking the same path as leading helix.
1. Material: Hot rolled carbon steel sheet, strip, or plate complying with ASTM A36/A36M or ASTM A572/A572M, Grade 50.

2. Thickness: 3/8 inch; 1/2 inch;
3. Profile: True helix-shaped plates, normal to shaft, leading and trailing edges within 1/4 inch.
4. Pitch: All helix plates shall have uniform pitch.
5. Spacing: See structural drawings

G. Bolts: SAE J429, Grade 8, bolts with nut.

H. Couplings: Integral to shaft; External sleeve welded to shaft with two bolt pattern; Detached sleeve couplings with four bolt pattern;

I. Anchor Plates or Pile Caps: Load-transfer assembly welded from structural steel complying with ASTM A36/A36M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures near the work and underground utilities from damage.

B. Mark underground utilities as required by authority having jurisdiction. Avoid contact with all marked underground facilities.

C. Locate the starting point of installation in relation to existing site elevation;

D. Notify Owner at least 48 hours prior starting to installation.

3.2 INSTALLATION

A. Install helical foundations as shown on drawings and approved design documentation. In event of conflict between drawings and approved anchorage design documentation, do not begin construction on any affected items until such conflict has been resolved.

B. Comply with manufacturer's written installation requirements and recommendations for specific project site and conditions.

C. Use installation methods that will not cause damage to existing adjacent or nearby structures.

D. Keep and submit a log of helical foundation installations, including the following data:

1. Date and time of installation.
2. Location of foundation element.
3. Installed foundation type and configuration.
4. Foundation reveal.
5. Total length of installed foundation element.
6. Installed inclination of foundation element.
7. For compression piles, installation torque measurements taken in one to three foot increments of total length.
8. Actual effective torsional resistance.
9. Calculated geotechnical capacity based on actual torsional resistance and soil parameters appropriate for subsurface conditions within three helix diameters above helix depth.

10. Comments pertaining to interruptions, obstructions, or other relevant information.

E. If required, position inclined helical anchors perpendicular in order to assist in advancement into soil before establishing required batter angle; after initial penetration, establish required angle of inclination

F. Engage helical sections into soil and advance in a smooth, continuous manner at a rate of rotation of 5 to 25 RPM.

G. Apply sufficient down pressure to uniformly advance helical sections a distance per revolution approximately equal to pitch of helix plates.

H. Adjust rate of rotation and magnitude of down pressure for specific soil conditions and depths.

I. Provide extension sections as required to achieve required results.

J. Achieve both minimum embedment length and minimum effective torsional resistance prior to terminating foundation installation.

K. Location Tolerances:

1. Pile Head Horizontal Tolerance: Within 2 inches of location shown on drawings.
2. Pile Shaft Angular Tolerance: Within 2 degrees of inclination angle shown on drawings.
3. Anchor Head Location Tolerance: Within 3 inches laterally and 3 inches longitudinally of location shown on drawings. Coordinate with contractor in field as to not disturb existing foundations.
4. Anchor Shaft Angular Tolerance: Within 2 degrees of inclination angle shown on drawings. Coordinate with contractor in field as to not disturb existing foundations.
5. Employ surveyor to document actual locations of foundation elements.

3.3 ACHIEVEMENT OF EFFECTIVE INSTALLATIONS

A. In the event that the initial installation of a foundation element does not achieve both minimum embedment length and minimum effective torsional resistance, adjust, repair, or replace that foundation element so that it does achieve both requirements.

1. The following procedures are considered acceptable and do not require prior approval unless otherwise indicated.
2. All other proposed remedies must be approved by Owner prior to implementation.

B. Minimum Embedment Length Achieved Before Achieving Minimum Effective Torsional Resistance: Use one of the following procedures:

1. Continue installation to greater depths until minimum effective torsional resistance is achieved, provided that, if maximum length constraint is applicable, continued installation does not exceed said maximum length.
2. Demonstrate acceptable foundation performance through testing.
3. Replace foundation with one having a different helix configuration, as follows:
   a. Embed replacement to a length placing last helix at least three times its own diameter beyond position of first helix of replaced foundation.

b. Achieve minimum effective torsional resistance.
c. Do not exceed any applicable maximum embedment length.
d. Test replacement.

C. Allowable Torque Rating Reached Before Achieving Minimum Embedment Length: Use one of the following procedures:
1. If permitted by Owner, terminate installation at length achieved.
2. Replace foundation with one having either a higher torsional strength rating or a different helix configuration, as follows:
a. Achieve minimum embedment length and minimum effective torsional resistance.
b. Embed replacement to length that places last helix at least three times helix diameter beyond position of first helix of replaced foundation.
c. Do not exceed any applicable maximum embedment length limit.
3. If allowed by location tolerance or approved by Owner, remove foundation section and reinstall as follows:
a. Position reinstalled foundation at least three times diameter of largest helix away from initial location.
b. Achieve original embedment length and torsional resistance criteria.
c. If repositioning requires installation of additional helical foundations, adjust nominal loads for spacing changes.

D. Maximum Embedment Length Reached Before Achieving Minimum Effective Torsional Resistance: Use one of the following procedures:
1. If allowed by location tolerance or approved by Owner, remove and reinstall foundation as follows:
a. Position reinstalled foundation at least three times diameter of largest helix away from initial location.
b. Achieve original minimum embedment length and minimum effective torsional resistance.
c. If repositioning requires installation of additional helical foundations, adjust nominal loads for spacing changes.
2. Demonstrate acceptable foundation performance through testing.
3. De-rate load capacity of helical foundation and install additional foundations as necessary; de-rated capacity and additional foundation location shall be subject to approval of Owner.
4. Replace foundation with one having a different helix configuration; achieve minimum embedment length and minimum effective torsional resistance.

E. Failure of Field Quality Control Test: Use one of the following procedures:

1. Install foundation to a greater depth and installation torque and re-test provided that, if a maximum embedment length constraint is applicable, continued installation will not exceed said maximum length constraint.
2. Replace foundation with one having a different helix configuration. Embed last helix at least three times its own diameter beyond position of first helix of replaced foundation without exceeding any applicable maximum embedment length requirements. Re-test replacement.
3. If approved by Owner, de-rate load capacity of helical foundation and install additional foundations at positions that are at least three times diameter of largest helix away from any other foundation locations; space anchors in cohesive soils not closer than four helix diameters.

3.4 FIELD QUALITY CONTROL

A. Owner will employ independent testing agency to field test helical foundations.

B. Cooperate with testing agency and provide full access to installed foundations.

C. Test installed helical foundations indicated per ASTM D1143/D1143M

D. Failure of Tests: Replace or re-drive, and re-test, helical foundations that any fail test and cannot be remedied using any of the procedures described above in "ACHIEVEMENT OF EFFECTIVE INSTALLATIONS" article.

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SECTION 32 05 23
CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Subbase for concrete pavements.
2. Pedestrian Pavement: Walks, grade slabs, and steps.

1.2 RELATED REQUIREMENTS

A. Field Testing: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Step Nosings and Railings: Section 05 50 00, METAL FABRICATIONS.

C. Subgrade Preparation and Subbase Compaction: Section 31 20 00, EARTHWORK.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American Association of State Highway and Transportation Officials (AASHTO):

M147-65-UL-04 ..... Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.

M233-86..... Boiled Linseed Oil Mixture for Treatment of Portland Cement Concrete.

C. American Concrete Institute (ACI):

305R-10 ..... Guide to Hot Weather Concreting.

306R-10 ..... Guide to Cold Weather Concreting.

D. American National Standards Institute (ANSI):

B101.3 ..... Wet DOCF of Common Hard Surface Floor Materials (Including Action and Limit Thresholds for the Suitable Assessment of the Measured Values).

E. ASTM International (ASTM):

A615/A615M-16..... Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.

A996/A996M-15..... Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.

A1064/A1064M-16..... Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

C33/C33M-16 ..... Concrete Aggregates.

C94/C94M-16 ..... Ready Mixed Concrete.

C143/C143M-15a ..... Slump of Hydraulic Cement Concrete.

C150/C150M-16 ..... Portland Cement.

C171-16 ..... Sheet Materials for Curing Concrete.

C260/C260M-10a ..... Air Entraining Admixtures for Concrete.
C309-11 ..... Liquid Membrane Forming Compounds for Curing Concrete.
C494/C494M-15a ..... Chemical Admixtures for Concrete.
D1751-04(2013)e1 ..... Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
D5893/D5893M-10 ..... Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
D6690-15 ..... Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
B. Submittal Drawings:
   1. Show size, configuration, and fabrication and installation details.
   2. Show reinforcing.
   3. Include jointing plan for concrete pavements.
C. Manufacturer's Literature and Data:
   1. Description of each product.
   2. Installation instructions.
D. Test reports: Certify products comply with specifications.
   1. Concrete materials.
   2. Select subbase materials.
   3. Field test reports.
E. Certificates: Certify products comply with specifications.
   1. Expansion joint filler.
   2. Reinforcement.
   3. Curing materials.
   4. Concrete protective coating.
F. Concrete mix design.
G. Select subbase job-mix design.
H. Proposed hot and cold weather concreting methods.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Regularly installs specified products.
B. Preconstruction Testing:
   1. Engage independent testing laboratory to perform tests and submit reports.
      a. Deliver samples to laboratory in number and quantity required for testing.

2. Concrete mix design.
3. Select subbase job-mix design. Report the following:
    a. Material sources.
    b. Gradation.
    c. Plasticity index.
    d. Liquid limit.
    e. Laboratory compaction curves indicating maximum density at optimum moisture content.

1.6 DELIVERY

A. Deliver steel reinforcement to prevent damage.

B. Before installation, return or dispose of distorted or damaged steel reinforcement.

C. Bulk Products: Deliver bulk products away from buildings, utilities, pavement, and existing turf and planted areas. Maintain dry bulk product storage away from contaminants.

1.7 STORAGE AND HANDLING

A. Store products indoors in dry, weathertight facility.

B. Protect products from damage during handling and construction operations.

1.8 FIELD CONDITIONS

A. Hot Weather Concreting Procedures: ACI 305R.

B. Cold Weather Concreting Procedures: ACI 306R.

1. Use non-corrosive, non-chloride accelerator admixture.
2. Do not use calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions.

1.9 WARRANTY

A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II.

B. Coarse Aggregate: ASTM C33/C33M; size to suit application.

C. Fine Aggregate: ASTM C33/C33M.

D. Mixing Water: Fresh, clean, and potable.

E. Air-Entraining Admixture: ASTM C260/C260M.

F. Chemical Admixtures: ASTM C494/C494M.

G. Reinforcing Steel: ASTM A615/A615M or ASTM A996/A996M, Grade 420 (60); deformed.

H. Welded Wire Fabric: ASTM A1064/A1064M, plain or deformed; Grade 515 (75); sized as indicated.

I. Expansion Joint Filler: ASTM D1751.

J. Sheet Materials for Curing Concrete: ASTM C171.

2.2 SELECT SUBBASE

A. Subbase: AASHTO M147; Grade A.

1. Select granular material composed of sand, sand-gravel, crushed stone, crushed or granulated slag, with or without soil binder, or combinations of these materials.

SUBBASE GRADING REQUIREMENTS		
Sieve Size		Percentage Passing by Mass
(mm)	(in)	Grade A
50	2	100
25	1	
9.5	3/8	30-65
4.47	No. 4	25-55
2.00	No. 10	15-40
0.425	No. 40	8-20
0.075	No. 200	2-8

B. Other Acceptable Gradations: Materials within three to five percent, plus or minus, of specified gradation, or as recommended by the geotechnical engineer and approved by the Contracting Officer's Representative.

1. Plywood: Exterior grade, free of defects and patches on contact surface.
2. Lumber: Sound, grade-marked, S4S stress graded softwood, minimum 50 mm (2 inches) thick, free from warp, twist, loose knots, splits, or other defects.
3. Form Coating: As recommended by Architect/Engineer.

C. Provide forms suitable in cross-section, depth, and strength to resist springing during depositing and consolidating concrete.

1. Do not use forms varying from straight line more than 3 mm in 3000 mm (1/8 inch in 10 feet), horizontally and vertically.

2.3 CONCRETE CURING MATERIALS

A. Concrete curing materials, conform to one of the following:

1. Burlap: Minimum 233 g/sq. m (7 ounces/sq. yd.) dry.
2. Sheet Materials for Curing Concrete: ASTM C171.
3. Curing Compound: ASTM C309, Type 1 clear; liquid membrane forming type, without paraffin or petroleum.

2.4 CONCRETE MIXES

A. Design concrete mixes according to ASTM C94/C94M, Option C.

B. Concrete Type: Air-entrained. See Table I.

TABLE I – CONCRETE TYPE			
Concrete Type	Minimum 28 Day Compressive Strength f'c MPa (psi)	Air-Entrained	
		Min. Cement kg/cu. m (lbs./cu. yd.)	Max. Water Cement Ratio
A	35 (5000)1,3	385 (650)	0.40
B	30 (4000)1,3	340 (570)	0.50
C	25 (3000)1,3	290 (490)	0.55
D	25 (3000)1,2	310 (520)	*

C. Maximum Slump: ASTM C143/C143M. See Table II.

TABLE II - MAXIMUM SLUMP	
APPLICATION	MAXIMUM SLUMP
Curb & Gutter	75 mm (3 inches)
Pedestrian Pavement	75 mm (3 inches)
Vehicular Pavement	50 mm (2 inches) Machine Finished 100 mm (4 inches) Hand Finished
Equipment Pad	75 to 100 mm (3 to 4 inches)

2.5 ACCESSORIES

A. Equipment and Tools: Obtain Contracting Officer's Representative's approval of equipment and tools needed for handling materials and performing work before work begins.

B. Maintain equipment and tools in satisfactory working condition.

C. Sealants:

1. Concrete Paving Expansion Joints: ASTM D5893/D5893M, Type SL, single component, self-leveling, silicone joint sealant.
2. Concrete Paving Joints: ASTM D6690, Type IV, hot-applied, single component joint sealant.

D. Concrete Protective Coating: AASHTO M233 linseed oil mixture.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

B. Protect existing construction and completed work from damage.

C. Prepare, construct, and finish subgrade. See Section 31 20 00, EARTHWORK.

D. Maintain subgrade in smooth, compacted condition, in conformance with the required section and established grade until the succeeding operation has been accomplished.

3.2 SELECT SUBBASE

A. Placing:
   1. Place subbase material on prepared subgrade in uniform layer to required contour and grades, and to maximum 200 mm (8 inches) loose depth.
   2. When required compacted thickness exceeds 150 mm (6 inches), place subbase material in equal thickness layers.
   3. When subbase elevation is 13 mm (1/2 inch) or more below required grade, excavate subbase minimum 75 mm (3 inches) deep. Place and compact subbase to required grade.

B. Compaction:
   1. Perform compaction with approved hand or mechanical equipment well suited to the material being compacted.
   2. Maintain subbase at optimum moisture content for compaction.
   3. Compact each subbase layer to minimum 95 percent or 100 percent of maximum density as specified in Section 31 20 00, EARTHWORK.

C. Protection:
   1. Protect subbase from damage until concrete is placed.
   2. Reconstruct damaged subbase before placing concrete.

3.3 SETTING FORMS

A. Form Substrate:
   1. Compact form substrate to uniformly support forms along entire length.
   2. Correct substrate imperfections and variations by cutting, filling, and compacting.

B. Form Setting:
   1. Set forms to indicated line and grade with tight joints. Rigidly brace forms preventing movement.
   2. Remove forms when removal will not damage concrete and when required for finishing.
   3. Clean and oil forms before each use.
   4. Correct forms, when required, immediately before placing concrete.

C. Form Tolerances:
   1. Variation from Indicated Line: Maximum 6 mm (1/4 inch).
   2. Variation from Indicated Grade: Maximum 3 mm in 3000 mm (1/8 inch in 10 feet).

3.4 PLACING REINFORCEMENT

A. Keep reinforcement clean from contamination preventing concrete bond.

B. Install reinforcement shown on drawings.

C. Support and securely tie reinforcing steel to prevent displacement during concrete placement.

D. Obtain Contracting Officer's Representative's reinforcement placement approval before placing concrete.

3.5 JOINTS - GENERAL

A. Place joints, where shown on approved submittal Drawings.
   1. Conform to details shown.
   2. Install joints perpendicular to finished concrete surface.

B. Make joints straight and continuous from edge to edge of pavement.

3.6 CONTRACTION JOINTS

A. Tool or cut joints to width, depth, and radius edge shown on drawings using grooving tool, jointer, or saw.

B. Finish joint edges with edging tool.

C. Score pedestrian pavement with grooving tool or jointer.

3.7 EXPANSION JOINTS

A. Form expansion joints with expansion joint filler of thickness shown on drawings.
   1. Locate joints around perimeter of structures and features abutting site work concrete.
   2. Create complete, uniform separation between structure and site work concrete.

B. Extend expansion joint material full depth of concrete with top edge of joint filler below finished concrete surface where sealant is indicated on Drawings.

C. Cut and shape material matching cross section.

D. Anchor with approved devices to prevent displacing during placing and finishing operations.

E. Round joint edges with edging tool.

3.8 PLACING CONCRETE - GENERAL

A. Preparation before Placing Concrete:
   1. Obtain Contracting Officer's Representative approval.
   2. Remove debris and other foreign material.
   3. Uniformly moisten substrate, without standing water.

B. Convey concrete from mixer to final location without segregation or loss of ingredients. Deposit concrete to minimize handling.

C. During placement, consolidate concrete by spading or vibrating to minimize voids, honeycomb, and rock pockets.
   1. Vibrate concrete against forms and along joints.
   2. Avoid excess vibration and handling causing segregation.

D. Place concrete continuously between joints without bulkheads.

E. Install construction joint in concrete placement suspended for more than 30 minutes.

F. Replace concrete with cracks, chips, bird baths, and other defects to nearest joints, approved by Contracting Officer's Representative.

3.9 PLACING CONCRETE FOR PEDESTRIAN PAVEMENT

A. Place concrete in one layer conforming to cross section shown on Drawings after consolidating and finishing.

B. Deposit concrete near joints without disturbing joints. Do not place concrete directly onto joint assemblies.

C. Strike concrete surface to proper section ready for consolidation.

D. Finish concrete surface with wood or metal float.

3.10 FORM REMOVAL

A. Keep forms in place minimum 12 hours after concrete placement. Remove forms without damaging concrete.

B. Do not use bars or heavy tools against concrete to remove forms. Repair damage concrete found after form removal.

3.11 CONCRETE FINISHING - GENERAL

A. Follow operation sequence below, unless otherwise indicated on Drawings:

1. Consolidating, floating, striking, troweling, texturing, and joint edging.

B. Use edging tool with 6 mm (1/4 inch) radius, unless otherwise shown on Drawings.

C. Keep finishing equipment and tools clean and suitable for use.

3.12 CONCRETE FINISHING - PEDESTRIAN PAVEMENT

A. Walks, Grade Slabs:

1. Finish concrete surfaces with metal float, troweled smooth, and finished with a broom moistened with clear water.
2. Finish slab edges and formed transverse joints with edger.
3. Broom surfaces transverse to traffic direction.
    a. Use brooming to eliminate flat surface produced by edger.
    b. Produce uniform corrugations, maximum 1.5 mm (1/16 inch) deep profile.
4. Provide surface uniform in color and free of surface blemishes, form marks, and tool marks.
5. Paving Tolerances:
    a. Variation from Indicated Plane: Maximum 5 mm in 3000 mm (3/16 inch in 10 feet).
    b. Variation from Indicated Thickness: Maximum 6 mm (1/4 inch).
6. Replace paving within joint boundary when paving exceeds specified tolerances.

B. Step Treads, Risers and Sidewalls: Finish as specified for pedestrian pavement, except as follows:

1. Remove riser forms sequentially, starting with top riser.

2. Rub riser face with wood or concrete rubbing block and water. Remove blemishes, form marks, and tool marks. Use outside edger to round nosing; use inside edger to finish bottom of riser.
3. Apply uniform brush finish to treads, risers, and sidewall.
    a. Apply stiff brush finish to treads to provide slip resistant surface complying with ANSI B101.3.
4. Step Tolerance:
    a. Variation from Indicated Plane: Maximum 5 mm in 3000 mm (3/16 inch in 10 feet).

3.13 CONCRETE CURING

A. Concrete Protection:
    1. Protect unhardened concrete from rain and flowing water.
    2. Provide sufficient curing and protection materials available and ready for use before concrete placement begins.
    3. Protect concrete to prevent pavement cracking from ambient temperature changes during curing period.
        a. Replace pavement damaged by curing method allowing concrete cracking.
        b. Employ another curing method as directed by Contracting Officer's Representative.

B. Cure concrete for minimum 7 days by one of the following methods appropriate to weather conditions preventing moisture loss and rapid temperature change:
    1. Burlap Mat: Provide minimum two layers kept saturated with water during curing period. Overlap Mats at least 150 mm (6 inches).
    2. Sheet Materials:
        a. Wet exposed concrete surface with fine water spray and cover with sheet materials.
        b. Overlap sheets minimum 300 mm (12 inches).
        c. Securely anchor sheet materials preventing displacement.
    3. Curing Compound:
        a. Protect joints indicated to receive sealants preventing contamination from curing compound.
        b. Insert moistened paper or fiber rope into joint or cover joint with waterproof paper.
        c. Apply curing compound before concrete dries.
        d. Apply curing compound in two coats at right angles to each other.
        e. Application Rate: Maximum 5 sq. m/L (200 sq. ft./gallon), both coats.
        f. Immediately reapply curing compound to surfaces damaged during curing period.

3.14 CONCRETE PROTECTIVE COATING

A. Apply protective coating of linseed oil mixture to exposed-to-view concrete surfaces, drainage structures, and features that project through, into, or against concrete exterior improvements to protect the concrete against deicing materials.

B. Complete backfilling and curing operation before applying protective coating.

C. Dry and thoroughly clean concrete before each application.

D. Apply two coats, with maximum coverage of 11 sq. m/L (50 sq. yds./gal.); first coat, and maximum 16 sq. m/L (70 sq. yds./gal.); second coat, except apply commercially prepared mixture according to manufacturer's instructions.

E. Protect coated surfaces from vehicular and pedestrian traffic until dry.

F. Do not heat protective coating, and do not expose protective coating to open flame, sparks, or fire adjacent to open containers or applicators. Do not apply material at temperatures lower than 10 degrees C (50 degrees F).

3.15 FIELD QUALITY CONTROL

A. Field Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.

1. Compaction.
    a. Pavement subgrade.
    b. Sidewalk.
2. Concrete:
    a. Delivery samples.
    b. Field samples.
3. Slip Resistance: Steps and pedestrian paving.

3.16 CLEANING

A. After completing curing:

1. Remove burlap and sheet curing materials.
2. Sweep concrete clean, removing foreign matter from the joints.
3. Seal joints as specified.

3.17 PROTECTION

A. Protect exterior improvements from traffic and construction operations.

1. Prohibit traffic on paving for minimum seven days after placement, or longer as directed by Contracting Officer's Representative.

B. Remove protective materials immediately before acceptance.

C. Repair damage.

1. Replace concrete containing excessive cracking, fractures, spalling, and other defects within joint boundary, when directed by Contracting Officer's Representative, and at no additional cost to the Government.

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SECTION 32 12 16
ASPHALT PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work shall cover the composition, mixing, construction upon the prepared subgrade, and the protection of hot asphalt concrete pavement. The hot asphalt concrete pavement shall consist of an aggregate or asphalt base course and asphalt surface course constructed in conformity with the lines, grades, thickness, and cross sections as shown. Each course shall be constructed to the depth, section, or elevation required by the drawings and shall be rolled, finished, and approved before the placement of the next course.

1.2 RELATED WORK

A. Laboratory and field testing requirements: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Subgrade Preparation: Paragraph 3.3 and Section 31 20 00, EARTHWORK.

1.3 INSPECTION OF PLANT AND EQUIPMENT

A. The COR shall have access at all times to all parts of the material producing plants for checking the mixing operations and materials and the adequacy of the equipment in use.

1.4 ALIGNMENT AND GRADE CONTROL

A. The Contractor’s Registered Professional Land Surveyor shall establish and control the pavement (aggregate or asphalt base course and asphalt surface course) alignments, grades, elevations, and cross sections as shown on the Drawings.

1.5 SUBMITTALS

A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:

B. Data and Test Reports:

1. Aggregate Base Course: Sources, gradation, liquid limit, plasticity index, percentage of wear, and other tests required by State Highway Department.
2. Asphalt Base/Surface Course: Aggregate source, gradation, soundness loss, percentage of wear, and other tests required by State Highway Department.
3. Job-mix formula.

C. Certifications:

1. Asphalt prime and tack coat material certificate of conformance to State Highway Department requirements.
2. Asphalt cement certificate of conformance to State Highway Department requirements.
3. Job-mix certification - Submit plant mix certification that mix equals or exceeds the State Highway Specification.

D. One copy of State Highway Department Specifications.

E. Provide MSDS (Material Safety Data Sheets) for all chemicals used on ground.

PART 2 - PRODUCTS

2.1 GENERAL

A. Aggregate base and asphalt concrete materials shall conform to the requirements of the following and other appropriate sections of the latest version of the State Highway Material Specifications, including amendments, addenda and errata. Where the term "Engineer" or "Commission" is referenced in the State Highway Specifications, it shall mean the VA COR or VA Contracting Officer.

B. Non-wearing Course: LVNW35030B.

C. Wearing Course: LVWE35030B.

1. No RAP will be allowed in the bituminous wearing course.

2.2 AGGREGATES

A. Provide aggregates consisting of crushed stone, gravel, sand, or other sound, durable mineral materials processed and blended, and naturally combined.

B. Subbase aggregate (where required) maximum size: 38mm(1-1/2").

C. Base aggregate maximum size:

1. Base course over 152mm(6") thick: 38mm(1-1/2");
2. Other base courses: 19mm(3/4").

D. Asphaltic base course:

1. Maximum particle size not to exceed 25.4mm(1”).
2. Where conflicts arise between this specification and the requirements in the latest version of the State Highway Specifications, the State Specifications shall control.

E. Aggregates for asphaltic concrete paving: Provide a mixture of sand, mineral aggregate, and liquid asphalt mixed in such proportions that the percentage by weight will be within:

Sieve Sizes	Percentage Passing
19mm(3/4")	100
9.5mm(3/8")	67 to 85
6.4mm(1/4")	50 to 65
2.4mm(No. 8 mesh)	37 to 50
600µm(No. 30 mesh)	15 to 25
75µm(No. 200 mesh)	3 to 8

plus 50/60 penetration liquid asphalt at 5 percent to 6-1/2 percent of the combined dry aggregates.

2.3 ASPHALTS

A. Comply with provisions of Asphalt Institute Specification SS2:

1. Asphalt cement:Penetration grade 50/60
2. Prime coat: Cut-back type, grade MC-250

3. Tack coat: Uniformly emulsified, grade SS-1H

2.4 SEALER

A. Provide a sealer consisting of suitable fibrated chemical type asphalt base binders and fillers having a container consistency suitable for troweling after thorough stirring, and containing no clay or other deleterious substance.

B. Where conflicts arise between this specification and the requirements in the latest version of the State Highway Specifications, the State Specifications shall control.

PART 3 - EXECUTION

3.1 GENERAL

A. The Asphalt Concrete Paving equipment, weather limitations, job-mix formula, mixing, construction methods, compaction, finishing, tolerance, and protection shall conform to the requirements of the appropriate sections of the State Highway Specifications for the type of material specified.

3.2 MIXING ASPHALTIC CONCRETE MATERIALS

A. Provide hot plant-mixed asphaltic concrete paving materials.

1. Temperature leaving the plant: 143 degrees C(290 degrees F) minimum, 160 degrees C(320 degrees F) maximum.
2. Temperature at time of placing: 138 degrees C(280 degrees F) minimum.

3.3 SUBGRADE

A. Shape to line and grade and compact with self-propelled rollers.

B. All depressions that develop under rolling shall be filled with acceptable material and the area re-rolled.

C. Soft areas shall be removed and filled with acceptable materials and the area re-rolled.

D. Should the subgrade become rutted or displaced prior to the placing of the subbase, it shall be reworked to bring to line and grade.

E. Proof-roll the subgrade with maximum 45 tonne (50 ton) gross weight dump truck as directed by VA COR or VA Contracting Officer. If pumping, pushing, or other movement is observed, rework the area to provide a stable and compacted subgrade.

3.4 BASE COURSES

A. Subbase (when required)

1. Spread and compact to the thickness shown on the drawings.
2. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead of the roller.
3. After completion of the subbase rolling there shall be no hauling over the subbase other than the delivery of material for the top course.

B. Base

1. Spread and compact to the thickness shown on the drawings.

2. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead of the roller.
3. After completion of the base rolling there shall be no hauling over the base other than the delivery of material for the top course.

C. Thickness tolerance: Provide the compacted thicknesses shown on the Drawings within a tolerance of minus 0.0mm (0.0") to plus 12.7mm (0.5").

D. Smoothness tolerance: Provide the lines and grades shown on the Drawings within a tolerance of 5mm in 3m (3/16 inch in ten feet).

E. Moisture content: Use only the amount of moisture needed to achieve the specified compaction.

3.5 PLACEMENT OF ASPHALTIC CONCRETE PAVING

A. Remove all loose materials from the compacted base.

B. Apply the specified prime coat, and tack coat where required, and allow to dry in accordance with the manufacturer's recommendations as approved by the Architect or Engineer.

C. Receipt of asphaltic concrete materials:
1. Do not accept material unless it is covered with a tarpaulin until unloaded, and unless the material has a temperature of not less than 130 degrees C(280 degrees F).
2. Do not commence placement of asphaltic concrete materials when the atmospheric temperature is below 10 degrees C (50 degrees F), not during fog, rain, or other unsuitable conditions.

D. Spreading:
1. Spread material in a manner that requires the least handling.
2. Where thickness of finished paving will be 76mm (3") or less, spread in one layer.

E. Rolling:
1. After the material has been spread to the proper depth, roll until the surface is hard, smooth, unyielding, and true to the thickness and elevations shown own the drawings.
2. Roll in at least two directions until no roller marks are visible.
3. Finished paving smoothness tolerance:
   a. No depressions which will retain standing water.
   b. No deviation greater than 3mm in 1.8m (1/8" in six feet).

3.6 APPLICATION OF SEAL COAT

A. Prepare the surfaces, mix the seal coat material, and apply in accordance with the manufacturer's recommendations as approved by the Architect or Engineer.

B. Achieve a finished surface seal which, when dry and thoroughly set, is smooth, tough, resilient, of uniform black color, and free from coarse textured areas, lap marks, ridges, and other surface irregularities.

C. When sealing new asphalt paving wait an entire year to allow for the expansion and contraction of a year's cycle of both warm and cool temperatures. This allows for the asphalt's oils to properly cure and begin oxidation before applying a seal coat.

D. When seal coating in less than a year apply two coats, spray applied. This application method is preferred for less than a year application when there is still plenty of asphalt cement present for the seal coat to bond to.

E. When seal coating existing paving that has new asphalt patches, apply two coats sprayed to the existing asphalt and a single lighter coat on new patch work, just enough to make the color of the new patches match the rest of the reseal coated paving.

F. When resealing existing paving 5, 10, 15 years and older, that is oxidized and is very light in color, squeegee apply the first coat of seal coat and spray on a second coat. Two coats are preferred in older paving when the asphalt cement has oxidized leaving the seal coat with nothing to bond to other than the aggregate that in many cases has polished over time leaving less than a desirable surface to bond to.

3.7 PROTECTION

A. Protect the asphaltic concrete paved areas from traffic until the sealer is set and cured and does not pick up under foot or wheeled traffic.

3.8 FINAL CLEAN-UP

A. Remove all debris, rubbish, and excess material from the work area.

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