



Project Manual for the
HCA Florida
Fort Walton-Destin Hospital
Santa Rosa Freestanding **ER**

2250 U.S. Highway 98
Santa Rosa Beach, Florida, 32459
Walton County
HCA Project Number: 3090900030

**VOLUME 2 – Fire Suppression, Plumbing, Heating,
Ventilation, and Air Conditioning (HVAC),
Electrical, and Communications**

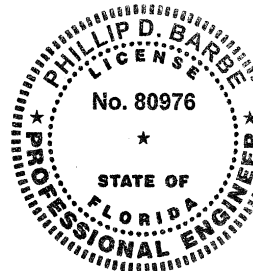
Construction Documents Set
HD Project No.: 225014.00
Date: December 18, 2025

SECTION 00 01 07
SEALS PAGE



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Josh Cartwright
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Phillip D. Barbe
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SANTA ROSA FSER

210100A FLOW TEST

WATER FLOW TEST REPORT



2896 North Hwy 81, Ponce de Leon, FL 32455 850-836-2288

HYDRANT# & LOCATION: **Flow Hyd - RUFH #2371 (see attached map) Read Hyd - RUFH#207**

DATE: 10/22/2025 Day or Week: Wednesday TIME OF DAY: 8:00 AM MIN. OF FLOW: 1

TEST BY: Bobby Gillett - Seago Fire Protection WITNESSED BY: Russ Peltz - Seago Fire Protection

WATER SUPPLIED BY: Regional Utilities 8" Dead End Water Main HYDRANT ELEVATION: 1'-6

DATA

FLOW HYDRANT(S)	A1	A2	A3
SIZE OPENING:	<u>1.75</u>	<u>1.75</u>	<u> </u>
COEFFICIENT:	<u>1.201</u> (see Remarks)	<u>1.1455</u>	<u> </u>
PITOT READING:	<u>35</u> "OA"	<u>31</u> "HML"	<u> </u>
GPM:	<u>649</u>	<u>583</u>	<u>0</u>

TOTAL FLOW DURING TEST: **1232** GPM

STATIC READING: **78** PSI

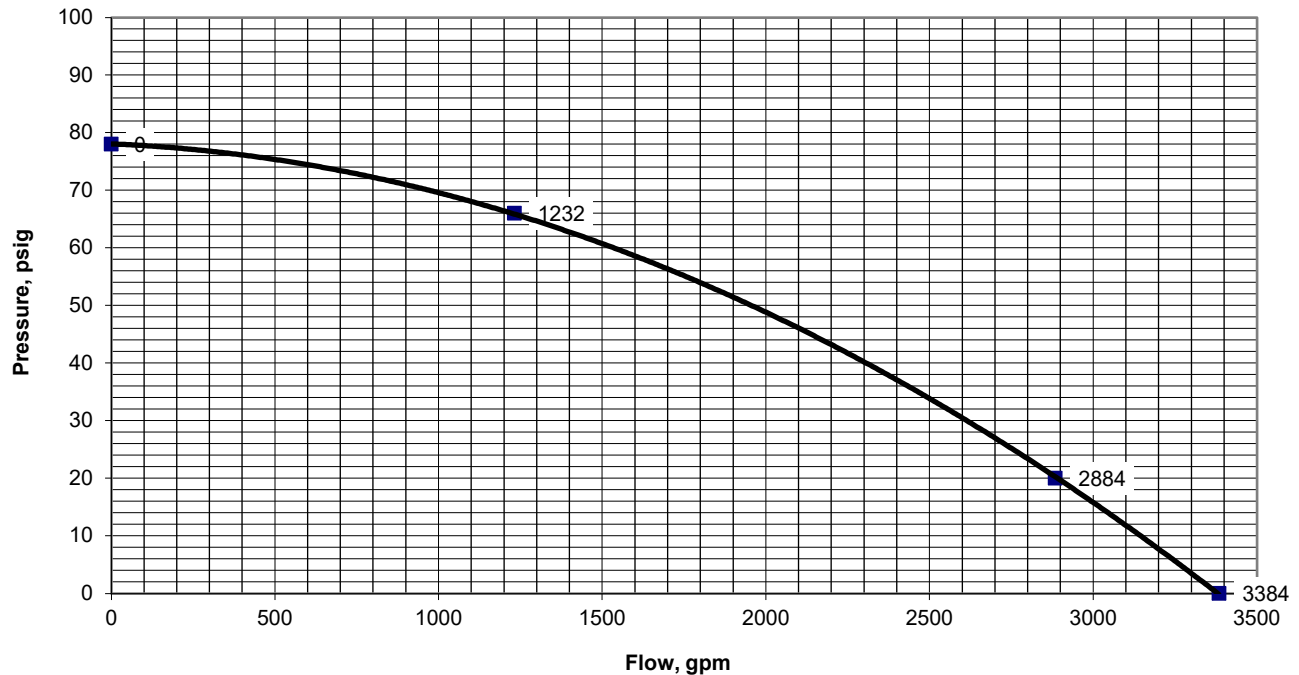
RESIDUAL: **66** PSI

RESULTS: AT 20 PSI RESIDUAL **2884** GPM

AT 0 PSI **3384** GPM

ESTIMATED CONSUMPTION: **1232** GAL.

REMARKS: **Pitot conversion per Hose Monster Chart for 1.75 Pitotless Nozzle**



ArcGIS Web Map



10/17/2025, 1:53:26 PM

- World_Boundaries_and_Places

Water Main

WaterTransMains (Not For Distribution)

FH - Tagged

Tagged

Water Lateral

Domestic
- Hydrant

Fire

WV Maintenance

Open

Water Fittings

Water Control Valve (Air Release)

Lift Stations (LS3)
- Sewer Force Main

No

Manholes

Sewer Gravity Mains

Sewer Reclaimed Water

Sewer Valves (Maintenance)

Open

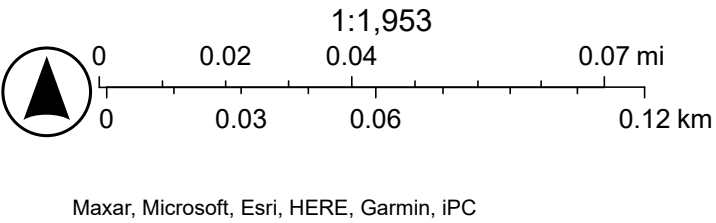
World Imagery

Low Resolution 15m Imagery

High Resolution 60cm Imagery

High Resolution 30cm Imagery

Citations



WATER FLOW TEST REPORT



2896 North Hwy 81, Ponce de Leon, FL 32455 850-836-2288

HYDRANT# & LOCATION: **Flow Hyd - RUFH #207 (see attached map) Read Hyd - RUFH#2371**

DATE: 10/22/2025 Day or Week: Wednesday TIME OF DAY: 8:20 AM MIN. OF FLOW: 1

TEST BY: Bobby Gillett - Seago Fire Protection WITNESSED BY: Russ Peltz - Seago Fire Protection

WATER SUPPLIED BY: Regional Utilities 8" Dead End Water Main HYDRANT ELEVATION: 1'-6

DATA

FLOW HYDRANT(S)	A1	A2	A3
SIZE OPENING:	<u>1.75</u>	<u>1.75</u>	<u> </u>
COEFFICIENT:	<u>1.2</u> (see Remarks)	<u>1.1455</u>	<u> </u>
PITOT READING:	<u>43</u> "OA"	<u>33</u> "HML"	<u> </u>
GPM:	<u>719</u>	<u>601</u>	<u>0</u>

TOTAL FLOW DURING TEST: **1320** GPM

STATIC READING: **76** PSI

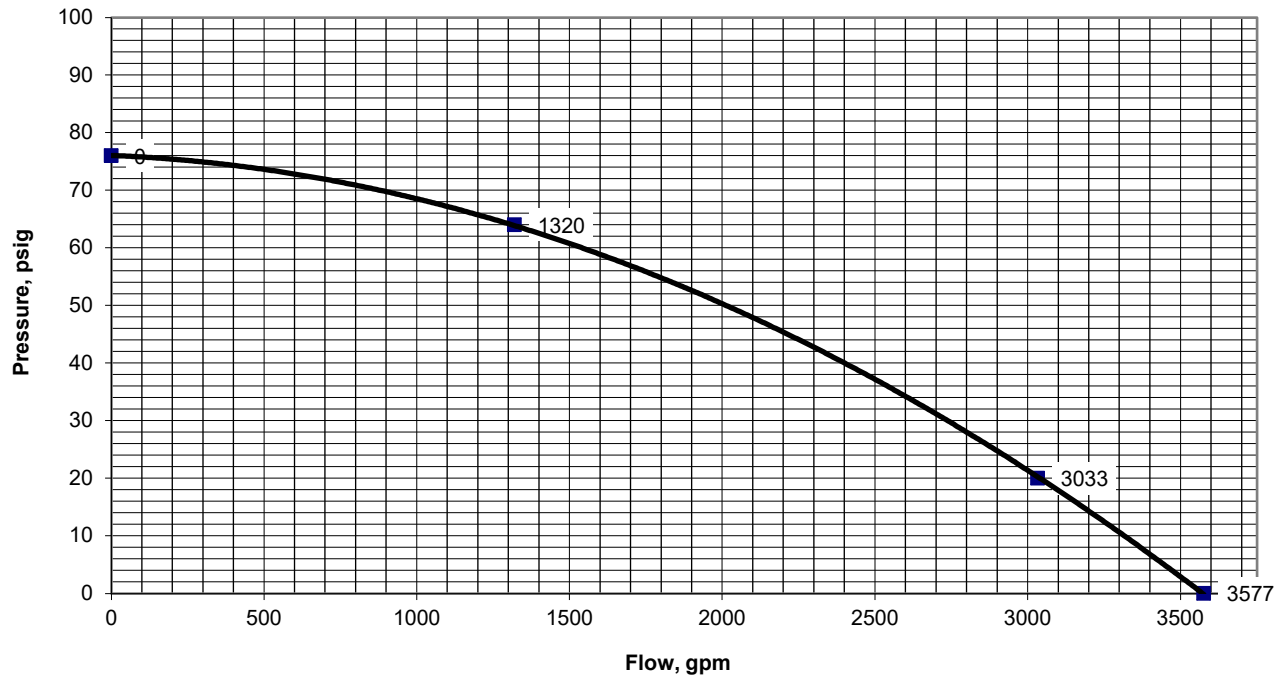
RESIDUAL: **64** PSI

RESULTS: **AT 20 PSI RESIDUAL** **3033** GPM

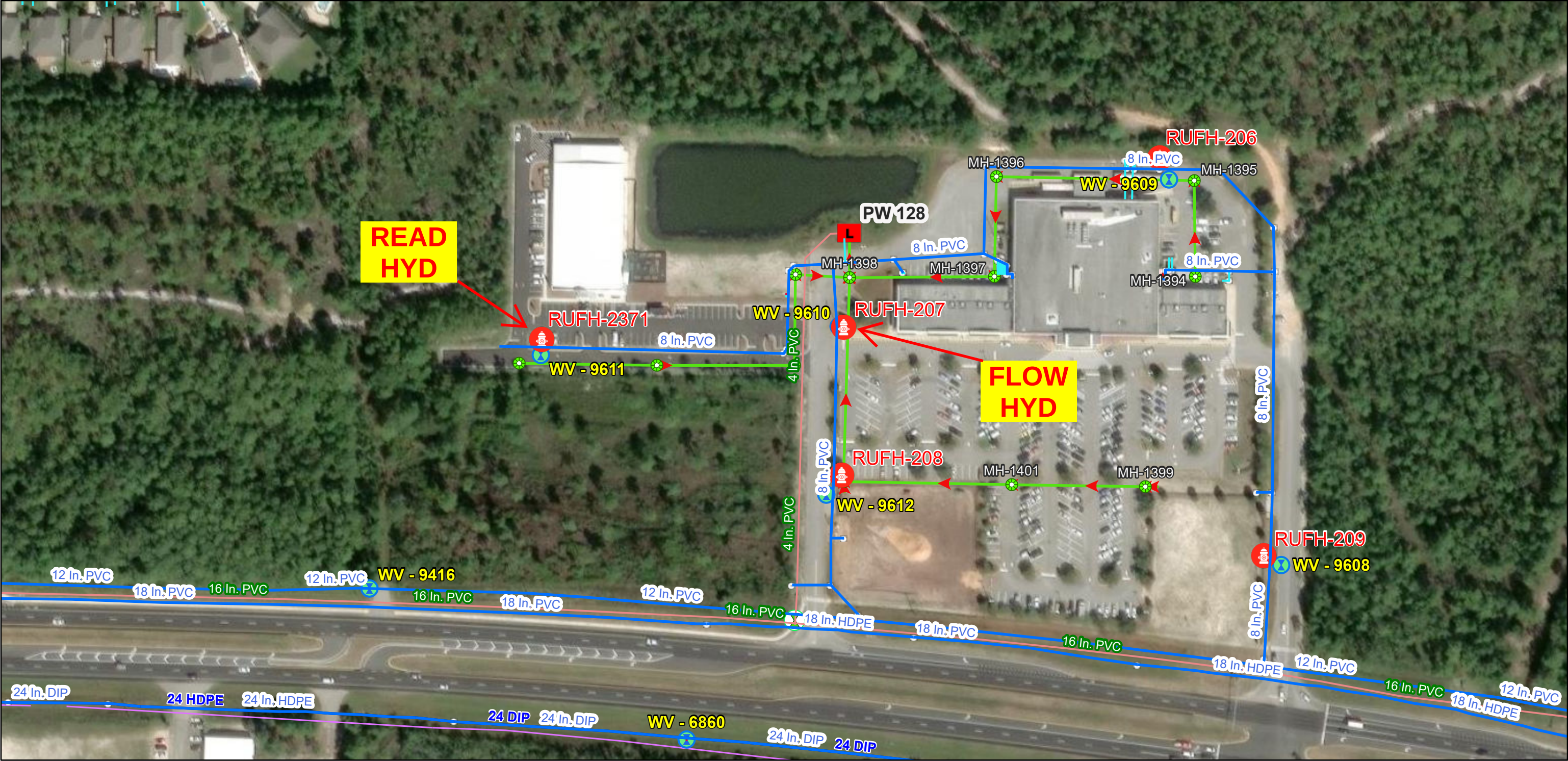
AT 0 PSI **3577** GPM

ESTIMATED CONSUMPTION: **1320** GAL.

REMARKS: **Pitot conversion per Hose Monster Chart for 1.75 Pitotless Nozzle**



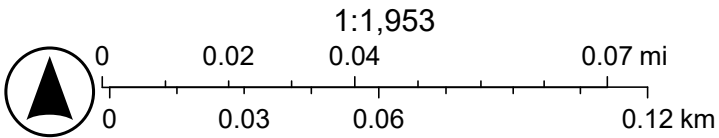
ArcGIS Web Map



10/17/2025, 1:53:26 PM

World_Boundaries_and_Places	Hydrant	Sewer Force Main
Water Main	Fire	No
WaterTransMains (Not For Distribution)	WV Maintenance	Manholes
FH - Tagged	Open	Sewer Gravity Mains
Tagged	Water Fittings	Sewer Reclaimed Water
Water Lateral	Water Control Valve (Air Release)	Sewer Valves (Maintenance)
Domestic	Lift Stations (LS3)	Open

- World Imagery
- Low Resolution 15m Imagery
- High Resolution 60cm Imagery
- High Resolution 30cm Imagery
- Citations



Maxar, Microsoft, Esri, HERE, Garmin, iPC

SANTA ROSA FSER

21 0100B HYDRAULIC CALCULATIONS

1. WET SYSTEM CALCULATION AREA-1

2. DRY SYSTEM CALCULATION AREA-2

HYDRAULIC CALCULATIONS
SANTA ROSA FSER
SANTA ROSA BEACH, FL
WET SYSTEM REMOTE AREA 1
FILE NUMBER: 2545-01862-00
DATE: DECEMBER 10, 2025

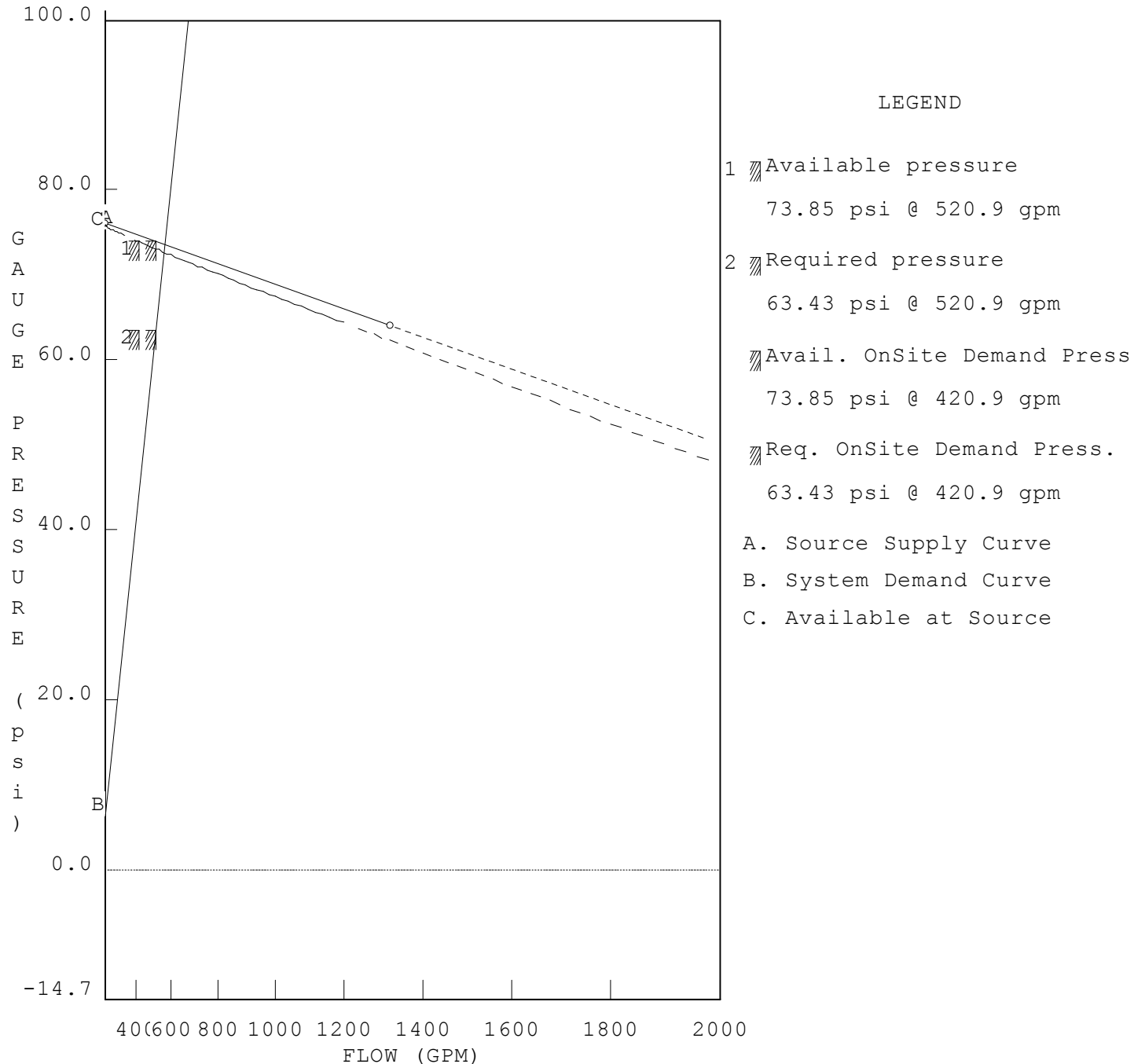
DESIGN DATA

OCCUPANCY CLASSIFICATION:	LIGHT HAZARD
DENSITY:	0.10 GPM/SQFT
AREA OF APPLICATION:	1,500 SQFT
COVERAGE PER SPRINKLER:	225 SQFT
NUMBER OF SPRINKLERS CALCULATED:	17
TOTAL SPRINKLER WATER FLOW REQUIRED:	420.9 GPM
TOTAL WATER REQUIRED (INCLUDING HOSE):	520.9 GPM
FLOW AND PRESSURE (@ BOR):	520.9 GPM @ 63.4 PSI
SPRINKLER ORIFICE SIZE:	1/2 INCH
DESIGN /LAYOUT BY:	REED H. COUK
AUTHORITY HAVING JURISDICTION:	AHCA

CALCULATIONS BY HASS COMPUTER PROGRAM (LICENSE)
HRS SYSTEMS, INC.

WATER SUPPLY ANALYSIS

Static: 76.00 psi Resid: 64.00 psi Flow: 1320.0 gpm



Note: (1) Dashed Lines indicate extrapolated values from Test Results

(2) On Site pressures are based on hose stream deduction at the source

SPRINKLER SYSTEM HYDRAULIC ANALYSIS

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DATE: 12/10/2025C CALCULATIONS\SANTA ROSA FSER WET SYSTEM REMOTE AREA.SDF

JOB TITLE: Santa Rosa FSER Wet System

NFPA WATER SUPPLY DATA

SOURCE NODE TAG	STATIC PRESS. (PSI)	RESID. PRESS. (PSI)	FLOW @ (GPM)	AVAIL. PRESS. (PSI)	TOTAL @ DEMAND (GPM)	REQ'D PRESS. (PSI)
SOURCE	76.0	64.0	1320.0	73.9	520.9	63.4

AGGREGATE FLOW ANALYSIS:

TOTAL FLOW AT SOURCE	520.9 GPM
TOTAL HOSE STREAM ALLOWANCE AT SOURCE	100.0 GPM
OTHER HOSE STREAM ALLOWANCES	0.0 GPM
TOTAL DISCHARGE FROM ACTIVE SPRINKLERS	420.9 GPM

NODE ANALYSIS DATA

NODE TAG	ELEVATION (FT)	NODE TYPE	PRESSURE (PSI)	DISCHARGE (GPM)	AREA (FT^2)	DENSITY REQ. ACT. (GPM/FT^2)
101	9.0	K= 5.60	17.3	23.3	225.0	0.100 0.104
102	9.0	K= 5.60	18.0	23.7	225.0	0.100 0.106
103	12.0	- - - -	17.9	- - -	- - -	- - - - - -
104	9.0	K= 5.60	19.8	24.9	225.0	0.100 0.111
105	12.0	- - - -	20.3	- - -	- - -	- - - - - -
106	9.0	K= 5.60	16.1	22.5	225.0	0.100 0.100
107	9.0	K= 5.60	18.6	24.1	225.0	0.100 0.107
108	12.0	- - - -	20.4	- - -	- - -	- - - - - -
109	9.0	K= 5.60	17.7	23.5	225.0	0.100 0.105
110	9.0	K= 5.60	19.8	24.9	225.0	0.100 0.111
111	12.0	- - - -	20.8	- - -	- - -	- - - - - -
112	9.0	K= 5.60	23.1	26.9	225.0	0.100 0.120
113	12.0	- - - -	21.4	- - -	- - -	- - - - - -
114	9.0	K= 5.60	21.4	25.9	225.0	0.100 0.115
115	12.0	- - - -	21.4	- - -	- - -	- - - - - -
116	9.0	K= 5.60	18.2	23.9	225.0	0.100 0.106
117	9.0	K= 5.60	20.2	25.2	225.0	0.100 0.112
118	12.0	- - - -	21.4	- - -	- - -	- - - - - -
119	9.5	K= 5.60	18.2	23.9	225.0	0.100 0.106
120	9.5	K= 5.60	20.4	25.3	225.0	0.100 0.112
121	9.0	K= 5.60	22.2	26.4	225.0	0.100 0.117
122	12.0	- - - -	21.6	- - -	- - -	- - - - - -
123	9.0	K= 5.60	21.1	25.7	225.0	0.100 0.114
124	12.0	- - - -	22.0	- - -	- - -	- - - - - -
125	9.5	K= 5.60	19.3	24.6	225.0	0.100 0.109
126	9.5	K= 5.60	21.6	26.0	225.0	0.100 0.116
127	12.0	- - - -	23.0	- - -	- - -	- - - - - -
128	12.0	- - - -	24.2	- - -	- - -	- - - - - -
129	12.0	- - - -	23.6	- - -	- - -	- - - - - -
130	12.0	- - - -	26.6	- - -	- - -	- - - - - -
R	-5.0	- - - -	37.9	- - -	- - -	- - - - - -

SPRINKLER SYSTEM HYDRAULIC ANALYSIS

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DATE: 12/10/2025C CALCULATIONS\SANTA ROSA FSER WET SYSTEM REMOTE AREA.SDF

JOB TITLE: Santa Rosa FSER Wet System

NODE ANALYSIS DATA

NODE TAG	ELEVATION (FT)	NODE TYPE	PRESSURE (PSI)	DISCHARGE (GPM)	AREA (FT^2)	DENSITY	
						REQ.	ACT.
						(GPM/FT^2)	(GPM/FT^2)
BP1	3.0	- - - -	46.7	- - -	- - -	- - -	- - -
BP2	3.0	- - - -	56.7	- - -	- - -	- - -	- - -
SOURCE	-5.0	SOURCE	63.4	420.9	- - -	- - -	- - -

SPRINKLER SYSTEM HYDRAULIC ANALYSIS

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DATE: 12/10/2025C CALCULATIONS\SANTA ROSA FSER WET SYSTEM REMOTE AREA.SDF

JOB TITLE: Santa Rosa FSER Wet System

NFPA PIPE DATA

Pipe Tag		K-fac	Add Fl	Add Fl	To	Fit:	L	C	(Pt)
To Node	El (ft)	PT	(q)	Node/	Nom ID	Eq.Ln.	F		(Pe)
Frm Node	El (ft)	PT	Tot.(Q)	Disch	Act ID	(ft.)	T	Pf/ft.	(Pf)
Pipe: 1		5.60	23.3	Disch			9.00	120	17.3
101	9.0	17.3	0.0		1.000	E: 2.0	2.00		-1.3
103	12.0	17.9	23.3		1.049		11.00	0.173	1.9
Pipe: 2		5.60	23.7	Disch			5.00	120	18.0
102	9.0	18.0	0.0		1.000	E: 2.0	2.00		-1.3
103	12.0	17.9	23.7		1.049		7.00	0.179	1.3
Pipe: 3		0.0	0.0				8.00	120	17.9
103	12.0	17.9	47.0		1.250	T: 6.0	6.00		0.0
105	12.0	20.3	47.0		1.380		14.00	0.167	2.3
Pipe: 4		5.60	24.9	Disch			5.00	120	19.8
104	9.0	19.8	0.0		1.000	2E: 4.0	4.00		-1.3
105	12.0	20.3	24.9		1.049		9.00	0.195	1.8
Pipe: 5		0.0	47.0	103			2.00	120	20.3
105	12.0	20.3	24.9	104	3.000	T:15.0	15.00		0.0
108	12.0	20.4	72.0		3.068		17.00	0.007	0.1
Pipe: 6		5.60	22.5	Disch			13.00	120	16.1
106	9.0	16.1	0.0		1.000	E: 2.0	2.00		0.0
107	9.0	18.6	22.5		1.049		15.00	0.162	2.4
Pipe: 7		5.60	24.1	Disch			13.00	120	18.6
107	9.0	18.6	22.5	106	1.250	T: 6.0	6.00		-1.3
108	12.0	20.4	46.6		1.380		19.00	0.164	3.1
Pipe: 8		0.0	46.6	107			6.00	120	20.4
108	12.0	20.4	72.0	105	3.000	T:15.0	15.00		0.0
111	12.0	20.8	118.6		3.068		21.00	0.019	0.4
Pipe: 9		5.60	23.5	Disch			10.00	120	17.7
109	9.0	17.7	0.0		1.000	E: 2.0	2.00		0.0
110	9.0	19.8	23.5		1.049		12.00	0.176	2.1
Pipe: 10		5.60	24.9	Disch			10.00	120	19.8
110	9.0	19.8	23.5	109	1.250	E: 3.0	3.00		-1.3
111	12.0	20.8	48.5		1.380		13.00	0.176	2.3
Pipe: 11		0.0	48.5	110			2.00	120	20.8
111	12.0	20.8	118.6	108	3.000	T:15.0	15.00		0.0
113	12.0	21.4	167.1		3.068		17.00	0.035	0.6
Pipe: 12		0.0	5.9	115			10.33	120	21.4
113	12.0	21.4	167.1	111	4.000	E:10.0	30.00		1.3
112	9.0	23.1	172.9		4.026	T:20.0	40.33	0.010	0.4

SPRINKLER SYSTEM HYDRAULIC ANALYSIS

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DATE: 12/10/2025C CALCULATIONS\SANTA ROSA FSER WET SYSTEM REMOTE AREA.SDF

JOB TITLE: Santa Rosa FSER Wet System

Pipe Tag		K-fac	Add Fl	Add Fl	To	Fit:	L	C	(Pt
To Node	El (ft)	PT	(q)	Node/	Nom ID	Eq.Ln.	F		(Pe)
Frm Node	El (ft)	PT	Tot.(Q)	Disch	Act ID	(ft.)	T	Pf/ft.	(Pf)
Pipe: 13		0.0	0.0				2.00	120	21.4
115	12.0	21.4	5.9		3.000	T:15.0	15.00		0.0
113	12.0	21.4	5.9		3.068		17.00	0.000	0.0
Pipe: 14		5.60	25.9	Disch			4.00	120	21.4
114	9.0	21.4	0.0		1.000	E: 2.0	2.00		-1.3
115	12.0	21.4	25.9		1.049		6.00	0.210	1.3
Pipe: 15		0.0	0.0				4.00	120	21.4
115	12.0	21.4	20.0		3.000	T:15.0	15.00		0.0
118	12.0	21.4	20.0		3.068		19.00	0.001	0.0
Pipe: 16		5.60	23.9	Disch			9.00	120	18.2
116	9.0	18.2	0.0		1.000	E: 2.0	2.00		0.0
117	9.0	20.2	23.9		1.049		11.00	0.181	2.0
Pipe: 17		5.60	25.2	Disch			11.00	120	20.2
117	9.0	20.2	23.9	116	1.250	E: 3.0	3.00		-1.3
118	12.0	21.4	49.0		1.380		14.00	0.180	2.5
Pipe: 18		0.0	49.0	117			12.00	120	21.4
118	12.0	21.4	20.0	115	3.000	T:15.0	15.00		0.0
122	12.0	21.6	69.1		3.068		27.00	0.007	0.2
Pipe: 19		5.60	23.9	Disch			10.00	120	18.2
119	9.5	18.2	0.0		1.000	E: 2.0	2.00		0.0
120	9.5	20.4	23.9		1.049		12.00	0.181	2.2
Pipe: 20		5.60	25.3	Disch			9.75	120	20.4
120	9.5	20.4	23.9	119	1.250	E: 3.0	3.00		-1.1
122	12.0	21.6	49.2		1.380		12.75	0.181	2.3
Pipe: 21		5.60	26.4	Disch			3.75	120	22.2
121	9.0	22.2	0.0		1.250	E: 3.0	9.00		-1.3
122	12.0	21.6	26.4		1.380	T: 6.0	12.75	0.057	0.7
Pipe: 22		0.0	49.2	120			1.00	120	21.6
122	12.0	21.6	69.1	118	3.000	T:15.0	15.00		0.0
124	12.0	22.0	144.6		3.068		16.00	0.027	0.4
Pipe: 23		5.60	25.7	Disch			8.50	120	21.1
123	9.0	21.1	0.0		1.000	E: 2.0	2.00		-1.3
124	12.0	22.0	25.7		1.049		10.50	0.208	2.2
Pipe: 24		0.0	144.6	122			11.50	120	22.0
124	12.0	22.0	25.7	123	3.000	T:15.0	15.00		0.0
127	12.0	23.0	170.3		3.068		26.50	0.037	1.0

SPRINKLER SYSTEM HYDRAULIC ANALYSIS

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DATE: 12/10/2025C CALCULATIONS\SANTA ROSA FSER WET SYSTEM REMOTE AREA.SDF

JOB TITLE: Santa Rosa FSER Wet System

Pipe Tag		K-fac	Add Fl	Add Fl To	Fit:	L	C	(Pt)	
To Node	El (ft)	PT	(q)	Node/	Nom ID	Eq.Ln.	F	(Pe)	
Frm Node	El (ft)	PT	Tot.(Q)	Disch	Act ID	(ft.)	T	(Pf)	
Pipe: 25		5.60	24.6	Disch			10.00	120	19.3
125	9.5	19.3	0.0		1.000	E: 2.0	2.00		0.0
126	9.5	21.6	24.6		1.049		12.00	0.191	2.3
Pipe: 26		5.60	26.0	Disch			9.75	120	21.6
126	9.5	21.6	24.6	125	1.250	E: 3.0	3.00		-1.1
127	12.0	23.0	50.7		1.380		12.75	0.191	2.4
Pipe: 27		0.0	50.7	126			4.83	120	23.0
127	12.0	23.0	170.3	124	3.000	T:15.0	15.00		0.0
128	12.0	24.2	221.0		3.068		19.83	0.060	1.2
Pipe: 28		0.0	0.0				115.00	120	24.2
128	12.0	24.2	221.0	127	4.000	2E:20.0	40.00		0.0
130	12.0	26.6	221.0		4.026	T:20.0	155.00	0.016	2.5
Pipe: 29		0.0	199.8	129		E:10.0	23.00	120	26.6
130	12.0	26.6	221.0	128	4.000	2T:40.0	52.00		7.4
R	-5.0	37.9	420.9		4.026	G: 2.0	75.00	0.052	3.9
Pipe: 30		0.0	0.0				185.00	120	37.9
R	-5.0	37.9	420.9	130	4.000	5E:50.0	50.00		-3.5
BP1	3.0	46.7	420.9		4.026		235.00	0.052	12.3
Pipe:	BP		0.0	Fixed Pressure Loss Device					
BP1	3.0	46.7	420.9	R	10.0 psi,	420.8 gpm			
BP2	3.0	56.7	420.8						
Pipe: 31		0.0	0.0				60.50	120	56.7
BP2	3.0	56.7	420.9	BP1	4.000	G: 2.0	2.00		3.5
SOURCE	-5.0	63.4	420.9		4.026		62.50	0.052	3.3
Pipe: 32		5.60	26.9	Disch			105.00	120	23.1
112	9.0	23.1	172.9	113	4.000	E:10.0	30.00		-1.3
129	12.0	23.6	199.8		4.026	T:20.0	135.00	0.013	1.8
Pipe: 33		0.0	0.0				40.00	120	23.6
129	12.0	23.6	199.8	112	3.000	E: 7.0	22.00		0.0
130	12.0	26.6	199.8		3.068	T:15.0	62.00	0.049	3.1

SPRINKLER SYSTEM HYDRAULIC ANALYSIS

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DATE: 12/10/2025C CALCULATIONS\SANTA ROSA FSER WET SYSTEM REMOTE AREA.SDF
JOB TITLE: Santa Rosa FSER Wet System

NOTES (HASS):

- (1) Calculations were performed by the HASS 2023 D computer program in accordance with (2020) under license no. 64836407 granted by
HRS Systems, Inc.
208 Southside Square
Petersburg, TN 37144
(931) 659-9760
- (2) The system has been calculated to provide an average imbalance at each node of 0.002 gpm and a maximum imbalance at any node of 0.076 gpm.
- (3) Total pressure at each node is used in balancing the system. Maximum water velocity is 10.9 ft/sec at pipe 26.
- (4) Items listed in bold print on the cover sheet

are automatically transferred from the calculation report.
- (5) Available pressure at source node SOURCE under full flow conditions is 73.50 psi with a flow of 565.54 gpm.
- (6) PIPE FITTINGS TABLE

HASS Pipe Table Name: standard

PAGE: A MATERIAL: S40 HWC: 120

Diameter (in)	Equivalent Fitting Lengths in Feet								
	E Ell	T Tee	L LngEll	C ChkVlv	B BfyVlv	G GatVlv	A AlmChk	D DPVlv	N NTee

	F								
	F45Ell								
1.049	2.00	5.00	2.00	5.00	6.00	1.00	10.00	2.00	5.00
	1.00								
1.380	3.00	6.00	2.00	7.00	6.00	1.00	10.00	10.00	6.00
	1.50								
3.068	7.00	15.00	5.00	16.00	10.00	1.00	13.00	13.00	15.00
	3.50								
4.026	10.00	20.00	6.00	22.00	12.00	2.00	20.00	20.00	20.00
	5.00								

HYDRAULIC CALCULATIONS
SANTA ROSA FSER
SANTA ROSA BEACH, FL
DRY SYSTEM REMOTE AREA 2
FILE NUMBER: 2545-01862-00
DATE: DECEMBER 10, 2025

DESIGN DATA

OCCUPANCY CLASSIFICATION:	ORDINARY HAZARD GROUP I
DENSITY:	0.15 GPM/SQFT
AREA OF APPLICATION:	1200 SQFT
COVERAGE PER SPRINKLER:	130 SQFT
NUMBER OF SPRINKLERS CALCULATED:	9
TOTAL SPRINKLER WATER FLOW REQUIRED:	123.6 GPM
TOTAL WATER REQUIRED (INCLUDING HOSE):	373.6 GPM
FLOW AND PRESSURE (@ BOR):	373.6 GPM @ 51.6 PSI
SPRINKLER ORIFICE SIZE:	1/2 INCH
DESIGN /LAYOUT BY:	REED H. COUK
AUTHORITY HAVING JURISDICTION:	AHCA

CALCULATIONS BY HASS COMPUTER PROGRAM (LICENSE)
HRS SYSTEMS, INC.

SPRINKLER SYSTEM HYDRAULIC ANALYSIS

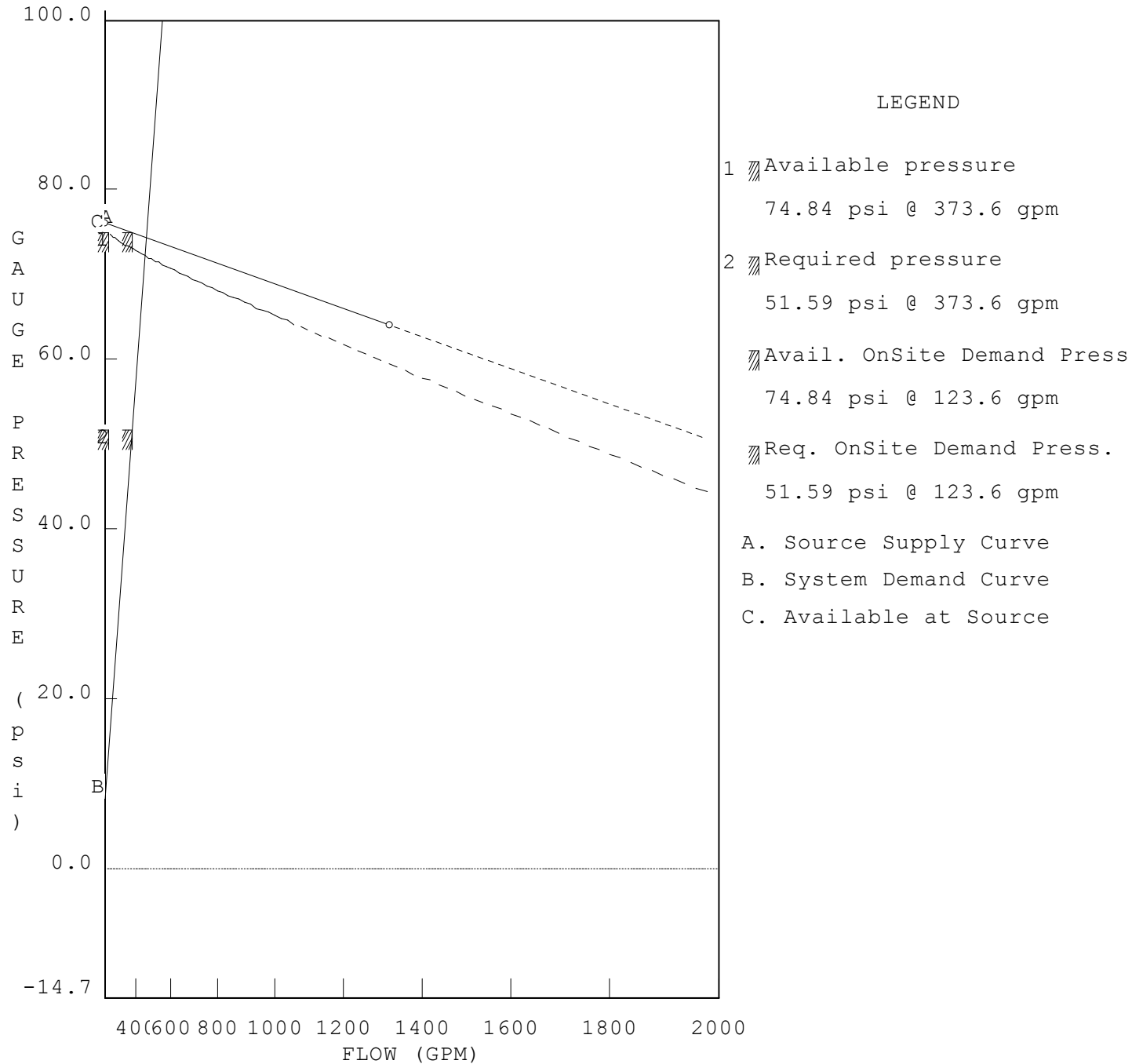
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DATE: 12/11/2025C CALCULATIONS\SANTA ROSA FSER DRY SYSTEM REMOTE AREA.SDF

JOB TITLE: Santa Rosa FSER Dry System

WATER SUPPLY ANALYSIS

Static: 76.00 psi Resid: 64.00 psi Flow: 1320.0 gpm



Note: (1) Dashed Lines indicate extrapolated values from Test Results

(2) On Site pressures are based on hose stream deduction at the source

SPRINKLER SYSTEM HYDRAULIC ANALYSIS

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DATE: 12/11/2025C CALCULATIONS\SANTA ROSA FSER DRY SYSTEM REMOTE AREA.SDF

JOB TITLE: Santa Rosa FSER Dry System

NFPA WATER SUPPLY DATA

SOURCE NODE TAG	STATIC PRESS. (PSI)	RESID. PRESS. (PSI)	FLOW @ (GPM)	AVAIL. PRESS. (PSI)	TOTAL @ DEMAND (GPM)	REQ'D PRESS. (PSI)
SOURCE	76.0	64.0	1320.0	74.8	373.6	51.6

AGGREGATE FLOW ANALYSIS:

TOTAL FLOW AT SOURCE	373.6 GPM
TOTAL HOSE STREAM ALLOWANCE AT SOURCE	250.0 GPM
OTHER HOSE STREAM ALLOWANCES	0.0 GPM
TOTAL DISCHARGE FROM ACTIVE SPRINKLERS	123.6 GPM

NODE ANALYSIS DATA

NODE TAG	ELEVATION (FT)	NODE TYPE	PRESSURE (PSI)	DISCHARGE (GPM)	AREA (FT^2)	DENSITY	
						REQ. (GPM/FT^2)	ACT. (GPM/FT^2)
1	14.0	K= 5.60	12.1	19.5	130.0	0.150	0.150
2	14.0	K= 5.60	12.5	19.8	130.0	0.150	0.152
3	14.8	- - - -	13.0	- - -	- - -	- - -	- - -
4	14.0	K= 5.60	13.9	20.9	130.0	0.150	0.161
5	14.0	K= 5.60	14.7	21.5	130.0	0.150	0.165
6	14.8	- - - -	15.0	- - -	- - -	- - -	- - -
7	14.0	K= 5.60	13.6	20.7	130.0	0.150	0.159
8	14.0	K= 5.60	14.4	21.3	130.0	0.150	0.163
9	14.8	- - - -	14.6	- - -	- - -	- - -	- - -
10	14.8	- - - -	16.0	- - -	- - -	- - -	- - -
11	14.8	- - - -	18.0	- - -	- - -	- - -	- - -
12	11.0	- - - -	20.9	- - -	- - -	- - -	- - -
13	11.0	- - - -	29.3	- - -	- - -	- - -	- - -
R	-5.0	- - - -	40.0	- - -	- - -	- - -	- - -
BP1	3.0	- - - -	37.8	- - -	- - -	- - -	- - -
BP2	3.0	- - - -	47.8	- - -	- - -	- - -	- - -
SOURCE	-5.0	SOURCE	51.6	123.6	- - -	- - -	- - -

SPRINKLER SYSTEM HYDRAULIC ANALYSIS

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DATE: 12/11/2025C CALCULATIONS\SANTA ROSA FSER DRY SYSTEM REMOTE AREA.SDF

JOB TITLE: Santa Rosa FSER Dry System

NFPA PIPE DATA

Pipe Tag		K-fac	Add Fl	Add Fl	To	Fit:	L	C	(Pt)
To Node	El (ft)	PT	(q)	Node/	Nom ID	Eq.Ln.	F		(Pe)
Frm Node	El (ft)	PT	Tot.(Q)	Disch	Act ID	(ft.)	T	Pf/ft.	(Pf)
Pipe: 1		5.60	19.5	Disch			7.67	120	12.1
1	14.0	12.1	0.0		1.000	E: 2.0	2.00		-0.3
3	14.8	13.0	19.5		1.049		9.67	0.124	1.2
Pipe: 2		5.60	19.8	Disch			1.75	120	12.5
2	14.0	12.5	0.0		1.000	T: 5.0	5.00		-0.3
3	14.8	13.0	19.8		1.049		6.75	0.127	0.9
Pipe: 3		0.0	0.0				10.50	120	13.0
3	14.8	13.0	39.3		1.250	T: 6.0	6.00		0.0
6	14.8	15.0	39.3		1.380		16.50	0.119	2.0
Pipe: 4		5.60	20.9	Disch			7.67	120	13.9
4	14.0	13.9	0.0		1.000	E: 2.0	2.00		-0.3
6	14.8	15.0	20.9		1.049		9.67	0.141	1.4
Pipe: 5		5.60	21.5	Disch			1.75	120	14.7
5	14.0	14.7	0.0		1.000	E: 2.0	2.00		-0.3
6	14.8	15.0	21.5		1.049		3.75	0.149	0.6
Pipe: 6		0.0	39.3	3			6.33	120	15.0
6	14.8	15.0	42.4	4	2.000	T:10.0	10.00		0.0
10	14.8	16.0	81.7		2.067		16.33	0.065	1.1
Pipe: 7		5.60	20.7	Disch			7.67	120	13.6
7	14.0	13.6	0.0		1.000	E: 2.0	2.00		-0.3
9	14.8	14.6	20.7		1.049		9.67	0.138	1.3
Pipe: 8		5.60	21.3	Disch			1.75	120	14.4
8	14.0	14.4	0.0		1.000	E: 2.0	2.00		-0.3
9	14.8	14.6	21.3		1.049		3.75	0.146	0.5
Pipe: 9		0.0	0.0				4.42	120	14.6
9	14.8	14.6	41.9		1.250	T: 6.0	6.00		0.0
10	14.8	16.0	41.9		1.380		10.42	0.134	1.4
Pipe: 10		0.0	41.9	9			4.42	120	16.0
10	14.8	16.0	81.7	6	2.000	T:10.0	10.00		0.0
11	14.8	18.0	123.6		2.067		14.42	0.139	2.0
Pipe: 11		0.0	0.0				3.75	120	18.0
11	14.8	18.0	123.6	10	2.000	E: 5.0	5.00		1.6
12	11.0	20.9	123.6		2.067		8.75	0.139	1.2
Pipe: 12		0.0	0.0				56.00	120	20.9
12	11.0	20.9	123.6	11	2.000	E: 5.0	5.00		0.0
13	11.0	29.3	123.6		2.067		61.00	0.139	8.5

SPRINKLER SYSTEM HYDRAULIC ANALYSIS

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DATE: 12/11/2025C CALCULATIONS\SANTA ROSA FSER DRY SYSTEM REMOTE AREA.SDF

JOB TITLE: Santa Rosa FSER Dry System

Pipe Tag	To Node	El (ft)	K-fac	PT	Add Fl (q)	Add Fl Node/	To Nom ID	Fit: Eq.Ln. (ft.)	L F T	C Pf/ft.	(Pt) (Pe) (Pf)
Pipe: 13			0.0		0.0				125.00	120	29.3
13	11.0	29.3	123.6		12	3.000	4E:28.0	58.00			6.9
R	-5.0	40.0	123.6			3.068	2T:30.0	183.00	0.020		3.7
Pipe: 14			0.0		0.0				185.00	120	40.0
R	-5.0	40.0	123.6		13	4.000	5E:50.0	50.00			-3.5
BP1	3.0	37.8	123.6			4.026		235.00	0.005		1.3
Pipe:	BP		0.0				Fixed Pressure Loss Device				
BP1	3.0	37.8	123.6		R	10.0	psi, 123.6 gpm				
BP2	3.0	47.8	123.6								
Pipe: 15			0.0		0.0				60.50	120	47.8
BP2	3.0	47.8	123.6		BP1	4.000	----	0.00			3.5
SOURCE	-5.0	51.6	123.6			4.026		60.50	0.005		0.3

NOTES (HASS):

(1) Calculations were performed by the HASS 2023 D computer program in accordance with (2020) under license no. 64836407 granted by HRS Systems, Inc. 208 Southside Square Petersburg, TN 37144 (931) 659-9760

(2) The system has been calculated to provide an average imbalance at each node of 0.006 gpm and a maximum imbalance at any node of 0.095 gpm.

(3) Total pressure at each node is used in balancing the system. Maximum water velocity is 11.8 ft/sec at pipe 12.

(4) Items listed in bold print on the cover sheet

are automatically transferred from the calculation report.

(5) Available pressure at source node SOURCE under full flow conditions is 74.60 psi with a flow of 412.60 gpm.

SPRINKLER SYSTEM HYDRAULIC ANALYSIS

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DATE: 12/11/2025C CALCULATIONS\SANTA ROSA FSER DRY SYSTEM REMOTE AREA.SDF

JOB TITLE: Santa Rosa FSER Dry System

(6) PIPE FITTINGS TABLE

HASS Pipe Table Name: standard

PAGE: A MATERIAL: S40 HWC: 120

Diameter (in)	Equivalent Fitting Lengths in Feet								
	E Ell	T Tee	L LngEll	C ChkVlv	B BfyVlv	G GatVlv	A AlmChk	D DPVlv	N NTee

	F								
	F45Ell								
1.049	2.00	5.00	2.00	5.00	6.00	1.00	10.00	2.00	5.00
	1.00								
1.380	3.00	6.00	2.00	7.00	6.00	1.00	10.00	10.00	6.00
	1.50								
2.067	5.00	10.00	3.00	11.00	6.00	1.00	10.00	10.00	10.00
	2.50								
3.068	7.00	15.00	5.00	16.00	10.00	1.00	13.00	13.00	15.00
	3.50								
4.026	10.00	20.00	6.00	22.00	12.00	2.00	20.00	20.00	20.00
	5.00								

SECTION 01 91 13
GENERAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE

- A. Work under this Section is subject to requirements of the Contract Documents including Divisions 00 and 01.

1.02 DESCRIPTION

- A. Commissioning is a systematic process of ensuring the HVAC systems perform interactively according to the design intent and Owner's operational needs. Commissioning will encompass and coordinate traditionally separate functions of system documentation, installation checkout, equipment startup, control system calibration and point-to-point checkout, testing and balancing, and functional performance testing. Commissioning is intended to achieve the following specific objectives according to the Contract Documents:
1. Verify systems are in accordance with the plans and specifications.
 2. Verify and document proper installation and performance of equipment and systems.
 3. Ensure O&M, maintenance training, and commissioning documentation requirements are complete.
 4. Provide Owner with functional buildings and/or systems with minimal operational problems at time of move-in.
- B. Commissioning does not take away from or reduce responsibility of system designers or installing contractors to provide a finished and fully functioning product.
- C. This section shall in no way diminish the responsibility of the Division 23 Sub-contractors and Suppliers in performing all aspects of work and testing as outlined in the contract documents. Any requirements outlined in this section are in addition to requirements outlined in Division 23 Specifications.

1.03 ABBREVIATIONS

- A. The following are common abbreviations used in the Specifications. Definitions are found further in this Section.
1. A/E - Architect and Design Engineers – The HVAC Engineer
 2. BAS - Building Automation System
 3. CA - Commissioning Agent – An employee or agent of the GC
 4. CM - Construction Manager – HCA Construction Manager
 5. CT - Commissioning Team
 6. Cx - Commissioning
 7. CC - Controls Contractor
 8. DFM - HCA Director of Facility Management
 9. EC - Electrical Contractor
 10. FPT - Functional Performance Test
 11. GC - General Contractor
 12. MC - Mechanical Contractor
 13. OR - Owner's Representative
 14. PC - Pre-functional Checklist
 15. TAB - Test, Adjust and Balance
 16. O&M - Operations & Maintenance
 17. RFI - Request for Information

1.04 RELATED WORK

- A. Specific commissioning requirements are given in the following sections of these specifications.

1.05 COORDINATION

- A. Commissioning Team: Members of the Commissioning Team (CT) will consist of:
1. Commissioning Agent (CA)

2. Owner's Representative(s) (OR)
 3. Construction Manager (CM)
 4. Architect and Design Engineers (A/E)
 5. Mechanical Contractor (MC)
 6. Electrical Contractor (EC)
 7. Test and Balance Contractor (TAB Contractor)
 8. Controls Contractor (CC)
 9. Equipment Suppliers and Vendors
- B. Management: The CA directs and coordinates commissioning activities. All members of the Commissioning Team shall cooperate to fulfill contracted responsibilities and objectives of the Contract Documents.
- C. Kick-off Meeting: Within 90 days of commencement of construction, CA will plan, schedule and conduct a commissioning kick-off meeting. Membership and responsibilities of the commissioning team will be clarified at this meeting. CA will distribute meeting minutes to all parties.
- D. Scheduling:
1. CA will work with commissioning team to establish required commissioning activities to incorporate in preliminary commissioning schedule. The CA and GC will integrate commissioning activities into the master construction schedule. Representatives of the commissioning team will address scheduling problems. Necessary notifications are to be made in a timely manner in order to expedite commissioning.
 2. The CA will provide initial schedule of primary commissioning events at commissioning kick-off meeting. As construction progresses, more detailed schedules are developed by the CA.

1.06 DEFINITIONS

- A. Acceptance Phase: Phase of construction after startup and initial checkout when Functional Performance Tests, O&M documentation review and training occur.
- B. Approval: Acceptance that a piece of equipment or system has been properly installed and is functioning in tested modes according to the Contract Documents.
- C. Architect/Engineer (A/E): Prime consultant (architect) and sub-consultants who comprise the design team, generally HVAC Mechanical Designer/Engineer and Electrical Designer/Engineer.
- D. Commissioning Agent (CA): An assigned employee or agent of the GC. CA directs and coordinates day-to-day commissioning activities.
- E. Contract Documents: Documents binding on parties involved in construction of this project (drawings, specifications, change orders, amendments, contracts, etc.).
- F. Control System: System and components associated with building automation system.
- G. Construction Manager (CM): Owner's employee assigned the responsibility of managing the overall project.
- H. Deferred Functional Tests: Functional tests performed after substantial completion due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow test from being performed.
- I. Deficiency: Condition of a component, piece of equipment or system that is not in compliance with Contract Documents (that is, does not perform properly or is not complying with design intent).
- J. Director of Facility Management (DFM): Facility employee responsible for the maintenance of the Physical Plant.
- K. Factory Testing: Testing of equipment on-site or at factory, by factory personnel.
- L. Functional Performance Test Procedures: Commissioning protocols and detailed test procedures and instructions that fully describe the steps required to determine if the system is

performing and functioning properly. These procedures are written by the A/E and shall be used to document Functional Performance Tests. They shall be included in the Project Manual.

- M. Functional Performance Test (FPT): A demonstration of the dynamic function and operation of equipment and systems. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, life safety conditions, power failure, etc. Systems are run through all specified sequences of operation. Components are verified to be responding in accordance with contract documents. The test results are both manually recorded on the FPT Procedure and with trending data using the BAS. Functional Performance Tests are executed after pre-functional checklists and startups are complete.
- N. General Contractor: Contracted directly to Owner. Sub-contractors report to the General Contractor.
- O. Indirect Indicators: Indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100% closed.
- P. Manual Test: Using hand-held instruments, immediate control system readouts, or direct observation to verify performance (contrary to analyzing monitored data taken over time to make "observation").
- Q. Monitoring: Recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or trending capabilities of control systems.
- R. Non-Compliance: See Deficiency.
- S. Non-Conformance: See Deficiency.
- T. Overridden Value: Writing over a sensor value in the control system to see response of a system (e.g., changing outside air temperature value from 50°F to 75°F to verify economizer operation). See also "Simulated Signal".
- U. Owner's Representative (OR) – An employee of the Owner or person contracted with the Owner to provide Cx Verification Services. The responsibility of the OR is to assist the Cx Team in understanding the Cx requirements of the project, monitor the Cx progress through site visits and Cx Team Meetings, review the completed Cx Pre-Functional Performance Checklists and Functional Performance Test for completeness, perform Cx verification testing as appropriate to determine that the Cx requirements of the project have been successfully completed.
- V. Owner Verification: A repeat of the FPTs in the presence of the OR and A/E. The OR will determine if only selected or all FPTs will be repeated based on his inspection and review of the Cx documentation submitted by the CA prior to this visit. Typically the length of this visit is less than 3 days. On phased projects, phased commissioning may be required.
- W. Phased Commissioning: Commissioning completed in phases (by floors, for example) due to size of structure or other scheduling issues.
- X. Pre-functional Checklist (PC): 1) A list of static inspections and elementary component tests that verify proper installation of equipment (e.g., belt tension, oil levels, labels affixed, gages in place, sensors calibrated, etc.). 2) Pre-functional Checklists may also include startup tests that prepare equipment and system for functional operation. 3) A summary of specified documentation is presented in checklist format. The A/E shall include the PCs in the Project manual.
- Y. Seasonal Performance Tests: Functional Performance Tests or parts thereof that are deferred until system(s) ambient conditions are closer to design conditions in order to verify proper system operation.
- Z. Simulated Condition: Condition created for testing component or system (e.g., applying heat to space temperature sensor to monitor response of VAV box).
- AA. Simulated Signal: Disconnecting a sensor and using a signal generator or a software value to simulate an input value to the BAS.
- BB. Specifications: Construction specifications of Contract Documents.

- CC. Startup: The activities where systems or equipment are initially tested and operated. Startup is completed prior to functional testing.
- DD. Sub-contractor: Contractors of GC, and their sub-contractors, who provide and install building components and systems.
- EE. Test Procedures: Step-by-step processes, which must be executed to fulfill test requirements.
- FF. Test Requirements: Requirements specifying what modes and functions, etc. will be tested.
- GG. Trending: Recording of parameters (flow, temperature, pressure, status, etc.) during system operation using the BAS.
- HH. Vendor: Supplier of equipment.
- II. Warranty Period: Warranty period for entire project, including equipment components.

1.07 SUBMITTALS

- A. CA shall provide the OR and A/E an “as-built” controls submittal 5 working days prior to the scheduled Owner’s Verification visit. The submittal shall include the full sequences of operation that describe the actual controls programming.

1.08 STARTUP

- A. Sub-contractor responsible for purchase, installation and startup of equipment shall perform the manufacturer’s detailed startup and checkout procedures in addition to the PCs.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

- A. Division sub-contractors shall provide all specialized tools, test equipment and instruments required to execute startup, checkout and functional performance testing of equipment under their contract.
- B. Test equipment shall be of sufficient quality and accuracy to test and/or measure system performance with tolerances specified. A testing laboratory shall have calibrated test equipment within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be calibrated according to manufacturer’s recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 EXECUTION

3.01 COMMISSIONING OVERVIEW

- A. The following provides a brief overview of typical commissioning tasks during construction and the general order in which they occur:
 - 1. Commissioning during construction begins with a kick-off meeting conducted by CA and OR where membership of commissioning team is established, responsibilities reviewed, and the Cx scope and procedures are reviewed.. A preliminary commissioning schedule is distributed for review.
 - 2. CA schedules subsequent meetings as necessary to plan, coordinate and schedule commissioning activities. Deficiencies and problem resolution will also be discussed at these meetings.
 - 3. CA develops, with cooperation of sub-contractor/vendor, detailed training plan. The CA schedules training activities with the facility’s staff.
 - 4. CA assembles the Cx team and for a step by step review of the FPT procedures in advance of the execution of the first FPT. The A/E shall lead this review and immediately update any FPT that requires changes.
 - 5. A/E shall be present to assist in the execution of the first FPT. The CA shall coordinate the schedule for this test to coincide with the A/E’s scheduled trip to attend an Owner-Architect-Contractor meeting.
 - 6. CA supervises the execution of the PCs. CA will witness startup of selected equipment.
 - 7. Functional testing is completed after TAB is completed.

8. Functional Performance Tests are executed by sub-contractors, under supervision of and documented by CA.
9. CA is responsible for having the completed FPT procedures, the specified trending data, the final T&B report, and the "as-built" control submittal to the OR and A/E not less than 5 working days prior to the scheduled Owner's Verification visit.
10. All the FPTs must be completed and the Owner's Verification must occur prior to occupancy unless otherwise directed by the CM. (Owner Verification may be waived on some phases of a phased project; however, the FPTs and controls submittal must be submitted to the OR prior to occupancy.)
11. Items of non-compliance in material, installation or setup will be corrected at sub-contractor expense and system shall be retested.

3.02 SYSTEMS TO BE COMMISSIONED

- A. Mechanical
 1. Air Handling Systems including air handlers, air terminal boxes, energy recovery systems, exhaust fans and ancillary equipment.
 2. Heating Hot Water System including boilers, pumps and ancillary equipment.
 3. Building Automation System
- B. Plumbing: Domestic Hot Water Recirculation System
- C. Electrical: Emergency Generator

3.03 RESPONSIBILITIES

- A. Responsibilities of commissioning team members are:
 1. Architect/Engineer (A/E):
 2. Develop detailed PCs.
 3. Develop detailed project specific FPT procedures.
 4. Review FPTs in detail with the Cx Team.
 5. Witnesses first run of first FPT.
 6. Review all Cx documentation, including TAB reports, and provide written comments to the OR and CA within 5 days of receipt.
- B. Commissioning Agent (CA):
 1. Coordinate and direct commissioning activities in a logical, sequential and efficient manner.
 2. Schedule and chair Cx kick-off meeting and issue minutes.
 3. Provide progress reports of commissioning status.
 4. Periodically update commissioning schedule.
 5. Supervise completion of Pre-functional Checklists and supporting documentation to verify systems readiness for Functional Performance Testing.
 6. Supervise Functional Performance Tests. Document test results and recommend system for acceptance.
 7. Review completed TAB reports.
 8. Develop, with cooperation of sub-contractor/vendor and DFM, a detailed training plan.
 9. Schedule and oversee training sessions.
 10. Prepare final Commissioning Turnover Documentation.
 11. Facilitate cooperation of sub-contractors in commissioning work.
 12. Incorporate commissioning activities into master construction schedule.
 13. Schedule and chair all commissioning team meetings.
 14. Forward completed TAB report, as-built controls submittal, FPT procedure, and trend data to OR and A/E and at least 5 working days prior to scheduled Owner Verification visit.
 15. Identify, track and coordinate resolution of non-compliance and deficiencies identified by commissioning team. Maintain records of all issues submitted by commissioning team.
 16. Coordinate sub-contractor/vendor participation in training sessions. Provide workspace or conference room as needed. Ensure attendance at training is documented.
 17. Schedule, coordinate and assist CT in seasonal or deferred testing.
- C. Sub-contractors/Vendors:

1. Review PCs and Functional Performance Test procedures.
 2. Ensure installation work is complete, is in compliance with Contract Documents and is ready for Functional Performance Testing.
 3. Execute Pre-functional Checklists and submit with supporting documentation to CA.
 4. Execute Functional Performance Tests developed by CA as described in contract documents.
 5. Provide certified and calibrated instrumentation required to take measurements of system and equipment performance during Functional Performance Testing.
 6. Assist CA with developing a comprehensive commissioning schedule.
 7. Attend commissioning kick-off meeting and other commissioning team meetings.
 8. Execute seasonal or deferred Functional Performance Testing.
 9. Make necessary amendments to O&M manuals and as-built drawings/submittals for applicable issues identified in the Cx process.
 10. Support the testing that occurs during the Owner's Verification visits.
- D. Controls Contractor (CC):
1. Completely install and thoroughly inspect startup, test, adjust, calibrate and document systems and equipment under BAS Contract.
 2. Provide laptop computer, software and training to accommodate TAB Contractor in system balancing.
 3. Maintain database of control parameters submitted by TAB Contractor subsequent to field adjustments and measurements.
 4. Provide on-site technician skilled in software programming and hardware operation to exercise sequences of operation and to correct control deficiencies identified during Functional Performance Testing and Owner's Verification.
 5. Provide instrumentation, computer, software and communication resources necessary to demonstrate total operation of building systems during Functional Performance Testing and Owner's Verification of control system equipment.
 6. Attend commissioning kick-off meeting and other commissioning team meetings.
 7. Maintain comprehensive system calibration and checkout records. Submit records to CA upon request.
 8. Setup trend logs as requested by CA to substantiate proper systems operation.
 9. Prepare the required trending information and submit to the CA.
- E. Test, Adjust and Balance (TAB) Contractor:
1. Attend commissioning kick-off meeting and other commissioning team meetings.
 2. Complete test and balance procedures prior to Owner's Verification visit.
 3. Cooperate with CC with execution of required work.
 4. Rebalance deficient areas identified during commissioning.
 5. Provide on-site technician, as necessary, skilled in TAB procedures to provide limited system TAB readings during Functional Performance Testing and Owner's Verification.

3.04 COMMISSIONING TEAM MEETINGS

- A. Commissioning team meetings will be held periodically as determined by CA with frequency increasing as construction advances and systems become operational. Attendance is mandatory. CA will record minutes and attendance. CA will chair Commissioning Team Meetings.
- B. Discussions held in Commissioning Team Meetings shall include, but not be limited to system/equipment startup, progress, scheduling, testing, documentation, deficiencies and problem resolution.

3.05 REPORTING

- A. CA will at OAC meetings provide regular status reports to CM and A/E.
- B. CA will regularly communicate with members of commissioning team, keeping them apprised of commissioning progress.
- C. CA shall submit non-compliance and deficiency reports to the CM.

3.06 STARTUP AND INITIAL CHECKOUT

- A. CA shall schedule equipment startup after the PCs are executed and documented by Sub-contractor. Startup shall not occur until after the CA and sub-contractors have reviewed the completed PCs.
- B. OR reserves the right to witness any startup or equipment testing. DFM shall be contacted and invited to witness all equipment startup.
- C. CA shall provide OR with signed and data copy of completed startup and pre-functional checklists. Only individuals having direct knowledge that a line item task was actually performed will initial or check that item off.
- D. CA shall clearly list outstanding items or initial startup and pre-functional procedures not completed successfully.
- E. CA shall review deficiency reports to determine if outstanding items prevent scheduling of Functional Performance Testing.

3.07 FUNCTIONAL PERFORMANCE TESTING

- A. Objectives and Scope:
 - 1. The objective of Functional Performance Testing is to demonstrate each system is operating according to documented design intent and Contract Documents. Functional Performance Testing facilitates bringing systems from a state of substantial completion to full dynamic operation. Additionally, during Functional Performance Testing, areas of deficient performance are identified and corrected, improving operation and functioning of systems.
 - 2. Each system shall be operated through all modes of operation where there is a specified system response. Verifying each sequence in the sequences of operation is required.
- B. Development of Test Procedures:
 - 1. The purpose of any given specific test is to verify and document compliance with stated criteria of acceptance given on test form. A/E shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Prior to execution, the CA will review the FPT procedures with the A/E and Cx Team (i.e. answering questions about equipment, operation, sequences, etc.). CA shall provide a copy of test procedures to Sub-contractor. Sub-contractor will review tests for feasibility, safety and equipment warranty protection. CA shall also submit tests to Owner, CM and A/E and other commissioning team members for review.
 - 2. Examples of test procedure forms to be developed by the A/E are included herein.
- C. Coordination and Scheduling:
 - 1. CA will conduct a step by step table top review of the FPT procedures with the CT weeks in advance of the first FPT.
 - 2. CA shall witness and document functional testing of equipment and systems. Sub-contractor shall execute tests under direction of CA.
 - 3. Functional Performance Testing is conducted after system operation and checkout is satisfactorily completed. Air balancing and water balancing is to be completed and debugged before functional testing of air-related or water-related equipment or systems.
 - 4. CA will schedule Owner's Verification visit with the OR and A/E.
 - 5. CA will transmit the completed FPT procedures, associated trend data, TAB report, and "as-built" control submittal to the OR and A/E on a schedule that will give them five working days to review this information prior to the scheduled Owner's Verification visit.

3.08 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

- A. Documentation: CA will witness and document the results of the FPTs using specific Functional Performance Test procedures developed for that purpose. CA will include filled out FPTs in Commissioning Turnover Package.
- B. Non-Conformance:

1. CA will record results of functional performance testing. Deficiency or non-conformance issues will be noted and reported to A/E and OR on notes section of the FPT procedure.
2. Corrections of minor deficiencies identified may be made during tests at discretion of CA. In such cases, deficiency and resolution will be documented on FPT form.
3. Every effort will be made to expedite testing and minimize unnecessary delays, while not compromising integrity of tests. CA shall not overlook deficient work or loosen acceptance criteria to satisfy scheduling or cost issues unless directed to do so by the OR.
4. Deficiencies are handled in the following manner:
 - a. When there is no dispute on deficiency and Sub-contractor accepts responsibility for remedial action:
 - 1) CA documents deficiency.
 - 2) CA reschedules test with Sub-contractor.
 - b. When there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
 - 1) CA documents deficiency and the sub-contractor's response and they go on to another test or sequence.
 - 2) CA facilitates resolution of deficiency. Other parties are brought into discussions as needed. Final interpretive authority is with A/E. Final acceptance authority is with the OR.
 - 3) CA documents the resolution.
- C. Approval: CA notes each satisfactorily demonstrated function on test form. CA, A/E and OR provide formal approval of FPT. CA recommends acceptance of each test to A/E and OR. The OR maintains a Cx Issues Log that documents the issues/problems that arise during Cx Verification. The OR and A/E work together to update the log until all the issues are resolved to the satisfaction of the OR. The OR notifies the CM when the Cx Issues are resolved to the extent that occupancy by the Owner can occur.

3.09 COMMISSIONING DOCUMENTATION

- A. Commissioning Turnover Package
 1. CA is responsible to compile and organize commissioning records. CA shall deliver Cx records to the OR in Commissioning Binders. Turnover Package to include the following:
 - a. "As-built" controls submittal
 - b. Pre-functional Checklists
 - c. Completed Functional Performance Test records
 - d. Trend data
 - e. A list of deficiencies referenced to a specific FPT section
 - f. Final TAB Report

3.10 TRAINING OF OWNER PERSONNEL

- A. Sub-contractors will provide complete training in startup, operation and maintenance of all equipment under contract.
- B. CA will be responsible for overseeing and approving content and adequacy of Facility Staff training.
- C. Sub-contractor responsible for training will submit a written training plan to CA for review and approval prior to training. Plan will cover the following elements:
 1. Equipment (included in training)
 2. Intended audience
 3. Location of training
 4. Objectives
 5. Subjects covered
 6. Duration of training on each subject
 7. Instructor for each subject
 8. Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)
 9. Instructors and qualifications

- D. CA coordinates and schedules training with CM, DFM and Sub-contractors. CA develops criteria to determine training satisfactorily completed. CA schedules training sessions with appropriate personnel.
- E. CA will provide videotaping of training sessions as required.

3.11 DEFERRED TESTING

- A. Deferred Seasonal Testing: During warranty period, seasonal testing (tests delayed until weather conditions are closer to system's design) will be completed as part of this contract. CA will coordinate this activity. Tests will be executed, documented and deficiencies corrected by appropriate contractor(s), with DFM, OR and CA witnessing. CA will incorporate final updates to Commissioning Turnover Package as necessary.
- B. Unforeseen Deferred Tests: Any check or test not completed due to building structure, required occupancy condition, or other deficiency, may be delayed upon approval of OR. These tests will be rescheduled as soon as possible.

3.12 PRE-FUNCTIONAL CHECKLISTS

- A. The A/E shall include in the specifications Pre-functional Checklists for the major equipment in the systems under going Functional Performance Tests. Included at the end of this section are example Pre-functional Checklists. The design consultant is responsible for including in this section of the Project Manual comprehensive, accurate, and clearly written Pre-functional Checklists for the major equipment called for in the Project.
- B. The Mechanical Contractor's field foreman shall inspect each piece of installed HVAC equipment using the appropriate Pre-functional Checklist. He shall initial and date each item when it passes inspection and re-inspect until all items pass.
- C. When all items have successfully passed inspection the Mechanical Contractor's superintendent and the General Contractor's project manager shall separately inspect, sign and date the checklists to verify that the installation is complete.

3.13 FUNCTIONAL PERFORMANCE TESTS AND TEST PROCEDURES

- A. AHU Functional Performance Test – The AHU FPT is to be conducted after the hydronic water balance and air side T&B for the spaces served by the AHU are complete. Portions of this FPT also require that the chilled water and heating water systems operate to produce chilled water and heating water at design temperatures. The AHU FPT requires a 24 hour trend at 3 minute intervals of AHU and chilled water system parameters listed in the FPT procedure. The trending should be scheduled to ensure that fire alarm tests or other activities do not shut down the AHU or hydronic systems during the 24 hour period.
 - 1. In the Function Performance Tests Section (Tab 3) there is an example of AHU FPT (including templates for calculating and displaying the trend data) for the AHU sequence of operation contained in this document (see BAS AHU with and without Preheat Coil Schematic and Sequence of Operation Sections, Tabs 8 and 9). The design consultant is responsible for including in this section of the Project Manual a comprehensive, accurate, and clearly written AHU FPT that is specific to the sequence of operation specified.
- B. Air Terminal Unit Functional Performance Tests – Two tests are performed on the Air Terminal Units, a Heating Mode Test and a Cooling Mode Test. Completion of the AHU FPT is a prerequisite to performing these tests. The VAV/CAV Air Terminal Unit Heating and Cooling tests are to be conducted after the hydronic water balance and air side T&B for the terminal units and the AHUs serving these units are completed. These FPTs also require that the chilled water and heating water systems produce design chilled water and heating water temperatures of typically 42°F and 180°F, respectively, continuously throughout the tests. Coordinate with other trades to insure that the chilled water, heating water, and AHUs involved will operate without interference throughout the duration of the tests, approximately 5 hours for each test. An effort should be made to keep all doors separating the terminal boxes' zones closed during these tests. The Air Terminal Unit FPT can be conducted simultaneously for all the terminal units in the project or selected terminal units may be tested separately from others provided the chilled water system,

heating hot water system, and the AHU serving the units meet the prerequisites for conducting the test.

1. The Heating Mode test is to be performed prior to the Cooling Mode test. The space thermostats involved in the Heating Mode test are to be set at 72°F at least 5 hours immediately prior to beginning the Heating Mode test. This is done to establish steady state temperature conditions prior to raising the space thermostats to a set point of 76°F.
 2. When the building has been given time to stabilize at 72°F begin trending the required parameters. Trend each data point every 3 minutes.
 3. Thirty minutes after beginning the trending of parameters globally change the thermostat set point of the boxes being tested to 76°F. Continue trending for another 5 hours. This completes the Heating Mode Test. The information requested on the Heating Mode Test form (see Functional Performance Test Procedures Section, Tab 3) is only supplied for terminal boxes that do not meet the test criteria specified at the bottom of the form.
 4. The Cooling Mode Test should immediately follow the Heating Mode Test. Globally set the thermostat set point of the boxes being tested to 69°F and continue trending the same parameters for 4½ hours.
 5. If the Cooling Mode Test does not immediately follow the Heating Mode Test, 5 hours prior to starting the Cooling Mode Test adjust the thermostat set point for the terminal units being tested to 74°F. After the 5 hour stabilization period, begin trending the parameters specified in the test form. Thirty minutes after beginning the trending, globally change the thermostat set point of the terminal units being tested to 69°F. Continue trending for another 5 hours.
 6. The trend data is to be presented as tabular data in an Excel workbook. The data for each terminal unit is to be contained in separate work sheets using the unique terminal unit designation as the name for each sheet. The columns of each work sheet are to be ordered from left to right as follows:
 7. Date and time in ascending order, zone thermostat set point, cooling set point, heating set point, actual zone temperature, terminal unit reheat coil discharge air temperature, reheat valve commanded position, actual cfm, heating cfm set point, cooling cfm set point, commanded damper position, AHU discharge air temperature, and heating hot water supply temperature. Shade data of the Heating Mode Test red and the Cooling Mode Test data blue.
 8. The system trend data, AHU discharge air temperature, chilled water valve control position, building chilled water supply temperature, building heating hot water supply temperature, and outside air temperature are to be combined in a separate worksheet for each AHU.
 9. Heating Mode and Cooling Mode test forms and templates for calculating and displaying the trend data are included in the Functional Performance Tests Section (Tab 3). These sheets are to be completed for the terminal units that fail the initial FTP or any subsequent FPT.
- C. Chilled Water System Functional Performance Test – The Chilled Water System FPT is conducted after chiller startup, hydronic TAB, and the AHU chilled water control valves are under automatic control. This FPT must test or demonstrate: user change of the order in which the chillers are staged; automatic start of the lead chiller; automatic start of the lag chillers in sequence; automatic de-staging of the lag chillers in sequence; automatic staging and control of pumps and pump speeds; the ability of the system to maintain minimum chiller flow; calibration of the chilled water system sensors.
1. In the Function Performance Tests Section (Tab 3) there is an example of a Primary/Secondary Chilled Water System FPT. The design consultant is responsible for including in this section of the Project Manual a comprehensive, accurate, and clearly written Chilled Water System FPT that is specific to the sequence of operation specified.

- D. BAS/ESC connectivity Functional Performance Test – Coordinate with HCA corporate Facility Group Energy Service center to verify full BAS communication between the facility and ESC.

3.14 PRE-FUNCTIONAL CHECKLISTS:

- A. Pre-Functional Checklist to be completed:
1. Air Handling Unit Pre-Functional Checklist
 2. Air Terminal Unit Pre-Functional Checklist
 3. Fan Coil Unit Pre-Functional Checklist
 4. Ductless Split Unit Pre-Functional Checklist
 5. Emergency Generator Pre-Functional Checklist
 6. General Exhaust Fan Pre-Functional Checklist
 7. Hot Water Boiler Pre-Functional Checklist
 8. Hydronic Pump Pre-Functional Checklist
 9. Isolation Room Exhaust Fan Pre-Functional Checklist
 10. Piping and Ductwork Pre-Functional Checklist
 11. Rooftop Unit Pre-Functional Checklist
- B. Examples of the HCA's template Checklists are available at the website below, in the PFCs folder: 'HCA MEP Guidelines/Appendix A – Commissioning/PFCs'
1. <https://app.e-builder.net/public/PublicFolderView.aspx?FolderID={834dd106-0651-4d4c-a19a-de5a97941b3e}>

3.15 FUNCTIONAL PERFORMANCE TEST PROCEDURES:

- A. Functional Performance test to be completed:
1. Air Handling Unit Functional Performance Test
 2. Air Terminal Unit Heating and Cooling Test Report Functional Performance Test
 3. BAS Graphics Programmers' Guide Functional Performance Test
 4. General Exhaust Fan Functional Performance Test
 5. Heating Hot Water Functional Performance Test
 6. Isolation Room Functional Performance Test
 7. VAV Trend Data Functional Performance Test
- B. Examples of the HCA's template Tests are available at the website below, in the FPTs folder: 'HCA MEP Guidelines/Appendix A – Commissioning/FPTs'
1. <https://app.e-builder.net/public/PublicFolderView.aspx?FolderID={834dd106-0651-4d4c-a19a-de5a97941b3e}>

END OF SECTION 01 91 13

SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, materials, tools, and services for a complete installation of equipment and systems contained in contract documents.
- B. Principal features of work included are:
 - 1. Fire Protection system.

1.02 RELATED WORK

- A. Electrical power and interlock and control wiring and conduit.
- B. Field painting of exposed pipe.

1.03 GENERAL

- A. The contract documents form a guide for a complete system. Provide all items necessary to provide a complete system but not specifically mentioned, such as hangers, transitions, offsets, and drains.
- B. Should Contractor find during progress of work that in his judgment existing conditions make desirable a modification, report such item promptly to Designer for instructions. Do not make deviations from contract documents without review of Designer.
- C. Supervise all work with a competent mechanic specifically qualified in fire protection work.
- D. The installing sprinkler contractor shall be licensed or permitted by the state and local authority having jurisdiction to perform fire protection installations. This shall be in compliance with all applicable state and local laws.

1.04 PERMITS

- A. Secure and pay for permits, licenses, and inspections for work under this Division, including water connections.

1.05 CODES

- A. Comply with all pertinent local, state, and national codes.

1.06 STANDARDS

- A. Comply with all pertinent standards. This list is provided as a convenience to the contractor and is not to be considered all inclusive.
 - 1. NFPA 13: Standard on automatic sprinkler systems.
 - 2. NFPA 24: Standard on fire service line.

1.07 SUBMITTALS

- A. Submit for review complete brochures and shop drawings for materials and equipment proposed.
 - 1. Brochures: Submit complete descriptions, illustrations and specification data for materials and equipment proposed. Clearly indicate proposed items when other items are shown on same sheet. Submit samples on request and/or set up for inspection. Samples will be returned to Contractor.
 - 2. Shop Drawings: Complete equipment, and piping systems.

1.08 PROJECT MAINTENANCE MANUALS

- A. Prior to final acceptance of project, provide Owner with bound maintenance manuals.

1.09 PROJECT TECHNICAL INSTRUCTION

- A. Prior to final inspection of project, provide technical instruction to Owner as follows:
 - 1. Field Instruction: Provide explanation of how systems and equipment are to operate.
 - 2. Field Demonstration: Demonstrate operation and routine maintenance for systems and equipment.

1.10 CONSTRUCTION RECORD DOCUMENTS

- A. Provide construction record documents. Keep at the project one set of drawings and daily record changes at the time they are made. Give drawings to Owner at project completion.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Provide materials and equipment of domestic manufacturer bearing the U.L. and F.M. label when such label is available.

PART 3 EXECUTION

3.01 COORDINATION

- A. Coordinate location of fire protection piping with equipment, ductwork, and other piping to eliminate conflict with other divisions.
- B. Provide proper chases and openings. Place sleeves and supports prior to pouring concrete or installation of masonry.

3.02 CUTTING AND PATCHING

- A. Repair or replace routine damage caused by cutting in performance of contract.
- B. Correct unnecessary damage caused due to installation of fire protection work.
- C. Perform repairs with materials that match existing in accordance with the appropriate sections of these specifications.

3.03 TRENCHING, EXCAVATION AND BACKFILLING

- A. Provide trenching, excavation and backfilling necessary for performance of fire protection work in accordance with the appropriate section of these specifications.

3.04 IDENTIFICATION

- A. Identify exposed or accessible piping with stenciling contents indicating pipe contents and direction of flow on piping not more than 20 feet apart, at valves, at access panels, and at least once above each space.
- B. Paint piping exposed in equipment rooms and stairwells. Paint to be Sherwin Williams Metalatex fire protection red.
- C. Identify all equipment with engraved brass, aluminum, or stainless steel nameplates or tags. Use equipment names and numbers appearing in schedules on drawings. Fasten nameplates to equipment using screws. Glue or adhesive is not acceptable. Fasten tags to equipment using brass, aluminum or stainless steel chains.
- D. Identify each valve with engraved brass, aluminum, or stainless steel identification tag indicating valve service and sequential identification number. Attach tag to valve handle with brass, aluminum or stainless steel chain. Provide two bound manuals to Owner listing each valve sequentially and indicating valve manufacturer, style, size, service, normal position, and specific location for each valve.

3.05 CLEANING

- A. Repair damaged factory finishes covering all bare places and scratches.

3.06 TESTING

- A. Test all installed equipment and systems and demonstrate proper operation. Correct and retest work found defective when tested.
- B. Thoroughly check piping system for leaks. Do not add any leak-stop compounds to the system. Make repairs to piping system with new materials. Peening, doping, or caulking of joints or holes is not acceptable.

END OF SECTION 21 05 00

SECTION 21 10 00
WATER BASED FIRE SUPPRESSION SYSTEMS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Furnish materials, accessories, equipment, tools, and transportation and performance of all services and labor required to completely execute the sprinkler and fire protection work for this project, as indicated on the drawings and as herein specified.

1.02 SCOPE OF WORK

- A. Shop drawings.
- B. Valves including check valves, system valves, backflow preventer, indicator valves.
- C. Pipe, fittings, exterior.
- D. Pipe, fittings, interior.
- E. Hangers, supports and sleeves.
- F. Sprinkler heads, extra sprinkler cabinet.
- G. Alarm check valves and accessories.
- H. Testing and flushing.
- I. Excavation and backfill.
- J. Fire Department connection.
- K. Hydraulically calculate sprinkler system, wet and/or dry as required by drawings. Maximum water velocity shall be 25 feet per second for interior piping and 10 feet per second for exterior piping.
- L. Cutting of holes necessary for the installation of work specified under this Section. Coordinate cutting of material with other Divisions. Employ services of other trades for patching of concrete, masonry, and other material. Use same material for patching and finish neatly.
- M. Unless otherwise noted on the drawings or these specifications, the entire project shall be fully protected, excluding no spaces.

1.03 DESIGN REQUIREMENTS

- A. Install system(s) in accordance with the drawings, specifications, and requirements of NFPA 13, NFPA 14, and NFPA 24.
- B. Furnish material and labor necessary to fully comply with the drawings and specifications and with the rules, regulations, and ordinances.
- C. Reduction of the system area of operation as allowed per NFPA 13 is not acceptable on this project.
- D. Small room rule as allowed per NFPA 13 is not acceptable on this project.
- E. Extended coverage heads are not acceptable on this project.

1.04 QUALITY ASSURANCE

- A. Materials bearing UL and FM approval, where such approval is applicable or required by the agencies having jurisdiction over fire protection work.
- B. The installing sprinkler contractor shall be licensed or permitted by the state and local authority having jurisdiction to perform fire protection installations. This shall be in compliance with all applicable state and local laws.

1.05 SUBMITTALS AND SHOP DRAWINGS

- A. The Contract Documents contain fire protection design drawings which indicate minor coordination. It is the responsibility of the Contractor to prepare detailed and coordinated working drawings and calculations, accurately representing the design of record.

- B. Prepare complete detailed working drawings for Fire Protection System. Submit drawings to Designer and to HCA's insuring agency, AIG, for review. Email plans to planreview.americas@aig.com and copy james.dipaoli@aig.com. Alternate contact information: Jamie DiPaoli, PE 99 High Street, 24th Floor, Boston, MA 02110 Tel. (617) 457-5847 Cell. (862) 245-3572. After receiving this approval, submit shop drawings to State Fire Marshal and local AHJ for his review and approval prior to starting installation. Prior approval by above listed authorities is required before sprinkler installation is begun.
- C. The Sprinkler Contractor shop drawings and calculations shall be stamped and signed by a firm employee who has a minimum NICET III level certification and signed by a Responsible Managing Employee. Shop drawings and calculations shall be submitted by a licensed and registered fire protection contractor.
- D. Equipment submittal drawings and data are required on all items named by manufacturer, including the following:
 - 1. Sprinkler Heads - Type and Manufacturer.
 - 2. Valves - Type and Manufacturer, interior and exterior.
 - 3. Water Flow and Tamper Switches - Type and Manufacturer.
 - 4. Piping and fittings.
- E. The sprinkler system shall be hydraulically designed by industry standard computer software. The Contractor shall submit computer calculations and copy of original water flow test report with working plans. Include in calculations allowance for outside hose streams and domestic water as required.
- F. Contractor will supply as-built drawings to the Owner, the Owner's Insurer, the Architect, the Engineer and other entities as required by the Owner or the Authority Having Jurisdiction.

1.06 SPRINKLER SYSTEM COORDINATION

- A. The contractor will be responsible for ensuring that the reflected ceiling plan shown on the working drawings is the latest revision from the Architect before commencing work.
- B. The contractor shall be responsible for providing to the Architect notification for any drawing changes resulting from movement of sprinkler piping or heads during installation.
- C. Failure to coordinate sprinkler system and building systems (including, but not limited to: ductwork, mechanical piping, and lighting fixtures) prior to fabrication or installation of sprinkler systems shall be corrected, modified, or changed as necessary at the expense of the contractor.
- D. The contractor is to completely investigate, PRIOR TO BID, all requirements of local water utility and fire department. Devices such as ADT and/or local alarm systems, double check valve assemblies, detector checks, tamper switches shall be provided complete, wired, connected, and installed in accordance with local authorities by this Contractor. In the event the authorities have no installation details, the Contractor shall submit for approval proposed installation.

1.07 APPLICABLE CODES

- A. NFPA 13
- B. NFPA 24

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Products listed indicate standard.

2.02 VALVES

- A. Acceptable Valve Manufacturers: Ames, Nibco, Anvil, Mueller, Kennedy, Wilkins.
- B. Outside System Valves:
 - 1. Full flow fire meters with OS&Y valves in a utility company approved vault. Size as indicated on drawings.

2. Section valves in valve pit: Kennedy Valve 8068A flange pattern outside screw and yoke wedge gate valves, epoxy coated.
 3. Underground sectional control valves: Kennedy Valve 8561 flanged, or Kennedy Valve 8571 mechanical joint, or G-Kennedy Valve 8901 Tyton joint, NRS gate valve, epoxy coated. Provide cast iron roadway box, extended to grade.
 4. Post indicator valves: Kennedy Valve 8701ASS flanged or Kennedy Valve 8071SS mechanical joint, or Kennedy Valve 8901 PSS Tyton joint, NRS gate valve, epoxy coated. Kennedy Valve 2945A indicator post with required extension sleeve. Install indicator post with window 30" above finished grade.
- C. Backflow Preventer
1. Double check detector valves: Ames C300 or Wilkins 350 ADA with 2" bronze by-pass meter or local water department standard. Size as indicated on drawings.
- D. Interior Valves:
1. Check valves:
 - a. Iron body, Kennedy Valve 1126 swing check valve, flanged body.
 - b. Bronze body, Nibco KT-403-W threaded check valve with dielectric unions.
 2. Gate valves:
 - a. Iron body, O.S.&Y. gate valves, Kennedy Valve FW-8068A, flanged.
 - b. Bronze body, O.S.&Y. gate valve, Nibco T-104-0, threaded with dielectric unions.
 3. Butterfly valves shall not be accepted.
- E. Exterior Pipe and Fittings:
1. Provide cement lined ductile iron pipe, Class 52 conforming to ANSI/AWWA C151/A21.51 for Tyton joint pipe or ANSI/AWWA C111/A21.11 for mechanical joint pipe. Acceptable Manufacturers: U.S. Pipe, American Pipe, McWane, or equivalent.
 2. Fittings shall be push-on joint ductile iron fittings, 350 PSI, with field loc gaskets, or mechanical joint ductile iron fittings conforming to ANSI/AWWA C110/A21.10 and C111/A21.11.
 3. Provide concrete thrust blocks at all fittings, valves, and changes in direction.
 4. Provide braces, bridle rods, or restraining systems typical of "MEGALUG" by EBBA, Inc., on all mechanical joint fittings and valves.
 5. Provide PVC water main pipe and fittings conforming to AWWA C900, Class 200 PSI, as manufactured by Johns Mansville, Certainteed, or equivalent.
 6. All exterior site piping shall be buried with a standard, permanent, bright colored, continuous printed plastic tape. Tape shall be intended for direct burial service and buried directly above the service line. The tape shall be 6 inches by 4 mils thick minimum. Tape shall be printed with proper identification of the service located below it.

2.03 PIPE AND FITTINGS

- A. Exterior Pipe and Fittings:
1. Provide cement lined ductile iron pipe, Class 52 conforming to ANSI/AWWA C151/A21.51 for Tyton joint pipe or ANSI/AWWA C111/A21.11 for mechanical joint pipe. Acceptable Manufacturers: U.S. Pipe, American Pipe, McWane, or equivalent.
 2. Fittings shall be push-on joint ductile iron fittings, 350 PSI, with field loc gaskets, or mechanical joint ductile iron fittings conforming to ANSI/AWWA C110/A21.10 and C111/A21.11.
 3. Provide concrete thrust blocks at all fittings, valves, and changes in direction.
 4. Provide braces, bridle rods, or restraining systems typical of "MEGALUG" by EBBA, Inc., on all mechanical joint fittings and valves.
 5. Provide PVC water main pipe and fittings conforming to AWWA C900, Class 200 PSI, as manufactured by Johns Mansville, Certainteed, or equivalent.

6. All exterior site piping shall be buried with a standard, permanent, bright colored, continuous printed plastic tape. Tape shall be intended for direct burial service and buried directly above the service line. The tape shall be 6 inches by 4 mils thick minimum. Tape shall be printed with proper identification of the service located below it.
- B. Interior Pipe and Fittings:
1. Piping shall be Schedule 40 black steel pipe 2" and smaller conforming to ASTM A135 or ASTM A53 and Schedule 10 black steel pipe 2-1/2" and larger conforming to ASTM A135.
 2. Fittings:
 - a. Ductile iron threaded fittings, ANSI B16.3 Class 300.
 - b. Cast iron threaded fittings, ANSI B16.4 Class 125 and 300 (extra heavy).
 - c. Cast iron flanged fittings, ANSI B16.1 Class 125 and 300.
 - d. Mechanical joint, grooved couplings, as manufactured by Tyco, Anvil, or equivalent. Couplings shall be rigid type, equivalent to 772 Domestic Rigid Coupling or Style 577 Rigid Import Coupling. All groove couplings and fittings shall be furnished by a single manufacturer.
 3. Piping for Dry Pipe systems and for drainage systems shall be Schedule 40 galvanized steel pipe, ASTM A795 or A135 with galvanized threaded fittings, ANSI B16.4, galvanized coated, both interior and exterior of pipe and fittings.
 4. Flexible stainless steel hose connections between sprinkler heads and branch piping are not permitted.
- C. Hangers, Supports, and Sleeves:
1. Support piping with UL and FM approved hangers. Acceptable manufacturers: Anvil, B-Line, Fee & Mason.
 2. Adjustable Clevis: Anvil Fig. 260.
 3. Adjustable Swivel: Anvil Fig. 69.
 4. Beam Clamp: Anvil Fig. 92 and Anvil Fig. 218 with retaining strap.
 5. Concrete Fasteners: Anvil steel shell and expander plug.
 6. Concrete Insert: Anvil Fig. 152.
 7. Riser Clamp: Anvil Fig. 261.
 8. Powder-driven inserts shall not be accepted.
 9. All pipes passing through rated floors or walls shall be sleeved and/or firestopped to an equivalent rating of the floor or wall assembly. Firestop materials shall meet ASTM E814 requirements.
 10. All piping hangers shall be listed for use with sprinkler systems.
 11. All hangers, bracing, etc., shall be designed to constrain the sprinkler discharge resulting from a system pressure of 175 psig at the base of the riser.

2.04 SPRINKLER HEADS, EXTRA SPRINKLER CABINET

- A. Provide the following sprinkler heads of proper types, ratings, and spacings for areas involved. Provide appropriate finishes compatible with space finishes being served. Acceptable manufacturers: Tyco, Viking, and Reliable.
1. Quick Response Type:
 - a. Pendent and brass upright chrome: Tyco TY-FRB (F.M. approved). K-Factor = 5.6
 - b. Recessed, chrome: Tyco TY-FRB (F.M. approved). K-Factor = 5.6
 - c. Fully concealed: Tyco-RF II, white coverplate. K-Factor = 5.6
 - d. Horizontal sidewall: Tyco-FRB.
 - e. Dry: Tyco Model DS-1, K-Factor = 5.6.
 - f. Institutional: Quick Response: Tyco "Raven" chrome and Tyco "Raven" K-Factor = 5.6.
- B. Pendent heads in ceilings and horizontal sidewall heads shall have one-piece, non-adjustable escutcheons. Two-piece or slip type escutcheons shall not be accepted. This does not apply to recessed heads.
- C. Provide sprinkler cabinet with spare sprinkler heads per NFPA 13.
- D. Contractor shall coordinate dry barrel length as required for field conditions.

2.05 SWITCHES

- A. Water Flow Switch: Notifier Model No. WFD-60 24 VDC vane type flow switch with pneumatic retard adjustable from 0 to 70 seconds, complete with two sets of single pole, double throw micro feature. Coordinate final voltage with Division 26.
- B. Tamper Switches: Notifier Model No. PIBV2(A) for 4" and larger, Potter Model No. OSYSU-2 24 VDC for pipe size less than 4", tamper switch double pole, double throw micro feature for ½-inch to 12-inch valves. Coordinate final voltage with Division 26.

2.06 WATER FLOW ALARMS

- A. Water Motor Alarm: Hydraulically operated impeller type alarm with 8" round aluminum alloy red enameled gong and motor housing, nylon bearings, and inlet strainer. Tyco Model: WMA-1 or approved equal.
- B. Electric Alarm: Electrically operated 24 VDC red enameled 10" round gong with pressure alarm switch. Coordinate final voltage with Division 26. Notifier MB-G10 or approved equal.
- C. Contractor Option: Contractor has option of providing water motor alarm in lieu of electric bell. Contractor shall provide all piping, retarding chamber, valves, etc. As required for a functioning system at no additional cost to Owner.
- D. Contractors Option: Contractor has option of providing electric bell in lieu of water gong. If contractor chooses this option, all required coordination with Division 26 and changes shall be provided at no additional cost to Owner.
- E.

2.07 FIRE DEPARTMENT CONNECTION

- 1. Remote Free Standing Fire Department Connection (Siamese): Croker Standard Figure 6510-PC 4" by 2-1/2" two-way, polished chrome with double clapper inlets siamese fire department connection. Overall height shall be 24". Hose threads shall be in accordance with local fire department requirements. Provide plugs with chains. If required by AHJ, provide 2-1/2" KNOX LOCKS on inlet connections.
- B. P
- C. Provide signage per NFPA 13, and requirements of local authority having jurisdiction for proper identification for fire department service.
- D. Furnish material and labor necessary to fully comply with the drawings and specifications and with the rules, regulations, and ordinances.
 - 1. Provide a 3/4" ball drip for all types of fire department connections. Route discharge, to outside of building.

2.08 WET ALARM CHECK VALVES AND ACCESSORIES

- A. Wet Alarm Check Valve and Accessories - Water Motor Gong:
 - 1. Alarm check valve shall be equal to Tyco AV-1-300 divided seat ring, rubber faced clapper (removable) and listed for installation in the [horizontal] [or] vertical position. Alarm check valve shall be equipped with gauge connections on the system side and supply side of the valve clapper. Refer to drawing for required size.
 - 2. Provide alarm check valve trim package to include as a minimum:
 - a. External bypass check valve to reduce false water flow alarms.
 - b. Main drain valve.
 - c. Alarm test valve.
 - d. Pressure gauges (system and supply).
 - e. Connection for water flow pressure alarm switch.
 - f. All trim piping shall be galvanized pipe.
 - g. Restriction assembly with stainless steel screen.

3. Provide retarding chamber equal to Tyco RC-1. Retarding chamber to be cast iron and 3/4 " x 1/2 " x 3/4:" tee for connection to water flow pressure alarm switch.
 4. Waterflow pressure alarm switch equal to System Sensor EPS10-2 24 VDC. Waterflow pressure alarm switch shall be bellows-activated type with adjustment range 4 to 20 psi with operating rising pressure from 4 to 8 psi. Switch shall be provided with two sets of single pole double throw contacts and 1/2". NPT male threaded connection. Coordinate final voltage with Division 26.
- B. Wet Alarm Check Valve and Accessories – Electric Bell
1. Alarm check valve shall be equal to Tyco CV-1FR with resilient elastomer seal facing on the spring-loaded clapper.
 2. Provide trim package to control include as a minimum as follows:
 - a. Main drain valve.
 - b. Pressure gauges (system and supply).
 3. Provide waterflow switch connected to electric bell and fire alarm system.

2.09 INSPECTOR TEST AND DRAIN

- A. Where indicated on drawings (riser or remote location), Inspector test and equal to AGF3011ASG. Inspector test and drain shall have:
1. Body Material: Bronze body, brass stem, steel handle, chrome-plated bronze ball, virgin Teflon valve seat. Sight Glass: Bronze housing with viewing window.
 2. Components: A tamper resistant test orifice and a tapped port for system access.
 3. Pressure Relief Valve and Drainage Piping: AGF Model 7000.
 - a. Pressure Rating: Factory rated at 175 psi.
 - b. Body Material: Bronze body and stainless steel spring.
 - c. Components: Nylobraid flexible tube, two 1/2" NPT by barbed 90 degree elbows, external identification plate and integral flushing handle to remove debris.
 - d. 1/2 inch MIPT inlet, 1/2 inch FIPT outlet.
 - e. Relief pressure shall be factory set to project specifications.
 - f. Relief valve shall operate to the OPEN position between 90% and 105% of the set pressure.
 - g. Relief valve shall reseal or CLOSE at a minimum of 80% of set pressure.
 4. Test Orifice Size: As required by NFPA 13, latest edition.
 5. Size: F.I.P.T., same as connected piping.
 6. Inlet and Outlet: Threaded.

2.10 DRY PIPE SYSTEM

- A. Dry Pipe System Alarm Check Valve :
1. Provide check type valve with divided seat ring, rubber faced clapper to automatically activate electric alarm. Alarm check valve shall be equal to TYCO DPV-1 with trim package.
 2. Accelerator
 3. Test and drain
 4. Air Maintenance device with low pressure alarm
 5. Alarm switch with supervisory capability
 6. Pressure gauges where required by NFPA 13
- B. Air Compressor
1. Coordinate with Division 26 for all wiring connection to approved air compressor. Air compressor shall be selected for 120/1/60.
 2. Contractor to select air compressor to:
 - a. Restore system pressure within 30 minutes or as required by NFPA 13.
 - b. Maintain system pressure as required by approved dry pipe valve or shall be 20 psi in calculated trip pressure of dry pipe valve.
- C. Calculations:
1. Provide calculations for water delivery time by approved software.

2. Water delivery shall be:
 - a. Ordinary Group 1 Hazard – 50 seconds
 3. Provide quick opening device as required.
- D. Drainage:
1. System branch lines shall be pitched at least ½ inch per 10 feet.
 2. Mains shall be pitched at least ¼ inch per 10 feet.
 3. Auxiliary Drains:
 - a. Located in areas subject to freezing shall be readily accessible.
 - b. If capacity of trapped section is less than 5 gallon drain shall consist of valve not less than ½ inch and drain plug.
 - c. If capacity of trapped section more than 5 gallon drain shall consist of two 1 inch valves and one 2 inch by 12 inch condensate nipple and shall be accessibly located.
 4. Test connection shall be located on end of most distant sprinkler pipe and equipped with readily accessible shut off valve and plug not less than 1 inch, at least one of which shall be brass.
- E. Gridded systems are not acceptable.

2.11 FIRE EXTINGUISHERS

- A. Fire Extinguisher Cabinet (ABC Extinguisher)
 1. Croker-Standard, Figure Number 1610 white baked enamel steel box with full acrylic panel door, containing the following by Croker-Standard:
 - a. Figure Number 4010 ten pound ABC multi-purpose dry chemical fire extinguisher with a UL rating of 4A:80B:C.
 - b. Provide Figure Number 1807 decal lettering for cabinet. Exterior frame of cabinet shall be painted to match wall surface.
- B. Fire Extinguisher (Wall Hung, ABC): Croker-Standard, Figure Number 4010, ten pound, ABC wall hung fire extinguisher, with UL rating of 4A:80B:C. Provide wall mounting bracket.
- C. Fire Extinguisher (CO2 Type, Wall Hung): Croker-Standard, Figure Number 4410 ten pound carbon dioxide fire extinguisher with an UL rating of 10B:C. Provide wall mounting bracket.

PART 3 EXECUTION

3.01 COORDINATION

- A. Coordinate installation with other Divisions to ensure there are no conflicts. Fire protection piping shall not take priority in routing over HVAC ductwork.

3.02 PIPE INSTALLATION

- A. Connect to water main as shown on drawings.
- B. Install underground piping to provide a minimum cover of 2.5 feet over the top of the pipe. Provide 3 feet of cover under roads and driveways.
- C. Install underground service utility tape approximately 18 inches above pipe.
- D. Attach hangers to structural steel work as specified above, except that structural work shall not be drilled and punched. Wherever necessary, furnish, install, and securely anchor to or between building members suitable angle iron or other steel members to support sprinkler work.
- E. Provide support for grooved piping in conformance with requirements of MSS-SP-69, "Pipe Hangers and Supports - Selection and Application". In addition to these requirements, leave no horizontal pipe unsupported between any two couplings nor shall any pipe be left unsupported whenever a change in direction of flow takes place. Provide supports meeting the requirements stated above, but ensure that the distance between supports does not exceed the following:

PIPE SIZE	MAXIMUM SPAN BETWEEN HANGERS
1 Inch	8 Feet
1-1/4 through 2 Inch	10 Feet
2-1/2 through 4 Inch	12 Feet

PIPE SIZE	MAXIMUM SPAN BETWEEN HANGERS
5 through 8 Inch	14 Feet

- F. Support vertical piping at every other floor or every other pipe length, whichever is most frequent. Set the base of the riser or base fitting on a pedestal or foundation.
- G. Piping Above Grade:
 - 1. In areas with no ceilings, run piping as high as possible. Minimum head room shall be 10'-0".
- H. Underground Pipe:
 - 1. Underground pipe and fittings shall be listed in the Underwriters' Laboratories approved fire protection equipment list.
 - 2. All underground piping for fire mains shall be installed, clamped and anchors, flushed and hydrostatically pressure tested according to the requirements of the Authorities Having Jurisdiction and NFPA 13 and 24.
 - 3. Trench and excavation work of the depth required by the Authorities and/or Agencies Having Jurisdiction for the proper installation of underground piping and valve shall be furnished by the sprinkler contractor.
 - 4. Trench and excavation work shall include excavating, cutting of holes through foundation walls and floors, preparing of trenches, backfilling as specified.
- I. Provide section valves where shown on drawings, complete with tamper switch, water flow alarm, and drain connections. Provide sight-glass where inspector's test discharge cannot be readily seen when operating valve.
- J. All control valves and indicating valves shall be chained into the open position and equipped with signaling devices per NFPA 13 – 8.15.1.1.2.1.
- K. All metallic sprinkler piping, including but not limited to, all risers, cross mains, drains, and branches are to be primed with at least one coat of rust inhibitive primer before installation. (Except where stainless steel or chrome plated piping is used.)
- L. All sprinkler piping shall be hydrostatically tested at 200 psi and shall maintain that pressure with no loss for 2 hours or as required by NFPA 13 for normal pressure in excess of 150 psi.
- M. Provide drain valves, pipes and test connections as required by NFPA 13. Pipe drain lines and test connections to outside building as shown on the drawings and details. Test lines must originate from the most hydraulically remote point of each sprinkler zone. All drain piping and fittings shall be galvanized coated, no exception.
- N. Cross mains and feed mains shall not pass through electrical rooms or similar spaces. Only the branch line serving such spaces shall be permitted within the boundaries of these rooms.
- O. Drain plugs shall be installed on trapped sections of piping between 5 and 50 gallons. Auxiliary drain valves, 1 inch or larger, shall be installed on trapped sections of pipe greater than 50 gallons, and piped to an accessible location.
- P. All dry pipe systems shall be tested in addition to hydrostatic test, an air pressure leakage test at 40 psi for 24 hours with a maximum pressure loss of 1-1/2 psi.

3.03 SPRINKLERS

- A. Install sprinkler heads and required piping in areas such as concealed spaces, lab hoods, and other special areas and spaces as required by NFPA 13, NFPA 101, applicable state and local codes.
- B. Install sprinkler heads centerline of corridors and locate in the center of the ceiling tiles. Install sprinkler heads in other designated spaces in the center of the ceiling tiles and symmetrically locate with other heads within the ceiling. (See Architectural reflected ceiling plans.) Do not install sprinkler heads in other locations any closer than six (6) inches to any ceiling grid or wall.
- C. Pendant sprinklers below ceiling shall be in alignment and parallel to ceiling features, walls, etc.

- D. When the light fixtures extend below the ceiling, the sprinklers shall be spaced so that the sprinkler spray pattern is not obstructed. See electrical plans.
- E. Provide guards on sprinkler heads where within 7'-6" of finished floor or wherever sprinklers may be subject to mechanical injury.
- F. Furnish one sprinkler cabinet complete with 12 sprinklers of assorted temperature ratings of the type necessary and in use throughout the installation, including one special sprinkler wrench. Locate and mount adjacent to riser.

3.04 MATERIAL AND TEST CERTIFICATE

- A. Provide copy of Contractor's Material and Test Certificate for underground and above ground piping as required by NFPA 13 and NFPA 24 in Owners O&M Manual.

3.05 OWNER'S INFORMATION CERTIFICATE

- A. Before commencing work, the sprinkler contractor shall obtain from the Owner, or his Agent, an Owner's Information Certification containing the elements outlined in NFPA 13 – 4.3.
- B. The Contractor shall provide a copy of the Owner's Certificate to the Engineer.

3.06 GUARANTEE

- A. The fire protection installation, as specified under this section of the specifications, shall be guaranteed for one year against defective equipment, materials, and workmanship.
- B. Guarantee shall not be construed as requiring the sprinkler contractor to render service or maintenance required in the normal operation of the equipment or to make repairs that may be needed due to normal wear and tear or the Owner's negligence, abuse, or breakage.

3.07 INSPECTION SERVICE

- A. After completion of the fire protection installation and at the start of the guarantee year, the Contractor shall execute the National Automatic Sprinkler and Fire Control Association, Inc., Standard form of "Inspection Agreement," without charge to the Owner, calling for four inspections of the sprinkler system during the guarantee year. These inspections will, at a minimum, comply with the provisions and requirements of NFPA 25. During the guarantee year, the inspections shall be made as per the inspection agreement, plus the following maintenance to be performed during the course of the fourth inspection.
 - 1. Operation of all control valves.
 - 2. Lubrication of operating stems of all interior control valves.
 - 3. Operation of water motor gong and/or electric alarms.
 - 4. Cleaning of alarm valves.
 - 5. Cleaning of dry pipe valves.
 - 6. Lubrication of Fire Department Connection inlets.
- B. The Standard Form of the National Automatic Sprinkler and Fire Control Association, Inc., "Report of Inspection" shall be filled out in triplicate after each inspection and the copies sent to the Owner, Insurance Carriers, Fire Department, or other authorities that the Owner may designate.

END OF SECTION 21 10 00

SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, materials, tools, and services for a complete installation of equipment and systems contained in contract documents.
- B. Principal features of work included are:
 - 1. Plumbing system.
 - 2. Medical gas system.

1.02 RELATED WORK

- A. Electrical power and interlock and control wiring and conduit.

1.03 INNOVATION MEMORANDUMS

- A. The owner has obtained purchase agreements for select equipment and materials. These purchase agreements are documented as Innovation Memorandums and are to be included as part of this project.
- B. Innovation Memorandum No. 6: All plumbing fixtures and related products to be purchased from Ferguson Enterprises. Refer to Section 22 43 00.
- C. Innovation Memorandum No. 7: All piping, valves, pipe fittings and related products to be purchased from Ferguson Enterprises. Refer to Sections 221116, 221119, 221316, 221319.

1.04 GENERAL

- A. The contract documents form a guide for a complete system. Provide all items necessary to provide a complete system but not specifically mentioned, such as hangers, transitions, offsets, and drains.
- B. Layouts indicated on drawings are diagrammatical only. Coordinate exact location of equipment, ductwork, and piping to eliminate conflict with other divisions. Designer reserves right to make reasonable changes in location of equipment, ductwork, and piping prior to construction.
- C. Should Contractor find during progress of work that in his judgment existing conditions make desirable a modification, report such item promptly to Designer for instructions. Do not make deviations from contract documents without review of Designer.
- D. Supervise all work with a competent mechanic specifically qualified in mechanical discipline.
- E. All products used for dispensing potable drinking water must be lead free and meet the requirements of NSF 61 and NSF 372 test standards via third party testing and certification.
- F. All piping and valves to be purchased from Ferguson Enterprises. Contact Bettina Dawson office (615) 316-1920 cell (931) 239-0466 or email HCA@Ferguson.com.

1.05 PERMITS

- A. Secure and pay for permits, licenses, and inspections for work under this Division, including water and sewage connections.

1.06 CODES

- A. Comply with all pertinent local, state, and national codes.

1.07 STANDARDS

- A. Comply with all pertinent standards. This list is provided as a convenience to Contractor and is not to be considered all inclusive.
 - 1. American Gas Association (AGA).
 - 2. CISPI Standard 301.
 - 3. ASTM A 74.

1.08 SUBMITTALS

- A. Submit for review complete brochures and shop drawings for materials and equipment proposed.
 - 1. Brochures: Submit complete descriptions, illustrations and specification data for materials and equipment proposed. Clearly indicate proposed items when other items are shown on same sheet. Submit samples on request and/or set up for inspection. Samples will be returned to Contractor.
 - 2. Submittals shall be submitted in line by line format. Each submittal shall be provided with a cover letter and supporting documentation indicating how the submittal meets each line of the referenced specification section. All discrepancies between the construction documents and the submitted product shall be clearly identified for engineer evaluation.
 - 3. If a product other than the basis of design is rejected by the engineer for any reason, the Contractor shall provide the basis of design product at no additional cost to the Owner.
 - 4. Shop Drawings:
 - a. Complete equipment and piping systems in equipment rooms.
 - b. Complete equipment and piping systems in entire building.
 - c. Owner furnished equipment rough-in layouts.
 - d. Laboratory equipment rough-in layouts.
 - e. Firestop systems.

1.09 PROJECT MAINTENANCE MANUALS

- A. Prior to final acceptance of project, provide Owner with bound maintenance manuals.

1.10 PROJECT TECHNICAL INSTRUCTION

- A. Prior to final inspection of project, provide technical instruction to Owner as follows:
 - 1. Field Instruction: Provide explanation of how systems and equipment are to operate during each season and during emergencies.
 - 2. Field Demonstration: Demonstrate operation and routine maintenance for systems and equipment.
 - 3. Videotape: Provide videotape or DVD of field instruction and demonstration to Owner at completion.

1.11 CONSTRUCTION RECORD DOCUMENTS

- A. Provide construction record documents. Keep at the project one set of drawings and daily record changes at the time they are made. Give drawings to Owner at project completion.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Provide materials and equipment of domestic manufacturer bearing the U.L. label when such label is available.
- B. Cast Iron Soil Pipe and Fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute  and listed by NSF[®] International.

PART 3 - EXECUTION

3.01 COORDINATION

- A. Coordinate locations of equipment, and piping to eliminate conflict with other divisions.
- B. Carefully examine contract documents to be thoroughly familiar with items which require plumbing or mechanical connections and coordination.
- C. Provide proper chases and openings. Place sleeves and supports prior to pouring concrete or installation of masonry.

3.02 CUTTING AND PATCHING

- A. Repair or replace routine damage caused by cutting in performance of contract.
- B. Correct unnecessary damage caused due to installation of plumbing work.

- C. Perform repairs with materials that match existing in accordance with the appropriate section of these specifications.

3.03 FLASHING, COUNTERFLASHING, AND SEALING

- A. Flash, counterflash, and seal piping at penetrations of roofs and outside walls.

3.04 TRENCHING, EXCAVATION AND BACKFILLING

- A. Excavate to a depth at least 6" below bottom of pipe and a minimum of 36" above top of pipe. Fill below pipe, around pipe, and minimum of 12" above pipe with sand or Class "B" crushed stone tamped firm and even. Provide topsoil for final layer of dirt (12" minimum). Provide 6" spacing between pipes and between pipe and trench sides. Hand-grade with batterboards placed every 25'. Backfill by hand. Do not use rock or stone above sand or Class "B" crushed stone.

3.05 CONNECTION TO EQUIPMENT

- A. Rough-in and connect to sterilizers, lab equipment, and Owner furnished equipment and provide a shutoff valve and union at each connection. Operating valves and/or controls for this equipment will be provided as an integral part of the equipment. Do not rough-in until shop drawings showing rough-in locations have been reviewed by Designer.

3.06 IDENTIFICATION

- A. Identify exposed or accessible piping with stenciling contents indicating pipe contents and direction of flow on piping not more than 20 feet apart, at valves, at access panels, and at least once above each space.
- B. Contractors option to identify exposed or accessible piping with snap-on or strap-on type markers. Color code markers in accordance with ANSI. Indicate pipe contents and direction of flow on marker. Install markers on piping not more than 20 feet apart, at valves, at access panels, and at least once above each space.
- C. Include design operating pressures in psig for compressed air services.
- D. Sanitary waste, storm and buried lines need not be marked.
- E. Identify all equipment with engraved brass, aluminum, or stainless steel nameplates or tags. Use equipment names and numbers appearing in schedules on drawings. Fasten nameplates to equipment using screws. Glue or adhesive is not acceptable. Fasten tags to equipment using brass, aluminum or stainless steel chains.
- F. Identify each valve with engraved brass, aluminum, or stainless steel identification tag indicating valve service and sequential identification number. Attach tag to valve handle with brass, aluminum or stainless steel chain. Provide two bound manuals to Owner listing each valve sequentially and indicating valve manufacturer, style, size, service, normal position, and specific location for each valve.

3.07 CLEANING

- A. Repair damaged factory finishes covering all bare places and scratches.
- B. Cleaning Domestic Water System: Flush domestic water system progressively by opening building outlets and permitting flow to continue from each until water runs clear. Sterilize system in accordance with requirements of State Department of Public Health by the following method or other method acceptable to local authorities:
 - 1. Introduce chlorine or a solution of calcium or sodium hypochlorite, filling lines slowly and applying sterilizing agent at a rate of 50 ppm of chlorine as determined by residual chlorine tests at ends of lines. Open and close all valves while the system is being chlorinated.
 - 2. After sterilizing agent has been applied and left standing for 24 hours, test for residual chlorine at ends of lines. If less than 25 ppm is indicated, repeat sterilizing process.
 - 3. After standing for 24 hours and tests show at least 25 ppm of residual chlorine, flush out system until all traces of chemical used are removed.

3.08 TESTING

- A. Test all installed equipment and systems and demonstrate proper operation. Correct and retest work found defective when tested.
- B. Thoroughly check piping system for leaks. Do not add any leak-stop compounds to the system. Make repairs to piping system with new materials. Peening, doping, or caulking of joints or holes is not acceptable.
- C. Test hot and cold domestic water piping systems upon completion of rough-in and before connection to fixtures at a water pressure of 125 psig for two hours without leaks.
- D. Test drainage and venting system with necessary openings plugged to permit system to be filled with water and subjected to a minimum water pressure of 10 feet head at top of system. System to hold water for two hours without a water level drop greater than 4" in a 4" standpipe and without visible leakage. Test system in sections if minimum head can be maintained in each section.
- E. Conduct air or smoke test if in opinion of Designer reasonable cause exists to suspect leakage or low quality workmanship.
- F. Test gas piping and compressed air piping with Nitrogen at 100 psi for two hours without leaks.
- G. Test flush valves for proper operation.

END OF SECTION 22 05 00

SECTION 22 07 19
PLUMBING INSULATION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Contractor shall provide all necessary labor, materials, tools, and equipment to perform work required on the drawings and specified herein.
- B. Certain equipment and/or systems to be factory insulated by manufacturer. Factory insulation materials to be as specified in applicable sections of the specifications.
- C. All pipe fittings, valves, and strainers in insulated pipe systems to be insulated.
- D. Thermal resistance "R" values used herein are expressed in units of "Hour, Degrees F., Sq. Ft./BTU per Inch of Thickness" on a flat surface at a mean temperature of 75 degrees F.
- E. Note that where electric cable wrap is called for, insulation is to be applied over cable.

1.02 DEFINITIONS

- A. "Exposed" equipment, and piping are areas which will be visible without removing ceilings or opening access panels.
- B. Outdoors is considered exposed to the weather.
- C. Underground is buried, whereas in a trench below grade is considered concealed.

1.03 CERTIFICATION/QUALITY ASSURANCE

- A. Products shall meet applicable national, state, and local building codes and be U.L. (or other recognized testing lab) listed for intended service.
- B. All insulations, jackets, adhesives, coatings, sealers, and tapes shall have a flame spread rating of 25 or less and smoke development rating of 50 or less when tested in accordance with ASTM E-84, NFPA 225, U.L. 723, and further must meet the requirements of NFPA 90-A and applicable building, and plumbing, codes.
- C. All insulation materials shall be delivered and stored in manufacturers' containers and kept free from dirt, water, chemical, and mechanical damage.
- D. Insulation shall be applied in a workmanlike manner by experienced, qualified tradesmen.
- E. Insulation shall not be applied until all pressure testing has been completed, inspected, and released for insulation application.
- F. Surfaces shall be clean and dry.
- G. Insulation joints shall be butted firmly together and all jackets and tapes shall be smoothly and securely installed.
- H. Insulation for duct, pipe, and equipment for above grade exposed to weather outside building shall be certified as being self-extinguishing for 1" thickness in less than 53 seconds when tested in accordance with ASTM D-1692.

1.04 APPLICABLE CODES AND STANDARDS

- A. ASTM E-84.
- B. U.L. 723.
- C. State of Florida Energy Code.

PART 2 PRODUCTS

2.01 EQUIPMENT REQUIREMENTS

- A. Materials for Pipe and Equipment: Provide factory pre-molded or shop or site mitered segment type insulation for pipe, pipe fittings, and valves. Fitting insulation to be of same thickness and material as adjoining pipe insulation. All insulation and related materials such as tape and mastic to meet applicable building code requirements for fire and smoke development.

1. Fiberglass: Provide factory-formed, factory-jacketed fiberglass piping insulation. Product to be Manville "Micro-Lok 650" with "Type AP-T" jacketing or equivalent product manufactured by CertainTeed, Knauf, or Owens-Corning. Product to have continuous operational temperature limit of 850 degrees F and a minimum "R" value of 4.3 per inch (K=0.23) at 75 degrees F mean temperature. Jacket to be fiberglass reinforced kraft paper with aluminum foil and pressure sensitive closure system. Vapor-barrier mastic for application to below ambient pipe insulation shall be fungus resistant per ASTM D 5590 with 0 growth rating; Water based; Permeance per ASTM E 96, Procedure B, 0.013 perm or less at 43-mil dry film thickness suitable for indoor and jacketed outdoor use. Products: Foster 30-80 AF. Color: White. A breather mastic for application to above ambient pipe insulation (fittings, tees, valves, etc) shall be water based Foster 46-50 mastic or Childers CP-10 / CP-11. Use fiberglass piping insulation for the following services:
 - a. Domestic hot water supply without recirculating system: 1-1/4" and under - 1/2" thick; 1-1/2" and greater - 1" thick.
 - b. Domestic hot water supply and recirculating return piping: All sizes – 1" thick.
 - c. Domestic cold water piping: 1/2" thick.
 - d. Horizontal rainwater leaders, overflow leaders, and roof drain bodies: 1" thick.

2.02 MATERIALS FOR FITTINGS, VALVES, AND SPECIAL COVERINGS

- A. Provide coverings and finishes for specific items hereinafter specified.
 1. Use pre-molded insulation fabricated by the manufacturer of insulation material or shop or site mitered segment type insulation for all pipe fittings, elbows, tees, valves, and couplings.
 2. PVC fitting covers over blanket fiberglass are NOT acceptable.
 3. Contractor's option to provide factory pre-molded one-piece PVC insulated fitting covers, precut fiberglass insulation inserts, and necessary installation materials for all pipe fittings. Materials to be equal to Manville Zeston white, U.V. resistant, 25/50 rated, 20 mil thickness insulated PVC fitting covers and insulation inserts.
- B. For any service, when below grade direct buried, cover straight pipe and fitting insulation with equivalent of Pittsburgh Corning "Pittwrap", Foster C.I. Wrap 50 mil or "Pittwrap SS11" jacketing. Valves in systems operating above 60 degrees F. and installed in valve boxes shall not be insulated; however, the valves shall be painted with a rust resistant product equivalent to Rustoleum.
- C. For pipe and fitting insulation when exposed-to-view inside building or exposed to the weather, finish with two coats of paint, custom color blended to match surrounding surfaces.
- D. When specifically approved by designer, when it is impossible to completely insulate pipe, fittings, or valves with specified insulation, Armstrong Armaflex insulation tape may be used to prevent condensate drip on small piping. Use of cork insulation tape is prohibited.

PART 3 EXECUTION

3.01 GENERAL

- A. No insulation shall be cut where a hanger is located. If hangers have been installed by pipefitter tradesmen which violates this strict requirement, notify Designer immediately.
- B. Piping systems shall be tested and found free of all leaks prior to installation of insulation covering.
- C. All surfaces shall be clean and dry when covering is applied. Covering to be dry when installed and during application of any finish, unless such finish specifically requires a wetted surface for application.
- D. All adhesives, cements, and mastics shall be compatible with materials applied and shall not attack materials in either wet or dry state.
- E. Install insulation using professional insulators who have adequate experience and ability.
- F. Exposed-to-view insulation shall have a well tailored appearance.

- G. Treat insulated pipe in equipment rooms and where exposed to normal view, so surfaces may be painted with water base latex paint. Use of mastics, adhesives, or jacketing which cause "bleeding" is prohibited.

3.02 INSTALLATION OF PIPE AND EQUIPMENT COVERING

- A. Where fiberglass is used on piping sized 2" and larger, insert a section of foamglass insulation at hanger or support points between pipe and metal shield for full length of shield to prevent crushing of insulation. Insulation thickness to be same as adjoining insulation. Where insulation passes through pipe hangers and across trapeze supports, 12" long metal saddles shall be used. On cold pipe, vapor barrier should be carried through the hanger and sealed.
- B. Apply PVC insulated fitting covers and precut insulation inserts as follows:
 - 1. Installation for hot systems:
 - a. Place the precut fiberglass insert around the fitting, positioning the points of the insert on the inside radius of the elbow.
 - b. Butt the ends of the fiberglass insert against the ends of the pipe covering. Tuck and fold the insulation so that it covers all bare surfaces. Keep the fiberglass fluffed up to the thickness of the adjacent pipe insulation to assure maximum thermal efficiency.
 - c. Insert two stainless steel serrated tacks approximately 1/4" from one of the lap edges of the fitting cover. Then snap the cover in place over the fiberglass insulation.
 - d. After the fitting cover is in position, push the tacks into the overlapping throat seam. Apply color-matched, pressure-sensitive tape to the butt joints.
 - 2. Installation for cold systems:
 - a. Position, tuck, and fold the fiberglass insulation insert as described above in steps (a) and (b) for hot systems.
 - b. Apply a vapor barrier mastic around the edges of the adjoining pipe insulation. Apply the mastic along the inside of the fitting cover throat overlap seam.
 - c. Place the fitting cover over the insulation, lapping the mastic-covered edge over the other side of the throat seam.
 - d. Apply color-matched, pressure-sensitive tape over the circumferential joints. The tape should extend over the adjacent pipe insulation and overlap itself by at least 2" on the downward side of the lap.

END OF SECTION 22 07 19

SECTION 22 11 16
DOMESTIC WATER PIPING AND VALVES

PART 1 GENERAL

1.01 SYSTEM REQUIREMENTS

- A. Submit pipe, valves, and fittings and have approved before starting installation. Pipe, valves, and fittings to be new, and marked clearly with manufacturers' name, weight, and classification or working pressure.
- B. Piping to run approximately as shown on drawings or as structural and architectural conditions permit.
- C. All products used for dispensing potable drinking water must be lead free and meet the requirements of NSF 61 and NSF 372 test standards via third party testing and certification.

PART 2 PRODUCTS

2.01 COPPER PIPES

- A. Type "L" hard-drawn seamless copper tubing, ASTM B-88: Domestic hot and cold water.
- B. Type "K" hard-drawn seamless copper tubing:
 - 1. Domestic water lines located under slab.
 - 2. Exterior domestic water lines 2-1/2" and smaller underground.
 - 3. Provide rolled, soft drawn type "K" seamless copper tubing for under slab and below grade where length of run between fittings exceeds maximum hard-drawn lengths.
- C. Copper Pipe Fittings:
 - 1. Provide sweat fittings, ASTM B-62, dimensions conforming to ANSI B16.22, wrought copper, with sweep patterns for copper tubing smaller than 4".
 - 2. Provide brazed fittings, ASTM B-88, dimensions conforming to ANSI B16.50, wrought copper, with sweep patterns for copper tubing, 4" and larger.
 - 3. Dielectric connection: Provide Epco Sales, lead free dielectric couplers at junction of steel pipe and equipment with copper piping systems. Use of steel or cast iron fittings in copper piping systems prohibited. T-drill branch tee connections shall not be allowed for domestic water piping.
- D. Unions to be brass ground joint, 250-pound working pressure.
- E. Nipples used in conjunction with copper pipe to be brass.

2.02 VALVES:

- A. Valves are specified by Manufacturer and Model Numbers to establish quality levels unless otherwise noted. Crane, Milwaukee, Hammond, Nibco, Stockham, Centerline, Apollo, Kitz, or Watts are considered equal manufacturers. Provide clamp lock hand lever operators on valves less than 8 inches.
 - 1. Gate Valves:
 - a. Gate valves for copper piping 2" and smaller systems to be Class 125, bronze body, solder ends, Nibco S-113 LF. Valve to have either solid or split wedge disc, inside screw, non-rising stem, and screwed bonnet.
 - 2. Globe Valves:
 - a. Globe valves 2-1/2" and larger to be Class 150, cast iron body, bronze mounted, flanged ends, Watts M6115-74 lead free. Valves to have renewable seat and disc, outside stem and yoke with rising stem, and bolted bonnet.
 - b. Globe valves 2" and smaller to be Class 150, bronze body, screwed ends, Apollo 121T-LF. Valve to be plug type with renewable seat and disc, rising stem, and union bonnet.
 - 3. Ball Valves: Ball valves for copper water piping systems 2" O.D. and smaller to be equal to Apollo "3" S-585-66LF, solder ends, and for 2-5/8" thru 3-1/8" O.D. to be equal to Nibco T T-585-66LF, threaded ends. Valves to have bronze body, chromium plated bronze ball,

PTFE seats, stuffing box ring and seals, and quarter turn on-off. Provide memory stops for valves used for balancing service. Valves to be rated for 400-psi WOG at 200 degrees F. Install threaded end valves with lead free brass adapters.

4. Check Valves:
 - a. Check valves for copper water piping systems to be swing type, Class 125, bronze body, screwed ends, Nibco T-413-Y-LF.
5. Flow balancing valves for domestic hot water service shall be Bell & Gossett lead free Circuit Setter Plus or approved equal. Valve shall provide flow balancing, flow measuring, and positive shutoff service. Provide valve with memory stop, capped differential pressure readout ports with internal check valves and preformed insulation. Valve construction to be bronze body and brass ball rated for 200 psig at 250 degrees F.

2.03 STRAINERS

- A. Provide cleanable "Y" type strainers in pump suction lines. Strainers to have iron body with screwed bronze or bolted iron cap. Strainer baskets to be brass. Water strainers to be Monel 20 mesh screen. Strainers to be line size complete with blow-down hose bibbs. When Suction Diffusers are specified for end suction pumps, strainers are not required. Strainers to be as follows:
 1. Screwed 400# WOG – Watts LFS 77F-D1.
 2. Flanged 125# - Watts LFS 77F-D1-125.
 3. Flanged 250# - Watts LFS 77F-D1-250.
 4. Solder joint 125# - Nibco S 413-Y-LF.

2.04 HANGERS

- A. Copper piping 1/2" O.D. thru 4" O.D., with no longitudinal movement to be Grinnell Figure 260, MSS SP-69 Type 1, adjustable clevis hanger with Figure 167, MSS SP-69 TYPE 40, galvanized steel insulation protection shield sized for maximum 10' span on 4 psi compressive strength insulation.
- B. Non-insulated copper tubing 1/2" O.D. thru 4" O.D. with no longitudinal movement to be Grinnell Figure CT-99C, MSS SP-69 TYPE 9, plastic coated adjustable tubing ring hanger.
- C. Insulated copper piping 1/2" O.D. thru 2-1/8" O.D. with longitudinal movement to be Grinnell Figure 171, MSS SP-69 TYPE 41, pipe roll complete with Figure 167, MSS SP-69 TYPE 40, galvanized steel insulation protection shield sized for maximum 10' span on 4 psi compressive strength insulation.
- D. Support copper pipe risers by Grinnell Figure CT-121C, MSS SP-69 TYPE 8, plastic coated riser clamps at floor penetrations.
- E. Support three or more parallel lines by trapeze hangers utilizing Unistrut channel or equal in bottom mounting arrangement with rod hanging support.
- F. Adequately size hangers on insulated piping for insulation to pass continuously through hangers. Insulated piping to be supported outside insulation covering.
- G. Provide concrete inserts, Grinnell Figure 282, MSS SP-69 TYPE 18, universal concrete insert, for attaching hangers to building structure. Inserts to be adequately sized and correctly positioned to support piping, valves, etc., when full of water and system is in operation.
- H. Provide C-clamps with locknut, Grinnell Figure 86, MSS SP-69 TYPE 23, where piping is to be hung from steel beams. Welding hanger rods to steel members is not permitted. Provide malleable beam clamps, Grinnell Figure 218, MSS SP-69 TYPE 30, with extension piece, Grinnell Figure 157, where piping is hung from bar joist.
- I. Attention is called to pipe spring isolation specified to be furnished by this Contractor.
- J. Support all piping by heavy steel, adjustable hangers, or brackets suitably fastened to structural portion of building. Place hangers in accordance with following tables.

COPPER TUBING SUPPORTS

SIZE (IN.)	DISTANCE BETWEEN SUPPORTS (FT.)

5/8	6
7/8 - 1-1/8	8
1-3/8 - 2-1/8	10
2-5/8 - 5-1/8	12

- K. Perforated metal, strap iron, or band iron hangers are not permitted. Offsets in hangers are not allowed. Pipe risers to be supported at regular intervals in pipe shafts within the limits of good practice.
- L. See Insulation Section for requirements at pipe hangers.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install piping not to interfere with opening of doors or other moving parts. Do not install piping near or directly over any portion of electrical equipment.

3.02 FIRE-RATED PARTITIONS

- A. Provide permanent firestop system at all piping penetrations of fire-rated walls and floors. Review details on drawing as well as this specification for permissible firestop systems. The firestop system shall have been tested and approved in accordance with ASTM E119 and U.L. 1479 (ASTM E814) and classified for up to 2 hours fire rating. Firestop system shall be type detailed on drawings or intumescent type capable of expanding up to 8 times its original volume. Firestop system to be 3M, Hilti, Nelson, Johns Manville, or Specified Technologies. Firestop system shall be installed in strict accordance with published U.L. approved installation instructions. Piping to pass through the fire-rated partition insulated or non-insulated as specified and detailed. Submit U.L. approved installation drawing for each type of penetration prior to construction.

3.03 NON-RATED PARTITIONS

- A. Piping to pass through the walls insulated or non-insulated as specified. Wall should be finished to fit neatly around the piping. Firestopping is not required at non-rated partitions.

3.04 PIPE SLEEVES

- A. Pipe sleeves shall be provided at non-rated partitions and floor penetrations. Pipe sleeves to be Schedule 40 or 18 gage steel. Sleeves to extend 1-1/2" in excess of partition depth on each side. Sleeves penetrating floors in wet areas, including all mechanical rooms, shall extend a minimum of 1 inch above the floor.
 - 1. Piping requiring sleeves: Copper pipes thru masonry walls
- B. Provide chromium-plated escutcheon plates for exposed uninsulated pipes projecting through floors or walls in finished spaces. Mechanical rooms and janitor closets are not considered "finished" spaces.
- C. Hang piping so equipment, flanges, and connections do not bear weight of piping.
- D. Adequately support vertical lines at their bases or by a suitable hanger placed in horizontal line near riser or by a base fitting set on pedestal.
- E. Pipes not to be hung or supported by pumps. No torque to be applied to pumps by connecting pipes. After final pipe adjustments and initial operation of the pumps, this Contractor to recheck alignment of pumps and realign as required.
- F. Run piping in straight lines; riser lines to be plumb with such offsets only as indicated or necessary. No sagging of lines permitted.
- G. Unless otherwise shown on drawings, lines to be installed to drain to sumps or sewer.
- H. Ream pipe after cutting to full bore. Remove foreign matter from inside of pipe before installing. Keep installed piping free from dirt and scale and protect open ends from foreign matter. Use temporary plugs or other approved methods of open end closure.

- I. Threads to be right-hand, pipe standard, clean cut, full depth, and tapered. Joints to be made tight without caulking. Approved pipe joint lubricant to be used, applied in thin layer to the male thread only.
- J. Install copper fittings with suitable flux and 95/5 lead free solder. Type K copper pipe to be joined by means of suitable flux and silver or phos-copper.
- K. Piping to have sufficient number of flanges or unions for convenient installation and removal of piping and equipment.
- L. Remake or replace defective, leaking, or otherwise unsatisfactory joints or material. Peening, caulking, or doping of piping is not permitted.
- M. Install piping to prevent stresses and strains to piping and hangers from expansion or contraction. Provision for proper loops, offsets, or expansion joints to be responsibility of Contractor. Make provision for servicing and removal of equipment without dismantling piping.

3.05 PIPING IN TRANSFORMER, ELECTRICAL, AND ELEVATOR EQUIPMENT ROOMS

- A. Refer to drawings. No water piping permitted in transformer, electrical, or elevator equipment rooms.

3.06 VALVE ACCESS

- A. Locate all shutoff and control valves for easy access and operation. Where valves must necessarily be located in enclosed spaces, they shall be provided with access panels of sufficient size for operation. Furnish these access panels to proper trades for installation.

END OF SECTION 22 11 16

SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section includes requirements for:
 - 1. Backflow preventers.
 - 2. Shock absorbers.
 - 3. Trap primers.
 - 4. Equipment connection backflow device.
 - 5. Vacuum breakers.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. All products to be purchased from Ferguson Enterprises. Contact Bettina Dawson office (615) 316-1920 cell (931) 239-0466 or email HCA@Ferguson.com.
- B. All products used for dispensing potable drinking water must be lead free and meet the requirements of NSF 61 and NSF 372 test standards via third party testing and certification.

2.02 BACKFLOW PREVENTERS

- A. Acceptable Manufacturer: Wilkins.
- B. Product must meet NSF-61.
- C. Provide completely automatic, unit, fitted with tight closing shut-off valves and test cocks at each end.
- D. Construct such that all parts are replaceable without removing unit from line.
- E. Design such that total pressure drop through complete backflow preventer does not exceed 12 PSI at rated flow. Certified U.S.C. flow curves shall be provided for each device as part of the submittal package.

2.03 SHOCK ABSORBERS

- A. Acceptable Manufacturer: Sioux Chief.
- B. Refer to drawings for placement and size of shock absorbers.
- C. Access Covers: Minimum size 12" x 12" located for access to shock absorbers.

2.04 TRAP PRIMERS

- A. Acceptable Manufacturer: Precision Plumbing Products.
- B. Construct trap primer valve of all bronze, chrome plated with removable operating parts, integral vacuum breaker, and gasketed access cover.
- C. Access Covers: Minimum size 12" x 12" located for access to trap primers.

2.05 EQUIPMENT CONNECTION BACKFLOW DEVICE

- A. Acceptable manufactures: McCann Engineering ASSE 1022 Backflow Preventer.
- B. Must meet ASSE 1022
- C. Provide the above referenced backflow device if beverage equipment does not have integral backflow device.

2.06 VACUUM BREAKERS

- A. Wilkins model 420

PART 3 EXECUTION

3.01 INSTALLATION AND TESTING

- A. Backflow Preventers:
 - 1. Pipe relief through fixed air gap and discharge to sewer.

2. Install adjacent to wall and/or floor utilizing stand-off brackets, angle frame, and/or concrete piers.
 3. Test unit for leaks and pressure drop. Clean and/or replace soiled strainer media.
 4. Provide dual parallel reduced pressure backflow preventers on the main domestic water entrance to the facility.
 5. Provide backflow prevention vacuum breaker on any water line feeding any piece of equipment which could cause back siphonage such as mechanical equipment, trap primer lines, etc.
- B. Shock Absorbers:
1. Install shock absorbers above ceiling, outside wall so access and maintenance can be performed without disturbing walls and non-liftouts ceilings.
 2. Install shock absorbers on all flush valves, solenoid valves and quick closing devices.
 3. Test and certify shock absorbers by plumbing and drainage institute.
- C. Trap Primers: Trap primers to have approval of plumbing and drainage institute.
- D. Equipment Connection Backflow device: Provide on all water lines feeding coffee makers, ice machines and beverage dispensers.
- E. Vacuum Breakers: Provide on water lines feeding equipment to protect against back siphonage of contaminated water.

END OF SECTION 22 11 19

SECTION 22 11 23
DOMESTIC WATER PUMPS

PART 1 - GENERAL AND PRODUCTS

1.01 HOT WATER RECIRCULATING PUMP

- A. Acceptable Manufacturers: Taco, Paco, or Bell and Gossett.
- B. Model number, capacity, and electrical characteristics as scheduled on drawings.
- C. Provide in-line pump with all bronze construction, flange connections, hardened steel shaft, bronze impeller, and mechanical seal.
- D. Provide flexible coupled motor with thermal overload protection Support motor from pump casing.

PART 2 - EXECUTION

2.01 INSTALLATION

- A. Verify location and clearance requirements.
- B. Install in accordance with manufacturers' published installation instructions.

2.02 START-UP AND TEST

- A. Start-up pump, verify integrity of connection, electrical phasing.
- B. Test pumps in operation under design load conditions.

END OF SECTION 22 11 23

SECTION 22 13 16
SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Submit pipe and fittings and have approved before starting installation. Pipe and fittings to be new, and marked clearly with manufacturers' name, weight, and classification or working pressure.
- B. Piping to run approximately as shown on drawings or as structural and architectural conditions permit.

PART 2 PRODUCTS

2.01 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, draining tube, drawn temper. Waste, vent and drainage piping 1-1/2 and smaller.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B 16.29, wrought copper, solder-joint fittings.
- C. Hard Copper Tube: ASME B 88, Type L, water tube, drawn temper.
- D. Copper Pressure Fittings:
 - 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- E. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- F. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.02 CAST IRON SOIL PIPE

- A. Standard weight cast iron soil pipe with drainage fittings:
 - 1. Waste, drainage, and vent lines 2" and larger. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute  and listed by NSF[®] International.
 - 2. Drain lines under concrete or other paving and under buildings, including to a distance of not less than 5'-0" from building. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute  and listed by NSF[®] International.
 - 3. Manufacturers: Charlotte Pipe and Foundry, Tyler Pipe, AB&I Foundry.
 - 4. Joints in cast iron soil pipe may be hub and spigot with neoprene compression gaskets conforming to ASTM C564 or "No-hub". No-hub shall not be permitted on underground systems. No-hub couplings shall be standard CISPI 310 couplings manufactured with 300 series stainless steel and neoprene rubber sleeve.

2.03 PVC PIPE

- A. Schedule 40 PVC DWV pipe, ASTM D-2665 solid wall Type 1, Grade 1.
 - 1. Schedule 40 DWV waste and drainage piping below grade ONLY. PVC piping not permitted within Boiler Room.
 - 2. Outside gravity, underground sanitary sewer drainage, from 5'-0" outside building to connection to local sewer.
- B. Fittings to match piping system. Fittings to have manufacturer's trademark permanently identified in accordance with MSS-SP-25. Supplier to include with submittal data certification that fittings and flanges have met requirements.

- C. Joints for piping to be made with tetrahydrofuron solvent cement. Joints to be in accordance with manufacturer's recommendations.
- D. Pipe, fittings, and cement to all be supplied by single manufacturer for entire project.
- E. All solvent cements shall be low emitting VOC at 510 g/L or less.

2.04 HANGERS

- A. Non-insulated cast iron soil pipe thru 8" to be Grinnell Figure 104, MSS SP-69 TYPE 6, adjustable swivel ring, split ring type, and pipe 10" thru 15" Grinnell Figure 260, MSS SP-69 TYPE 1, adjustable clevis hanger.
- B. Support three or more parallel lines by trapeze hangers utilizing Unistrut channel or equal in bottom mounting arrangement with rod hanging support.
- C. Adequately size hangers on insulated piping for insulation to pass continuously through hangers. Insulated piping to be supported outside insulation covering.
- D. Provide concrete inserts, Grinnell Figure 282, MSS SP-69 TYPE 18, universal concrete insert, for attaching hangers to building structure. Inserts to be adequately sized and correctly positioned to support piping, valves, etc., when full of water and system is in operation.
- E. Provide C-clamps with locknut, Grinnell Figure 86, MSS SP-69 TYPE 23, where piping is to be hung from steel beams. Welding hanger rods to steel members is not permitted. Provide malleable beam clamps, Grinnell Figure 218, MSS SP-69 TYPE 30, with extension piece, Grinnell Figure 157, where piping is hung from bar joist.
- F. Attention is called to pipe spring isolation specified to be furnished by this Contractor.
- G. Support all piping by heavy steel, adjustable hangers, or brackets suitably fastened to structural portion of building. Place hangers in accordance with Cast Iron Supports. Support each fitting, at intervals of not more than 5 feet, and at least at each joint.
- H. Perforated metal, strap iron, or band iron hangers are not permitted. Offsets in hangers are not allowed. Pipe risers to be supported at regular intervals in pipe shafts within the limits of good practice.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install piping not to interfere with opening of doors or other moving parts. Do not install piping near or directly over any portion of electrical equipment.

3.02 FIRE-RATED PARTITIONS

- A. Provide permanent firestop system at all piping penetrations of fire-rated walls and floors. Review details on drawing as well as this specification for permissible firestop systems. The firestop system shall have been tested and approved in accordance with ASTM E119 and U.L. 1479 (ASTM E814) and classified for up to 2 hours fire rating. Firestop system shall be type detailed on drawings or intumescent type capable of expanding up to 8 times its original volume. Firestop system to be 3M, Hilti, Nelson, Johns Manville, or Specified Technologies. Firestop system shall be installed in strict accordance with published U.L. approved installation instructions. Piping to pass through the fire-rated partition insulated or non-insulated as specified and detailed. Submit U.L. approved installation drawing for each type of penetration prior to construction.

3.03 NON-RATED PARTITIONS

- A. Piping to pass through the walls insulated or non-insulated as specified. Wall should be finished to fit neatly around the piping. Firestopping is not required at non-rated partitions.
- B. Provide chromium-plated escutcheon plates for exposed uninsulated pipes projecting through floors or walls in finished spaces. Mechanical rooms and janitor closets are not considered "finished" spaces.
- C. Hang piping so equipment, flanges, and connections do not bear weight of piping.

- D. Adequately support vertical lines at their bases or by a suitable hanger placed in horizontal line near riser or by a base fitting set on pedestal.
- E. Pipes not to be hung or supported by pumps. No torque to be applied to pumps by connecting pipes. After final pipe adjustments and initial operation of the pumps, this Contractor to recheck alignment of pumps and realign as required.
- F. Run piping in straight lines; riser lines to be plumb with such offsets only as indicated or necessary. No sagging of lines permitted.
- G. Unless otherwise shown on drawings, lines to be installed to drain to sumps or sewer.
- H. Ream pipe after cutting to full bore. Remove foreign matter from inside of pipe before installing. Keep installed piping free from dirt and scale and protect open ends from foreign matter. Use temporary plugs or other approved methods of open end closure.
- I. Threads to be right-hand, pipe standard, clean cut, full depth, and tapered. Joints to be made tight without caulking. Approved pipe joint lubricant to be used, applied in thin layer to the male thread only.
- J. Piping to have sufficient number of flanges or unions for convenient installation and removal of piping and equipment.
- K. Remake or replace defective, leaking, or otherwise unsatisfactory joints or material. Peening, caulking, or doping of piping is not permitted.
- L. Install piping to prevent stresses and strains to piping and hangers from expansion or contraction. Provision for proper loops, offsets, or expansion joints to be responsibility of Contractor. Make provision for servicing and removal of equipment without dismantling piping.

3.04 PIPING IN TRANSFORMER, ELECTRICAL, AND ELEVATOR EQUIPMENT ROOMS

- A. Refer to drawings. No water piping permitted in transformer, electrical, or elevator equipment rooms.

3.05 GRADES AND ELEVATIONS

- A. Uniformly grade sanitary drainage lines to elevations shown. If no elevations are given, pitch sewers not less than 1/8" per foot.

END OF SECTION 22 13 16

SECTION 22 13 19
SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section includes requirements for:
 - 1. Cleanouts.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Cleanouts and grease interceptors to be purchased from Ferguson Enterprises. Contact Bettina Dawson office (615) 316-1920 cell (931) 239-0466 or email HCA@Ferguson.com.

2.02 CLEANOUTS

- A. Acceptable Manufacturer: Zurn. The following model numbers listed are Zurn.
- B. Exterior: ZN-1402-HD cast iron cutoff ferrule with round nickel bronze scoriated frame and cover, secured.
- C. Finished Concrete Floor: ZN-1400-HD inside caulk round nickel bronze scoriated frame and cover.
- D. Resilient Tile Floor: ZN-1400-X inside caulk round nickel bronze scoriated frame and cover, secured.
- E. Wall: Z-1446 cast iron cleanout with bronze plug and round stainless steel cover.
- F. Access Covers: Minimum size 12" x 12" located for access to valves, shock absorbers, trap primers, wall cleanouts, etc.
- G. Furnish cleanouts occurring in waterproof floors with clamping devices.

PART 3 EXECUTION

3.01 INSTALLATION AND TESTING

- A. Cleanouts:
 - 1. Locate line size cleanouts, except 4" largest required, at base of all soil and waste stacks, at all changes in direction and in straight runs. Ensure spacing in straight runs does not exceed 50 feet inside building and 100 feet outside the building.
 - 2. Extend inaccessible cleanouts up through floor and/or wall provided easy accessibility cannot be obtained otherwise.

END OF SECTION 22 13 19

**SECTION 22 14 00
STORM DRAINAGE**

PART 1 GENERAL

1.01 SYSTEM REQUIREMENTS

- A. Submit pipe and fittings and have approved before starting installation. Pipe, and fittings to be new, manufactured domestically, and marked clearly with manufacturers' name, weight, and classification or working pressure.
- B. Piping to run approximately as shown on drawings or as structural and architectural conditions permit.

PART 2 PRODUCTS

2.01 CAST IRON SOIL PIPE

- A. Standard weight cast iron soil pipe with drainage fittings:
 - 1. Storm water piping.
 - 2. Rainwater leaders inside building.
 - 3. Drain lines under concrete or other paving and under buildings, including to a distance of not less than 5'-0" from building.
 - 4. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute  and listed by NSF® International.
 - 5. Joints in cast iron soil pipe may be hub and spigot with neoprene compression gaskets or "No-hub". No-hub shall not be permitted on underground systems. No-hub couplings shall be standard CISPI 310 couplings manufactured with 300 series stainless steel and neoprene rubber sleeve.

2.02 PVC PIPE

- A. Schedule 40 PVC pipe, ASTM D-1785 Type 1, Grade 1, 200-psi test:
 - 1. Storm water piping below grade.
- B. Fittings to match piping system. Fittings to have manufacturer's trademark permanently identified in accordance with MSS-SP-25. Supplier to include with submittal data certification that fittings and flanges have met requirements.
- C. Joints for piping to be made with tetrahydrofuron solvent cement. Joints to be in accordance with manufacturer's recommendations.
- D. Pipe, fittings, and cement to all be supplied by single manufacturer for entire project.
- E. All solvent cements shall be low emitting VOC at 510 g/L or less.

2.03 HIGH DENSITY POLYETHYLENE PIPE

- A. High density, perforated polyethylene pipe shall be manufactured to AASHTO M252 and M294, ASTM F405 and F667:
 - 1. Underfloor slab drainage pipe.
 - 2. Retaining wall drainage pipe.
- B. Pipe shall be covered 100 percent polyester, knitted fabric to prevent infiltration of sand and soils.
- C. Contractor shall backfill around pipe with Class 1 materials per ASTM D2321. Minimum compaction of 85 percent shall be required.

2.04 HANGERS

- A. Non-insulated cast iron soil pipe thru 8" to be Grinnell Figure 104, MSS SP-69 TYPE 6, adjustable swivel ring, split ring type, and pipe 10" thru 15" Grinnell Figure 260, MSS SP-69 TYPE 1, adjustable clevis hanger.
- B. Support three or more parallel lines by trapeze hangers utilizing Unistrut channel or equal in bottom mounting arrangement with rod hanging support.

- C. Adequately size hangers on insulated piping for insulation to pass continuously through hangers. Insulated piping to be supported outside insulation covering.
- D. Provide concrete inserts, Grinnell Figure 282, MSS SP-69 TYPE 18, universal concrete insert, for attaching hangers to building structure. Inserts to be adequately sized and correctly positioned to support piping, valves, etc., when full of water and system is in operation.
- E. Provide C-clamps with locknut, Grinnell Figure 86, MSS SP-69 TYPE 23, where piping is to be hung from steel beams. Welding hanger rods to steel members is not permitted. Provide malleable beam clamps, Grinnell Figure 218, MSS SP-69 TYPE 30, with extension piece, Grinnell Figure 157, where piping is hung from bar joist.
- F. Attention is called to pipe spring isolation specified to be furnished by this Contractor.
- G. Support all piping by heavy steel, adjustable hangers, or brackets suitably fastened to structural portion of building. Place hangers in accordance with Cast Iron Supports. Support each fitting, at intervals of not more than 5 feet, and at least at each joint.
- H. Perforated metal, strap iron, or band iron hangers are not permitted. Offsets in hangers are not allowed. Pipe risers to be supported at regular intervals in pipe shafts within the limits of good practice.
- I. See Insulation Section for requirements at pipe hangers.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install piping not to interfere with opening of doors or other moving parts. Do not install piping near or directly over any portion of electrical equipment.
- B. Provide chromium-plated escutcheon plates for exposed uninsulated pipes projecting through floors or walls in finished spaces. Mechanical rooms and janitor closets are not considered "finished" spaces.
- C. Hang piping so equipment, flanges, and connections do not bear weight of piping.
- D. Adequately support vertical lines at their bases or by a suitable hanger placed in horizontal line near riser or by a base fitting set on pedestal.
- E. Pipes not to be hung or supported by pumps. No torque to be applied to pumps by connecting pipes. After final pipe adjustments and initial operation of the pumps, this Contractor to recheck alignment of pumps and realign as required.
- F. Run piping in straight lines; riser lines to be plumb with such offsets only as indicated or necessary. No sagging of lines permitted.
- G. Unless otherwise shown on drawings, lines to be installed to drain to sumps or sewer.
- H. Ream pipe after cutting to full bore. Remove foreign matter from inside of pipe before installing. Keep installed piping free from dirt and scale and protect open ends from foreign matter. Use temporary plugs or other approved methods of open end closure.
- I. Threads to be right-hand, pipe standard, clean cut, full depth, and tapered. Joints to be made tight without caulking. Approved pipe joint lubricant to be used, applied in thin layer to the male thread only.
- J. Piping to have sufficient number of flanges or unions for convenient installation and removal of piping and equipment.
- K. Remake or replace defective, leaking, or otherwise unsatisfactory joints or material. Peening, caulking, or doping of piping is not permitted.
- L. Install piping to prevent stresses and strains to piping and hangers from expansion or contraction. Provision for proper loops, offsets, or expansion joints to be responsibility of Contractor. Make provision for servicing and removal of equipment without dismantling piping.

3.02 FIRE-RATED PARTITIONS

- A. Provide permanent firestop system at all piping penetrations of fire-rated walls and floors. Review details on drawing as well as this specification for permissible firestop systems. The firestop system shall have been tested and approved in accordance with ASTM E119 and U.L. 1479 (ASTM E814) and classified for up to 2 hours fire rating. Firestop system shall be type detailed on drawings or intumescent type capable of expanding up to 8 times its original volume. Firestop system to be 3M, Hilti, Nelson, Johns Manville, or Specified Technologies. Firestop system shall be installed in strict accordance with published U.L. approved installation instructions. Piping to pass through the fire-rated partition insulated or non-insulated as specified and detailed. Submit U.L. approved installation drawing for each type of penetration prior to construction.

3.03 NON-RATED PARTITIONS

- A. Piping to pass through the walls insulated or non-insulated as specified. Wall should be finished to fit neatly around the piping. Firestopping is not required at non-rated partitions.

3.04 PIPING IN TRANSFORMER, ELECTRICAL, AND ELEVATOR EQUIPMENT ROOMS

- A. Refer to drawings. No water piping permitted in transformer, electrical, or elevator equipment rooms.

3.05 GRADES AND ELEVATIONS

- A. Uniformly grade storm drainage lines to elevations shown. If no elevations are given, pitch sewers not less than 1/8" per foot.

END OF SECTION 22 14 00

SECTION 22 15 13
GENERAL SERVICE NATURAL GAS PIPING AND VALVES

PART 1 GENERAL

1.01 SYSTEM REQUIREMENTS

- A. Submit pipe, valves, and fittings and have approved before starting installation. Pipe, valves, and fittings to be new, and marked clearly with manufacturers' name, weight, and classification or working pressure.
- B. Piping to run approximately as shown on drawings or as structural and architectural conditions permit.
- C. All piping is to be installed, inspected and tested prior to operation in strict conformance with NFPA 54. Inspection and Testing is to be witnessed by general contractor's field superintendent with documentation of appropriate measures, test results, parties witnessing and completing work close out documentation provided to Owner.

PART 2 PRODUCTS

2.01 STEEL PIPES

- A. Butt welded, electric resistance welded, or seamless black steel pipe, ANSI B 36.10, ASTM A-53, Grade "B" or "A", Schedule 40 for piping 10" and smaller for the following services:
 - 1. Gas piping.
 - 2. LP gas piping.
 - 3. Mill wrap all uninsulated underground steel pipe with Republic X-Tru-Coat or equal.

2.02 STEEL PIPE FITTINGS

- A. Flanges, fittings, unions and other products recognized as regularly available products to be marked in accordance with MSS SP-25. Markings on products of small size or shape may be omitted in the sequence allowed by MSS SP-25, except manufacturers' name or trademark.
- B. Fittings 2-1/2" and larger to be standard weight, carbon steel, buttwelding fittings conforming to ASTM A-234 and ANSI B16.9.
- C. Branch connections from mains or headers 2-1/2" or larger to be welded tees or welding outlets. Outlets to be equal to Weldolets or Thredolets manufactured by Bonney Forge. Forged outlets to be used only if branch line is at least one pipe size smaller than main or header. Stub-in welded piping is not acceptable.
- D. Fittings 2" and smaller to be threaded, Class 150, standard, malleable iron fittings, conforming to ANSI B16.3 and ASTM A-197
- E. Flanges to be 150 lb. carbon steel conforming to ASTM A-105, ASTM A-181, and ANSI B16.5.
- F. Unions to be Class 150 malleable iron with bronze-to-iron ground joint conforming to ANSI B16.39, ANSI B1.20.1, and ASTM A-197
- G. Bolting materials to be semi-finished carbon steel bolts and hex nuts conforming to ASTM A-307. Threads and dimensions to be in accordance with ANSI B1.1 and B18.2.
- H. Thread lubricant to be Crane "Formular 425" or equal. Approved Teflon tape may be used at Contractor's option.
- I. Gaskets to be 1/8" thick "Cranite", "Sepco" or equal.

2.03 VALVES

- A. Valves are specified by NIBCO and Apollo model numbers to establish quality levels unless otherwise noted. Provide clamp lock hand lever operators on valves less than 8 inches. Provide hand wheel and closed housing worm gear on valves 8 inches and larger unless indicated otherwise below. Provide chain operators for all equipment room and powerhouse valves 4 inch and larger which are located over 6 feet 6 inches above the finish floor.

- B. Gate Valves:
1. Gate valves for 2-1/2" and larger steel piping systems to be Class 125, cast iron body, bronze mounted, flanged ends, NIBCO F-617-0. Valves to have solid wedge disc, outside stem and yoke with rising stem, and bolted bonnet.
 2. Gate valves for 2" and smaller steel piping systems to be Class 125, bronze body, screwed ends, NIBCO T-111. Valve to have solid disc, rising stem, and union bonnet.
- C. Ball Valves:
1. Ball valves for copper water piping systems 2-1/8" O.D. and smaller to be equal to Apollo "3" Figure 82-200, solder ends, and for 2-5/8" thru 3-1/8" O.D. to be Apollo Figure 82-200, threaded ends. Valves to have bronze body, chromium plated bronze ball, teflon seats, stuffing box ring and seals, and quarter turn on-off. Valves to be rated for 400-psi WOG at 200 degrees F. Install threaded end valves with brass adapters.
- D. Plug Valves: Plug valves shall be lubricated cylindrical plug valves constructed of ASTM A-126, grade B semi-steel and rated for 150 psig working pressure. Square head shall move from fully opened to fully closed with quarter turn of plug. Plug shall float in lubricant. Teflon head seat gasket shall be backed by lubricant reservoir. Valves 2" and smaller shall have screwed ends, 2-1/2" and larger to be flanged. Provide one wrench per valve size and mount on rack in equipment room. Homestead #611 (or Nordstrom/Rockwell) for valves 2" and smaller, Homestead #612 for valves 2-1/2" through 6", Homestead #612-GW for valves 8" and larger. Valves to be factory pre-lubricated with Homestead #204. Provide two high pressure lubricant guns with 17-1/2" long extension hose equivalent to Homestead Type "B" and two cartons of Homestead #204 gun stick lubricant suited for clean water service between minus 30 degrees F and 400 degrees F. Wall mount lubricant guns on a red colored painted wood panel and locate panel in main equipment room near pumps.

2.04 GAS SHUTOFF VALVES

- A. Shutoff valves shall be provided at each piece of equipment and shall be Class 125 gas line cocks with cast iron body, bronze plug and washer, and iron nut, Crane Figure 324.

2.05 HANGERS

- A. Non-insulated steel piping 1/2" thru 24" with no longitudinal movement to be Grinnell Figure 260, MSS SP-69 Type 1, adjustable clevis hanger.
- B. Support steel pipe risers by Grinnell Figure 261, MSS SP-69 TYPE 8, riser clamps at floor slab penetrations.
- C. Support three or more parallel lines by trapeze hangers utilizing Unistrut channel or equal in bottom mounting arrangement with rod hanging support.
- D. Provide concrete inserts, Grinnell Figure 282, MSS SP-69 TYPE 18, universal concrete insert, for attaching hangers to building structure. Inserts to be adequately sized and correctly positioned to support piping, valves, etc., when full of water and system is in operation.
- E. Provide C-clamps with locknut, Grinnell Figure 86, MSS SP-69 TYPE 23, where piping is to be hung from steel beams. Welding hanger rods to steel members is not permitted. Provide malleable beam clamps, Grinnell Figure 218, MSS SP-69 TYPE 30, with extension piece, Grinnell Figure 157, where piping is hung from bar joist.
- F. Attention is called to pipe spring isolation specified to be furnished by this Contractor.
- G. Support all piping by heavy steel, adjustable hangers, or brackets suitably fastened to structural portion of building. Place hangers in accordance with following table:

STEEL PIPE SUPPORTS	
SIZE (IN.)	DISTANCE BETWEEN SUPPORTS (FT.)
3/4 - 1-1/4	8
1-1/2 - 2-1/2	10
3	12

- H. Perforated metal, strap iron, or band iron hangers are not permitted. Offsets in hangers are not allowed. Pipe risers to be supported at regular intervals in pipe shafts within the limits of good practice.
- I. Support horizontal piping across roof in accordance with Specification Section.

PART 3 EXECUTION

3.01 COORDINATION

- A. Install piping as shown on coordinated shop drawings not to interfere with opening of doors or other moving parts. Do not install piping near or directly over any portion of electrical equipment.

3.02 FIRE-RATED PARTITIONS

- A. Provide permanent firestop system at all piping penetrations of fire-rated walls and floors. Review details on drawing as well as this specification for permissible firestop systems. The firestop system shall have been tested and approved in accordance with ASTM E119 and U.L. 1479 (ASTM E814) and classified for up to 2 hours fire rating. Firestop system shall be type detailed on drawings or intumescent type capable of expanding up to 8 times its original volume. Firestop system to be 3M, Hilti, Nelson, Johns Manville, or Specified Technologies. Firestop system shall be installed in strict accordance with published U.L. approved installation instructions. Piping to pass through the fire-rated partition insulated or non-insulated as specified and detailed. Submit U.L. approved installation drawing for each type of penetration prior to construction.

3.03 NON-RATED PARTITIONS

- A. Piping to pass through the walls insulated or non-insulated as specified. Wall should be finished to fit neatly around the piping. Firestopping is not required at non-rated partitions.

3.04 PIPING PROJECTING THROUGH FINISHED SYSTEMS

- A. Provide chromium-plated escutcheon plates for exposed uninsulated pipes projecting through floors or walls in finished spaces. Mechanical rooms and janitor closets are not considered "finished" spaces.

3.05 QUALITY AND ADJUSTMENT

- A. Hang piping so equipment, flanges, and connections do not bear weight of piping.
- B. Adequately support vertical lines at their bases or by a suitable hanger placed in horizontal line near riser or by a base fitting set on pedestal.
- C. Run piping in straight lines; riser lines to be plumb with such offsets only as indicated or necessary. No sagging of lines permitted.

3.06 PIPING IN TRANSFORMER, ELECTRICAL, AND ELEVATOR EQUIPMENT ROOMS

- A. Refer to drawings. No piping permitted in transformer, electrical, or elevator equipment rooms.

3.07 METHODS AND ASSEMBLY

- A. Ream pipe after cutting to full bore. Remove foreign matter from inside of pipe before installing. Keep installed piping free from dirt and scale and protect open ends from foreign matter. Use temporary plugs or other approved methods of open end closure.
- B. Threads to be right-hand, pipe standard, clean cut, full depth, and tapered. Joints to be made tight without caulking. Approved pipe joint lubricant to be used, applied in thin layer to the male thread only.
- C. Piping to have sufficient number of flanges or unions for convenient installation and removal of piping and equipment.
- D. Remake or replace defective, leaking, or otherwise unsatisfactory joints or material. Peening, caulking, or doping of piping is not permitted.

- E. Install piping to prevent stresses and strains to piping and hangers from expansion or contraction. Provision for proper loops, offsets, or expansion joints to be responsibility of Contractor. Make provision for servicing and removal of equipment without dismantling piping.
- F. Pressure test as required by Section 23 01 00. Coordinate witnessing of testing with general contractor and/or commissioning agent.

3.08 VALVE ACCESS

- A. Locate all shutoff and control valves for easy access and operation. Where valves must necessarily be located in enclosed spaces, they shall be provided with access panels of sufficient size for operation. Furnish these access panels to proper trades for installation.

END OF SECTION 22 15 13

SECTION 22 33 31

COMMERCIAL STORAGE ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide a factory packaged, electric storage type domestic water heater.

PART 2 - PRODUCTS

2.01 EQUIPMENT

- A. Unit manufactured by PVI, Hesco, A. O. Smith, Lochinvar, or State Industries. Model number, input, capacity, electrical characteristics, accessories scheduled on drawings as basis of design.
- B. Storage tank shall be carbon steel, glass lined, and ASME Code stamped in accordance to Section IV, Part HLW of the ASME code, vessel shall be National Board Registered for 150 psi working pressure. Tank shall have a minimum of one manway opening allowing for complete access to the tank interior.
- C. Electrical elements shall be 75 watts per sq. inch density, 36 KW, and switched through magnetic contactors and protected by power fuses.
- D. Element control shall be through a building management system.
- E. Safety controls shall include:
 - 1. Electronic low water cutoff.
 - 2. Low water pressure (below 30 psi).
 - 3. Door interlock.
 - 4. Power distribution blocks shall be solderless.
 - 5. Control circuit shall be fused and switched, 120 volts.
 - 6. Two immersion operating thermostats.
 - 7. Immersion temperature limiting device.
- F. Provide 3-1/2 inch dial thermometer and 3-1/2 inch pressure gauge, console mounted.
- G. ASME temperature and pressure relief valve.
- H. Operating instructions and written warranties.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Verify location and clearance requirements.
- B. Installation in accordance with manufacturers' recommendations and project drawings.

END OF SECTION 22 33 31

SECTION 22 34 00
FUEL - FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide a factory package, dual fuel, direct natural and propane gas fired, forced draft, ASME type domestic water heater.
- B. Condensing type, gas fired domestic water heater, size and style as listed on plan schedule.

1.02 RELATED WORK

- A. Section 23 51 00, Prefabricated Gas Vent Pipe.
- B. AL 29 4C as required by manufacturer.

PART 2 - PRODUCTS

2.01 EQUIPMENT

- A. Unit manufactured by Intellihot or approved equal. Model number, capacity, accessories scheduled on drawings are basis of design.
- B. Burners to be stainless steel and 100% safety shutoff controls, spark ignition, combustion blower unit, gas-air mixer, pilot flame rod, regulators, pressure switches, relief door, low water cutoff, high limit control, panel-mounted temperature and pressure gauges.
- C. ASME temperature and pressure relief valve.
- D. Fiberglass insulation with steel jacket to meet latest ASHRAE standards.
- E. Operating instructions and written warranties.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Verify location and clearance requirements.
- B. Installation in accordance with manufacturers' recommendations and project drawings.
- C. Furnish and install a Hesco Model HGD II-S, gas safety alarm monitor, 120/1/60, equipped with Power-ON indicator light, alarm indicator light, automatic audio alarm shut off, terminal strip with 24-volt contacts, 12-volt contacts, and 9-volt contacts to allow interface to remote alarm light, remote alarm bell, exhaust fan, or electric gas valve in the event hazardous gases reach alarm levels listed below.
- D. The HGD II-S shall be calibrated at the factory with carbon monoxide, and shall be sensitive to the following gases at the levels listed below:

Gas	Alarm Level
Carbon Monoxide	300 PPM
Propane (L.P.)	5,250 PPM
Natural/Methane Gas	12,500 PPM

- E. The HGD II-S shall be equipped with a built-in manual reset switch that will not allow the unit to be reset while hazardous gases are present in the equipment room at the above listed levels.

END OF SECTION

SECTION 22 43 00
HCA PLUMBING FIXTURES

PART 1 GENERAL

1.01 MANUFACTURERS

- A. Provide plumbing fixtures and drains as listed on drawings and described herein. Fixture numbers are per HCA standard per purchase agreement for all products. All products to be purchased from Ferguson Enterprises. Contact Bettina Dawson office (615) 316-1920 cell (931) 239-0466 or email HCA@ferguson.com.
- B. All drainage products to be Zurn no exceptions. All drains installed above slab to be complete with clamping device.
- C. Stainless steel sinks shall be Elkay no exceptions.
- D. Flush valves shall be Zurn-AV no exceptions.
- E. Pressure balancing shower valves shall be Symmons
- F. Commercial or public faucets shall be Zurn no exceptions.
- G. Gooseneck faucets shall be Zurn no exceptions. All gooseneck water supply spouts for lavatories and sinks shall discharge a minimum of 5" above the rim of the specified fixture. All gooseneck faucets shall be furnished with plain end spouts; aerators shall not be accepted. An in-line flow control device to limit flow to 1.5 GPM maximum shall be installed on all gooseneck faucets, including gooseneck sensor faucets unless otherwise called for on specific fixtures.
- H. Fixture supplies, stops, and traps to be commercial grade Proflo. Traps to be 17 gauge with wall flange. Supplies to be flexible stainless steel supply lines and stops to be Proflo quarter turn compression stops.
- I. Water closet seats shall be Proflo, no exceptions.
- J. Thermostatic master mixing valves shall be Symmons, Powers, or Leonard.
- K. China or enamel fixtures to be white in color
- L. All wall-mounted lavatories shall be capable of supporting a minimum vertical load of 250 pounds. Install wall-mounted lavatories with floor-anchored carriers which fit in standard stud walls.
- M. All water supply spouts for lavatories and sinks shall discharge a minimum of 1" above the rim of the specified fixture.
- N. Where blade handles are specified, they shall not be less than 3-1/2", or more than 4-1/2" in length, except that handles of clinical sinks shall not be less than 6" long.
- O. All products used for dispensing potable drinking water must be lead free and meet the requirements of NSF 61 and NSF 372 test standards via third party testing and certification.
- P. InPro Solid Surface Shower receptacles no exceptions. Fixture color to be Bone per HCA design team

PART 2 PRODUCTS

2.01 FIXTURES

- P101 Water Closet - Public, Floor Mounted, Barrier-Free, 1.28 Gallon:
Zurn Z5665-BWL1 Floor Mt water closet 1.28gpf Bowl
Zurn Z-6000-AV-HET 1.28gpf flush valve
Proflo PFTSCOF2000WH Comm Elongated OF Closet seat
- P107 Water Closet - Ligature Resistant, Exposed Flush Valve:
Whitehall WH2142-ADA-T-0023 ADA water closet, top spud, integral seat. Whitehall WH2802-SLPT-ADA-1.6 flush valve cover with hydraulic flush valve

- P301 Lavatory, Wall Hung, Public, TMV:
 Zurn Z5344 White 20x18 4cc wall mount lavatory
 Zurn Z812A4-XL-FC-05 gooseneck, wrist blades
 Wilkins ZW3870XLT4PC 3/8" point of use therm mixing valve 4-PORT
 Proflo PFGD100 1-1/4x6 CP 17ga grid drain
 Proflo PFPTB400 1-1/4" 17ga P trap
 Proflo PFXQAC32C ¼ turn angle stop (2)
 Proflo PFX146324 20" Flex SS riser (2)
 Proflo PFE7 ½" CP escutcheon (2)
 Proflo PF202WH Trap wrap kit
 Zurn ZZ1231 wall carrier
- P304 Lavatory, Wall Hung, Patient, Barrier-Free, Gooseneck:
 Zurn Z5344 White 20x18 4cc wall mount lavatory
 Zurn Z812A4-XL-FC1.5 CP 1.5gpm, GN wrist blade hdl, plain end spout
 Proflo PFGD101 1-1/4x6 CP 17ga offset grid drain
 Proflo PFPTB400 1-1/4" 17ga P trap
 Proflo PFXQAC32C ¼ turn angle stop (2)
 Proflo PFX146324 20" Flex SS riser (2)
 Proflo PFE7 ½" CP escutcheon (2)
 Proflo PF203WH Trap wrap kit
 Zurn ZZ1231 wall carrier
- P310 Lavatory, Wall Hung, Faucet/Eyewash Combination:
 Zurn Z5348 White 20x18 wall mount vitreous china lavatory
 Speakman SEF1800-CA-LF-TW eyewash faucet & mixing valve
 Proflo PFGD100 17ga CP grid drain
 Proflo PFPTB400 17ga 1-1/4" chrome P trap
 Proflo PFXQAC32C 5/8od compression angle stop (2)
 Proflo PFX146324 SS braided supply lines (2)
 Proflo PFE7 5/8od chrome escutcheon (2)
 Proflo PF202WH Trap wrap kit
 Zurn ZZ1231 wall carrier
- P312 Lavatory, Wall Hung, Patient, Barrier-Free, Gooseneck:
 Zurn Z5344 White 20x18 4cc wall mount lavatory
 Zurn Z812A4-XL-FC1.5 CP 1.5gpm, GN wrist blade hdl, plain end spout
 Proflo PFGD100 17ga grid drain CP
 Ipex 156501 W501 1-1/2 Universal acid waste trap
 Proflo PFXQAC32C ¼ turn angle stop (2)
 Proflo PFX146324 20" Flex SS riser (2)
 Proflo PFE7 ½" CP escutcheon (2)
 Zurn ZZ1231 wall carrier
- P313 Lavatory, Wall Hung, Bariatric, Barrier-Free, Gooseneck:
 Willoughby BHS3123 ada bariatric wall mount lavatory with drain
 Zurn Z812A4-XL-FC1.5 CP 1.5gpm, GN wrist blade hdl, plain end spout
 Proflo PFPTB400 1-1/4" 17ga P trap
 Proflo PFXQAC32C ¼ turn angle stop (2)
 Proflo PFX146324 20" Flex SS riser (2)
 Proflo PFE7 ½" CP escutcheon (2)
 Zurn ZZ1224 wall carrier

- P331 Ligature Resistant Single-Station Lavatory:
 Whitehall WH3776LWH3775SOBATMXP solid surface, sensor controls, thermostatic mixing valve, SS trap cover and P-trap. Provide Whitehall MC-FLR Fixture support floor mounted type.
 Proflo PFXQAC32C ¼ turn angle stop (2)
 Proflo PFX146324 20" Flex SS riser (2)
 Proflo PFE7 ½" CP escutcheon (2)
- P402 Single Compartment Sink, Gooseneck Faucet: Barrier free
 Elkay LRAD1919-55-3 stainless sink
 Zurn Z831B4-XL-FC gooseneck, wrist blades
 Proflo PFWTST wide top grid drain
 Proflo PFXQAC32C ¼ turn angle valve (2)
 Proflo PFX146324 20" flex riser (2)
 Proflo PFE7 ½" CP escutcheon (2)
 Proflo PFPTB403 1-1/2 17 ga P trap
- P410 Single Compartment, Decontamination Room
 Elkay DLR-1919-10-3 stainless sink
 Zurn Z831B4-XL-FC 1.5 gooseneck, wrist blades
 Elkay LK18B flat grid strainer with tailpiece
 Ipex 156501 W501 1-1/2 Universal acid waste trap
 Proflo PFXQAC32C ¼ turn angle valve (2)
 Proflo PFX146324 20" flex riser (2)
 Proflo PFE7 ½" CP escutcheon (2)
- P413 Single compartment sink, Undermount, Gooseneck Faucet:
 Barrier free Elkay ELUHAD191645 stainless sink
 Zurn Z831B4-XL-FC 1.5 gooseneck, wrist blades
 Proflo PFWTS wide top grid drain
 Proflo PFTPB100 17 ga flanged tailpiece
 Proflo PFPTB403 1-1/2 17 ga P trap
 Proflo PFXQAC32C ¼ turn angle valve (2)
 Proflo PFX146324 20" flex riser (2)
 Proflo PFE7 1/2" CP escutcheon (2)
- P502 Clinical Sink, Floor Mounted:
 Zurn Z5420 with rim guards
 Zurn Z6017-AV-H
 Zurn Z843D65XTLVBPEFTYJ with 6" wrist blades
 Zurn Z85500WM-XL-EVB-HK-SE-SH2-VC bedpan washer, vacuum breaker
 Stern Williams #1028 universal pedestal. Pedestal shall be mounted flush with face of the wall.
- P503 Scrub Sink, Sensor Faucet:
 Kohler K-12794-0 with wall hanger/support brackets
 Zurn Z6920-XL-FC1.5-ADM2-H4 gooseneck, sensor faucet plain end spout
 Zurn Z8739-SW-PC CP strainer with tailpiece
 Proflo PFXQAC32C ¼ turn angle valve (2)
 Proflo PFX146324 20" flex riser (2)
 Proflo PFE7 ½" CP escutcheon (2)
- P504 Service Sink:
 Stern-Williams SB-902 (24"x 24"x12") with stainless steel caps, two tiling flanges
 Proflo PFWG24S 24x24 back panels
 Stern-Williams TC3 / TC3NH gasket
 Zurn ZZ843M4CSRC integral spring-loaded check stops, 4" wrist blades

- P608 Shower, 36" Solid Surface Base:
Walls, grab bar, soap dish, fold-up seat furnished by others
InPro E3636LCCDBO 36"x36" low curb shower base, center drain
Symmons SYM9605-X-PLR-231 Shower faucet w/ ADA HH spray
ProFlo PF140NC CP shower Drain
- P701 Floor Drain, Regular:
Zurn ZN-415-P-Y type B strainer, nickel bronze top, trap primer, sediment bucket
- P702 Floor Drain, 12" Mechanical Room:
Zurn ZN-541-P, nickel bronze top, sediment bucket, trap primer
- P710 Roof Drain, 15" Diameter:
Zurn ZA-100-DR, aluminum dome, adjustable drain riser extension assembly
- P711 Roof Drain, Overflow:
Zurn ZA-100-W2-DR, aluminum dome, adjustable drain riser extension assembly, internal 2" dam
- P721 Floor Drain, Process, A.R.E. Coated:
Zurn Z-550-P-Y-AR, trap primer, sediment bucket
All components shall be A.R.E coated, interior and exterior
- P724 Downspout Nozzle
Zurn ZARB199-IP-SS
- P801 Wall Hydrant, Exterior:
Zurn Z-1310, non-freeze with vacuum breaker and stainless steel face
Install 18" above finished grade
- P802 Hose Bibb, Interior:
Zurn Z1341-P34-PC polished chrome finish with vacuum breaker
Install 18" above finished floor
- P804 Ice Machine Connection:
Oatey No. 39140 metal ice maker box with metal face plate.
Box with valve and water hammer arrestor
- P811 Drinking Fountain, Remote Chiller
Elkay EDFPB117C with stainless steel finish
Elkay ECH8 remote chiller
Elkay EACCESS12X385 access panel & bracket
Proflo PFXQAC32C ¼ turn angle valve (1)
Proflo PFX146324 20" Flex riser (1)
Proflo PFE 7 ½ OD escutcheon (1)
Proflo PFPTB400 1-1/4" 17ga P trap
- P812 Emergency Eyewash/Shower:
Bradley S19314EW shower and eyewash, manual close valves
Bradley S19-2100 thermostatic control valve
- P814 Wall Hydrant, Exterior, Hot/Cold:
Zurn Z-1325-VB, dual-temp, non-freeze with vacuum breaker enclosed in nickel bronze box with hinged cover
Install 18" above finished grade
- P816 Emergency Eye Wash:
Bradley S19-44011ABC wall mount
Bradley S19-2000 thermostatic mixing valve
- P817 Decontamination Room Shower – Interior
Symmons 125-VT-FSX-R-72 Visu-temp shower faucet, with 6 FT. vinyl hose and Attachment hooks
- P819 Roof Hydrant
Zurn ZZ1388XL34VBAC Non-freeze roof hydrant, vacuum breaker and casing guard
- P901 Ligature Resistant Single-Station Lavatory, Behav Tlt Rm:
Whitehall WH3776-E500-LWH3775SOBATMXP solid surface sensor controls, thermostatic mixing valve, SS trap cover and P-trap.
Proflo PFXQAC32C ¼ turn single stop (2)

Proflo PFX146324 20" Flex SS riser (2)
Proflo PFE7 1/2" CP escutcheon (2)

PART 3 EXECUTION

3.01 REQUIREMENTS

- A. Water closets shall be installed complete with wall carriers, wax rings, bolt caps, and flush valves (or float valves).
- B. Elevated vacuum breakers, where specified, shall be installed 7'-6" above the finished floor.
- C. Countertop sinks shall be installed complete with required mounting rim or clips.
- D. After installation, all fixtures shall be cleaned and labels removed. Where fixtures are in contact with walls, floors, or countertops, caulking shall be applied. Caulking shall be General Electric white silicon sanitary sealant.
- E. Water closets identified on plans as barrier free fixtures shall have the flush valves installed per American Disabilities Act. Flush valves shall have the handle installed on the wide side of the stall. Coordinate with the architectural drawings.
- F. Non pre-fabricated showers shall have chloraloy 240 brand non-plasticized chlorinated polyethylene concealed waterproofing membrane .040 inch thick. Installation shall be per manufacturers recommendations.
- G. At each flush valve, solenoid valve and other quick closing devices provide shock absorber.

END OF SECTION 22 43 00

SECTION 22 45 00
EMERGENCY PLUMBING FIXTURES

PART 1 GENERAL

1.01 MANUFACTURERS

- A. Provide plumbing fixtures and drains as listed on drawings and described herein. Fixture numbers are Zurn products. All products to be purchased from Ferguson Enterprises. Contact Bettina Dawson office (615) 316-1920 cell (931) 239-0466 or Randy Akin (615) 316-1853 or email HCA@ferguson.com.
- B. All drainage products to be Zurn no exceptions. All drains installed above slab to be complete with clamping device.
- C. Fixture supplies, stops, and traps to be commercial grade Zurn, no exceptions. Traps to be 17 gauge with wall flange. Supplies and stops to be heavy pattern with wheel handle unless noted otherwise.
- D. Thermostatic mixing valves shall be Symmons, Holby, Powers, or Leonard.

PART 2 PRODUCTS

2.01 FIXTURES

- P812 Emergency Eyewash/Shower:
 - Bradley S19314EW shower and eyewash, manual close valves
 - Bradley S19-2100 thermostatic control valve
- P816 Emergency Eye Wash:
 - Bradley S19-44011ABC wall mount
 - Bradley S19-2000 thermostatic mixing valve

PART 3 EXECUTION

3.01 REQUIREMENTS

- A. Elevated vacuum breakers, where specified, shall be installed 7'-6" above the finished floor.
- B. After installation, all fixtures shall be cleaned and labels removed. Where fixtures are in contact with walls, floors, or countertops, caulking shall be applied. Caulking shall be General Electric white silicon sanitary sealant.

END OF SECTION 22 45 00

SECTION 22 47 00
DRINKING FOUNTAINS & WATER COOLERS

PART 1 GENERAL

1.01 MANUFACTURERS

- A. Provide plumbing fixtures and drains as listed on drawings and described herein. Fixture numbers are Zurn products. All products to be purchased from Ferguson Enterprises. Contact Bettina Dawson office (615) 316-1920 cell (931) 239-0466 or Randy Akin (615) 316-1853 or email HCA@ferguson.com.
- B. All drainage products to be Zurn no exceptions. All drains installed above slab to be complete with clamping device.
- C. Fixture supplies, stops, and traps to be commercial grade Zurn, no exceptions. Traps to be 17 gauge with wall flange. Supplies and stops to be heavy pattern with wheel handle unless noted otherwise.
- D. All products used for dispensing potable drinking water must be lead free and meet the requirements of NSF 61 and NSF 372 test standards via third party testing and certification.

PART 2 PRODUCTS

2.01 FIXTURE

- P811 Electric Water Cooler (Split Level):
 - Elkay EDFPB117C with stainless steel finish
 - Elkay ECH8 remote chiller
 - Zurn ZH8824-XL-PC stop
 - Zurn Z8700-PC p-trap
 - Install with lower bubbler 36" above finished floor
 - Provide ADA cane guard

PART 3 EXECUTION

3.01 REQUIREMENTS

- A. After installation, all fixtures shall be cleaned and labels removed. Where fixtures are in contact with walls, floors, or countertops, caulking shall be applied. Caulking shall be General Electric white silicon sanitary sealant.

END OF SECTION 22 47 00

SECTION 22 60 06
CERTIFICATION PROCEDURE FOR MEDICAL GAS PIPELINES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section is to outline the responsibilities and procedures to be followed in final certification of the medical gas pipelines and included as a supplement to Section 22 60 13 Medical Gas Piping System.
- B. When new piping is "cut-in" to previously installed piping, it is possible that previously installed piping could be disturbed so as to cause crossed piping in previously installed systems. It is imperative that previously installed systems be inspected for crossed piping in conjunction with new system medical gas pipeline inspection and certification to the point of source.
- C. The certification procedure shall comply with all requirements of NFPA 99, latest published edition and as stated herein.
- D. Pipeline certification shall be performed by an independent third party Certification Agency. The Certification Agency qualifications data to be submitted and approved before any work to certify the systems has been performed.

PART 2 PRODUCTS

2.01 EQUIPMENT REQUIREMENTS

- A. Refer to Section 22 6013 Medical Gas Piping System.

PART 3 EXECUTION

3.01 INSTALLATION

- A. The General Contractor shall furnish a verified list designating number and location of all medical gas outlets to the Certification Agent. The General Contractor shall review and check this list with the appropriate subcontractors and the medical gas system personnel performing the medical gas pipeline inspection.
- B. The Plumbing Contractor is to perform mechanical check of all medical gas outlets prior to the certification inspection. Any necessary repairs or rework to be done prior to system suppliers inspection. Check to include:
 - 1. Outlets properly supported.
 - 2. Installation complete.
 - 3. Appropriate adapters fit and securely lock in place.
- C. The Owner is responsible for ensuring that bulk tank and/or cylinder supplies are installed, connected, and filled (or partially filled) prior to system suppliers inspection.
- D. All medical gas outlets shall be tested by the Certification Agent, excluding none.
- E. Certification Agent shall provide factory trained, qualified representatives to perform pipeline inspection and to provide report and certification in accordance with NFPA 99, latest published edition.
 - 1. Any discrepancies discovered during the inspection shall be noted, corrected, and any and all portions of the system affected by corrective action shall be retested and findings recorded after retest.
- F. Plumbing Contractor to provide representative who shall serve as customer contact person and who shall witness the inspection and certify that all outlets on the list furnished by the General Contractor have been checked and is in accord with inspection procedure and findings as witnessed.
- G. Hospital Engineering Department shall provide a representative who shall witness the inspection and certify that all spaces and the outlets therein listed on the list furnished by the General Contractor have been checked in accordance with inspection procedure.

- H. Certification Agent shall perform a cross connection test on all medical gas outlets using oil-free nitrogen as described in NFPA 99, latest published edition. Each pipe system shall be reduced to atmospheric pressure. Certification Agent shall then pressurize and test each piping system, one system at a time.
- I. Contractor shall connect all designated gas systems and purge the systems, completely. Certification Agent shall then analyze each medical gas outlet for proper oxygen content.
- J. The Certification Agent to furnish copies of Medical Gas Pipeline Inspection Report and Medical Gas Pipeline Certification to General Contractor to be distributed as follows:
 - 1. Plumbing Contractor
 - 2. Owner's Construction Manager
 - 3. Consulting Engineer
 - 4. Hospital
- K. The following procedure should be followed in addition to the above on extensions to existing systems:
 - 1. Owner's Representative shall, with adequate advance notice, request that system supplier's inspector or inspection team be on-site when old piping is cut-in for installation of new lines.
 - 2. Owner's Representative and system supplier's representative shall arrange to have inspector or inspection team on-site when the existing piping is cut into for installation of new lines.
 - 3. Main line shut-off vales shall be installed in new piping as close as possible to point of cut-in to previously installed piping.
 - 4. NOTE: Following verification of proper labeling or proper gas distribution of previously installed piping after cut-in procedure, the aforementioned valves (Item 3) shall be considered the "source" of supply for the new piping.

GAS ANALYSIS		
Gas	Concentration (%)	Pressure (psig)
Oxygen	99-100	50 +/- 5
Vacuum	—	Negative
Air	19.5 - 23.5 O ₂ content	50 +/- 5

END OF SECTION 22 60 06

SECTION 22 60 13
MEDICAL GAS PIPING SYSTEM

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Furnish and test the following systems:
 - 1. Oxygen (O₂).
 - 2. Vacuum (V).
 - 3. Medical/clinical compressed air (A).
- B. Outlets, valve boxes, valves, alarm systems, pressure and vacuum switches, and miscellaneous accessories for complete systems.
- C. Oxygen manifold system.
- D. Air manifold system.
- E. Pressure testing, cross connection testing and final testing, including purging and analyzing.
- F. Electrical power wiring for ceiling columns/hose drops, alarms, vacuum pumps, medical air compressor, and other electrical accessories associated with the system shall be furnished and installed under Division 26.
- G. Medical gas contractor shall furnish and install all low voltage control raceways and wiring associated with alarms and controls.

1.02 CODE COMPLIANCE/QUALITY ASSURANCE

- A. Install in compliance with the recommendations of the National Fire Protection Association (NFPA) as set forth in locally enforced editions of NFPA 99, Latest Edition, and NFPA 55.
- B. Comply with all local, state or federal codes applicable in this jurisdiction.
- C. Employ only qualified journeymen for this work. Employ a competent qualified mechanic/piping foreman, who has satisfactorily completed at least five other similar hospital installations, for this work. Provide brazers performance qualification test records for each brazer used on installation.

1.03 COORDINATION

- A. Coordinate with other trades to assure timely installations and to avoid conflicts and interference.
- B. Work closely with the metal stud partition installer and/or mason to assure that anchors, sleeves and similar items are provided in sufficient time to avoid delays; chases and openings are properly sized and prepared.
- C. Coordinate layout of medical gas systems in all spaces and identify all piping accurately.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Piping System Components:
 - 1. Allied Health Products, Chemtron Division.
 - 2. AMICO Corporation.
 - 3. Puritan Bennett.
 - 4. Beacon Medical Systems to match existing hospital outlets.
 - 5. Medical gas outlets shall match or be compatible with existing outlets, no exception.

2.02 QUALIFICATION OF MANUFACTURER

- A. Pipeline System Components:
 - 1. One manufacturer shall supply the medical gas piping system(s) equipment to include outlets, valves and gauges, valve boxes, alarm boxes, medical air manifold system, and oxygen manifold system.
 - 2. This manufacturer shall have a pipeline system engineer or product specialist available to periodically check with the contractor during installation of pipeline system equipment and

provide a service organization to certify the system. The contractor may use a third party certification agency at his discretion.

3. Provide ongoing service support to the hospital after turnover to the Owner.

2.03 PIPING MATERIALS AND HANGERS

- A. Piping: All piping including vacuum shall be seamless Type K or L (ASTM B819) copper tubing, pre-cleaned for oxygen use, in accordance with NFPA 9. Piping shall be pre-cleaned, marked and plugged by supplier before shipment to job site. Any system operating above 200 psi shall have Type K tubing.
- B. Fittings: Wrought copper, brass or bronze designed expressly for brazed connection. All fittings shall comply with ANSI B16.22. Cast fittings shall not be used. T-drill branch tee connections shall not be allowed for medical gas piping.
- C. Brazing alloy: Melting point of at least 1000 degrees F.
- D. Flux: Do not use for copper-to-copper joints. Use flux for joining copper to brass or bronze. In those cases where flux is used, exercise particular care in applying the flux to avoid leaving any excess inside the completed joints.
- E. Pipe hangers shall be copper coated adjustable swivel ring, typical of B-Line B3170CT. Strut systems may be incorporated with rubber isolators, typical of B-Line Vibra Cushion or Vibra Clamp pipe clamps. The taping of pipes for isolation shall not be permitted. Medical gas piping within metal stud walls shall be supported with plastic isolators such as Pipe-Tytes System or equivalent.

2.04 HIGH PRESSURE CYLINDER MANIFOLDS

- A. Provide automatic manifold control including self-shifting to reserve bank on exhaustion of the primary service bank and automatic reset of replaced bank to reserve status. Incorporate pressure switches for the purpose of actuating designated signals when the primary service bank is exhausted. Incorporate in control unit a visible means of determining when either bank is exhausted and operation has automatically switched to "reserve in use". Visible indication shall be by red light over exhausted bank and by gauges showing remainder pressure in each bank. Continuous visible indication of electrical circuits in effective operation shall be by means of green light. Line pressure shall be shown by separate visible gauge. Manifolds shall be installed as shown on drawings.
- B. Medical Air (A) manifold: to accommodate 6 cylinders divided into 2 equal banks.
- C. Oxygen (O2) manifold: to accommodate 12 cylinders divided into 2 equal banks.

2.05 MEDICAL GAS OUTLET STATIONS

- A. Quick-Connect Recessed Wall Outlets:
 1. Medical Gas Outlet Stations shall be modular, Quick-Disconnect recessed type. Modular outlet stations shall be field-assembled with sequences and services indicated on the plans. Centerline spacing of multiple outlets shall be 5 inches minimum.
 2. Outlet stations for medical gases shall have a stainless steel faceplate mounted on a chrome-plated, zinc die-cast cover plate. The cover plate assembly shall contain the quick-connect latch release mechanism, indexing pins for safety keying the gas-specific cover plate to the appropriate rough-in box, and color-coded gas service identification. The safety-keying index pins shall be permanently captured between the cover plate and latch assembly. Designs with index pins molded in plastic will not be accepted.
 3. The latch mechanisms shall be designed for one-handed, single thrust mounting and one-handed fingertip release of secondary equipment. The outlet stations shall be capable of supporting common secondary equipment, including suction regulator and half-gallon collection bottle, without the use of slide brackets.
 4. The cover plate shall attach to the primary valve assembly. The primary valve shall be threaded into the rough-in box separately from the cover plate to facilitate leak-testing around the valve. Designs which prevent this test will not be acceptable. The primary valve body shall be made of brass and shall be adjustable to compensate for variation in plaster

- thickness. Provide an O-ring within the valve to seal mating adapter plugs. Future replacement of the O-ring shall not require disassembly of the cover plate. The primary valve poppet shall be self-sealing in service, requiring no dust cap or cover.
5. Each rough-in box shall contain a base and tube assembly consisting of a Type K copper pigtail, flared to accept 1/4" ID, 3/8" O.D. supply line, brass block and base housing a secondary check valve per NFPA 99 (not required in vacuum), primary valve O-ring seal, check valve deflator spring (except vacuum), pressure testing cap plug, and plaster shield. The copper inlet tube shall be capable of rotating 360 degrees to adjust for field piping conditions.
 6. Medical gas outlets shall be cleaned for oxygen service in accordance with CGA Pamphlet G-4.1. The assembly shall be capped and internal parts poly-bagged for shipment. The outlet assembly shall bear the label of listing under Re-examination Service of Underwriters' Laboratory.
 7. Quantity and gas type shall be provided as indicated on plans.

2.06 MEDICAL GAS VALVING

- A. Main and Base of Riser Valves (Valves Not in Boxes):
 1. All valves and tubing shall be specially prepared for oxygen service and shall conform in all particulars to NFPA 99. All valves shall be a lockable ball-type, with teflon seats and adjustable stem packing gland with teflon stem seal, through 2-inch sizes. 2-1/2" to 3" valves have teflon seats and double teflon stem seal. 4-inch valves shall have Buna-N ball seats.
 2. All ball valves rated at 400 psig, actuate from full "ON" to full "OFF" by 90 degrees turn of vinyl gripped valve handle. Factory installed copper tubing shall be extended sufficiently to help prevent valve seat damage during soldering.
 3. Unless specifically noted or obviously required, main and riser valves located in other than public areas are not required to be installed in box.
 4. Lock valves in the open position, and turn keys over to hospital maintenance upon completion of the project.
- B. Area/Zone Valves (Valves in Boxes):
 1. Zone valve boxes shall be constructed of extruded aluminum or 18 gauge sheet steel with air dried lacquer finish. The cover frame shall be made of an anodized aluminum and attached to the box by concealed screws. The finished assembly shall be substantially dust-tight. The frame assembly shall be capable of adjusting for variances in wall thickness up to one inch. The frame assembly shall contain an easily removable cover window with pull ring. The window shall conceal exposed piping and valves within the box and shall be labeled "Caution - Medical Gas Shut-Off Valves - Close Only in Emergency". Clean viewing space shall be provided in the window to display the gas service, the area controlled by the valve, and pressure gauges on units so equipped.
 2. Frames for all valve boxes shall have uniform width for balanced appearance. Manufacturer shall provide color-coded self-adhesive gas service labels for compliance with NFPA 99 labeling requirements. Apply labels to each valve within the assembly for proper gas service identification according to the manufacturer's instructions.
 3. Placement of the valve within the zone valve box shall be such that the removable window cannot be replaced when any valve is closed. Factory installed Type K copper pipe extensions shall extend three (3) inches outside the valve box. Design of the valve box shall be such that valves may be removed prior to brazing, without disassembly of the box, to permit field rearrangement of valves if necessary. Valves shall be ball type, cleaned for oxygen service, supplied with capped ends, and shall operate full open to closed position with 90 degree handle rotation. Provide chrome finish on valves and piping within valve boxes.
 4. Gauge model zone valve assemblies shall include 1-1/2" pressure gauges reading 0-100 psig for oxygen, nitrous oxide and air; 0-300 psi for nitrogen, and 0-30" Hg for vacuum or evacuation vacuum. The gauge port shall be equipped with removable plug for pressure testing prior to final assembly of gauge.

5. All gauge model zone valve box assemblies shall read pressure downstream and vacuum upstream of the valve per NFPA 99. Valves shall be piped left to right.

2.07 MEDICAL GAS ALARM SYSTEMS

- A. Line pressure alarms shall be of modular construction where additional modules may be field expanded. The alarm assembly shall be U.L. listed requiring 115-volt supply. Internal voltage shall be stepped down to 24 or 12 volts for control circuit power. Each service (gas or vacuum) shall be provided with an audible alarm and visual red light flasher for abnormal pressure conditions. Audible alarm may be silenced by push-button, but visual alarm will continue to flash until abnormal condition is corrected. A green light for each service shall indicate normal pressure conditions. A pressure gauge or solid state readout shall display the pressure of each service.
 1. The alarm assembly shall be recessed within standard 3-5/8" stud walls. Type "K" copper pipe (1/4" I.D.) shall be provided for connection to each service.
- B. Master alarm panel shall be of modular construction where additional modules may be field expanded. The alarm assembly shall be U.L. listed requiring 115-volt supply. Internal voltage supply shall be stepped down to 24 or 12 volts for control circuit power. Each service (gas or vacuum) shall be provided with an audible alarm and a visual red light flasher for abnormal pressure conditions. Audible alarm may be canceled but visual alarm will continue until abnormal condition is corrected. Alarm signals shall be received from master pressure switches located at the supply source downstream of the main line shutoff valves.
 1. A minimum of two master alarm panels shall be installed. Reference the drawings for locations. Panels shall be wired in parallel to the pressure switches, not in series. Control wiring between switches and alarm panels shall be in 3/4" minimum EMT conduit. Wiring shall be 22-gauge shielded, twisted pair cable equal to Belden #8451 or West Penn #452 or per manufacturer requirements.
 2. Master alarm panel shall be recessed within standard 3-5/8" stud wall.
 3. The Multi-Signal Alarm Panel functions to be as follows:

FUNCTION	
O ₂	Changeover to reserve
O ₂	Reserve in use
O ₂	Reserve low
O ₂	Line pressure high
O ₂	Line pressure low
Air	Line pressure high
Air	Line pressure low
Vacuum	Line pressure low
Vacuum	Reserve pump in use
Vacuum	Line pressure high
Vacuum	General local alarms

- C. Provide pressure and vacuum switches, as companion to each Master alarm of the Hi-Lo single-pole double-throw approved snap-acting type enclosed in a NEMA 4 watertight housing. Switches to be factory set to activate alarms as follows:
 1. O₂--40 psi-low and 60 psi-high
 2. Air--40 psi-low and 60 psi-high
 3. Vacuum--12" Hg-low
- D. Provide monitoring gauges in accordance with NFPA 99 for nonflammable medical gases using lettered identification labels and color coding.

PART 3 EXECUTION

3.01 IDENTIFICATION

- A. All medical gas piping to be labeled with self-adhesive markers including the name of the gas, direction of flow, operating pressure and pipe size. Labels to be spaced not more than 20 feet intervals and at least once in each room and on each floor at the risers for each story traversed by the piping system. Labels shall be color coded per NFPA 99.

3.02 INSTALLATION

- A. Copper pipe, tubing, valves, and fittings shall be pre-cleaned and prepared for medical gas service in accordance with NFPA 99, except those supplied especially prepared for such service by the manufacturer and received sealed on the job.
- B. Joints in all the piping including vacuum piping, except those at equipment requiring screwed connections, shall be made with silver brazing alloy or similar high melting point (at least 1000 degrees F) brazing metal. Silver brazing material for pipes and fittings in the medical gas system shall be Stay-Silv-15 or equal to the following: Silvaloy-15, Aircosil No. 15, or Phos-Silver-15. The silver brazing alloy shall contain a minimum of 15% silver, 80% copper, and 5% phosphorus and shall not contain cadmium alloy. The silver brazing alloy shall have a minimum of 1000 degrees F. liquidus melting point and shall have an ASTM rating of "BCuP5". The use of flux is prohibited from the making of joints between copper to copper pipes and fittings. Appropriate flux similar to "Stay-Silv-Black Flux" or "Stay-Silv-White Flux" is required between dissimilar metals such as copper to brass or bronze material, when parts are heated over a prolonged period. DURING THE BRAZING OF PIPE CONNECTIONS, THE INTERIOR OF THE PIPE SHALL BE PURGED CONTINUOUSLY WITH NITROGEN. The outside of the tube and fittings shall be cleaned by washing with hot water after assembly.
- C. Threaded joints in piping systems shall be tinned or made up with polytetrafluorethylene (such as teflon) tape or other thread sealants suitable for oxygen service. Sealants shall be applied to the male threads only.
- D. All piping shall be supported with pipe hangers or strut systems at intervals per NFPA 99, and NOT supported by other piping. Isolation of all copper piping from dissimilar metals shall be of a firm, positive nature. Duct tape is not acceptable as isolation material. Hanger Spacing Shall be as Follows:

Pipe Size	Hanger Spacing
1/2 inch	6 feet
3/4 inch	7 feet
1 inch	8 feet
1-1/4 inch	9 feet
1-1/2 inch and larger	10 feet

- E. Install screw joints used in shutoff valves, including station outlet valves, by tinning the male thread with soft solder. Litharge and glycerin or an approved oxygen luting or sealing compound are acceptable.
- F. Use prepared flux manufactured by Handy and Harman which consists of dry boric and water boric for hard solder joints. Alcohol mixture is prohibited. Resin or petroleum base of similar paste flux may contain compounds objectionable for oxygen service and shall not be employed.
- G. After installation of the piping, but before installation of the outlet valves, blow lines clear by means of oil-free, dry air or nitrogen.
- H. Buried piping shall be adequately protected against frost, corrosion, and physical damage. Ducts or casings shall be used on all buried piping.
- I. Identification tape shall be buried approximately 18 inches above the piping, and immediately on top of the conduit.
- J. Piping exposed to physical damage shall be adequately protected.

3.03 PRESSURE TESTING

- A. After installation of the piping and valves, but before installation of the service outlets, alarm actuating switches and gauges, the line shall be blown clear by means of oil-free, dry air or nitrogen.
- B. Next, each section of the piping system shall be subjected to a test pressure of one and one-half (1-1/2) times the maximum working pressure, but not less than 150 psig, with oil-free, dry nitrogen. This test pressure shall be maintained for at least 24 hours. Then each joint shall be

examined for leakage by means of soapy water or other effective means of leak detection safe for use with oxygen.

- C. All leaks shall be repaired and the section retested.
- D. After completing the testing of each individual piping system, all of the medical gas systems shall be subjected to a pressure test at one and one-half (1-1/2) times the maximum working pressure, but not less than 150 psig. The test gas shall be oil-free, dry nitrogen. The main line shut-off valve shall be closed during the test.
- E. After completion of the above test procedure the finishing assemblies of station outlets, alarms, and all components (e.g. pressure switches, gauges, relief valves, etc.) shall be installed and all medical gas piping systems shall be subjected to a 24 hour standing pressure test at 20% above the normal operating line pressure with oil-free, dry nitrogen. The main line shut-off valve shall be closed during this test.
- F. Leaks, if any, shall be located, repaired, and the system retested.
- G. To determine that no cross connection to other pipeline systems exists, reduce all systems to atmospheric pressure. Disconnect all sources to test gas from all of the systems with the exception of the one system to be checked. Pressure this system with oil-free, dry air or nitrogen to a pressure of 50 psig. With appropriate adapters matching outlet labels, check each individual station outlet of all systems installed to determine that test gas is being dispensed from only the outlets of this system.
- H. When all medical gas piping systems have been tested, the source of test gas shall be disconnected and the proper gas source of supply connected to each respective system. Following this connection and pressurization, all outlets shall be opened in a progressive order, starting nearest the source and completing the process of purge flushing at the outlet farthest from the source. Gas shall be permitted to flow from each outlet until each system is purged of test gas used during previous tests. After completion of purge flushing of the pipeline system, the outflow from each designated and labeled oxygen outlet station, anesthesia machine, and other oxygen dispensing equipment shall be tested (using an oxygen analyzer) to confirm the presence of the desired purity of oxygen.

3.04 CROSS CONNECTION TESTING AND CERTIFICATION

- A. General Requirements:
 - 1. This section is to outline the responsibilities and procedures to be followed in final certification of the medical gas pipelines and outlets.
 - 2. When new piping is "cut-in" to previously installed piping, it is possible that previously installed piping could be disturbed so as to cause cross connections. It is imperative that previously installed systems be inspected for crossed piping in conjunction with new system medical gas pipeline inspection and certification to the point of source.
 - 3. The certification procedure shall comply with all requirements of NFPA 99, Latest Edition and as stated herein.
 - 4. Pipeline certification shall be performed by an independent subcontractor (certification agent) not associated with the medical gas equipment supplier.
- B. Certification Procedure:
 - 1. The Contractor shall furnish a verified list designating number and location of all medical gas outlets to the Certification Agent. The Contractor shall review and check this list with the medical gas system personnel performing the medical gas pipeline inspection.
 - 2. The Contractor is to perform mechanical check of all medical gas outlets prior to the certification inspection. Any necessary repairs or rework to be done prior to system suppliers inspection. Check to include:
 - a. Outlets properly supported.
 - b. Installation complete.
 - c. Appropriate adapters fit and securely lock in place.
 - 3. The Owner is responsible for ensuring that bulk tank and/or cylinder supplies are installed, connected, and filled (or partially filled) prior to system suppliers inspection.

4. All medical gas outlets shall be tested by the Certification Agent, excluding none.
5. Certification Agent shall provide factory trained, qualified representatives to perform pipeline inspection and to provide report and certification in accordance with NFPA 99, Latest Edition.
 - a. Any discrepancies discovered during the inspection shall be noted, corrected, and any and all portions of the system affected by corrective action shall be retested and findings recorded after retest.
6. Contractor to provide representative who shall serve as customer contact person and who shall witness the inspection and certify that all outlets on the list furnished by the Contractor have been checked and is in accord with inspection procedure and findings as witnessed.
7. Hospital Engineering Department shall provide a representative who shall witness the inspection and certify that all spaces and the outlets therein listed on the list furnished by the Contractor have been checked in accordance with inspection procedure.
8. Certification Agent shall perform a cross connection test on all medical gas outlets using oil-free nitrogen as described in NFPA 99, Latest Edition. Each pipe system shall be reduced to atmospheric pressure. Certification Agent shall then pressurize and test each piping system, one system at a time.
9. Contractor shall connect all designated gas systems and purge the systems, completely. Certification Agent shall then analyze each medical gas outlet for proper oxygen content.
10. The Certification Agent to furnish copies of Medical Gas Pipeline Inspection Report and Medical Gas Pipeline Certification to General Contractor to be distributed as follows:
 - a. Plumbing Contractor
 - b. Owner's Construction Manager
 - c. Consulting Engineer
 - d. Hospital
11. The following procedure should be followed in addition to the above on extensions to existing systems:
 - a. Owner's Representative shall, with adequate advance notice, request that system supplier's inspector or inspection team be on-site when old piping is cut-in for installation of new lines.
 - b. Owner's Representative and system supplier's representative shall arrange to have inspector or inspection team on-site when the existing piping is cut into for installation of new lines.
 - c. Main line shut-off vales shall be installed in new piping as close as possible to the point of cut-in to existing piping.
 - d. NOTE: Following verification of proper labeling or proper gas distribution of previously installed piping after cut-in procedure, the aforementioned valves (Item 3) shall be considered the "source" of supply for the new piping.

GAS ANALYSIS		
Gas	Concentration (%)	Pressure (psig)
Oxygen	99-100	50 +/- 5
Vacuum	—	Negative
Air	19.5 - 23.5 O ₂ content	50 +/- 5

END OF SECTION 22 60 13

SECTION 22 62 19
MEDICAL VACUUM EQUIPMENT

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Furnish and test Vacuum (V) system.
- B. Pressure and vacuum switches, vacuum pump and miscellaneous accessories for complete systems.
- C. Pressure testing, cross connection testing and final testing, including purging and analyzing.
- D. Electrical power wiring for alarms, vacuum pumps, and other electrical accessories associated with the system shall be furnished and installed under Division 26.
- E. Medical gas contractor shall furnish and install all low voltage control raceways and wiring associated with alarms and controls.

1.02 CODE COMPLIANCE/QUALITY ASSURANCE

- A. Install in compliance with the recommendations of the National Fire Protection Association (NFPA) as set forth in locally enforced editions of NFPA 99, Latest Edition, and NFPA 55.
- B. Comply with all local, state or federal codes applicable in this jurisdiction.
- C. Employ only qualified journeymen for this work. Employ a competent qualified mechanic/piping foreman, who has satisfactorily completed at least five other similar hospital installations, for this work. Provide brazers performance qualification test records for each brazer used on installation.

1.03 COORDINATION

- A. Coordinate with other trades to assure timely installations and to avoid conflicts and interference.
- B. Work closely with the metal stud partition installer and/or mason to assure that anchors, sleeves and similar items are provided in sufficient time to avoid delays; chases and openings are properly sized and prepared.
- C. Coordinate layout of medical gas systems in all spaces and identify all piping accurately.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Vacuum Pump Systems:
 - 1. Allied Health Products, Chemtron Division
 - 2. Beacon Medaes
 - 3. Powerex
 - 4. Amico Products
 - 5. Pattons Medical

2.02 QUALIFICATION OF MANUFACTURER

- A. Vacuum Pump:
 - 1. Manufacturer/supplier shall have had at least fifteen (15) years' experience in the manufacture of oil-less medical vacuum pumps.
 - 2. Provide a service organization with staffing during working days, and repair parts, within 200 miles of the facility.
 - 3. The supplier shall supply drawings for installation operating and maintenance instructions manuals, and parts lists. The supplier shall provide both warranty and after warranty service for the total package. The service representative shall not be third party and shall be factory trained.

2.03 MEDICAL VACUUM PUMPS

- A. Medical vacuum pumps shall be a factory assembled and tested duplex package, pre-wired and pre-piped on a fabricated steel base, ready for single point connection at the job site.

Specifically, there is one electrical connection, single manifold discharge connection, and one vacuum connection to hospital.

- B. The vacuum pumps shall have a rated SCFM capacity at 19" HG, horsepower and electrical requirements as scheduled on the drawings.
- C. Furnish all required accessories for installing the vacuum pump (vibration dampeners, isolation pads or springs, flex connectors on incoming and exhaust lines, etc.).
- D. The control cabinet shall be a U.L. listed NEMA 12 dustproof cabinet. The cabinet shall contain the following:
 - 1. Fusible disconnect or circuit breaker switches for each pump.
 - 2. Magnetic motor starters with thermal overload protection for each pump.
 - 3. Vacuum control switches set to maintain the vacuum level between a minimum of 19 inches H.G. and a maximum setting of 25 inches H.G.
 - 4. Thermal overload reset buttons.
 - 5. Redundant control circuit transformers.
 - 6. Hand-Off-Automatic selector switch for each pump.
 - 7. Local alarm for reserve pump operation and output signal for master alarm panel.
 - 8. Automatic alternator between pumps.
 - 9. Minimum run timers to prevent short cycle.
 - 10. Local alarm for high discharge temperature and output signal for master alarm panel.
 - 11. Vacuum gauges.
- E. The warranty for the vacuum pump system shall be 18 months from start-up or 24 months from date of shipment, whichever comes first.
- F. Motors shall be drip-proof, 40 degree C rise, 3 phase, NEMA Design B type motors.
- G. Vacuum pumps shall be claw type, air-cooled type pumps. Oil supply shall be totally recirculating. Oil separator shall be capable of removing 99.9 percent of oil from the pump exhaust. Each pump shall have isolation valving, check valves, flexible connectors, and drive enclosures.
- H. Receiver tank shall be ASME rated and galvanized coated. Receiver tank shall have drain valve and isolation valve. A three-valve bypass shall be provided to permit servicing the receiver.
- I. Vacuum pumps, control cabinet and receiver shall be a complete unit, factory assembled. The system shall be factory tested prior to shipment. Manufacturer shall provide representative to assist in system start-up at the project site.

PART 3 EXECUTION – NOT APPLICABLE

END OF SECTION 22 62 19

SECTION 22 66 53
ACID WASTE, PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers as indicated in subsequent paragraphs.

1.02 EQUIPMENT

- A. Corrosive Waste and Vent Piping:
1. Material: Provide Schedule 40 polypropylene pipe and fittings that conform to dimensions and tolerances per ASTM F1412. Pipe and fittings to be manufactured with a chemically resistant polypropylene material conforming to ASTM D4101.
 2. Pipe:
 - a. Below grade pipe shall be either flame retardant or non-flame retardant Schedule 40 polypropylene in accordance with ASTM D4101.
 - b. Above ground pipe shall be flame retardant Schedule 40 polypropylene in accordance with ASTM D4101.
 3. Fittings: All fittings shall be manufactured to Schedule 40 polypropylene pipe dimensions of a chemically resistant and fire retardant polypropylene material conforming to ASTM D4101. Polypropylene Fittings to conform to applicable tolerances in ASTM F1412.
 4. Acceptable Manufacturer: U.S Shott or equal.
 5. Provide tempered glass pipe, fittings and joints as manufactured by O. I. Shott or equal.

PART 2 PRODUCTS

2.01 INSTALLATION

- A. Corrosive Waste and Vent Piping:
1. Joints: All joints shall be fusion except those under casework.
 2. Install at minimum slope of 1/8 inch per foot.
 3. Follow manufacturers' recommendation for hanging and burial.
 4. Each section or floor shall be tested with not less than 10 feet head of water for 24 hours with no leaks.
 5. Polypropylene pipe shall be installed with appropriate expansion loops so as to eliminate creeping and/or bowing of the pipe due to temperature changes.
 6. Where polypropylene pipe penetrates fire-rated floors or walls, approved UL listed fire stops must be installed.

PART 3 EXECUTION - NOT APPLICABLE

END OF SECTION 22 66 53

SECTION 22 67 19.19
DEIONIZED WATER PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. General:
 - 1. Furnish all labor, materials, tools, equipment, and services for distilled and deionized water piping system, as indicated, in accordance with provisions of Contract Documents.
 - 2. Completely coordinate with work of all other trades.
 - 3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.
 - 4. See Section 23 01 00 for special mechanical requirements.
 - 5. See Division 01 for General Requirements.

1.02 QUALITY ASSURANCE

- A. Standard for Sterilization: AWWA C601.

1.03 SUBMITTALS

- A. Submit product for owner approval for water purification equipment. Submittal data not required for piping, fittings, support, etc.
- B. Submit test reports to Owner at completion of job.
 - 1. Pressure tests.
 - 2. Sterilization tests.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Acceptable Manufacturers: As indicated for individual items.

2.02 VALVES

- A. All valves: Rated for 125 PSIG working pressure, non-shock.
 - 1. Acceptable manufacturer: Enfield.
 - 2. Use valves of same material as piping system in which they are installed.
- B. Shut-off valves: Ball type, socket or threaded ends, and teflon seating.
- C. Check valves: Ball type for either vertical or horizontal mounting, with threaded or socket ends.
- D. Provide reduced pressure backflow preventer in piping serving equipment producing distilled or deionized water.

2.03 PIPE AND FITTINGS

- A. Deionized water piping: Polypropylene pipe and fittings, with electrically welded or threaded joints.
- B. Fire-Rated Pipe Enclosures: Provide noncombustible, inorganic fireproofing jacketed wrap for fire-rated pipe enclosures equivalent to Thermal Ceramics Fire Firemaster, CertainTeed Flamecheck, Johns Manville Firetemp, or Nelso FlameShield. The system shall be designed for 2300 degrees F. continuous service and meet the following testing standards: ASTM E-84 and E-119; U.L. 263, 1479, and 1709; and U.L. Classification for fire-rated plastic pipe enclosures. A total 2-hour fire-rated assembly shall be created.
- C. Install fireproof pipe enclosure in accordance with U.L. classification and manufacturer's published U.L. installation instructions.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

- A. Install piping and fittings as indicated in 22 11 16 DOMESTIC WATER PIPING AND VALVES.

- B. Install piping to provide every fixture and item of equipment requiring deionized water with suitable supply connection.
- C. Consult manufacturers' data and large scale details of rooms containing plumbing fixtures on architectural drawings before roughing in piping. Plug or cap piping immediately after installation.
- D. Connect equipment furnished by others in accordance with 23 01 00 GENERAL PROVISIONS OF HVAC SYSTEMS and 22 01 00 PLUMBING GENERAL PROVISIONS.
 - 1. For each water supply piping connection to equipment by others, furnish and install a union and a gate or angle valve. Provide a wheel handle stop valve at each sink water supply. Minimum line size 1/2 IN.
 - 2. Cap and protect until such time as installation is performed.

3.02 STERILIZATION OF SYSTEMS

- A. Sterilize system as indicated, or in accordance with AWWA C601.
- B. Thoroughly flush system.
- C. After flushing, introduce chlorine or chlorine compound into system with dosage sufficient to give an initial residual chlorine content of 50 ppm.
- D. Collect samples from various taps and fixtures throughout buildings during introduction of chlorine to assure uniform distribution. Open and close valves several times.
- E. After 24-hour contact period, flush all traces of heavily chlorinated water from systems.
- F. After flushing is complete, provide evidence of effectiveness of disinfection by filing with Designer, laboratory reports of bacteriological tests on samples taken from system.
 - 1. Number and locations of taking samples as specified by Designer.
- G. If satisfactory results are not obtained, repeat above disinfection process until satisfactory results are obtained.
- H. Do not put system into service until satisfactory tests are reviewed by Designer.

3.03 TESTING

- A. Do not insulate, conceal or furr in pipe until it has been tested to satisfaction of Designer.
- B. Upon completion of a section of system, test hydrostatically to pressure not less than 50 percent in excess of maximum pressure to which pipe will ordinarily be subjected, but in no case less than 100 PSI.
- C. If test shows defects, replace such defective work or material and repeat tests.
 - 1. Make repair to piping with new material.
 - 2. No caulking of screwed joints or holes will be acceptable.

END OF SECTION

SECTION 22 70 10
NATURAL / PROPANE GAS CONNECTION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section includes requirements for:
 - 1. Natural gas connection.
 - 2. Propane gas connection.

PART 2 PRODUCTS

2.01 NATURAL GAS CONNECTION

- A. Provide connection to local gas company's line on building side of gas meter.
- B. Provide shut-off valve, wall sleeve, and building gas pressure regulator.

PART 3 EXECUTION

3.01 INSTALLATION AND TESTING

- A. Natural Gas Connection:
 - 1. Arrange and coordinate with local gas company for service line, meter, regulator, fees, permits, and pressure desired on house side of meter.
 - 2. Maintain clear access and protection from mechanical damage to meter.
 - 3. Maintain minimum 10 foot separation of meter from fresh air intakes to building.

END OF SECTION 22 70 10

SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC SYSTEMS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, materials, tools, and services for a complete installation of equipment and systems contained in contract documents.
- B. Principal features of work included are:
 - 1. Heating, ventilating, and air-conditioning system.
 - 2. Control system including low voltage control wiring and conduit.
 - 3. Demolition of existing equipment, ductwork, and piping.
 - 4. General Commissioning Refer to Section 019113.

1.02 RELATED WORK

- A. Electrical power and interlock wiring and conduit.
- B. Laboratory equipment.

1.03 INNOVATION MEMORANDUMS

- A. The owner has obtained purchase agreements for select equipment and materials. These purchase agreements are documented as Innovation Memorandums and are to be included as part of this project.
 - 1. Innovation Memorandum No. 7: All piping, valves, pipe fittings and related products to be purchased from Ferguson Enterprises. Refer to Section 23 2113.
 - 2. Innovation Memorandum No. 9: All VAV boxes to be purchased from JCI. Refer to Section 23 36 00.
 - 3. Innovation Memorandum No. 13: All building automation systems to be purchased from JCI. Refer to Section 23 09 23.

1.04 GENERAL

- A. The contract documents form a guide for a complete system. Provide all items necessary to provide a complete system but not specifically mentioned, such as hangers, transitions, offsets, and drains.
- B. Layouts indicated on drawings are diagrammatical only. Coordinate exact location of equipment, ductwork, and piping to eliminate conflict with other divisions. Designer reserves right to make reasonable changes in location of equipment, ductwork, and piping prior to construction. Coordination drawings shall be submitted prior to any equipment/systems being installed to ensure that installation conflicts between trades are minimized.
- C. Should Contractor find during progress of work that in his judgment existing conditions make desirable a modification, report such item promptly to Designer for instructions. Do not make deviations from contract documents without review of Designer.
- D. Supervise all work with a competent mechanic specifically qualified in mechanical discipline.

1.05 PERMITS

- A. Secure and pay for permits, licenses, and inspections for work under this division.

1.06 CODES

- A. Comply with all pertinent local, state, and national codes. Refer to Division 01.

1.07 STANDARDS

- A. Comply with all pertinent standards. This list is provided as a convenience to Contractor and is not to be considered all inclusive.
 - 1. Sheet Metal and Air-Conditioning Contractors National Association (SMACNA).
 - 2. American Gas Association (AGA).
 - 3. Air Moving and Conditioning Association (AMCA).

4. Air-Conditioning, Heating and Refrigeration Institute (AHRI).
5. American Society of Mechanical Engineers (ASME).

1.08 SUBMITTALS

- A. Submit for review complete brochures and shop drawings for materials and equipment proposed in accordance with Division 01.
 1. Brochures: Submit complete descriptions, illustrations and specification data for materials and equipment proposed. Clearly indicate proposed items when other items are shown on same sheet. Submit samples on request and/or set up for inspection. Samples will be returned to Contractor.
 2. Submittals shall be submitted in line by line format. Each submittal shall be provided with a cover letter and supporting documentation indicating how the submittal meets each line of the referenced specification section. All discrepancies between the construction documents and the submitted product shall be clearly identified for engineer evaluation.
 3. If a product other than the basis of design is rejected by the engineer for any reason, the Contractor shall provide the basis of design product at no additional cost to the Owner.
 4. Shop Drawings:
 - a. Control systems.
 - b. Complete equipment, ductwork, and piping systems.
 - c. Equipment room layouts with actual equipment, piping and duct.
 - d. Roof layouts.
 - e. Dimensioned floor drain locations.

1.09 PROJECT MAINTENANCE MANUALS

- A. Prior to final acceptance of project, provide Owner with bound maintenance manuals in accordance with Division 01.

1.10 PROJECT TECHNICAL INSTRUCTION

- A. Prior to final inspection of project, provide technical instruction to Owner as follows:
 1. Field Instruction: Provide explanation of how systems and equipment are to operate during each season and during emergencies.
 2. Field Demonstration: Demonstrate operation and routine maintenance for systems and equipment.
 3. Video: Provide digital video of all field instruction and demonstration to Owner at completion.

1.11 PROTECTION

- A. Protect all materials and equipment in accordance with Division 01.
- B. The contractor must take appropriate precautions, during construction, to prevent unnecessary dust and debris from getting into air and water handling systems by covering equipment, controls and open-ended ducts and pipes as the installation progresses.

1.12 CONSTRUCTION RECORD DOCUMENT

- A. Provide construction record documents in accordance with Division 01. Keep at the project one set of drawings and daily record changes at the time they are made. Give drawings to Owner at project completion.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Provide materials and equipment of domestic manufacture bearing the U.L. label when such label is available.

PART 3 EXECUTION

3.01 COORDINATION

- A. Coordinate work in accordance with Division 01. Coordinate locations of equipment, ductwork, and piping to eliminate conflict with other divisions.

- B. Carefully examine contract documents to be thoroughly familiar with items which require plumbing or mechanical connections and coordination.
- C. Provide proper chases and openings. Place sleeves and supports prior to pouring concrete or installation of masonry.

3.02 CUTTING AND PATCHING

- A. Repair or replace routine damage caused by cutting in performance of contract.
- B. Correct unnecessary damage caused due to installation of mechanical work.
- C. Perform repairs with materials that match existing in accordance with the appropriate section of these specifications.
- D. Duct floor penetrations and plenum floor penetrations in mechanical rooms shall have a minimum 2" curb.
- E. Floor sleeves in wet areas and mechanical rooms shall extend a minimum of 2" above the floor to prevent water entrance to the sleeve. Vertical pipe supports shall be extended to the floor rather than support from the sleeve.

3.03 FLASHING, COUNTERFLASHING, AND SEALING

- A. Flash, counterflash, and seal ductwork and piping at penetrations of roofs and outside walls.

3.04 TRENCHING, EXCAVATION AND BACKFILLING

- A. Provide trenching, excavation, and backfilling necessary for performance of mechanical work accordance with Division 02.
- B. Trenching and excavation of rock to be as described in Division 02.
- C. Excavate to a depth at least 6" below bottom of pipe and a minimum of 36" above top of pipe. Fill below pipe, around pipe, and minimum of 12" above pipe with sand or Class "B" crushed stone tamped firm and even. Provide topsoil for final layer of dirt (12" minimum). Provide 6" spacing between pipes and between pipe and trench sides. Hand-grade with batterboards placed every 25'. Backfill by hand. Do not use rock or stone above sand or Class "B" crushed stone.

3.05 CONNECTION TO EQUIPMENT

- A. Rough-in and connect to, lab equipment, and Owner furnished equipment and provide a shutoff valve and union at each connection. Operating valves and/or controls for this equipment will be provided as an integral part of the equipment. Do not rough-in until shop drawings showing rough-in locations have been reviewed by Designer.

3.06 IDENTIFICATION

- A. Identify exposed or accessible piping with stenciling contents indicating pipe contents and direction of flow on piping not more than 20 feet apart, at valves, at access panels, and at least once above each space.
- B. Valve tags are required for all emergency shutoff valves and all manual valves 1" and larger. These shall be engraved brass tags hung from valves with minimum 1" high lettering. Submit valve tag directory in close-out documents. Mark ceiling grid with colored marker indicating valve locations above the ceiling. Emergency shutoff valves shall include all valves 2" and larger for the following services: domestic hot and cold water, heating hot water, and natural gas.
- C. CAV/VAV terminal units concealed above lay-in ceilings shall be marked by a physical tag clipped or adhered to the grid.
- D. Identify all mechanical equipment with engraved brass, aluminum, or stainless steel nameplates or tags. Use equipment names and numbers appearing in schedules on drawings. Fasten nameplates to equipment using screws. Glue or adhesive is not acceptable. Fasten tags to equipment using brass, aluminum or stainless steel chains.
- E. Air terminal units (CAV/VAV) concealed above ceilings shall be marked by a marker clipped or adhered to the grid. Include box ID number on marker.

- F. Frame and mount control diagrams and sequences in each equipment room. Use non-fading black and white prints encased in aluminum frame with plexiglass cover.

3.07 CLEANING

- A. Thoroughly clean ductwork and equipment casings before fans and filters are operated.
- B. Repair damaged factory finishes covering all bare places and scratches.
- C. Cleaning HVAC Systems Water Piping:
1. Clean all equipment and piping of iron cuttings and other foreign matter as they are installed.
 2. Do not install devices in which foreign matter could become lodged, such as control valves, until cleaning and flushing are completed. Position valves to bypass chiller, boiler and heat exchanger. Connect supply and return runouts together at each coil location. Make connection of supply and return runouts with short lengths of high pressure rubber hose and brass fittings. One fitting shall be swivel type to eliminate turning fitting in hose.
 3. Fill system at city water make-up connection with all air vents open. After filling, close vents.
 4. Start main pump with pressure reducing valve makeup open. Check vents in sequence to bleed off any trapped air in order to assure circulation through all components of system. Verify pumps are properly aligned and bolted down before start-up to prevent damage to seals or couplings. Circulate water for at least two hours and then drain completely to flush out foreign matter.
 5. Remove, clean, and replace all strainer baskets. Clean all dirt legs. If indications are found of excessive dirt, repeat the above flushing.
 6. Fill the system with fresh water, adding precleaning chemicals designed to remove depositions such as pipe dope, oils, rust, mill scale, and other extraneous materials. Provide dosages of precleaner chemicals recommended by water treatment supplier. Alternate operation of primary and standby pumps, and circulate the cleaning solution for 24 hours. Then turn off the pump and completely drain the system.
 7. Remove, clean, and replace all strainer baskets. Clean all dirt legs. Replace suction diffuser start-up strainer with conventional strainer. Refill the system with clean water, venting all high points and equipment of air and gases. Bring water systems to operating temperature. Recheck all vent points during this process and remove all air.
 8. After the system has been completely cleaned, test system by litmus paper or other dependable method and leave system on slightly alkaline side (ph 7.5 to 8.5). If system is still on acid side (ph 7.0 or lower), add water conditioner.

3.08 TESTING

- A. Test all installed equipment and systems and demonstrate proper operation. Correct and retest work found defective when tested.
- B. Thoroughly check piping system for leaks. Do not add any leak-stop compounds to the system. Make repairs to piping system with new materials. Peening, doping, or caulking of joints or holes is not acceptable.
- C. Conduct air or smoke test if in opinion of Designer reasonable cause exists to suspect leakage or low quality workmanship.
- D. Test HVAC systems water piping at a water pressure of 125 psig for two hours without leaks.
- E. Vibration Tests:
1. Test vibration isolation system in accordance with methods and procedures described in the Testing, Adjusting, and Balancing Chapter in the latest edition of ASHRAE Applications Handbook.
 2. Verify all vibration isolation systems are free floating and not short circuited by any connection between equipment and building structure.
 3. Operate mechanical systems and verify visually and audibly that there is no excessive vibration or noise generated by the system.

END OF SECTION 23 05 00

SECTION 23 05 13
ELECTRIC MOTORS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide and install electric motors for mechanical and plumbing equipment.

1.02 SUBMITTALS

- A. Submittal data is NOT required for products under this section as separate items. It is assumed they will be reviewed with appropriate equipment submittal.

PART 2 PRODUCTS

2.01 MOTORS

- A. Electric motors shall be new NEMA Standard, sized and designed to operate at full load and full speed continuously without causing noise, vibration, and temperature rise in excess of their rating.
- B. Motors on belt driven equipment shall have slide rails with adjusting screws for belt tension adjustment. Motors exposed to the weather shall be weather protected.
- C. Premium efficiency electric motors shall be provided for all motors 1 horsepower and greater. Any motor used with a variable speed motor controller shall be premium efficiency type and VFD compatible.
- D. Inverter-duty motor design shall include:
1. Spike-proof inverter motor such that voltage spikes will not damage motor insulation.
 2. No distance restrictions between any inverter and motor - no carrier frequency limitations.
 3. Motor design shall not require inverter power conditioning equipment to protect motor. Grounding rings on driven end of shaft are required on all motors with VFDs.
 4. Motor must meet NEMA MG-1, Part 31, part H.
 5. Provide inverter-duty motors with a 5-year warranty.
- E. Acceptable Manufacturers: MagneTek/ Century, Lincoln, Marathon, Gould, Toshiba, Baldor, Reliance, US Motors, General Electric.
- F. Premium efficiency motors shall have efficiency and losses determined in accordance with the latest revisions of IEEE Standard 112. Polyphase squirrel-cage motors rated 1 through 125 horsepower shall be tested by dynamometer method B. The efficiency shall be determined using segregated losses in which stray load loss is obtained from a linear regression analysis to reduce the effect of random errors in the test measurements. Guaranteed minimum full load efficiency shall be as follows:

MINIMUM NOMINAL FULL-LOAD EFFICIENCY (%)		
	Open Motors	Enclosed Motors
Number of Poles	4	4
Synchronous Speed (RPM)	1750	1750
Motor Horsepower		
3	89.5	89.5
5	89.5	89.5
7.5	91.0	91.7
10	91.7	91.7
15	93.0	92.4
20	93.0	93.0
25	93.6	93.6
30	94.1	93.6
40 – 75	94.1	94.1
100 above	95.4	95.4

MINIMUM NOMINAL FULL-LOAD EFFICIENCY (%)		
	Open Motors	Enclosed Motors
Refer to Latest Edition of ASHRAE 90.1 for other motor rpm and efficiencies.		

- G. Motor sound power levels shall not be greater than recommended in NEMA M61-12.49.
- H. Motors shall be provided with drive shafts long enough to extend completely through belt sheaves.
- I. Motor characteristics shall be as follows:
 - 1. 120V/1/60 Hz: Capacitor start, open drip-proof type, ball bearing, rated 40 degrees C. continuous rise.
 - 2. 460V/3/60 Hz: NEMA Design B, normal starting torque, single speed, squirrel cage type, open drip-proof, rated 40 degrees C. continuous rise, with ball bearings rated for B-10 life of 100,000 hours and fitted with grease fittings and relief ports. Provide motors with aluminum end brackets with steel inserts in bearing cavities.
- J. Provide grounding rings on all motors equipped with a VFD.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Arrange and set motors.
- B. Line up motors on direct drive equipment using dial type gauges.
- C. Electrical Contractor to make connections and test motor for proper rotation/phasing.

3.02 ADJUSTMENTS

- A. All motors together with driven equipment shall be statically and dynamically balanced by equipment supplier, start-up representative, or this contractor using approved balancing equipment. Fan vibration should be limited to manufacturers' recommendations, but should not exceed 2 mils in any case.

END OF SECTION 23 05 13

SECTION 23 05 48
VIBRATION ISOLATION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Isolate equipment as shown on drawings and specified herein with factory-fabricated vibration isolators in accordance with recommendations in the latest edition of ASHRAE Applications Handbook. Provide isolators of proper sizes and weight loading to meet the requirements.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Mason Industries, Kinetics Noise Control, Vibration Eliminator Co., Vibration Mountings & Control, Inc., Korfund Co., Amber Booth, Vibro-Acoustics, or Hyspan. Provide isolators by a single manufacturer.

2.02 FLOOR MOUNTED SPRING ISOLATORS

- A. Provide Kinetics Model FLS freestanding isolators for:
 - 1. Clinical vacuum pumps if not provided by equipment manufacturer as part of a packaged system (minimum 2" deflection).

2.03 FIBERGLASS OR NEOPRENE PADS

- A. Provide Kinetics Model KIP for:
 - 1. Hot water pumps.

2.04 SPRING AND RUBBER ISOLATION HANGERS

- A. Provide Kinetics Model SFH or SRH for:
 - 1. Suspended square in-line centrifugal fans (minimum 1.0" deflection).
 - 2. Horizontal fan coil units (minimum 1.0" deflection).

2.05 FLEXIBLE PIPE CONNECTORS

- A. Provide Metraflex or approved substitute twin-sphere flexible rubber pipe connectors with female unions or floating flanges on piping connections to equipment subject to vibration.
- B. Provide connectors rated for 150 PSI working pressure.
- C. Provide flexible pipe connectors for the following:
 - 1. Water connections to pumps.
 - 2. Vacuum connections to vacuum pump.

2.06 SPRING VIBRATION ISOLATION ROOF CURBS

- A. Support all rooftop air handling units with spring vibration isolation roof curbs, Kinetics Model KSCR, Mason Model RSC or approved substitute. The isolation curbs shall be complete assemblies designed to resiliently support the equipment at the proper elevation and shall provide a fully enclosed, air- and weathertight system.
- B. The isolation curb shall consist of an upper support frame on which the equipment rests and a lower support assembly which is attached to the roof structure separated by freestanding unhoused laterally stable steel springs.
- C. The lower support assembly shall incorporate means of attachment to the building as well as a continuous 2" x 2" wood nailer for attachment of the roofing material. The lower support assembly shall also contain provisions for supporting rigid insulation board.
- D. Select spring isolators to provide minimum 2" operating static deflection. Space spring isolators a maximum of 96" O.C. Provide a neoprene pad under springs.
- E. Design springs with lateral stiffness greater than one times the rated vertical stiffness and minimum 50 percent overload capacity.
- F. Include an adjustment bolt to permit leveling of the equipment after installation. Each spring isolator shall be fully accessible for adjustment without interfering with the integrity of the roof.

- G. Provide isolation curb with vertical and lateral restraints as required in order to withstand the project specific wind loads as indicated on the structural drawings. Provide signed and sealed installation details for attachment to structure as part of the equipment submittal to document compliance.
- H. The isolation curb shall be air and weathertight using an elastomeric boot which is attached to the upper support frame, extends down past the wood nailer of the lower support assembly, and is counterflashed over the roof materials. Provide sloped to drain cap below any portions of the unit that are not weather tight.
- I. Provide isolation curb with cross bracing on the upper and lower assemblies as required to assure stability.

2.07 SPRING VIBRATION ISOLATION ROOF CURB RAILS

- A. Support all roof mounted HVAC units with spring vibration isolation roof curb rails, Kinetics Model KSR, Mason Model CMAB or approved substitute. The isolation curb rails shall be complete assemblies and provide a fully enclosed, air and weathertight system. Coordinate locations with all trades to prevent interruption of roof drainage layout and function.
- B. Isolation curb rails shall consist of extruded aluminum or roll-formed steel top and bottom members connected with spring isolators. Provide continuous air and water seal for the entire rail perimeter. Select and space spring isolators according to weight distribution of the supported equipment.
- C. Provide means for attachment to the roof curb and the supported equipment. Provide additional stiffening members as required to assure stability. Provide vertical and lateral restraints as required in order to withstand the project specific wind loads as indicated on the structural drawings. Provide signed and sealed installation details for attachment to structure as part of the equipment submittal to document compliance.
- D. Select spring isolators to provide minimum 1" operating static deflection. Spring components shall be freestanding, unhooused, laterally stable steel springs. Design springs with lateral stiffness greater than 0.8 times the rated vertical stiffness and minimum 50 percent overload capacity.

2.08 OUTDOOR APPLICATIONS:

- A. All isolators located outside exposed to weather shall be corrosion resistant construction with hot dip galvanizing or PVC coating.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install vibration isolation in accordance with the isolator and equipment manufacturer's published installation instructions.
- B. Size vibration isolation in accordance with weight distribution, pull or the imposed torque of actual equipment provided.
- C. Set anchor bolts when concrete is placed. Install vibration isolation roof curb [**vibration isolation roof curb rails**] in accordance with manufacturers' published installation instructions to provide an air and watertight seal.

END OF SECTION 23 05 48

SECTION 23 05 49
BASIC MATERIALS AND METHODS FOR HVAC

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Work required under this section of the specifications consists of basic materials and methods applicable to work under Division 23.

PART 2 PRODUCTS

2.01 V-BELT DRIVES

- A. Provide all fan drives with V-belts rated for 150% of nameplate motor horsepower. Provide adjustable pitch motor sheaves for motor sizes through 20 hp. For motor sizes 25 hp and larger provide fixed pitch motor sheaves after balancing to within plus 5% of design air quantity. Select motor sheaves so centerline does not extend past end of motor shaft and such that motor bearing grease fitting and relief port is not obstructed.
- B. Provide belt guards for all belt driven equipment. Provide expanded metal cover with access to driven shaft for tachometer.

2.02 FOUNDATIONS AND PADS

- A. Provide foundations, pads, and bases required for equipment. Concrete to be in accordance with concrete division of specifications.
- B. Coordinate proper sizes and locations of foundations, pads, bases, louvers, anchors, supports, and other items to be built into structure. Housekeeping pads for all air handling units to be tall enough to allow for proper p-trap installation.

2.03 FASTENINGS TO STRUCTURES

- A. Provide structural fastening devices for equipment, materials, piping and ductwork. Devices to be concrete inserts, expansion shields and lag bolts, and through bolts-washers-nuts. All bolted devices to use jamb nuts. Inserts to be continuous type as manufactured by Unistrut or approved substitute. Install per manufacturer's published installation instructions in lengths to suit specific application, complete with spring nuts, end caps, and plastic coated filler to prevent concrete seepage.
- B. Use of power drive "shot-pins" is permitted only for ducts 20" in width and smaller and single pipes 1" and smaller.

2.04 ACCESS PANELS

- A. Wall and ceiling access panels to be provided by Division 01. Coordinate locations so panels will provide proper access to equipment served. Minimum size: 24" x 24".

2.05 ROOF CURBS

- A. Provide prefabricated metal roof curbs at all roof ductwork and piping penetrations and for support of all roof-mounted equipment, fans and ductwork. Construct curbs according to National Roof Contractor's Association guidelines. Prefabricated metal roof curbs shall be manufactured by ThyCurb, Custom Curb, or approved substitute.
- B. Construct curbs with minimum 18 gauge galvanized steel (14 gauge for curbs with any side longer than 4'-0" and for all curbs supporting equipment) with fully mitered and welded corners, raised 3" integral cant for roof deck insulation, integral base plate, internal reinforcing with 1" x 1" x 1/8" steel angle for curbs with any side longer than 3'-0", factory installed 1-1/2" thick, 3-pound density fiberglass insulation and factory installed pressure treated wood nailer. Minimum height of curb shall be 12" above finished roof surface. (Consult architectural plans for roof type and thickness.) Curbs for kitchen hood exhaust fan shall be height necessary to provide 40" minimum height from finished roof surface to fan discharge. Construct curbs to match slope of roof and provide a level top surface for mounting of mechanical equipment.
- C. Curb types shall be as follows:

1. Fan and duct penetration curbs with standard curb construction as described above - ThyCurb Model TC.
 2. Equipment piping and ductwork support curbs with minimum 18 gauge galvanized steel shell, base plate and counterflashing, wood nailer, and internal bulkhead reinforcement - ThyCurb Model TEMS.
 3. Pipe penetration curbs with standard curb construction as described above and insulated metal piping cover - ThyCurb Model TC with Model TP-2 piping cover.
- D. Install curbs in strict accordance with manufacturer's published installation instructions and as detailed on the drawings. Coordinate proper curb size, construction, and base prior to fabrication.

PART 3 EXECUTION - NOT APPLICABLE

END OF SECTION 23 05 49

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Perform test and balance work by a Test and Balance Agency which is engaged solely in full time test and balance work, is a member of the Associated Air Balance Control (AABC) or approved equal, and is selected and employed by the General Contractor.
- B. Perform test and balance in accordance with AABC Standards.
- C. Contract to the Test and Balance Agency shall be issued by the General Contractor. Coordination with the agency at the job site shall be the responsibility of the contractor in order to ensure proper scheduling and operation of the systems. All correspondence (reports, letters and communications) between any parties shall have copies sent directly to the designer and contractor.
- D. The TAB agency shall review construction plans and specifications. If any discrepancies are noted which would hinder balancing, notify the designer with copy to the contractor. Make inspections of the job during construction for proper installation of the system(s) and of balancing aids in the system(s). Any discrepancies noted shall be brought to the attention of the contractor and designer. The number of inspections vary with the size and complexity of the job and shall be adequate for the purpose intended. Report ALL job visits in writing -MANDATORY.
- E. The TAB agency shall work in close coordination with the contractor in calibrating all airflow and water flow stations and all duct and pipe mounted differential pressure sensor / transmitters. The tests shall be documented and included in the final TAB report.
- F. The Owner has hired an independent Cx agent to commission the mechanical and controls systems serving this facility. The TAB agency should refer to Specification 019113 General Commissioning Requirements, in order to be apprised of, and become familiar with his responsibilities and accountabilities throughout the Cx process.

1.02 RESPONSIBILITIES OF PROJECT CONTRACTOR

- A. The contractor shall:
 - 1. Provide approved Test and Balance Agency with copy of plans and specifications upon issue of construction documents.
 - 2. Have the building and HVAC systems in operational readiness for TAB work to begin.
 - 3. Correct prompt deficiencies of materials and workmanship identified as delaying completion of TAB work.
 - 4. Be responsible for any added costs to the owner resulting from his failure to have the building and HVAC systems ready or from his failure to correct deficiencies promptly.
- B. Complete operational readiness of the building requires that construction status of the building shall permit closing of doors, windows, ceilings installed, etc., to obtain projected operating conditions.
- C. Complete operational readiness of the air conditioning systems requires that the following be accomplished:
 - 1. Air Distribution Systems:
 - a. Verify installation conforms to design. All supply, return and exhaust ducts terminated and pressure tested for leakage as required by specifications.
 - b. All volume, control, fire and smoke dampers properly located and functional. All dampers shall be fully open. MVD gradients and spin damper handles should be exposed through insulation. Dampers serving requirements of minimum and maximum outside, return and relief air shall provide tight closure and full opening, smooth and free operation.
 - c. All supply, return, exhaust and transfer grilles, registers, diffusers, terminal boxes and filters installed.

- d. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., shall be sealed to eliminate bypass or leakage of air.
 - e. All fans operating at full load and verified for freedom from vibration, proper fan rotation and belt tension; heater elements in motor starters to be of proper size and rating. Check motor amperage and verify that it is under nameplate rating.
 - 2. Water Circulating Systems:
 - a. Check and verify pump alignment and rotation. Verify location of thermometers, gages, and PT test plugs.
 - b. Open all valves to full open position. Close bypass stop valves. Set mixing valves to full flow through system components. Remove and clean all strainers. Verify specified pipe cleaning has taken place. Repeat operation until circulating water is clean.
 - c. Record pump motor amperage on each phase and voltage after reaching rated speed. Readings shall not exceed nameplate rating. Verify heater elements in motor starters to be of proper size and rating.
 - d. All water circulating systems shall be full and free of air; expansion tanks set for proper water level; all air vents installed at high points of systems and operating freely. System static pressure to be set minimum 5 psig above highest system elevation.
 - e. Check and set operating temperatures of heat exchangers to design requirements.
 - f. Verify that piping to coils is complete and set for counter flow. Verify location of thermometers, gauges, PT test plugs, and flow balancing/measuring valves.
 - 3. Automatic Controls:
 - a. Verify that all control components are installed and functional in accordance with project requirements, including all electrical interlocks, damper sequences, temperature resets, and safeties.
 - b. Verify that pressure controllers are calibrated and control variable speed motor controllers as required to maintain a stable pressure.
 - c. All controlling instruments calibrated and set for designed operating conditions.
 - 4. Notification of System Readiness: After completion of the work above, the contractor shall notify the TAB firm and designer certifying that the work has been accomplished and that the building and HVAC systems are in readiness for testing, adjusting, and balancing.
- D. As part of this project contract, the contractor shall make any changes in the sheaves, belts and dampers required for correct balance as required by the TAB firm.
 - E. The contractor shall provide and coordinate services of qualified, responsible contractors, suppliers and personnel as required to correct, repair, or replace any and all deficient items or conditions found during the testing, adjusting and balancing period.
 - F. In order that all systems may be properly tested, balanced, and adjusted, the contractor shall operate systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB.
 - G. Project schedules shall provide sufficient time to permit the completion of TAB services prior to owner occupancy.
 - H. The plans and specifications have indicated valves, dampers and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the contractor shall provide access as requested by the TAB firm. Also, any malfunction encountered by TAB personnel shall be reported to the contractor and designer and corrected by the contractor immediately so the balancing work can proceed.
 - I. The TAB fieldwork shall not begin on any system / equipment item until signed prefunctional, startup checklists, pertaining to applicable equipment, have been submitted by the installing contractor to the Cx team.

1.03 QUALIFICATIONS OF THE TAB CONTRACTOR

- A. The firm shall submit six (6) completed projects of like size and scope. Provide references for each project.
- B. The test and balance firm shall submit a resume for the individual proposed to directly supervise the project. The supervisory personnel for the test and balance firm shall be certified test and balance engineers. All project managers and technicians shall be permanent, full-time employees of the agency.
- C. The test and balance firm shall submit a list of its calibrated instrumentation to perform the work.

1.04 DOCUMENTS

- A. The contractor shall furnish to the TAB firm the following:
 - 1. One set of mechanical specifications.
 - 2. Three sets of mechanical drawings.
 - 3. All pertinent addenda and change orders.
 - 4. One set of control submittal drawings.
 - 5. Approved submittal data on equipment installed, and related changes as required to accomplish the TAB test procedures outlined below.

PART 2 PRODUCTS - NOT APPLICABLE

PART 3 EXECUTION

3.01 RESPONSIBILITIES OF THE TAB FIRM

- A. The TAB personnel shall check, adjust, and balance the components of the HVAC system which will result in minimum noise, specified temperature, and air flow conditions in the conditioned spaces of the building while the equipment of the system is operating economically. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents.
- B. GC to engage TAB at the start of the project if there are existing airside or hydronic systems affected and an existing TAB report is required. GC should set up a meeting with design team to define the overall scope of existing TAB to be performed before any new tie in or demolition.
- C. TAB contractor is responsible for meeting requirements in Cx Specification 019113.

3.02 LIAISON AND EARLY INSPECTION

- A. The personnel on the job shall act as liaison between the owner, designer and contractor. They shall inspect the installation of piping systems, ductwork systems, control systems, and other component parts of the HVAC systems during the construction stage to verify proper arrangement and adequate provisions for the testing and balancing.
- B. During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the contractor shall be advised in writing so that the condition can be corrected by the contractor. The TAB firm shall suggest solutions to noted problems. Data from malfunctioning equipment shall not be recorded in the final TAB report.

3.03 THE TAB REPORT

- A. TAB activities shall culminate in a report to be provided in triplicate to the designer. The intent of the final report is to provide a reference of actual operating conditions for the owner's operating personnel.
- B. All measurements and recorded readings (of air, water, electricity, sound, etc.) that appear in the reports must be done on-site by permanently employed technicians or engineers of the firm.
- C. All comment sheets (punch lists) shall be signed by the contractor to acknowledge receipt. Any outstanding items at the time of completion shall be included in the report.
- D. The report shall be certified and approved by the firm's test and balance engineer. The report shall be recorded on standard forms.

3.04 ACTUAL TESTING AND BALANCING PROCEDURES

A. Airside:

1. Supply Fan:
 - a. Fans checked for rotation, amperage, static pressure, etc.
 - b. Terminal boxes set to maximum cfm and adjust supply fan to within 0% to +10% of design cfm.
 - c. Main supply duct pitot tube traverse and adjustment of fan speed to produce design cfm while maintaining minimum system static pressure for proper terminal box operation.
 - d. The report shall record the VFD speed for the supply fan.
2. Outside Air:
 - a. Fans checked for rotation, amperage, static pressure, etc.
 - b. With supply system in the maximum and minimum mode, traverse return duct and adjust minimum outside air damper to design cfm.
 - c. Documents down the building as net zero pressure for AHJ compliance, but building is to be balanced to positive pressure by increasing balanced exhaust fan total CFM+10% for OA minimum. Record required minimum damper position.
3. Exhaust Fan:
 - a. Fans checked for rotation, amperage, static pressure, etc.
 - b. With supply system in the maximum mode, traverse and adjust exhaust fan to within +/- 10% of design cfm.
 - c. Confirmed exhaust fan operation with building static pressure sensor. Fan to only turn on when building static pressure sensor. Fan to only turn on when building static pressure is above +0.07" and modulate to maintain +0.04" positive pressure. Fan to be off at building pressure of +0.03" and below.
4. Diffusers, Registers, and Grilles:
 - a. Balance each supply air outlet to within 0% to 10% of design cfm.
 - b. Balance each return air outlet to within +/- 10% of design cfm.
 - c. Balance each exhaust air outlet to within 0% to -10% of design cfm.
 - d. Check and/or adjust pressure relationships so that each positive pressure and each negative pressure area is at least 10% positive or negative as appropriate.
5. After completion, take total air-handling system static profile and record all final statics, amperages, rpm, cfm, etc.
6. The TAB contractor shall compare the sum of the CAV/VAV box diffuser readings with the flow indicated by the box controller prior to calibrating the box controller. If the two readings agree within $\pm 5\%$, the factory calibration factors shall not be changed. If the readings are not within $\pm 5\%$, a documented trouble-shooting procedure consisting of checking and resolving the following shall be conducted prior to calibrating the controller to verify:
 - a. Box size is per the approved submittal
 - b. Manufacturer gain/flow factor has been correctly entered into the controller
 - c. Low pressure duct/connections are tight
 - d. Velocity pressure connections at the box inlet and controller are tight and undamaged
 - e. Static pressure at the box inlet exceeds the minimum required
 - f. Box flow measuring device is undamaged.
7. This procedure and results for carrying out steps 1 – 7 above are to be retained by the Mechanical Contractor for delivery to the Owner/Design Engineer on request.
8. After completion, take total air handling system static profile and record all final statics, amperages, RPM, airflow, etc.
9. Measure and include in the report AHU supply and return fan flow, RPM, HP, and sensed duct static pressure at the dirty differential pressure drop across both the pre-filter and final filter.
10. Measure system performance with the pressure drop across filters at the value specified for dirty filters.

- B. Waterside:
1. Hot Water:
 - a. Check system for cleanliness.
 - b. With all hot water coils (including terminal box reheat coils) calling for full heating, test, set and record pump head and flow.
 - c. Test, set and record pressure drop and flow through each boiler to within 0% to 5% of design.
 - d. Test, set and record pressure drop and flow through each flow balancing station.
 - e. Test, set and record pressure drop and flow through each heating coil to within 0% to 5% of design.
 - f. Verify that piping system is vented.
 - g. Verify removal of pump start-up strainer and replacement with operating strainer.
 2. Domestic Hot Water Recirculation System:
 - a. Balance recirculation pumps $\pm 5\%$ of design gpm flow.
 - b. Set balancing valves to gpm settings as noted on plumbing drawings.
 - c. Ensure domestic water balance is completed prior to sanitization or ultra-sonic testing is to be used.
- C. Controls:
1. AHU Controls:
 - a. Check temperature controls for proper calibration and setpoint.
 - b. Check economizer controls for proper damper operation and control calibration.
 - c. Check exhaust fan economizer system under maximum and minimum conditions for proper operation and confirm positive building pressure throughout operation with calibrated building differential pressure sensor.
 - d. Check static pressure control under maximum and minimum conditions for proper operation.
 - e. Record the following: The supply duct static pressure reading, VFD Hz, and fan rpm when the AHU supply fan is meeting the design airflow of all terminal units simultaneously. Also record the supply static pressure set point established and transmitted to the controls subcontractor.
 2. Thermostats and Controllers:
 - a. Check for proper control of valves, dampers, terminal boxes, exhaust fans, etc.
 - b. Set at design set point.
 - c. Verify calibration of thermostats.
- D. Hydronics in Control Verification:
1. Record the following: The hydronic system pressure setpoint, VFD Hz, and pump RPM when the system is meeting the design water flow of all associated coils simultaneously. Also record the operating system pressure established and transmitted to the controls contractor.
- E. Capacity and Performance Test:
1. Cooling Coils:
 - a. Test, set and record pressure drop and flow through each coil.
 - b. Measure entering and leaving dry and wet bulb air temperatures with glass stem, mercury thermometers accurate to 1/2 degrees F.
 - c. Measure entering and leaving water temperature with glass stem, mercury thermometer if thermometer wells are provided. If P.T. plugs are provided, use a bi-metal thermometer which reads in 1 degree F. increments and use the same thermometer for both supply and return water temperature measurements.
 - d. Record final temperatures, BTU/HR. and GPM.
 - e. Convert actual test conditions to design conditions to insure design coil capacities at design temperatures.
 2. Terminal Box Heating Coils: Test, set and record flow through hot water branch main balancing valves or individual terminal box heating coil. HCA standard is that heating coils

- on VAV boxes are not provided with individual balancing valves. The contractor shall review the drawings to determine the number of balancing valves on the project.
3. Thermostat Calibration:
 - a. Measure and record dry and wet bulb temperatures at each thermostat.
 - b. Report any thermostat which is not controlling with $\pm 1\frac{1}{2}$ degree F.
 4. Control Temperature Readouts:
 - a. Test actual temperature next to sensor (if possible) and compare to readout.
 - b. Report any sensor which is not within $\pm 1\frac{1}{2}$ degrees F.
- F. Noise Level:
1. The TAB Contractor shall measure the HVAC background noise level in all the spaces as follows:
 - a. The sound level shall be measured at the patient head location in patient sleeping and therapy rooms.
 - b. In all other rooms the sound level is to be measured at the approximate center of the room 48" above floor level.
 - c. The TAB report shall document the measure NC level for each space.
 - d. The TAB report shall also include an NC curve for any space that exceeds the specified NC limit.
 - e. HVAC system produced noise shall not exceed the requirements in the FGI Guidelines.
 - f. The only exception is that operating rooms and C-Section rooms shall not exceed NC 42.
- G. The General Contractor and the Mechanical Contractor shall be responsible for reviewing the NC curve for spaces which exceed the required levels and make appropriate adjustments to the system to bring the NC level into range. The final TAB report shall document all spaces with appropriate NC levels.

3.05 REPORTS

- A. Problems Encountered: Any items not installed, improperly installed or not functioning properly shall be reported to the contractor.
- B. Final Report:
 1. Any unresolved problems shall be reported in a general remarks section in front of the test and balance report.
 2. Any unusual operations or pertinent remarks which may aid the maintenance personnel or ease the reading of the report shall be made in the general remarks section of the report.
 3. All operating data and final tests shall be reported in the final report. This data shall include, but not necessarily be limited to the scope of work outlined above.
 4. TAB contractor shall compile an Excel spreadsheet for all terminal boxes, listing each box by its unique identification number, the inlet flow area established by the box manufacturer, the manufacturer's gain factor for the box, final TAB calibrated gain factor for the box if field calibrated, and the ratio of the calibrated gain factor to the manufacturer's gain factor.
 5. Report shall include building and space pressure relationships in all modes of operation. Critical space pressures that include pressure monitors shall be provided in the report as well as air change rates.

3.06 CALLBACK

- A. Test and Balance Agency shall retest any unresolved problems noted in the final report. The revised results shall be forwarded after completion of test.
- B. At the discretion of the designer before final acceptance of the TAB report, the report data shall be verified one time on the job site by selection of random check points in the presence of the designer. Representatives of the testing firm shall be present and provide the necessary equipment for test data verifications.
- C. The firm shall be responsible for testing, adjusting, balancing, and reporting on the performance of all fans, dampers, air distribution devices, pumps and heat exchangers, the flow through all coils, pumps and heat exchangers, and the power consumption of all motors. The contractors

and the suppliers of the equipment installed shall cooperate with the balancing agency to provide all necessary data on the design and proper application of the system components and shall furnish all labor and material required to eliminate any deficiency.

- D. Make one (1) inspection within ninety (90) days after occupancy of the building to ensure that satisfactory conditions are being maintained.

3.07 OPPOSED SEASON TESTING

- A. This service allows for testing of equipment that, due to extreme weather conditions, cannot be accurately tested at the time of the initial balance. If a project is balanced during the summer, the opposed season testing is performed during the winter months and vice-versa.
- B. During the opposed season testing, any necessary modifications to the initial adjustment required to produce optimum operation of the system components shall be made to produce the proper seasonal conditions in each conditioned space. At the time of opposite season testing, the designer and owner shall be given timely notification before any readings or adjustments are made so that he may participate.

END OF SECTION 23 05 93

SECTION 23 07 10
INSULATION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Contractor shall provide all necessary labor, materials, tools, and equipment to perform work required on the drawings and specified herein.
- B. Certain equipment and/or systems to be factory insulated by manufacturer. Factory insulation materials to be as specified in applicable sections of the specifications.
- C. All pipe fittings, valves, and strainers in insulated pipe systems to be insulated.
- D. Thermal resistance "R" values used herein are expressed in units of "Hour, Degrees F., Sq. Ft./BTU per Inch of Thickness" on a flat surface at a mean temperature of 75 degrees F.

1.02 DEFINITIONS

- A. "Exposed" equipment, ducts, and piping are areas which will be visible without removing ceilings or opening access panels.
- B. Outdoors is considered exposed to the weather.
- C. Underground is buried, whereas in a trench below grade is considered concealed.

1.03 CERTIFICATION/QUALITY ASSURANCE

- A. Products shall meet applicable national, state, and local building codes and be U.L. (or other recognized testing lab) listed for intended service.
- B. All insulations, jackets, adhesives, coatings, sealers, and tapes shall have a flame spread rating of 25 or less and smoke development rating of 50 or less when tested in accordance with ASTM E-84, NFPA 225, U.L. 723, and further must meet the requirements of NFPA 90-A and applicable building, plumbing, and mechanical codes.
- C. All insulation materials shall be delivered and stored in manufacturers' containers and kept free from dirt, water, chemical, and mechanical damage. Under no circumstances shall insulation applied to exterior ductwork be allowed to get wet prior to final material covering.
- D. Insulation shall be applied in a workmanlike manner by experienced, qualified tradesmen.
- E. Insulation shall not be applied until all pressure testing has been completed, inspected, and released for insulation application.
- F. Surfaces shall be clean and dry.
- G. Insulation joints shall be butted firmly together and all jackets and tapes shall be smoothly and securely installed.
- H. Insulation for duct, pipe, and equipment for above grade exposed to weather outside building shall be certified as being self-extinguishing for 1" thickness in less than 53 seconds when tested in accordance with ASTM D-1692.

1.04 APPLICABLE CODES AND STANDARDS

- A. ASTM E-84.
- B. U.L. 723.
- C. NFPA 90-A.
- D. ASHRAE 90.1
- E. Florida Energy Conservation Code.

PART 2 PRODUCTS

2.01 MATERIALS FOR PIPE AND EQUIPMENT

- A. Materials for Pipe and Equipment: Provide factory pre-molded or shop or site mitered segment type insulation for pipe, pipe fittings, and valves. Fitting insulation to be of same thickness and

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Hospital

HCA #3090900030

Insulation

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material as adjoining pipe insulation. All insulation and related materials such as tape and mastic to meet applicable building code requirements for fire and smoke development.

1. Cellular Glass (Foamglass): Pittsburgh Corning "Foamglass." Product must be guaranteed by manufacturer to have a continuous operational temperature limit of 250 degrees F. and a minimum "R" value of 3.7 per inch ($K=0.27$) at 75 degrees F mean temperature. Vapor-barrier mastic for application to below ambient pipe insulation shall be fungus resistant per ASTM D 5590 with 0 growth rating; Water based; Permeance per ASTM E 96, Procedure B, 0.013 perm or less at 43-mil dry film thickness suitable for indoor and jacketed outdoor use. Products: Foster 30-80 AF. Color: White. Fittings on foam glass insulation shall be made up of mitered sections of foam glass. For all butt joints, a pliable insulation joint sealant shall be used. Products: Foster 95-50 or Childers CP-76. Use foamglass for the following services:
 - a. Where hanger saddles are installed instead of other piping insulation (fiberglass, flexible tubular) to prevent crushing of insulation at hangers.
2. Flexible Tubular: Provide 25/50 rated, closed-cell, flexible tubular rubber type pipe insulation. Product to have continuous operational temperature limit of 200 degrees F. and a minimum "R" value of 3.7 per inch ($K=0.27$) at 75 degrees F mean temperature. Product to be Armstrong AP Armaflex or approved equal pipe insulation. Use flexible tubular for the following services:
 - a. Moisture condensate drains: 1" thick.
 - b. Refrigerant suction lines for split systems: 1" thick.
 - c. Provide multiple layers as required to obtain minimum thickness.
3. Fiberglass: Provide factory-formed, factory-jacketed fiberglass piping insulation. Product to be Manville "Micro-Lok 650" with "Type AP-T" jacketing or equivalent product manufactured by CertainTeed, Knauf, or Owens-Corning. Product to have continuous operational temperature limit of 850 degrees F and a minimum "R" value of 3.5 per inch thickness ($K=0.28$) at 75 degrees F mean temperature. Jacket to be fiberglass reinforced kraft paper with aluminum foil and pressure sensitive closure system. Vapor-barrier mastic for application to **below** ambient pipe insulation shall be fungus resistant per ASTM D 5590 with 0 growth rating; Water based; Permeance per ASTM E 96, Procedure B, 0.013 perm or less at 43-mil dry film thickness suitable for indoor and jacketed outdoor use. Products: Foster 30-80 AF. Color: White. A breather mastic for application to above ambient pipe insulation (fittings, tees, valves, etc) shall be water based Foster 46-50 mastic or Childers CP-10 / CP-11. Use fiberglass piping insulation for the following services:
 - a. Heating hot water piping: below 1-5/8" – 1-1/2" thick; 1-5/8" and greater - 2" thick.
 - b. Vents from condensate receiver tank, flash tank, and pressure reducing station relief valve where exposed in building: 1" thick.

2.02 MATERIALS FOR DUCTS

- A. Blanket Type Duct Insulation: Provide minimum 3/4 pound per cubic foot density, flexible blanket fiberglass duct insulation with FSKL aluminum foil vapor barrier facing and 2" tab. Insulation shall have minimum 'R' value of 3.4 per inch ($K=0.29$) at 75 degrees F mean temperature. Product to be Manville "Microlite" or equivalent standard duct wrap by CertainTeed, Knauf, or Owens-Corning. Use blanket type duct insulation for the following:
 1. Unlined heating and/or cooling supply air and return air ductwork concealed from view: 2" thick.
- B. Board Type Duct Insulation: Provide minimum 3 pound per cubic foot density, semi-rigid fiberglass duct insulation with FSKL aluminum foil vapor barrier facing. Insulation shall have a minimum 'R' value of 3.8 per inch ($K=0.26$) at 75 degrees F mean temperature. Product to be Manville "800 series Spin-Glas" or equivalent by CertainTeed, Knauf, or Owens-Corning. Use board type duct insulation for the following services:
 1. Unlined exposed heating and/or cooling supply air and return air ducts: 1-1/2" thick.

2.03 MATERIALS FOR FITTINGS, VALVES, AND SPECIAL COVERINGS

- A. Provide coverings and finishes for specific items hereinafter specified.

1. Use pre-molded insulation fabricated by the manufacturer of insulation material or shop or site mitered segment type insulation for: All pipe fittings, elbows, tees, valves, and couplings. Fittings on fiberglass pipe insulation shall be mitered insulation for piping up to 2" diameter and molded fittings for pipe 2-1/2" diameter and larger.
 2. PVC fitting covers over blanket fiberglass are NOT acceptable.
- B. For heat exchangers, air separators, large pipes, etc., in systems operating over 60 degrees F., when exposed-to-view inside building or in equipment rooms, cover insulation with a smoothing coat of Keane Powerhouse cement, one layer of white colored glass mesh embedded and finished with Foster 46-50 mastic or Childers CP-10 / CP-11 mastic.
 - C. Fabricate and install readily removable insulation caps to facilitate service and maintenance accessibility to all strainers including suction diffusers in systems operating below 60 degrees F.
 - D. For any service when above grade exposed-to-the-weather outside building, cover straight pipe insulation with 0.016" thick aluminum jacket equivalent to ITW or RPR and cover valves and fittings with .024" thick aluminum factory formed covers equivalent to Childers Ell-Jacs.
 - E. For flexible tubular pipe and fitting insulation when exposed-to-view inside building finish with two coats of paint, custom color blended to match surrounding surfaces.
 - F. When specifically approved by designer, when it is impossible to completely insulate pipe, fittings, or valves with specified insulation, Armstrong Armaflex insulation tape may be used to prevent condensate drip on small piping. Use of cork insulation tape is prohibited.

PART 3 EXECUTION

3.01 GENERAL

- A. No insulation shall be cut where a hanger is located. If hangers have been installed by pipefitter tradesmen which violates this strict requirement, notify Designer immediately.
- B. Piping and ductwork systems shall be tested and found free of all leaks prior to installation of insulation covering.
- C. All surfaces shall be clean and dry when covering is applied. Covering to be dry when installed and during application of any finish, unless such finish specifically requires a wetted surface for application.
- D. All adhesives, cements, and mastics shall be compatible with materials applied and shall not attack materials in either wet or dry state.
- E. Install insulation using professional insulators who have adequate experience and ability.
- F. Exposed-to-view insulation shall have a well tailored appearance.
- G. See Section 23 21 13 and 23 22 13 for sleeves and insulation requirements.
- H. Stop all duct coverings, including jacket and insulation, at fire and smoke dampered penetrations of partitions. "Fan-Out" or extend jacketed insulation at least 2" beyond angle frames of dampers and secure insulation to partition. Maintain vapor barrier. Where insulated duct access door is not used, install covering over damper access panel so as to be readily removable and identifiable.
- I. Treat insulated pipe and duct surfaces in equipment rooms and where exposed to normal view, so surfaces may be painted with water base latex paint. Use of mastics, adhesives, or jacketing which cause "bleeding" is prohibited.

3.02 INSTALLATION OF DUCT COVERING

- A. Apply jacketed blanket type fiberglass covering to ducts pulled snug but not so tight as to compress corners more than 1/4". Use insulation having 2" tab, or cut insulation long enough to allow for "peel off" of insulation from jacket to effect a minimum overlap of 2". Secure 2" jacket laps using equivalent of Foster 85-75 or CP-82 adhesive and staple lap with flare type staples on 2" centers. Cover standing seams, stiffeners, and braces with same insulation blanket, using 2" jacket lap and staple lap as hereinbefore outlined. Cover and seal all staples with Foster 30/80 AF, fire resistant vapor barrier coating reinforced with glass cloth.

- B. For duct 24" or wider, mechanically fasten insulation to duct bottom, using weld pins or nylon "stick-clip" base plates having self-locking coated metal or nylon discs. Locate fasteners on not over 12" centers laterally and longitudinally. Seal pins as above.
- C. For ducts more than 20" deep, mechanically fasten insulation to duct sides, using one row of pins, plates, or discs located on not over 12" centers longitudinally and equidistant laterally between duct top and bottom. For ducts over 24" deep, apply fasteners as before only using minimum of two rows.
- D. Apply jacketed board type fiberglass covering to ducts using weld pins or nylon "stick-clip" base plates having self-locking coated metal or nylon discs. Locate fasteners on not over 12" centers laterally and longitudinally. If insulation is grooved to fit around corners, in order to eliminate as many joints as possible, pin as required to hold insulation tight to duct, especially on bottom of duct. Seal pins and joints with Foster 30-80 AF reinforced with glass mesh.
- E. Cover all joints, rips, tears, punctures, disc heads, staples, or breaks in vapor barrier jacket with 4" wide woven glass fabric tape embedded in Foster 30-80 AF fire resistant vapor barrier coating. PRESSURE SENSITIVE TAPE NOT ALLOWED.
- F. Ductwork manual volume damper (MVD) handles, airflow station pressure ports, access door handles, duct-mounted instrumentation, etc., shall be left exposed and/or accessible above the insulation vapor barrier.

3.03 INSTALLATION OF PIPE AND EQUIPMENT COVERING

- A. Where fiberglass or flexible tubular insulation is used on piping sized 2" and larger, insert a section of foamglass insulation at hanger or support points between pipe and metal shield for full length of shield to prevent crushing of insulation. Insulation thickness to be same as adjoining insulation. Where insulation passes through pipe hangers and across trapeze supports, 12" long metal saddles shall be used. On cold pipe, vapor barrier should be carried through the hanger and sealed.
- B. Apply flexible tubular insulation to pipe and fittings using the slip-on method with all joints tightly fitted and sealed with Armstrong 520, Foster 85-75, Childers CP-82 adhesive or approved equal. Seal butt joints, miter joints and torn or damaged insulation with adhesive.
- C. Prior to application of flexible sheet insulation, thoroughly clean all metal surfaces, making sure that all dirt, scale, loose paint, plaster, and oil have been removed and that surfaces are dry. If surface has been primed, test a 2 square foot section using adhesive equivalent to Armstrong No. 520, Foster 85-75, Childers CP-82 in order to determine whether solvent in adhesive will loosen or lift the primer. If primer is loosened, then remove it. When testing proves acceptable, adhere insulation with smooth side out, using thin but adequate coating of same adhesive. Follow manufacturers' instructions. Coat all butt edges of each sheet. Stagger all joints. Insulate all standing seams or flanges with same thickness of insulation material as that used on main surface.
- D. All hot water pump casings shall be insulated with readily removable insulation sections that allow easy access to all pump components, pressure gauges, P/T ports, etc., requiring testing or maintenance access.
- E. Piping insulation on in-line mounted P/T ports, circuit setting pressure ports, calibrated balancing valve pressure ports, etc., shall be made easily removable so that access to the ports can be readily obtained without destroying the insulation.

END OF SECTION 23 07 10

SECTION 23 09 23

DIRECT DIGITAL CONTROL/BUILDING AUTOMATION SYSTEM (DDC/BAS)

PART 1 GENERAL

1.01 DESCRIPTION

- A. Direct Digital Control/Building Automation Systems (DDC/BAS) shall be JCI. For pricing contact:
 - 1. Johnson Controls Metasys
Contact: Kevin P. Tolbert
507 E. Michigan St, M-30
Milwaukee, WI 53202
email: BE-HCA@jci.com
478-952-8740
- B. All new points are to be mapped back to and integrated with existing HCA Florida Westside Hospital, Plantation, FL. Provide software upgrade to accept new controllers and graphics updates if required to integrate project.
- C. The work specified under this section of the specifications includes furnishing, installing, programming, and placing into operation the DDC/BAS systems.
- D. The BAS/DDC shall use BACNet/IP protocol capable of communicating over an Ethernet system. It shall be capable of residing on the HCA Enterprise WAN/LAN by having an assigned IP address. BAS/DDC systems are required to permit a remote user with password access, monitor points and issue basic commands over the HCA WAN/LAN using a PC type terminal without the need for proprietary BAS/DDC software. The system front end shall reside on a server not a PC. The user interface is to be installed on an owner-furnished workstation. Controls Contractor to coordinate and verify with FacilitiGroup Automation Services Manager full BAS communication between facility and FacilitiGroup Automation Services. Provide a new laptop with BAS software to the facility when a new BAS is installed or there is a major upgrade to the system.
- E. The DDC/BAS systems shall be furnished and installed under this section of the specifications and shall consist of microprocessor based digital system controllers. The systems shall be complete in every respect, including all auxiliary and accessory items as required, and shall be thoroughly coordinated so as to provide a compatible and completely workable system.
- F. Provide a complete control system including electrical interlocks, wiring, conduit, relays, switches, control transformers, and other devices as required to accomplish automatic control of the mechanical systems. Refer to drawings for details.
- G. All systems shall be guaranteed against defects of any nature and to operate properly for a period of not less than 12 months after final acceptance of the job by the Owner. During this period, the BAS manufacturer shall service and adjust the systems as required for proper operation, replacing components as required.
- H. The contractor shall work in close cooperation with the TAB agency in calibrating all airflow and water flow stations and all duct and pipe mounted differential pressure sensor/transmitters.
- I. Commissioning of the mechanical and control systems is part of this project. The Cx procedures shall include Prefunctional Performance Testing and final Functional Performance Test. The contractor should refer to Specification Sections 01 9113, in order to be apprised of, and become familiar with his responsibilities and accountabilities throughout the Cx process.
- J. The controls contractor shall furnish the test and balance contractor with appropriate DDC system software available to assist in the TAB process. The contractor shall work in close cooperation with the TAB agency in calibrating all airflow and water flow stations and all duct and pipe mounted differential pressure sensor/transmitters. The controls contractor shall provide a technician for 8 hours to assist/train the TAB technician in the coordination/interface of the BAS with TAB activities.

1.02 SUBMITTALS

- A. Submit complete shop drawings, equipment and component brochures, list of control valve CV and pressure drops, list of control dampers, written sequences of operations, diagrams indicating panels, gauges, components, spring ranges, and setpoints, and complete composite wiring diagrams indicating all equipment interlocks for entire control system.
- B. At the time of submission to architect/engineer, the contractor shall submit an information only copy of the complete BAS/DDC submittal to HCA Engineering, HCA Healthcare Building 3, 2545 Park Plaza, Nashville, TN 37203.

PART 2 PRODUCTS

2.01 GENERAL PRODUCT DESCRIPTION

- A. The building automation system shall consist of the following:
 - 1. Stand-alone DDC panels.
 - 2. Stand-alone application specific controllers (ASCs).
 - 3. Portable laptop PC operator terminal.
 - 4. DDC panel-mounted operator terminal.
- B. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, stand-alone DDC panels, and operator devices.
- C. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- D. Stand-alone DDC panels shall be able to access any data from or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device. Stand-alone DDC panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.

2.02 NETWORKING/COMMUNICATIONS

- A. The design of the BAS shall network operator workstations and stand-alone DDC panels.
- B. Local Area Network:
 - 1. Workstation/DDC Panel Support: Operator workstations and DDC panels shall directly reside on a local area network such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstations on a peer-to-peer basis.
 - 2. Dynamic Data Access: All operator devices shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network.
 - 3. General Network Design: Network design shall include the following provisions:
 - a. High speed data transfer rates. The minimum transfer rate shall be 100 Mb (Mb/s).
 - b. Commonly available, multiple source, networking components and protocols shall be used to allow the BAS to coexist with other networking applications. MAP, ETHERNET, IBM Token Ring and ARCNET are acceptable technologies.
 - c. Use of an industry standard IEEE protocol.
 - d. Synchronization of the realtime clocks in all DDC panels shall be provided.
 - e. Permit at least four simultaneous users to access the system over the LAN, based on password level. Users shall have access to monitor parameters, change set points, set up trends, or start/stop controlled equipment. A remote user shall have this capability without having the system data base loaded on his/her remote computer.
 - f. Text/Email feature shall be provided with capability to telephone/email selected facility maintenance personnel to notify them of critical BAS alarms.

4. Connection to Facility's LAN: The BAS shall be connected to the facility's Ethernet LAN to the extent possible to avoid duplication of LAN wiring. Coordinate connection with owner.
 - a. The BAS shall be connected to the facility LAN and shall permit unlimited simultaneous users to access the system over the LAN and to (based on password level), monitor parameters, change set points, set up trends, or start/stop controlled equipment.
 - b. A remote user shall have this capability without having the system data base loaded on his/her remote computer.
 - c. Connection by remote Energy Management system shall be accommodated by allowing polling of BAS parameters over Bacnet IP.

2.03 STAND-ALONE DDC PANELS

- A. General: Stand-alone DDC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each stand-alone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules.
- B. Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases.
- C. Point Types: Each DDC panel shall support the following types of point inputs and outputs:
 1. Digital Inputs for status/alarm contacts
 2. Digital Outputs for on/off equipment control
 3. Analog Inputs for temperature, pressure, humidity, flow, and position measurements
 4. Analog Outputs for valve and damper position control, and capacity control of primary equipment
 5. Pulse Inputs for pulsed contact monitoring
- D. Expandability: The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators.
- E. Serial Communication Ports: Stand-alone DDC panels shall provide at least two RS-232C serial data communication ports for simultaneous operation of multiple operator I/O devices such as industry standard printers, laptop workstations, PC workstations, and panel mounted or portable DDC panel operator's terminals. Stand-alone DDC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.
- F. Hardware Override Switches: The operator shall have the ability to manually override automatic or centrally executed commands at the DDC panel via local, point discrete, on-board hand/off/auto operator override switches for binary control points and gradual switches for analog control type points. These override switches shall be operable whether the panel is powered or not.
- G. Hardware Override Monitoring: DDC panels shall monitor the status or position of all overrides and inform the operator that automatic control has been inhibited.
- H. Local Status Indicator Lamps: The DDC panel shall provide local status indication for each binary input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
- I. Integrated On-Line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment.
- J. Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.
- K. Powerfail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all stand-alone DDC panels to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery

back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.

- L. Provide a battery backup (UPS) system to support DDC panel functions for a minimum of 15 minutes upon loss of power. The UPS system shall be provided regardless of connection to facility emergency power system.

2.04 SYSTEM SOFTWARE FEATURES

- A. General:
 - 1. All necessary software to form a complete operating system as described in this specification and on drawings shall be provided.
 - 2. The software programs shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.
- B. Control Software Description:
 - 1. Pre-Tested Control Algorithms:
 - a. Two Position Control
 - b. Proportional Control
 - c. Proportional plus Integral Control
 - d. Proportional, Integral, plus Derivative Control
 - e. Automatic Control Loop Tuning
 - 2. Equipment Cycling Protection.
 - 3. Heavy Equipment Time Delays.
 - 4. Powerfail Motor Restart.
- C. Energy Management Applications: DDC panel shall have the ability to perform any or all of the following energy management routines:
 - 1. Time of Day Scheduling
 - 2. Calendar Based Scheduling
 - 3. Holiday Scheduling
 - 4. Temporary Schedule Overrides
 - 5. Optimal Start/Stop
 - 6. Night Setback/Setup Control
 - 7. Economizer
 - 8. Peak Demand Limiting
 - 9. Temperature Reset
- D. Custom Process Programming Capability: DDC panels shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
- E. Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to noncritical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC workstation or local I/O device, or communications with other panels on the network.
- F. Historical Data and Trend Analysis: A variety of historical data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways:
 - 1. Continuous Point Histories.
 - 2. Control Loop Performance Trends.
 - 3. Extended Sample Period Trends.
 - 4. Data Storage and Archiving.
- G. Runtime Totalization: Stand-alone DDC panels shall automatically accumulate and store runtime hours for binary input and output points.

- H. Analog/Pulse Totalization: Stand-alone DDC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
- I. Event Totalization: Stand-alone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off.

2.05 APPLICATION SPECIFIC CONTROLLERS - HVAC APPLICATIONS

- A. Each stand-alone DDC controller shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASCs).
- B. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.
- C. Each ASC shall have sufficient memory to support its own operating system and data bases.
- D. The operator interface to any ASC point data or programs shall be through any network-resident PC workstation or portable operator's terminal connected to any DDC panel in the network.
- E. Application specific controllers shall directly support the temporary use of a portable service terminal.
- F. Powerfail Protection: All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.
- G. Battery Backup (UPS): UPS shall be provided to support ASC functions for a minimum of 15 minutes upon loss of power. The UPS system shall be provided regardless of connection to facility emergency power system.
- H. The modes of operation supported by each ASC shall minimally include, but not be limited to, the following:
 - 1. Daily/Weekly Schedules
 - 2. Occupancy Mode
 - 3. Economy Mode
 - 4. Temporary override Mode
- I. Continuous Zone Temperature Histories: Each ASC shall automatically and continuously maintain a history of the associated zone temperature to allow users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of two samples per hour shall be stored.
- J. Alarm Management: Each ASC shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.
- K. Application Descriptions:
 - 1. VAV Terminal Unit Controllers:
 - a. VAV terminal unit controllers shall support, but not be limited to, the control of the following configurations of VAV boxes to address current requirements as described in the Execution portion of this specification, and for future expansion.
 - 1) Single Duct (Cooling Only or Cooling With Reheat)
 - b. VAV terminal unit controllers shall support the following types of point inputs and outputs:
 - 1) Proportional Cooling Outputs
 - 2) Heating Outputs (Proportional Analog Hot Water Control Valve or SCR Electrical)
 - c. Each VAV terminal unit space temperature sensor shall include setpoint potentiometer, room temperature indication, and communication port for portable operators terminal. Controller shall be capable of controlling to a discharge temperature that is reset based on the difference between space temperature and space temperature set point changes.

- d. VAV box differential pressure transmitter shall be by JCI or Setra, 0 to 1.5" pressure range, +/- 0.0008" w.c. linearity, +/- 0.00075 w.c. repeatability.
- 2. Unitary Controllers:
 - a. Unitary controllers shall support, but not be limited to, the following types of systems to address specific applications indicated on the drawings:
 - 1) Heat Pumps (Air-to-Air, Water-to-Air)
 - 2) Packaged Rooftops
 - b. Unitary controllers shall support the following types of point inputs and outputs:
 - 1) Economizer Switchover Inputs
 - 2) Drybulb
 - 3) Outdoor Air Enthalpy
 - 4) Differential Temperature
 - 5) Differential Enthalpy
 - 6) Binary Input from a separate controller
 - 7) Economizer Outputs
 - 8) Integrated Analog with minimum position
 - 9) Binary output to enable self-contained economizer actuator
 - 10) Heating and Cooling Outputs
 - 11) 1 to 3 Stages
 - 12) Analog Output with two-pipe logic
 - 13) Reversing valve logic for Heat Pumps
 - 14) Fan Output
 - 15) On/Off Logic Control
- 3. AHU Controllers:
 - a. AHU controllers shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally stand-alone fashion.
 - b. AHU controllers shall have a library of control routines and program logic to perform the sequence of operation.

2.06 OPERATOR INTERFACE

- A. Command Entry/Menu Selection Process: Operator workstation interface software shall minimize operator training through the use of English language prompting, English language point identification, and industry standard PC application software.
- B. The operator interface shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device, and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change setpoints from graphical displays through the use of a mouse or similar pointing device.
- C. Graphical and Text-Based Displays: Operator workstations shall provide consistent graphical or text-based displays of all system point and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all workstations.
- D. Password Protection: Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.
- E. Operator Commands: The operator interface shall allow the operator to perform commands including, but not limited to, the following:
 - 1. Start-up or shutdown selected equipment.
 - 2. Adjust setpoints.
 - 3. Add/Modify/Delete time programming.
 - 4. Enable/Disable process execution.
 - 5. Lock/Unlock alarm reporting for each point.
 - 6. Enable/Disable Totalization for each point.
 - 7. Enable/Disable Trending for each point.
 - 8. Override PID Loop setpoints.

9. Enter temporary override schedules.
 10. Define Holiday Schedules.
 11. Change time/date.
 12. Enter/Modify analog alarm limits.
 13. Enter/Modify analog warning limits.
 14. View limits.
 15. Enable/Disable Demand Limiting for each meter.
 16. Enable/Disable Duty Cycle for each load.
- F. Logs and Summaries: Reports shall be generated automatically or manually, and directed to either CRT displays, printers, or disk files. Summaries shall be provided for specific points, for a logical point group, for a user-selected group of groups, or for the entire facility without restriction due to the hardware configuration of the building automation system. Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.
- G. Dynamic Color Graphic Displays:
1. Color graphic floor plan displays, and system schematics for each piece of mechanical equipment shall be provided to optimize system performance analysis and speed alarm recognition.
 2. The BAS shall include a trend viewing utility that shall have access to all data base points. It shall be possible to display trend data in histogram (X-Y plots) format without exporting the data to another application. Refer to the enclosed sheets at the end of this section for an example of summary sheet displays.
- H. System Configuration and Definition: All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.
1. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently add/delete/modify all functions.
 2. Programming Description: Definition of operator device characteristics, DDC panels, individual points, applications, and control sequences shall be performed through fill-in-the-blank templates and graphical programming approach.
 3. System Definition/Control Sequence Documentation: All portions of system definition shall be self-documenting to provide hardcopy printouts of all configuration and application data. Control process and DDC control loop documentation shall be provided in logical, graphical flow diagram format to allow control sequences to be easily interpreted and modified at any time in the future.

2.07 PORTABLE LAPTOP PC OPERATOR TERMINAL

- A. Furnish one Portable Laptop PC Operator's Terminal and software to be used for communication with any controller. The terminal shall be a Windows Vista Business edition based laptop personal computer that uses controller interface software to communicate with the controllers. Manufacturer shall be Dell, Inc. or approved equal.
- B. When plugged into any controller on the BAS network, the portable terminal shall have the same functionality as a stationary terminal with full editing, programming, display, and command functions. The terminal shall allow access to the entire network.
- C. The terminal shall have minimum 3.0 GHZ Intel Pentium Duo Core processor, 4.0 GB RAM internal memory, built-in 250 GB hard drive and 48X CDRW/DVD Combo drive. In addition, the terminal shall have an RS232 serial port, two USB ports and expansion slot for modem.

2.08 STAND-ALONE DDC PANEL-MOUNTED OPERATOR'S TERMINAL:

- A. Each DDC panel (except VAV terminal unit controllers) shall include a local panel-mounted operator's terminal for local command entry, instantaneous and historical data display, setpoint adjustment and program additions and modifications.
 1. The DDC panel operator terminal shall provide access to all real or calculated points in the controller to which it is connected or any other controller in the network.

2. Operator access at all DDC panel operator terminals shall be identical to each other, as well as identical to the PC operator workstations. Any password changes shall automatically be downloaded to all controllers on the network.
3. The DDC panel operator terminal shall provide English language prompting to eliminate the need for the user to remember command formats or point names.
4. A multi-function touchpad shall be provided for point and command selection, as well as parameter entry.
5. Context-Sensitive Help.
6. Identification for all real or calculated points shall be consistent for all network devices. Use English language names to access points at the DDC panel operator's terminal.
7. In addition to instantaneous summaries, the DDC panel operator's terminal shall allow a user to view a point history file for system points.

2.09 ELECTRONIC AND ELECTRIC CONTROL COMPONENTS

- A. All sensors, pressure transmitters, transducers, etc., shall be selected such that the pressure range midpoint shall coincide with the anticipated normal operating pressure.
- B. Electric Thermostats: Thermostats to be manufacturer's best commercial grade thermostat with adjustable setpoint, dials calibrated in degrees F, and digital temperature indication. Select thermostats with suitable range for service intended. Temperature measurement accuracy shall be +/- 0.5 degrees F. Thermostats located in public areas such as corridors or elsewhere as indicated on drawings shall be provided with programming lockout to prevent unauthorized adjustment. Thermostats located where subject to physical damage and/or where identified on drawings shall be provided with tamper resistant cover. Warmer / Cooler setpoint adjustment will not be acceptable.
- C. Electronic Sensors/Transmitters: Sensors/transmitters to be 1000 Ohm platinum RTD type with high resistance change vs. temperature or humidity change, accurate to +/- 1.0 degrees F for temperature and +/- 2.0% for humidity at applicable range, and provide 4 to 20 MA or 0 to 5 VDC output signal. Sensors/transmitters to be suitable for room, duct, or well mounting as required by application. Room type to have built-in setpoint potentiometer and digital room temperature or humidity indication. Select for temperature/humidity range of application. Provide appropriate mounting plate and hardware. Temperature sensors used as a part of Energy (BTU) Measurement System shall meet the applicable requirements of that section. Sensors shall have setpoint adjustment through BAS only. Sensors located where subject to physical damage and/or where identified on drawings shall be provided with protective cover. Sensor stability shall be less than 0.1 °F in 5 years. Provide these devices where identified on the contract documents or if not shown on design documents provide at all locations listed within this section. Humidity sensors are to be stand-alone sensors and at a minimum provided within each Trauma Room, Lab, CT, and Rad Rooms, Procedure Room, if not already shown on the contract documents.
- D. Smoke Detectors: Install duct-mounted smoke detectors at locations indicated on drawings and in accordance with published smoke detector installation requirements. Smoke detectors to be furnished to Division 23 by Division 26.
- E. Control Panels: Control panels to be constructed of unitized steel or aluminum cabinets. Provide cabinets with hinged, locking door opening to the front. Multiple panels mounted side-by-side to be hinged to the left or on opposite sides to open in the middle. Start-stop switches, hand-off-automatic switches, pilot lights, and temperature indicating devices to be flush-mounted in panel door. All other devices to be internally mounted within panel. Local panels exposed to weather to be weatherproof construction. Panel locations to be approved by Designer and be accessible for operation and maintenance. All devices specified to be mounted on control panel that require electrical connections to be prewired to a dual, numbered terminal strip located inside panel. All lines in panel shall have number I.D. bands. Gauges shall be installed on all pneumatic lines entering or leaving the panel. All devices inside the panel or mounted on panel face shall have an engraved laminated plastic nameplate. Wiring within panel to conform to National Electrical Code, and shall be neatly bundled and laced or enclosed in panduit trough.

- F. Control Valves: Two-inch and smaller water service valves to be screw connected chrome plated characterized brass ball type with characterized port to allow equal percentage throttling. Valve pressure rating to be in accordance with piping and fitting specifications. (Minimum 125 psi operating pressure.) Valve actuators to be selected to close valves against pump shutoff head. Provide stainless steel stem with removable composition disc and self adjusting spring-loaded Teflon packing. Output signal of 4-20mA or 0-10 V shall be used to control the position of all modulating valves. Tri-state, pulse type, or similar non-proportional control valves/actuators are not acceptable.
- G. Automatic Control Dampers: Ultra low-leak automatic control dampers to be Arrow Pin Lock opposed-blade dampers for modulating control and parallel blades for 2-position control or approved equal. Frames and blades to be minimum 16 gauge extruded aluminum or galvanized steel construction with 4" to 6" deep frame and 8" maximum width blades. Pivot rods to be 1/2" diameter, extruded aluminum or plated steel. Bearings to be corrosion resistant. Install blade linkage hardware in angle or channel frame section out of airstream. All hardware to be corrosion resistant. Seals to be replaceable extruded vinyl or silicone rubber blade seals and flexible metal compression type jamb seals. Dampers to have maximum 4 cfm per square foot leakage at 1" water gauge static pressure and 8 cfm per square foot leakage at 4" water gauge static pressure, verified by independent testing laboratory.
- H. Electronic Actuators: Actuators shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. End switches to deactivate the actuator at the end of rotation or magnetic clutch is not acceptable. For power-failure/safety applications, a mechanical, spring return mechanism shall be used. Non-mechanical forms of fail-safe are not acceptable. All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by changing mounting orientation. Proportional actuators shall accept a 2 to 10 VDC or 4 to 20 mA and provide a 2 to 10 VDC position feedback signal. 24 VAC/DC actuators shall not require more than 15 VA for AC or 8 watts for DC applications. All non-spring return actuators shall have an external manual gear release to aid in installation and allow manual positioning when the actuator is not powered. All actuators shall have an external direction of rotation switch to aid in installation and provide proper control response. Actuators shall be provided with a factory-mounted 3-foot electrical cable and conduit fitting to provide easy hook-up to an electrical junction box. Provide cover mounted control transformer for 120-VAC power supply. The actuators shall be U.L. listed.
- I. Room Differential Pressure Alarm System: Room differential pressure devices shall be TSI PresSura or equal by Accutrol, Siemens, or Setra. Provide a unit outside of each isolation room. Refer to the architectural floor plans for exact number of rooms. Provide unit with audible and visual alarm, digital display of room pressure differential, through-the-wall pressure sensor and transformer. Provide BacNet interface for device monitoring through the BAS. System accuracy shall be +/- 10% of pressure reading ± 0.00001 in H₂O with range of +/- 0.2000" w.c. Output signal shall be: 4-20mA. The device shall be provided with a door switch and field adjustable timer to minimize nuisance alarm indication due to door opening.
- J. Hot Water Differential Pressure Transmitter: Static pressure measuring stations with +/- 0.25% FS accuracy, suitable for line installation at pressure to 250 psig. Provide 3-valve manifold brass body factory assembled and suitable for pipe or wall mounting. Setra Model 230 – 3V or approved equal. Output signal shall be 4-20mA. Select unidirectional or bidirectional type with transmitter span matched to application. Provide hard wire connection to pump controller rather than network connection.
- K. Duct Static Pressure Devices: Static pressure measuring stations with +/- 2% accuracy equal to Paragon Controls PE-5000 or equal by Setra or Air Monitor Corp. shall be provided. Industrial quality, electronic solid state, 1/2 percent accuracy static pressure transmitters equal to Paragon Controls Model DPT-4001 shall be provided. Transmitter span shall be matched to application. Duct probe shall be 6063-T5 anodized aluminum. Output signal shall be 4-20mA.
- L. Transformers: Provide all 24-volt control transformers necessary to convert 120-volt line voltage power to control voltage at control devices.

- M. Relays, Hand-Off-Auto Switches, Pilot Lights: Provide all relays, hand-off-auto switches, and pilot lights necessary to accomplish automatic control of the mechanical systems. See electrical drawings for starters provided integral with hand-off-autos, pilot lights, and auxiliary contacts.
- N. Pressure Switches: Pressure switches shall have contact action and pole configuration as required by application, U.L. listing, and adjustable setpoint.
- O. Current Sensing Relays:
 - 1. Acceptable Manufacturer: Hawkeye Model 908, H308 (H540 for small fractional HP motor applications) or approved equivalent.
 - 2. Current sensor shall be induce powered from the monitored load and shall have an adjustable operating range from 2.5 - 135 A, 0.75 – 50 A or 0.25 – 20 A selected for application. Visual indicators (LEDs) shall indicate output status and sensor power. Adjustable trip setpoint to +/- 1%. Current sensor output shall be N.O., solid state, 0.1A @ 30 VAC/DC.
 - 3. The current sensor shall have a sensing range sensitivity selected that will enable BAS to distinguish between small motors operating with and without belts and small pump motors operating with and without water flow.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Components:
 - 1. Provide sensors, transmitters, controllers, actuators, valves, dampers, and related items, necessary to accomplish control sequence shown on drawings. Install all such devices except as noted herein to the contrary.
 - 2. Deliver control valves to the job site to be installed by Mechanical Tradesman under supervision of Control Tradesman.
 - 3. Deliver automatic dampers to the job site to be installed by Mechanical Tradesman under supervision of Control Tradesman.
 - 4. Mechanical Tradesmen to install flow switches, immersion wells, pressure tapping, and all associated shut-off cocks required for control systems.
 - 5. The control equipment and connecting piping shall be installed in a neat and workmanlike manner by trained mechanics in the direct employ of the control manufacturer.
 - 6. All exposed tubing and conduit shall be run parallel to or at right angles to the building structure, and shall be concealed in all finished spaces. Tubing and conduit may be run exposed in mechanical rooms or areas where other piping is exposed.
 - 7. Prepare coordinated composite wiring diagram showing all interlock wiring associated with starters, control panels, and controls.
 - 8. Drawings and Layouts: The controls contractor shall provide to the mechanical contractor complete schematic drawings for the entire control system for submittal to the Designer for approval before work shall begin. Brochures describing each item of control equipment or component shall be included.
 - 9. Provide sequence of operation written so that building engineer can read and understand control scheme.
 - 10. As-built drawings to be framed under plexiglass and placed in each respective equipment room area.
- B. Electrical:
 - 1. Division 23 (Mechanical Tradesman) shall furnish and install low-voltage control wiring, including conduit, conductors, and terminations for same. Division 23 shall also furnish and install control components associated with the low-voltage control systems and shall wire and connect components in accordance with approved wiring diagrams.
 - 2. Division 26 (Electrical Tradesman) shall furnish and install power wiring including conduit, conductors, and terminations to motors, safety switches, starters, relays, valve and damper actuators, and other components requiring power as indicated on the electrical drawings, by the specifications, and in accordance with approved wiring diagrams. Division 26 shall also furnish and install starters as scheduled on the electrical drawings.

3. Division 23 to furnish and install all local area network wiring, including conduit, conductors, and terminations for same. The local area network (LAN) shall be configurable as either a bus or a star, or a combination of the two. The LAN shall use twisted pair, coax, or fiber optic cable, or any combination of the three to meet noise immunity and/or distance requirements. The network design shall provide a high speed data transfer rate for alarm and report generation of no less than 100 Mb (Mb/s).
 4. Division 23 to furnish all input and output control wiring, including conduit, conductors, and terminations for same. All input and output control wiring shall be #18 twisted and shielded cable. No input or output point shall be more than 250 feet from its respective panel. All shields to be grounded at the control panel. All shields at the sensors or transducers to be folded back and taped. All cable splices shall have joints soldered and taped including the shield. No mechanical connections will be acceptable. All connections within the panels must be made with connectors of appropriate size and design for the terminals being applied. All cables must be labeled and identified on corresponding termination drawings. A copy of the termination drawing shall be adequately protected and left in its respective panel.
 5. Install all control wiring associated with DDC/BAS in minimum 1/2" size EMT. Provide all associated couplings, connectors, and fittings.
 6. All wiring shall be in accordance with local regulations and the National Electrical Code.
- C. Room Devices:
1. Room devices shall be mounted so that the top of the device is 48" above the floor and aligned with the top of the light switch plates and 8" from the light switch if shown on the drawings adjacent to the light switch.
 2. Room device locations shall be coordinated with door swings, light switches, and other wall-mounted items.
- D. Pressure/Temperature test ports shall be installed on the entering and leaving side of all heat transfer coils, heat exchangers (HVAC and domestic, both hot and cold fluid), control valves, flow meters, pumps, etc. Installation of P/T ports will facilitate the "Sensor Calibration Check" phase of the functional performance testing (FPT).
- E. The contractor shall provide Tee type connections (and associated stop cocks or caps) in the pressure sensor tubing at all differential pressure sensors, including ductwork static pressure, high static pressure, airflow measuring devices, hot and cold water differential pressure, etc., that will allow field test measurements to be taken without interrupting the BAS reading. Providing this type connection will facilitate the sensor calibration check phase of functional performance testing and maintenance, by allowing simultaneous comparison of the BAS reading versus the actual field-measured parameter.
- F. Calibrated balancing valves, flow elements and meters shall be installed in strict accordance with the manufacturer's recommendations for orientation, required straight length of upstream and downstream piping, etc., and in no case shall the pressure ports be pointed downward, in order to prevent the accumulation of trash and debris inside the ports. The ports shall be installed in such a manner that allows unobstructed access for the TAB agency to plug into the ports for purposes of measuring and verifying the differential pressure of the valve.

3.02 QUALITY CONTROL

- A. Control system to be set up and checked out by factory-trained competent technician skilled in the setting and adjustment of temperature controls used in this project. This mechanic to be experienced in type systems associated with this control system.
- B. At time of final observation, Control Contractor to demonstrate the entire sequence of operation for the systems to the Engineer. At this time, Engineer to observe function of entire control system, observe temperature control operations, damper positions, necessary to assure that temperature control system is operating as intended by mechanical design.
- C. Final acceptance of system not to occur until sequence of operation check has taken place and certified by Engineer's representative.

- D. The Control Tradesman to be responsible for returning to job during the opposite season to verify operation of control system. Engineer to be given notice of this return and to accompany Control Tradesman to observe the sequence of operation.

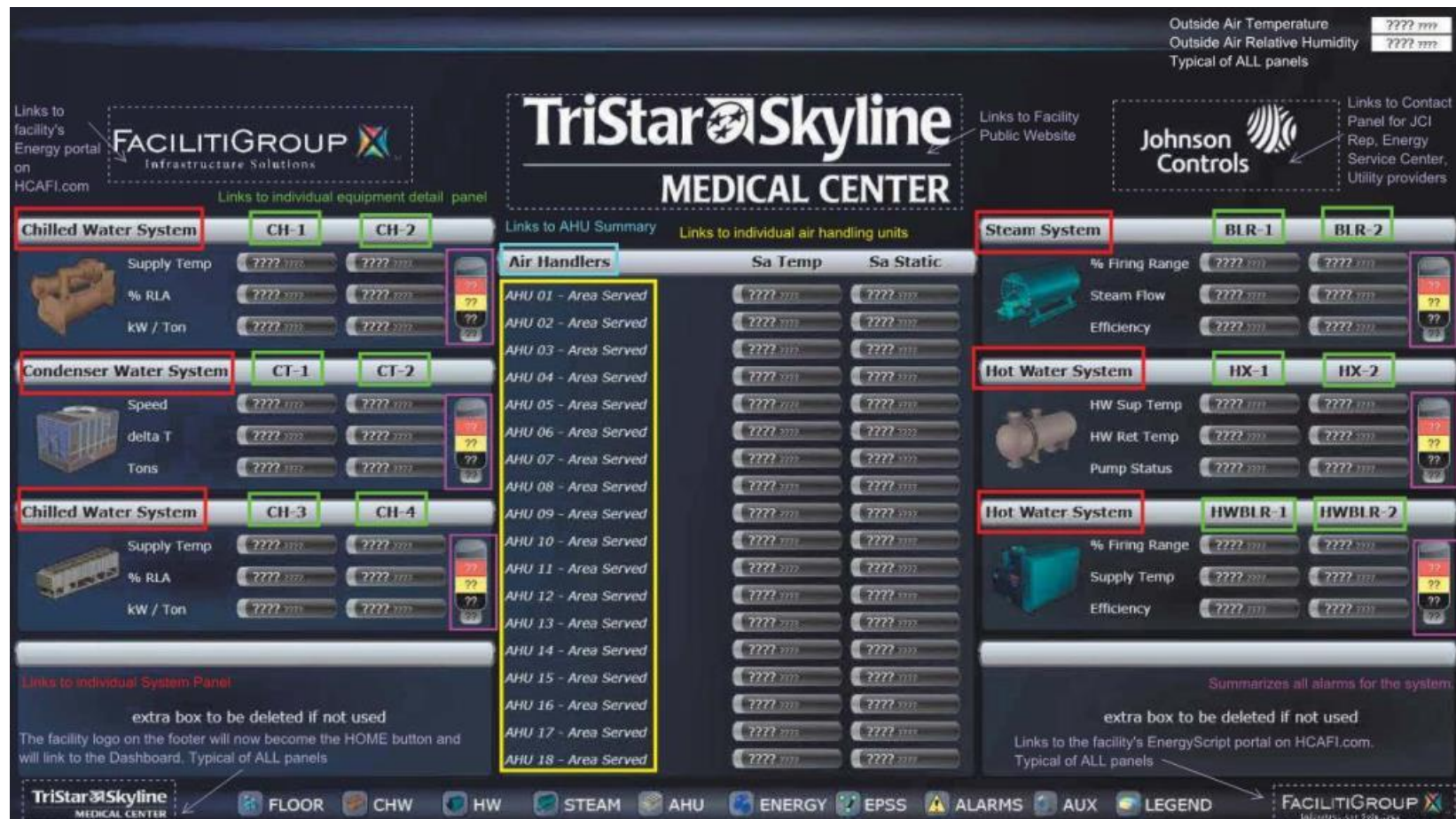
3.03 INSTRUCTION AND ADJUSTMENT

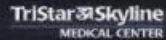
- A. On completion of the job, the controls contractor shall have completely adjusted the entire control system. He shall arrange to instruct the Owner's representative on operation of the control system and supply him with three (3) copies of the control operating and instruction manuals.
- B. The Controls Contractor shall obtain from the Owner's representative a signed receipt that he has received the instruction manuals and complete instruction on the operation of the system.
- C. Contractor Adjustment: At the completion of the job, the controls contractor must submit to the Architect a letter stating that he has made final calibrations and adjustments to the system and that the Owner's operating personnel have been instructed in its use.

3.04 WARRANTY SERVICE

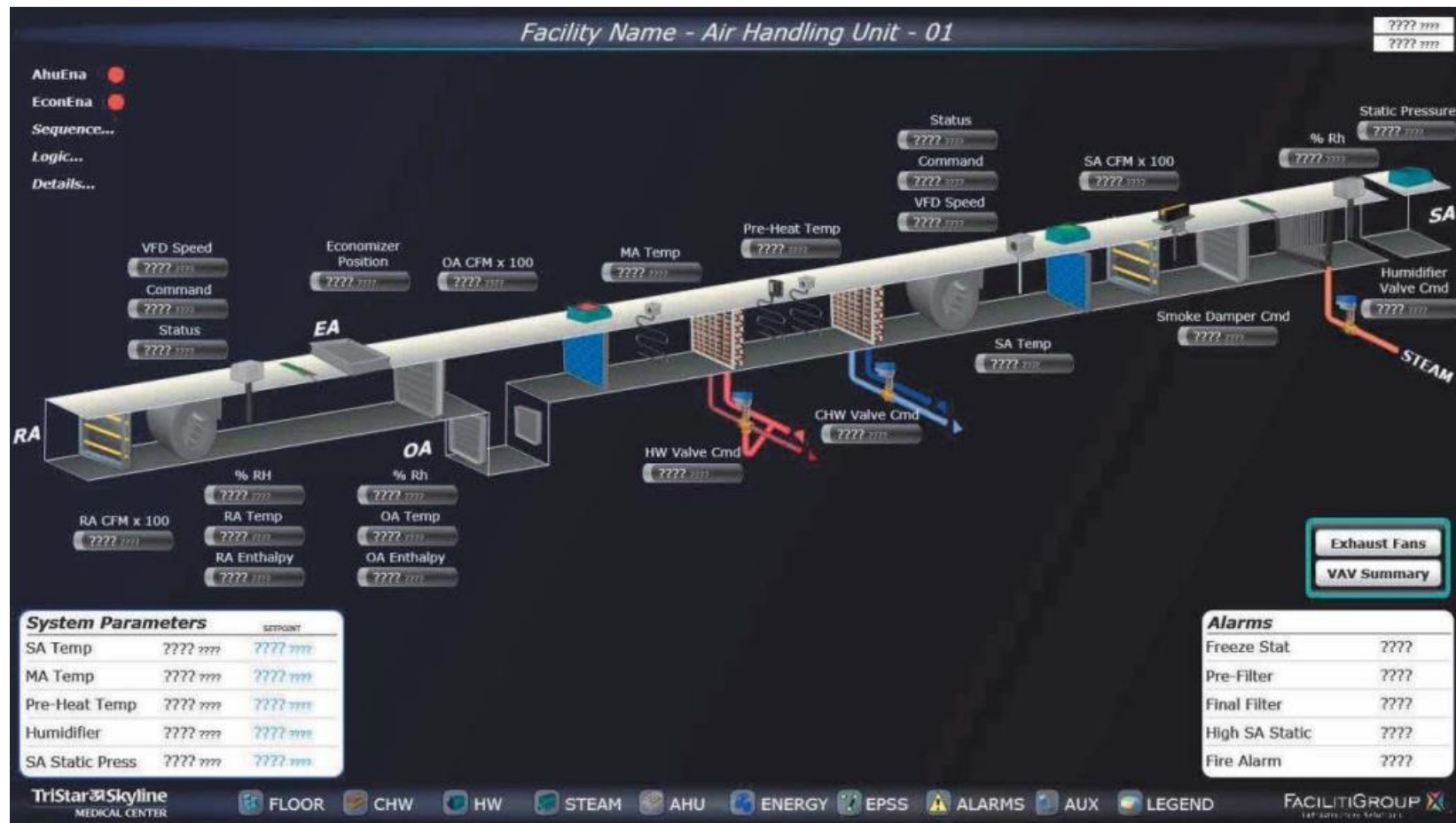
- A. Warranty servicing shall be for a period not less than 24 months after final acceptance of the job by the owner and include the following provisions:
 - 1. Emergency maintenance service on regular working hour basis during warranty.
 - 2. Replacing defective parts and components as required.
 - 3. Servicing by factory trained and employed service representatives of system manufacturer.
 - 4. Maintaining of system programming.

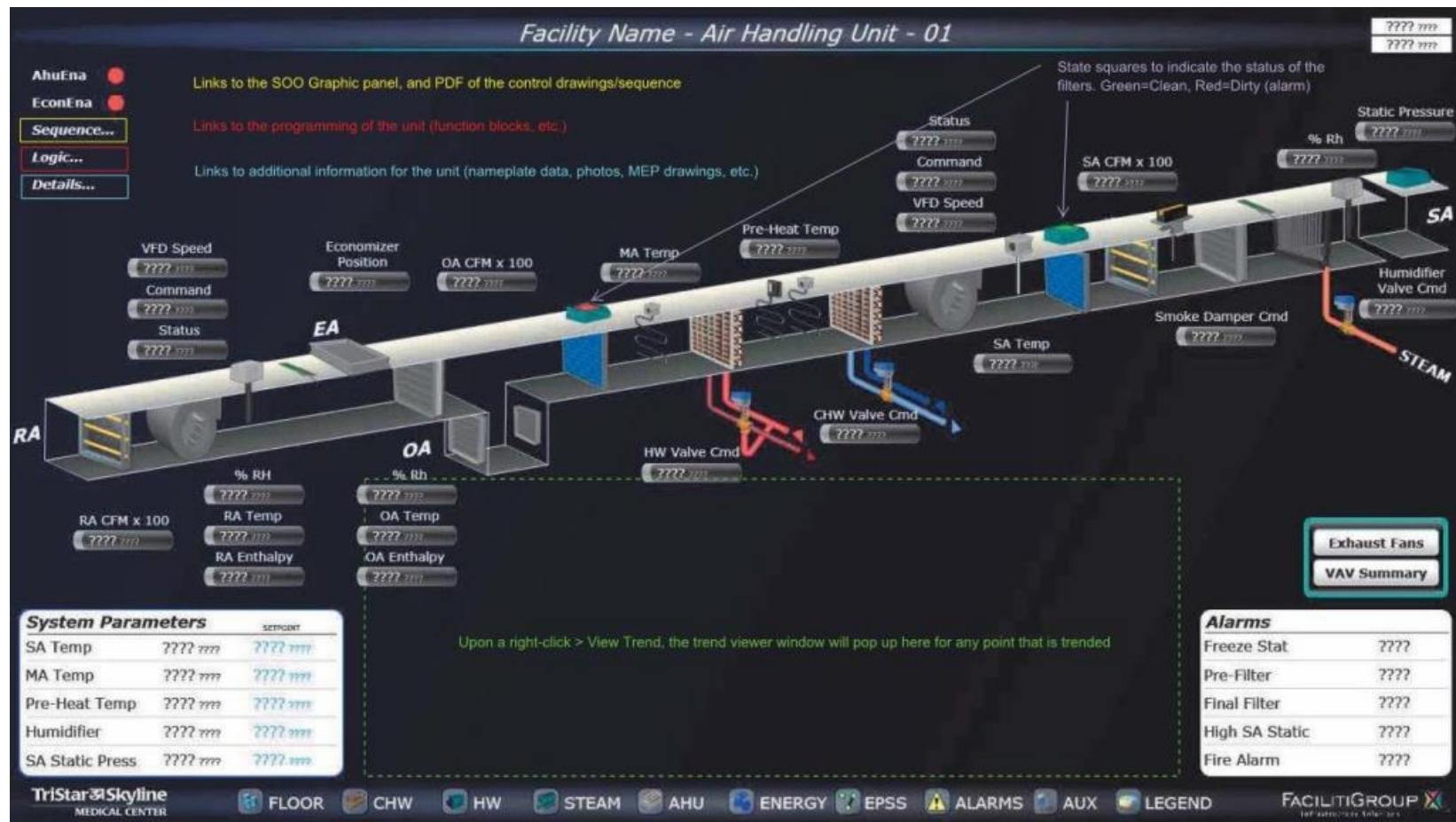
END OF SECTION 23 09 23

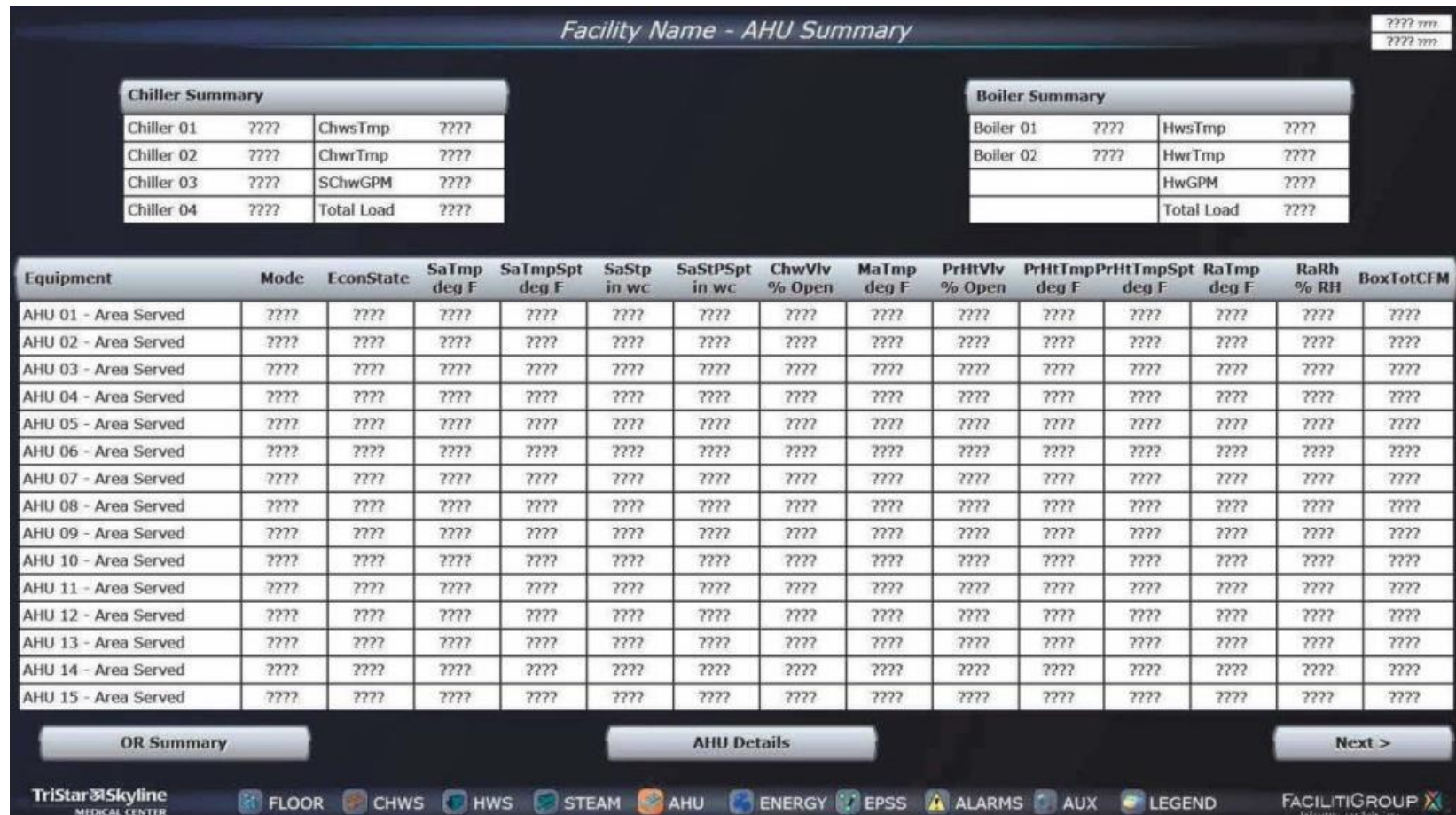












Facility Name - AHU Summary

??? mm
 ??? mm

Chiller Summary

Chiller 01	????	ChwsTmp	????
Chiller 02	????	ChwrTmp	????
Chiller 03	????	SChwGPM	????
Chiller 04	????	Total Load	????

[Links to individual equipment detail panels](#)

Boiler Summary

Boiler 01	????	HwsTmp	????
Boiler 02	????	HwrTmp	????
		HwGPM	????
		Total Load	????

Links to individual air handling units.

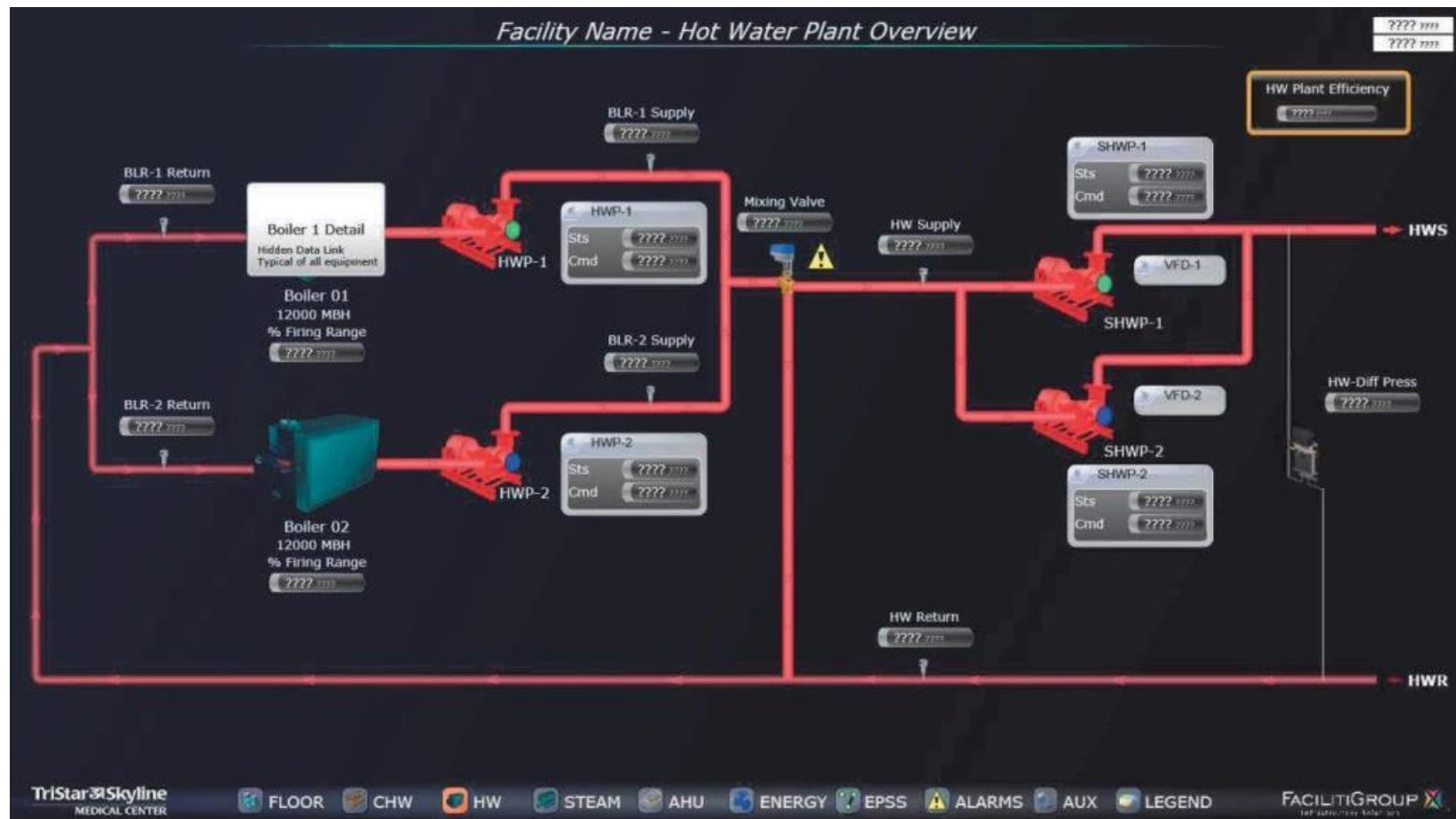
Equipment	Mode	EconState	SaTmp deg F	SaTmpSpt deg F	SaStp in wc	SaStPSpt in wc	ChwVlv % Open	MaTmp deg F	PrHtVlv % Open	PrHtTmp deg F	PrHtTmpSpt deg F	RaTmp deg F	RaRh % RH	BoxTotCFM
AHU 01 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 02 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 03 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 04 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 05 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 06 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 07 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 08 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 09 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 10 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 11 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 12 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 13 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 14 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????
AHU 15 - Area Served	????	????	????	????	????	????	????	????	????	????	????	????	????	????

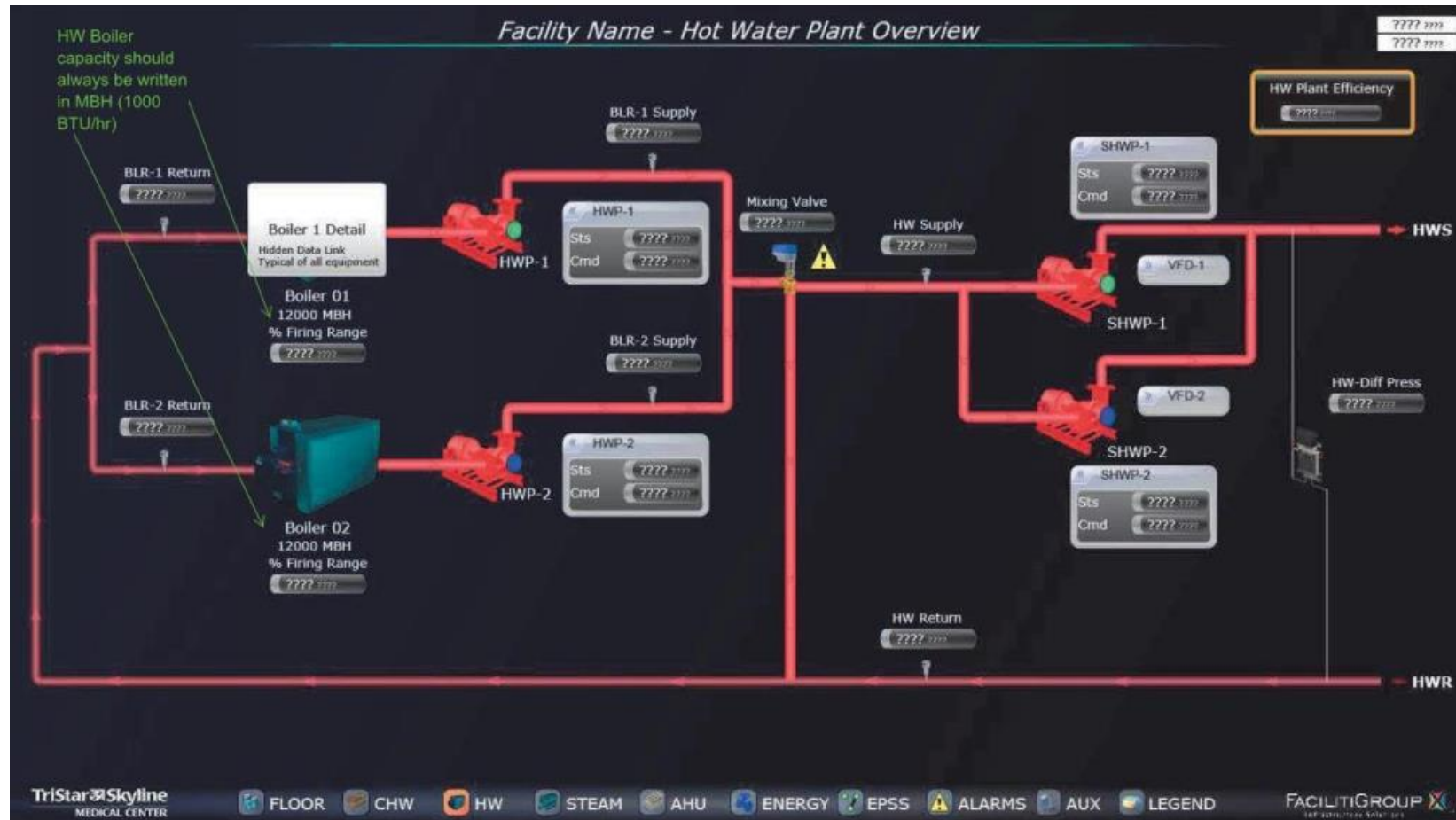
[OR Summary](#)
Links to Operating Room Summary

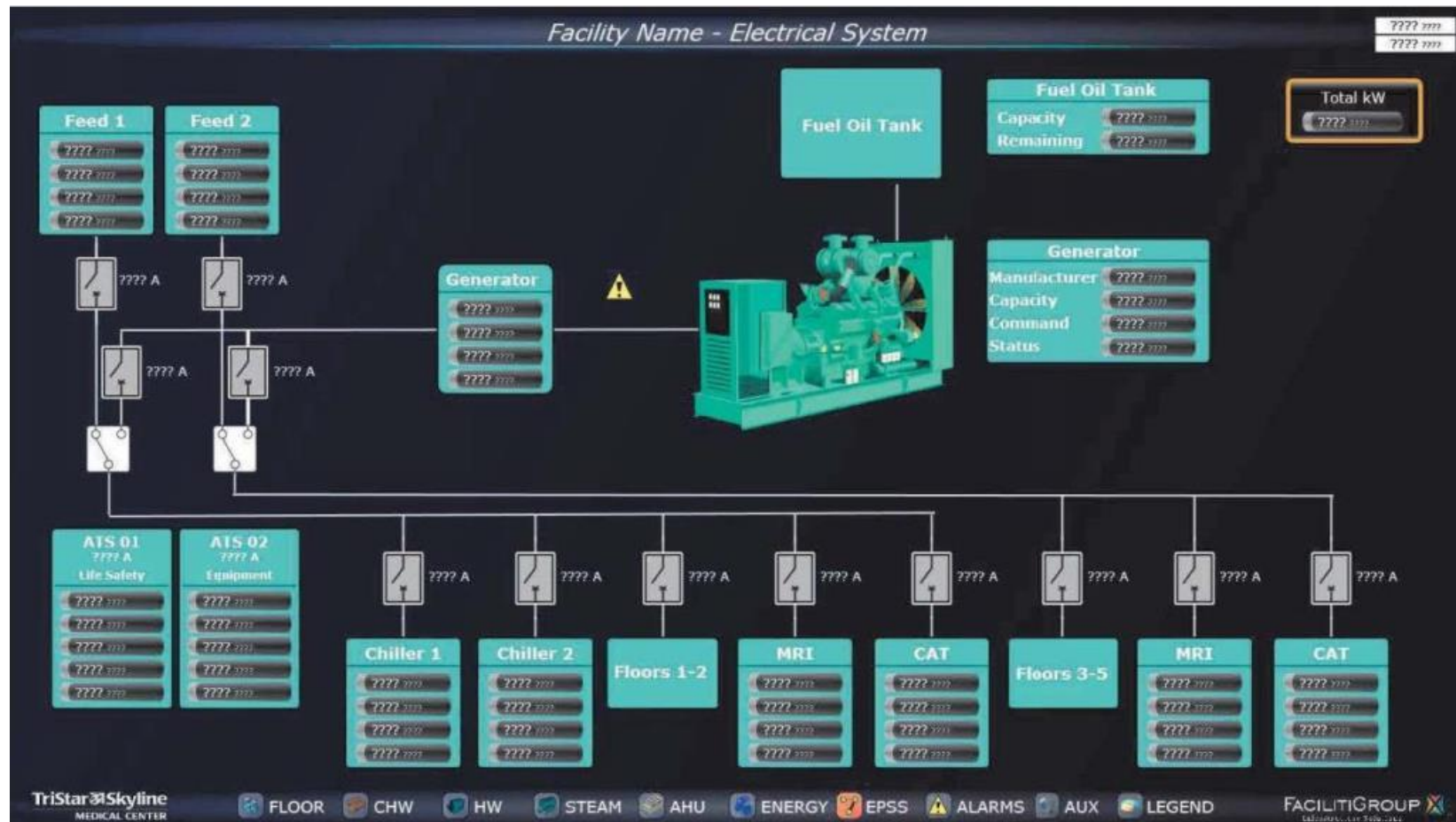
[AHU Details](#)
Links to Tailored Summary with all other AHU points

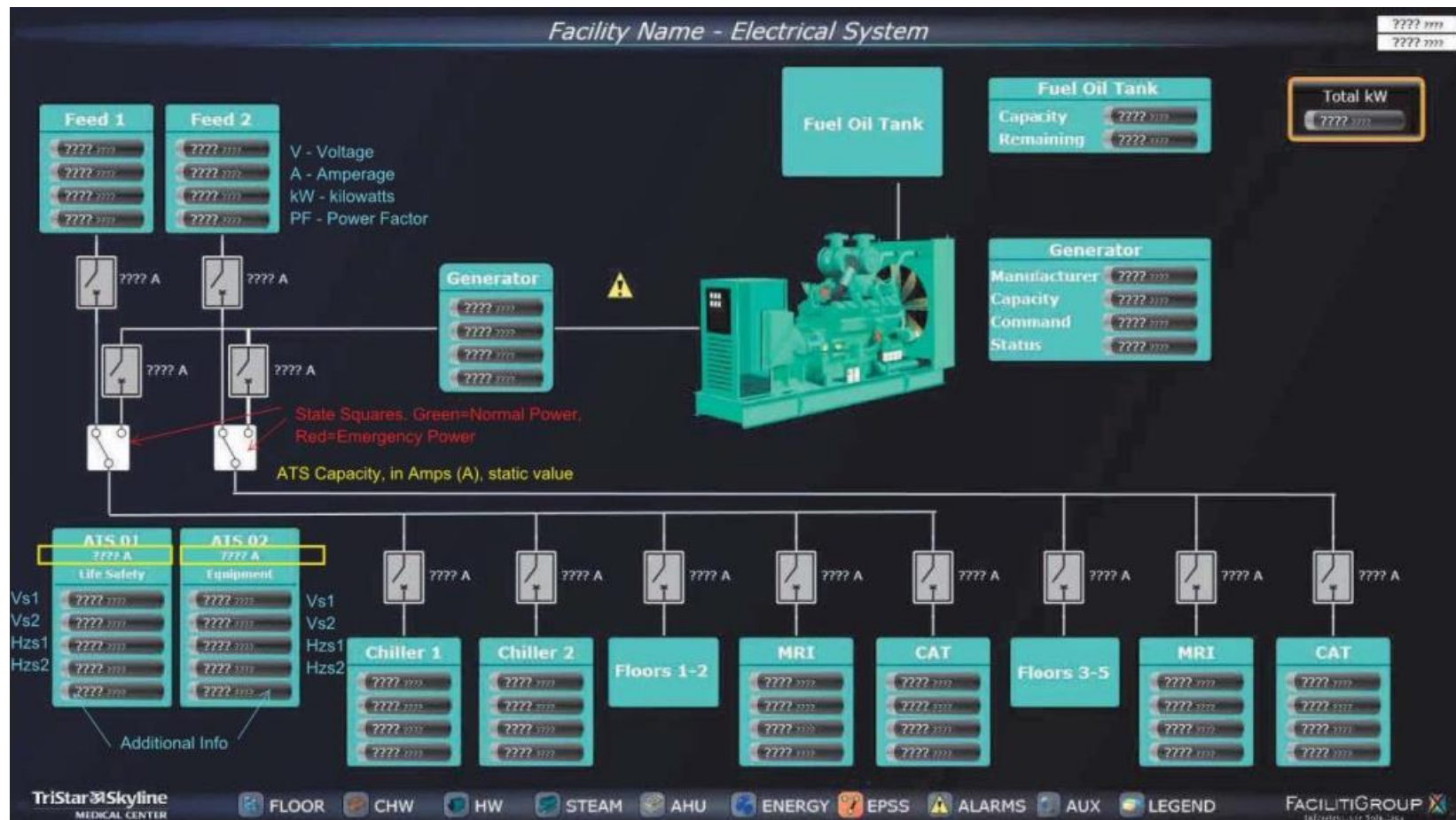
[Next >](#)
Links to 2nd panel for additional AHUs. Delete if unused

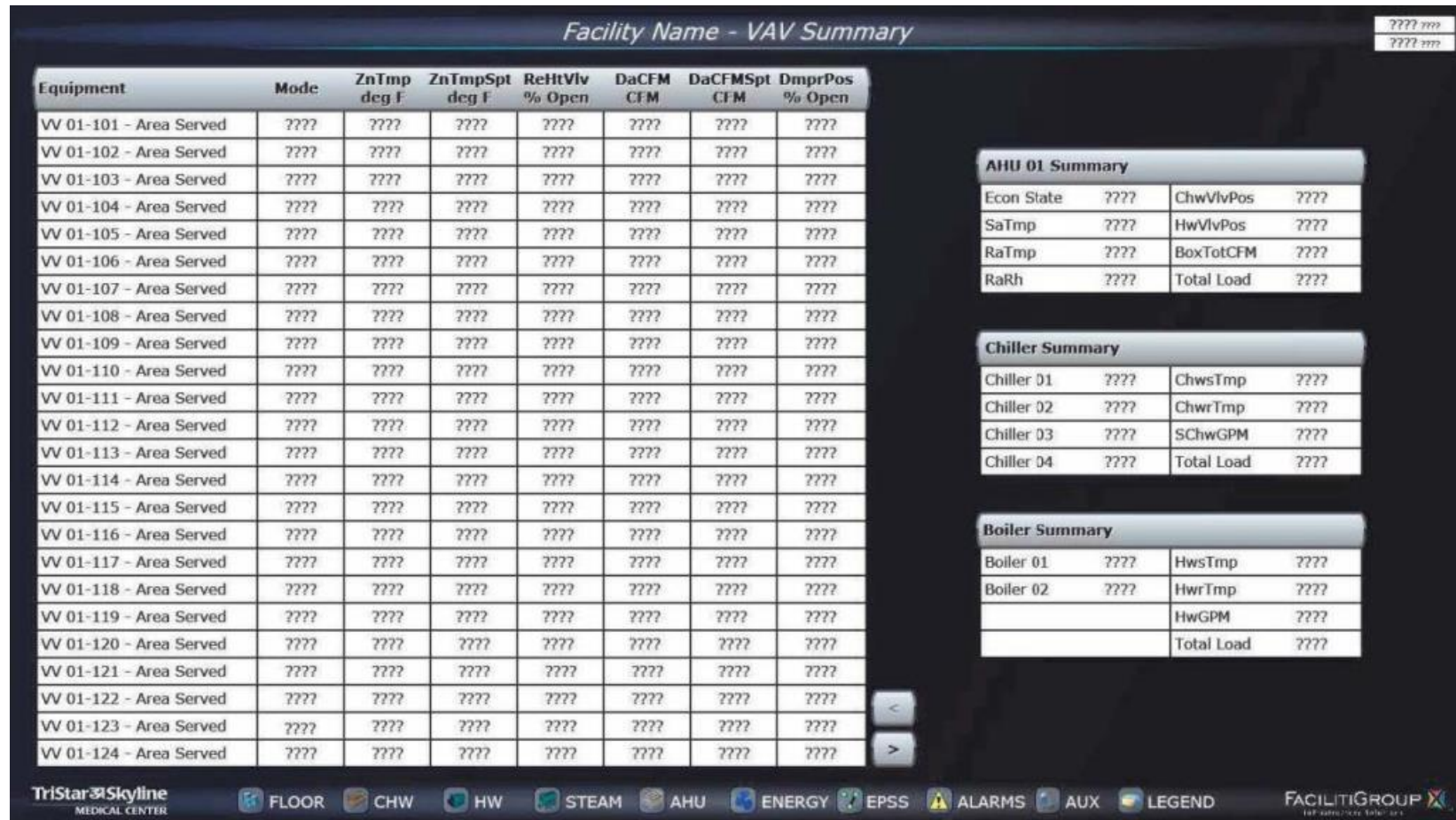
FLOOR CHWS HWS STEAM AHU ENERGY EPSS ALARMS AUX LEGEND

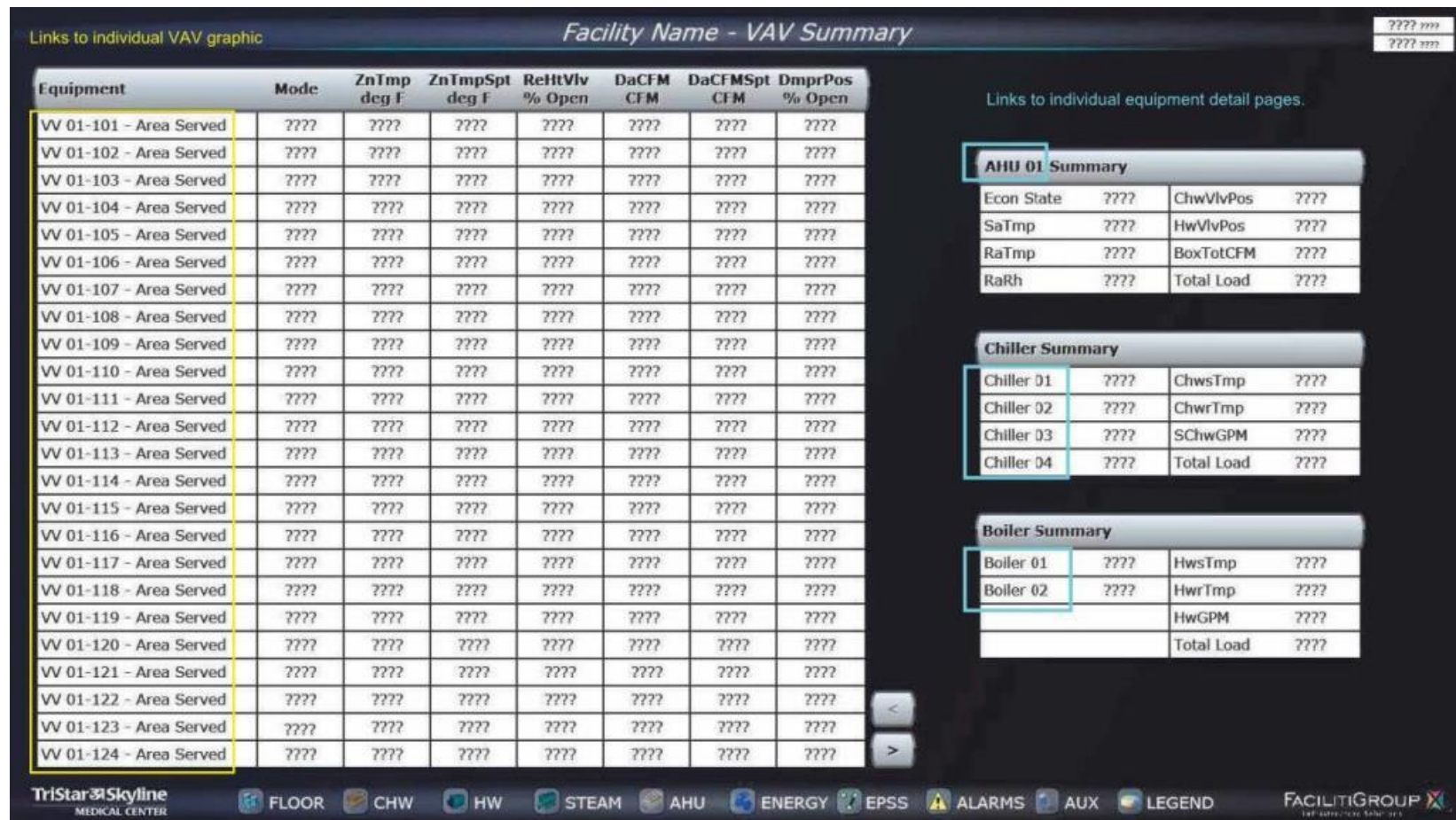












SECTION 23 21 13
HYDRONIC PIPING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Submit pipe, valves, and fittings and have approved before starting installation. Pipe, valves, and fittings to be new, and marked clearly with manufacturers' name, weight, and classification or working pressure.
- B. Piping to run approximately as shown on drawings or as structural and architectural conditions permit.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide products by the following:
 - 1. Ferguson Enterprises
Contact: Bettina Dawson
Office: (615) 316-1920
Cell: (931) 239-0466
Email: HCA@Ferguson.com

2.02 COPPER PIPES

- A. Type "L" hard-drawn seamless copper tubing, ASTM B-88:
 - 1. HVAC hot water piping 2-1/8" O.D. and smaller. Piping dimensions on drawings for piping 2-1/8" and smaller are outside diameter. (O.D.).
- B. Type "K" hard-drawn seamless copper tubing: NOT APPLICABLE
- C. Type "DWV" hard-drawn seamless copper tubing: Above-ground moisture condensate drain piping.
- D. Copper Pipe Fittings: NOT APPLICABLE
 - 1. Provide sweat fittings, ASTM B-62, dimensions conforming to ANSI B16.22, wrought copper, with sweep patterns for copper tubing.
 - 2. Dielectric connection: Provide Epco Sales, dielectric couplers at junction of steel pipe and equipment with copper piping systems. Use of steel or cast iron fittings in copper piping systems prohibited.
 - 3. Fittings for drainage piping to be drainage pattern type.
- E. Unions to be brass ground joint, 250-pound working pressure.
- F. Nipples used in conjunction with copper pipe to be brass.

2.03 PP-RCT PIPE NOT APPLICABLE

2.04 VALVES

- A. Valves are specified by Nibco model numbers to establish quality levels unless otherwise noted. Milwaukee or Apollo are considered equal manufacturers. Provide clamp lock hand lever operators on valves less than 8 inches. Provide hand wheel and closed housing worm gear on valves 8 inches and larger unless indicated otherwise below. Provide chain operators for all equipment room and powerhouse valves 4 inch and larger which are located over 6 feet 6 inches above the finish floor.
- B. Gate Valves:
 - 1. Gate valves for copper piping systems to be Class 125, bronze body, solder ends, Nibco Model S111. Valve to have either solid or split wedge disc, inside screw, rising stem, and screwed bonnet.
- C. Globe Valves: NOT APPLICABLE

1. Globe valves 2-1/2" and larger to be Class 125, cast iron body, bronze mounted, flanged ends, Nibco Model F718-B. Valves to have renewable seat and disc, outside stem and yoke with rising stem, and bolted bonnet.
 2. Globe valves 2" and smaller to be Class 150, bronze body, screwed ends, Nibco Model T235Y. Valve to be plug type with renewable seat and disc, rising stem, and union bonnet.
- D. Ball Valves:
1. Ball valves for copper water piping systems 2-1/8" O.D. and smaller to be equal to Apollo "3" Figure 82-200, solder ends, and for 2-5/8" thru 3-1/8" O.D. to be equal to Apollo Figure 70-100, threaded ends. Valves to have bronze body, chromium plated bronze ball, teflon seats, stuffing box ring and seals, and quarter turn on-off. Provide memory stops for valves used for balancing service. Valves to be rated for 400-psi WOG at 200 degrees F. Install threaded end valves with brass adapters.
- E. Butterfly Valves: NOT APPLICABLE
- F. Check Valves:
1. Check valves for copper water piping systems to be swing type, Class 125, bronze body, screwed ends, Nibco Model T/S413.

2.05 STRAINERS

- A. Provide cleanable "Y" type strainers in pump suction lines. Strainers to have iron body with screwed bronze or bolted iron cap. Strainer baskets to be brass. Water strainers to be Monel 20 mesh screen. Strainers to be line size complete with blow-down hose bibbs. When Suction Diffusers are specified for end suction pumps, strainers are not required. Strainers to be as follows:
1. Screwed 125# - Crane 988-1/2.
 2. Flanged 125# - Crane 989-1/2.
 3. Solder joint 250# - Muessco 353-1/2.

2.06 HANGERS

- A. Copper piping 1/2" O.D. thru 4" O.D., with no longitudinal movement to be Grinnell Figure 260, MSS SP-69 Type 1, adjustable clevis hanger with Figure 167, MSS SP-69 TYPE 40, galvanized steel insulation protection shield sized for maximum 10' span on 4 psi compressive strength insulation.
- B. Insulated copper piping 1/2" O.D. thru 2-1/8" O.D. with longitudinal movement to be Grinnell Figure 171, MSS SP-69 TYPE 41, pipe roll complete with Figure 167, MSS SP-69 TYPE 40, galvanized steel insulation protection shield sized for maximum 10' span on 4 psi compressive strength insulation.
- C. Support three or more parallel lines by trapeze hangers utilizing Unistrut channel or equal in bottom mounting arrangement with rod hanging support.
- D. Adequately size hangers on insulated piping for insulation to pass continuously through hangers. Insulated piping to be supported outside insulation covering.
- E. Provide concrete inserts, Grinnell Figure 282, MSS SP-69 TYPE 18, universal concrete insert, for attaching hangers to building structure. Inserts to be adequately sized and correctly positioned to support piping, valves, etc., when full of water and system is in operation.
- F. Provide C-clamps with locknut, Grinnell Figure 86, MSS SP-69 TYPE 23, where piping is to be hung from steel beams. Welding hanger rods to steel members is not permitted. Provide malleable beam clamps, Grinnell Figure 218, MSS SP-69 TYPE 30, with extension piece, Grinnell Figure 157, where piping is hung from bar joist.
- G. Support all piping by heavy steel, adjustable hangers, or brackets suitably fastened to structural portion of building. Place hangers in accordance with following tables:]

COPPER TUBING SUPPORTS	
SIZE (IN.)	DISTANCE BETWEEN SUPPORTS (FT.)
7/8 - 1-1/8	8
1-3/8 - 2-1/8	10
2-5/8 - 5-1/8	12
6-1/8 - 8-1/8	14

- H. Perforated metal, strap iron, or band iron hangers are not permitted. Offsets in hangers are not allowed. Pipe risers to be supported at regular intervals in pipe shafts within the limits of good practice.
- I. See Insulation Section for requirements at pipe hangers.
- J. Support horizontal piping across roof in accordance with Specification Section 23 05 49.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install piping not to interfere with opening of doors or other moving parts. Do not install piping near or directly over any portion of electrical equipment.
- B. Provide chromium-plated escutcheon plates for exposed uninsulated pipes projecting through floors or walls in finished spaces. Mechanical rooms and janitor closets are not considered "finished" spaces.
- C. Hang piping so equipment, flanges, and connections do not bear weight of piping.
- D. Adequately support vertical lines at their bases or by a suitable hanger placed in horizontal line near riser or by a base fitting set on pedestal.
- E. Pipes not to be hung or supported by pumps. No torque to be applied to pumps by connecting pipes. After final pipe adjustments and initial operation of the pumps, this Contractor to recheck alignment of pumps and realign as required.
- F. Run piping in straight lines; riser lines to be plumb with such offsets only as indicated or necessary. No sagging of lines permitted.
- G. Unless otherwise shown on drawings, lines to be installed to drain to sumps or sewer.
- H. Ream pipe after cutting to full bore. Remove foreign matter from inside of pipe before installing. Keep installed piping free from dirt and scale and protect open ends from foreign matter. Use temporary plugs or other approved methods of open end closure.
- I. Threads to be right-hand, pipe standard, clean cut, full depth, and tapered. Joints to be made tight without caulking. Approved pipe joint lubricant to be used, applied in thin layer to the male thread only.
- J. Install copper fittings with suitable flux and 95/5 solder. Type K copper pipe to be joined by means of suitable flux and silver or phos-copper.
- K. Piping to have sufficient number of flanges or unions for convenient installation and removal of piping and equipment.
- L. Remake or replace defective, leaking, or otherwise unsatisfactory joints or material. Peening, caulking, or doping of piping is not permitted.
- M. Install piping to prevent stresses and strains to piping and hangers from expansion or contraction. Provision for proper loops, offsets, or expansion joints to be responsibility of Contractor. Make provision for servicing and removal of equipment without dismantling piping.
- N. Where indicated on the drawings that the pipe will be exposed to direct UV light for more than 30 days, it shall be provided with a Factory applied, UV-resistant coating. Alternate UV protection methods are not acceptable.
 - 1. Pipe fittings shall be Nupi Niron® Clima Cool-Pro®.

- O. Life Cycle and Environmental Product Declaration
 - 1. Manufacturer shall be required to produce LEED v4.0+ LCA (Life Cycle Assessment) and EPD (Environmental Product Declaration) that is recognized by the USGBC. Manufacturer shall be able to provide a minimum of 10 data packages from previous jobsites showing compliance with this requirement.
- P. Thermal and Vapor Barrier
 - 1. Where standard pipe insulation is indicated on the drawings or in these specifications, the contractor shall provide a thermal (radiant, conductive, and convective) and vapor barrier insulation. The insulation products shall be provided in the appropriate thickness or as indicated on the drawings or elsewhere in these specifications. The standard pipe insulation shall be UV resistant, CFC- free, non-porous, non-fibrous, and resist mold growth.
- Q. Valve Applications
 - 1. Install gate valves close to the main on each branch and riser serving 2 or more equipment connections and where indicated.
 - 2. Install gate or ball valves on the inlet to each equipment item and elsewhere as indicated.
 - 3. Install drain valve at the base of each riser, at low points of horizontal runs, and where required to drain hydronic piping system.
 - 4. Install swing check valve on the discharge side of each pump and elsewhere as indicated.
 - 5. Install ball valves in each hot-water circulating loop and the discharge side of each pump.

3.02 FIRE-RATED PARTITIONS

- A. Provide permanent firestop system at all piping penetrations of fire-rated walls and floors. Review details on drawing as well as this specification for permissible firestop systems. The firestop system shall have been tested and approved in accordance with ASTM E119 and U.L. 1479 (ASTM E814) and classified for up to 2 hours fire rating. Firestop system shall be type detailed on drawings or intumescent type capable of expanding up to 8 times its original volume. Firestop system to be 3M, Hilti, Nelson, Johns Manville, or Specified Technologies. Firestop system shall be installed in strict accordance with published U.L. approved installation instructions. Piping to pass through the fire-rated partition insulated or non-insulated as specified and detailed. Submit U.L. approved installation drawing for each type of penetration prior to construction.

3.03 NON-RATED PARTITIONS

- A. Piping to pass through the walls insulated or non-insulated as specified. Wall should be finished to fit neatly around the piping. Firestopping is not required at non-rated partitions.

3.04 PIPE SLEEVES

- A. Pipe sleeves shall be provided at non-rated partitions and floor penetrations. Pipe sleeves to be Schedule 40 or 18 gage steel. Sleeves to extend 1-1/2" in excess of partition depth on each side. Sleeves penetrating floors in wet areas, including all mechanical rooms, shall extend a minimum of 1 inch above the floor.
 - 1. Piping requiring sleeves:
 - a. Heating hot water
 - b. Copper pipes thru masonry walls

3.05 PIPING IN TRANSFORMER, ELECTRICAL, AND ELEVATOR EQUIPMENT ROOMS

- A. Refer to drawings. No water piping permitted in transformer, electrical, or elevator equipment rooms.

3.06 VALVE ACCESS

- A. Locate all shutoff and control valves for easy access and operation. Where valves must necessarily be located in enclosed spaces, they shall be provided with access panels of sufficient size for operation. Furnish these access panels to proper trades for installation.

3.07 AIR VENTING

- A. Provide manual air vents at high points of vertical risers and at each water coil to eliminate air from HVAC water systems.

3.08 WATER DRAINING

- A. Provide 3/4" hose end gate valves at low points and bottom of each riser to drain HVAC water systems.

END OF SECTION 23 21 13

SECTION 23 21 16
HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Expansion tank.
- B. Tank air control fitting.
- C. Tangential air separator.
- D. Suction diffuser.
- E. P.T. test plugs.
- F. Pressure gauges.
- G. Digital thermometers.
- H. Thermometer test wells.
- I. Flow balancing valve.
- J. Flow measuring meter.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Bell and Gossett ITT, Dieterich Standard, Flow Design, Gerand, Mueller, Peterson Engineering, Taco, Thrush, John Wood Industrial Products, Weiss Instruments, Inc.

2.02 EQUIPMENT

- A. Compression Tank:
 - 1. Tanks to be constructed of carbon steel in accordance with ASME Boiler and Pressure vessel code.
 - 2. Tank to be constructed and ASME stamped for 125 psi working pressure at 375 degrees F.
 - 3. Unit shall be stamped with ASME "U" symbol.
 - 4. Provide tanks with mounting saddles.
 - 5. Compression tank to be manufactured by Bell & Gossett, Taco, Wood Industrial, or approved equal.
- B. Tank Air Control Fittings:
 - 1. Furnish an air control tank fitting containing an air separating trap and water control baffle to provide unrestricted airflow to the compression tank and air-free water flow from the tank.
 - 2. Fittings to be equipped with manual vent tube.
 - 3. Construct fitting for 125 psi working pressure at 240 degrees F.
 - 4. Fitting to be Bell & Gossett ITT Airtrol tank fitting, or approved equal.
- C. Tangential Air Separator:
 - 1. Provide an external air separation unit consisting of a steel tank, strainer, and collector tube.
 - 2. Unit to have screwed flanged tangential inlet and outlet connections.
 - 3. Design internal perforated stainless air collector tube to direct released air into compression tank.
 - 4. Removable stainless steel system strainer to have 3/16 inch diameter perforations and free area of not less than five times cross-sectional area of connecting pipe.
 - 5. Construct unit in accordance with ASME Boiler and Pressure Vessel Code and stamp for 125 psig working pressure at 350 degrees F.
 - 6. Unit shall be stamped with ASME "U" symbol.
 - 7. Provide blowdown connection on bottom of unit to facilitate routine cleaning of unit.
 - 8. Unit to prevent accumulation of air in hydraulic heating and/or cooling system and prevent noises caused by entrained air in piping.
 - 9. Separator to be Bell & Gossett ITT Rolairtrol, Spirotherm Spirovents, or approved equal.

- D. Suction Diffuser:
1. Provide at each end-suction pump a Suction Diffuser with integral strainer.
 2. Unit to consist of cast iron, angle type body with steel inlet vanes and combination diffuser-strainer-orifice cylinder with 3/16 inch diameter openings for pump protection.
 3. Equip orifice cylinder with a disposable, fine mesh strainer which shall be removed after system start-up.
 4. Design orifice cylinder to withstand pressure differential equal to pump shutoff head and have a free area equal to five times cross-sectional area of pump suction opening.
 5. Vane length to be not less than 2-1/2 times the pump connection diameter.
 6. Suction diffuser shall be provided with bottom blowdown connection, inlet gauge port, and adjustable support foot to carry weight of suction piping.
 7. Suction diffuser to be constructed for 125 psi working pressure.
 8. Suction diffusers to be manufactured by Bell & Gossett ITT, Taco, Mueller, or approved equal.
- E. P.T. Test Plugs:
1. Provide 1/4 inch solid brass pressure/temperature test plugs at each BAS temperature sensor and at the entering and leaving connections of coils, chillers, hot water boilers, and heat exchangers.
 2. Nordel self-closing valve to be rated for 275 degrees F. service.
 3. Plugs to be manufactured by Flow Design, Peterson Engineering, SISCO, or approved equal.
- F. Pressure/Temperature Test Kit:
1. Provide Owner complete portable pressure and temperature test kit.
 2. Kit to be complete with pressure test gauge, necessary connector hoses, temperature test thermometer with adapter, shutoff and vent valves and carrying case.
 3. Readout kit to be manufactured by Bell & Gossett ITT or approved equal.
- G. Pressure Gauges:
1. Gauges in mechanical rooms to be 3-1/2" dial equal to Trerice Model No. 800LFB with glycerin liquid fill, nylon, steel, or aluminum case, acrylic plastic window, brass movement, phosphor bronze bourdon tube, and brass socket. Accuracy to be guaranteed within one percent.
 2. Gauges in the powerhouse/central energy plant to be 4-1/2" dial equal to Trerice Model No. 450LFSS with glycerin liquid fill, reinforced polypropylene case, acrylic window, stainless steel movement, stainless steel tube and socket. Accuracy to be guaranteed within one-half of one percent.
 3. Select scale range of gauges to indicate design pressure near midpoint of scale.
 4. Provide each gauge with 1/4 inch size, brass construction needle valve equal to Trerice Model No. 735-2.
 5. Provide each gauge with impulse dampener equal to Trerice Model No. 870.
- H. Digital Thermometers:
1. Provide solar digital vari-angle Weiss Instruments, Inc., Model DVU-35 (no substitutions) with adjustable angle (rear, front, and side) thermometers across indoor chiller coolers and condensers, entering and leaving heat exchanger, hot water boilers and AHU coils where equipment is protected from weather.
 2. Provide solar digital vari-angle Weiss Instruments, Inc. Model 5DVU35-300 (no substitutions) with adjustable angle thermometer for applications where device is exposed to weather.
 3. Each thermometer to be self-powered and within 1% accuracy. Stem assembly to be industrial glass.
- I. Thermometer Wells:
1. Provide Trerice or equal stainless steel thermometer wells for water temperature sensors and at other locations shown on drawings.

2. Test wells to be stainless steel with 2-1/2 inch extension neck and screw plug cap with chain and shall be filled with light clear oil.
- J. Flow Balancing Valve:
1. Balancing/shut-off valve to be ball type with bronze/brass body, chromium plated bronze ball, Teflon seats, blowout proof stem with Teflon packing and nut, and full size quarter turn handle with grip and memory stop.
 2. The flow measuring element shall be a low loss/high signal Venturi type of one to ten rangeability equipped with dual Schrader type pressure test ports and caps for connection to a portable differential pressure meter.
 3. Meter connections to have built-in check valves.
 4. Valves to provide for leak tight shutoff service at full rated working pressure.
 5. Sizes 1/2" through 2" to be threaded ends with brass adapters; sizes 2-1/2" and larger to be flanged.
 6. Valves and Venturis to be rated for 125 psig working pressure at 250 degrees F.
 7. Combination flow measuring, balancing, and shutoff valves to be Bell & Gossett Circuit Setter Plus or approved equal Ball valve up to 3" or Globe valve 4" to 12" type.
- K. Flow Measuring Meter:
1. Provide portable flow measuring meter capable of indicating pressure differential across previously specified flow balancing valves and flow measuring stations.
 2. Unit to be complete with hoses, shutoff and vent valves, and carrying case.
 3. Flow measuring meter to be made by manufacturer of associated flow balancing/measuring devices.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install hydronic specialties in strict accordance with manufacturers' published installation instructions.
- B. Provide 1/2" manual air vents at top of pipe risers and other locations where air can be trapped or collected.
- C. Provide 3/4" hose end gate valve drains at bottom of pipe risers and other locations to drain water systems.
- D. Pipe relief valve outlets from hydronic systems to nearest floor drain.
- E. Support pump inlet and strainer fittings with floor mounted pipe and flange supports.
- F. Locate thermometers and pressure gauges no higher than 7 feet above finished floor elevation.
- G. PT test plugs shall be located at each hydronic BAS temperature sensor and at the entering and leaving connections of coils, chillers, hot water boilers and heat exchangers.

END OF SECTION 23 21 16

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Pump to be non-overloading, single-stage, bronze fitted, centrifugal type pump driven by single-speed, squirrel-cage motors.
- B. Pump manufacturer shall furnish and be responsible for the selection, compatibility, and performance of each unit consisting of pump, motor, coupling, and base plate.
- C. Pumps to be Bell & Gossett, Armstrong, Taco, Peerless, Aurora, Paco, Weinman, Grundfos or Tigerflow.
- D. NOTE: Motor horsepower indicated on schedule to allow non-overloading operation of pump. Pumps requiring larger motors will not be acceptable.
- E. Pumps shall not be selected requiring impeller sizes within 10 percent of maximum impeller size for that pump size and/or have an efficiency of 80 percent or less.

PART 2 PRODUCTS

2.01 IN-LINE PUMPS

- A. Volute to be cast iron, designed for 175 psi working pressure, include suction and discharge nozzles of equal size, gauge tappings, and drain fittings.
- B. Impeller to be bronze enclosed type, hydraulically and dynamically balanced, keyed to shaft and secured by suitable locking cap screw.
- C. Shaft to be steel. Replaceable shaft sleeve to be aluminum bronze. Shaft sleeve to completely cover wetted area under mechanical seal.
- D. Standard mechanical seal to be provided to seal off liquid cavity.
- E. Pump to be designed so pump internals can be serviced without disturbing connecting pipe.

2.02 MOTOR

- A. See separate Section 23 05 13.

2.03 COUPLING AND BASE PLATE FOR BASE MOUNTED PUMPS

- A. Manufacturer to furnish and mount pump and motor on common steel base plate with drip rim.
- B. Manufacturer to furnish and mount flexible coupling. Fasten metal coupling guard to pump base plate.
- C. NAMEPLATE: Provide pump and motor with stainless steel or aluminum nameplate securely fastened to casings. Nameplates to provide all data necessary for equipment identification and replacement.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide base-mounted pumps with soleplates, bedplates, or base plates carefully leveled, grouted, and bolted in place on concrete pads or foundations. Grout to be expanding type containing catalyzed metallic aggregate. After grout has set, cut flush with bedplate and seal to prevent fraying deterioration at edges.
- B. Install pipe supports on each side of in-line pumps to prevent undue strain on piping system.
- C. Make hot alignment check on couplings between motors and pumps. Operate equipment until components have reached operating temperature before hot check is made. Reposition equipment as required and repeat hot alignment check until parallel and angular alignments in both plan and elevation are within limits set by equipment manufacturer.
- D. Provide Suction Diffusers on each pump where show on the documents.

- E. Both entering and leaving flanges on pumps and suction diffusers are to be drilled and tapped for gauge connections.
- F. Concentric reducers are not permitted at pump inlets. To avoid air pockets, use eccentric reducers with flat side on top where transitions are required.

END OF SECTION 23 21 23

SECTION 23 23 00
REFRIGERANT PIPING SYSTEM

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Refrigeration piping, valves and fittings to connect split system heat pump air conditioning systems including computer room air conditioning systems.

1.02 SAFETY CODE

- A. Comply with the requirements of ANSI B9.1, Code for Refrigerant Systems.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Piping: Type "L" ACR hard copper, ASTM B88.
- B. Fittings: Wrought copper.
- C. Solder: Silver solder, or phos-copper solder having a melting point of 1125 degrees F. or higher.

2.02 EQUIPMENT

- A. Service Valves: Henry valves or equal. Provide packed type receiver, purge, and gauge valves with valve stem seal cap ports.
 - 1. Valves up to 5/8" O.D.: Henry Figure 516 or equal, diaphragm type.
 - 2. Valves larger than 5/8" O.D.: Henry Figure 203 or equal.
- B. Solenoid Valves: Manufactured by Sporlan Co., or equal, suitable for the type of refrigerant used, and of a type permitting manual lifting of stem for emergency operation. Size valves for pressure drop of 3 pounds at design flow.
- C. Refrigerant Filter Dehydrator: Sporlan Co. Reversible Heat Pump or equal sealed core type of size recommended by manufacturer for maximum design tonnage. For systems 20 nominal tons and larger, provide replaceable core filter driers.
- D. Moisture Indicator: Sporlan Co. See-All type SA-125 or equal.
- E. Pipe Supports:
 - 1. Pipes subject to vibration: Isolation type brackets.
 - 2. Pipes not subject to vibration: Grinnel No. CT-95 or equal.
 - 3. Riser clamps: Grinnel CT-121 or equal.
- F. Escutcheons: Chrome plated escutcheons sized for pipe.
- G. Sleeves: Provide sleeves as specified in Section 23 21 13 and 23 2213.
- H. Insulation: Insulate piping as specified in Section 23 07 10.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Make solder joints with carbon dioxide or nitrogen passing through joints being soldered. Ensure a clean, tight system. Pull a clean rag through each piece of tubing after cutting or reaming.
- B. Install pipe and hangers in accordance with hanger manufacturers' printed instructions.
- C. Provide escutcheons at all visible wall penetrations in finished areas.

3.02 LEAK TESTING

- A. Test for leaks by use of carbon dioxide or nitrogen and a liquid soapsuds solution. Correct leaks found.
- B. Evacuate system to 20" vacuum and charge with refrigerant until a pressure of 15 psig is reached. Then test for leaks using a Halide leak detector. Correct leaks found.

- C. Pressurize system, with carbon dioxide or nitrogen, to 300 psig on the high side, and 200 psig on the low side, and test for leaks. Correct leaks found.

3.03 SYSTEM DEHYDRATION

- A. Dehydrate system by "Double Dehydration" method.
- B. Use a suitable vacuum pump. Evacuate system to a vacuum of 0.2" Hg absolute and operate pump for eight hours when that pressure is reached.
- C. After eight hours, admit dry nitrogen directly to the system, and then evacuate system to a vacuum of 0.2" Hg absolute and operate pump for four hours.

3.04 CHARGING SYSTEM

- A. When system dehydration is complete and all leaks are corrected, charge system with refrigerant.

END OF SECTION 23 23 00

SECTION 23 25 13
WATER TREATMENT FOR CLOSED HYDRONIC SYSTEMS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide a complete water treatment system for the hot water systems as specified herein. Provide system start-up and adjustment.
- B. Provide one years supply of water treatment chemicals and systems pre-cleaning chemicals.
- C. Submit complete water treatment systems for approval.
- D. All hot water piping and related equipment shall be thoroughly flushed out with pre-cleaning chemicals designed to remove deposition such as pipe dope, oils, loose rust, mill scale and other extraneous materials. Recommended dosages of pre-cleaner chemical products shall be furnished by water treatment supplier and added and circulated throughout the water systems. The water systems shall then be drained, refilled and flushed thoroughly until no foreign matter is observed and total alkalinity of the rinse water is equal to that of the make-up water.

PART 2 PRODUCTS

2.01 CLOSED HOT WATER TREATMENT SYSTEMS

- A. Provide a one-shot chemical feeder of 5-gallon capacity and minimum 125 PSI working pressure for each closed water system. Feeder to be complete with funnel with fill valve, and inlet, outlet and drain connections.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install and place complete water treatment systems in proper operating condition in accordance with drawings, specifications, and manufacturer's published installation instructions. Provide communication link between water treatment microprocessor and Building Automation System PC.
- B. Permanent facility pumps should not be used for circulating the cleaning water. However if it is impractical to use temporary pumps, the permanent facility pump may be used provided that the pump is unconditionally warranted for two years, parts and labor, after the date of substantial completion by the mechanical contractor.
- C. Water treatment equipment manufacturers' representative to supervise systems pre-cleaning, water treatment systems installation and start-up, and train owners' representatives a minimum of 8 hours concerning proper feeding and control techniques. Provide two copies of water treatment systems operating and maintenance manuals to Designer.
- D. Cleanness of the system shall be determined by water sampling performed by the water management chemical engineer and witnessed and approved in writing by the General Contractor's quality control representative.
- E. System Startup Chemicals: Mechanical contractor shall purchase startup chemicals from HCA's designated supplier, and utilize the supplier's representative to operationally treat the systems until such time as this responsibility is formally accepted by HCA. Weekly testing of the efficacy of the chemical treatment of the cooling towers and boilers shall be conducted and the results immediately copied to the hospital's DFM.

END OF SECTION 23 25 13

SECTION 23 29 23
VARIABLE FREQUENCY MOTOR CONTROLLER

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Furnish complete variable frequency motor controllers (VSMC) as specified herein for the fans and pumps designated. All standard and optional features shall be included within the VSMC enclosure unless otherwise specified.
- B. Provide VSMCs for as scheduled on the drawings in accordance with this section. All VSMCs provided to be of same manufacturer.

1.02 QUALITY ASSURANCE

- A. To ensure quality and minimize infantile failures at the job site, the VSMC shall be burned in at an ambient of 40 degrees Celsius minimum for at least 120 hours. The VSMC shall be operating a dynamometer and the load and speed shall be cycled during the test. All optional and special features shall be functionally tested at the factory for proper operation.

1.03 WARRANTY

- A. The VSMC shall be warranted by the manufacturer for a period of 36 months from date of start-up. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized on-site service.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. VSMC to be as manufactured by ABB, Danfoss-Graham, York/Toshiba, or approved equal.
- B. The VSMC shall convert 3-phase, 60-Hz utility power to adjustable voltage and frequency, 3-phase, AC power for stepless motor speed control from 5% to 100% of the motor's Hz speed. Input voltage shall be as indicated on the equipment schedules on drawings.
- C. Converter Section: Full wave diode bridge rectifier.
- D. Inverter Section: Transistorized sine coded pulse width modulated (PWM) type for stepless motor speed control.
- E. Silicon-controlled rectifiers (SCRs) or GTOs shall not be used in the circuitry.
- F. The VSMC maximum output current rating shall be 110 percent of the motor nameplate full load current.
- G. The VSMC and options shall be tested to ANSI/UL Standard 508. The complete drive including all options shall be listed by a nationally recognized testing agency such as U.L. or ETL.
- H. The VSMC and options shall comply with the applicable requirements of the latest standards of ANSI, IEEE, and the National Electrical Code. The VSMCs full load amp rating shall meet or exceed NEC Table 430-150.
- I. The VSMC shall not emit either conducted or radiated RFI in excess of the limitations set forth in the FCC Rules and Regulations, Part 15, Subpart J, for class A computing devices. The VFD shall have an FCC compliance label. Provide RFI filters if required.
- J. The increase in audible motor noise with the VSMC operating shall not exceed 3 decibels.

2.02 BASIC FEATURES

- A. The VSMC shall include the following basic features:
 - 1. The VSMC shall be housed in a NEMA 1 wall-mounted enclosure.
 - 2. The following operator controls shall be located on the front of the enclosure:
 - a. Hand/Off/Auto selector switch to start and stop the motor. In the auto position, the drive will start/stop from a remote contact closure.

- b. Auto/Manual selector switch. In the auto position, motor speed is determined by the follower signal. In the manual position, motor speed is determined by the manual speed potentiometer.
- c. Manual speed potentiometer.
- d. Power on pilot light to indicate that the AFC is being supplied by the power line.
- e. Fault pilot light to indicate that the AFC has tripped on a fault condition.
- f. Digital meter to indicate percent speed and percent load.
- 3. Two sets of form C, dry contacts to indicate when the VSMC is in the run mode.
- 4. One set of form C, dry contacts to indicate when the VSMC is in the fault mode.
- 5. When input power returns to normal following a fault trip for under-voltage, over-voltage, or phase loss, the VSMC shall automatically restart. The VSMC shall not automatically restart following fault trips due to overload or over-current.
- 6. The VSMC shall include a door interlocked, padlockable, input power disconnect switch.
- 7. Speed Control: The output frequency may be adjusted in proportion to any one of the following:
 - a. 0-10 VDC Analog Signal.
 - b. 0-5 VDC Analog Signal.
 - c. 4-20 MA DC Analog Signal.
 - d. 3-15 psig Pneumatic Signal.
- 8. Coordinate with controls supplier for exact input signal and type to provide proper input follower (i.e., grounded or floating).
- 9. Provide open protocol BACnet MS-TP, LONtalk, Johnson N2, etc. interface card to connect to Building Automation System. Coordinate with existing controls system provider for preferred interface language.

2.03 PROTECTIVE FEATURES

- A. The VSMC shall include the following protective features:
 - 1. Current limiting semiconductor fuses for the power input.
 - 2. Separate overload relay for each motor controlled.
 - 3. Protection against input power under-voltage, over-voltage, and phase loss.
 - 4. Protection against output current overload and over-current.
 - 5. Protection against over-temperature within the VSMC enclosure.
 - 6. Protection against over-voltage on the DC bus.
 - 7. In the event of a power loss, shutdown without component failure. Upon return of power, automatically return drive to normal operation, if the start is in the "ON" condition, being able to restart into a rotating motor regaining positive speed control without shutdown or component failure.
 - 8. In the event of a phase-to-phase short circuit, shutdown safely without component failure.
 - 9. In the event that an input or output power contactor is opened or closed while the drive is activated, no damage to the VSMC shall result.
 - 10. Any disconnect switches between the VSMC and the motor shall include an auxiliary contact interlocked to the VSMC fault trip circuit. In the event that a disconnect switch is opened while the drive is running, the drive shall shut down.
 - 11. DC bus discharge circuit for protection of service personnel.
 - 12. Insensitive to incoming power phase sequence.

2.04 ADJUSTMENTS

- A. The VSMC shall include the following adjustments available via potentiometers inside the enclosure:
 - 1. Maximum speed, adjustable 50-100% base speed.
 - 2. Minimum speed, adjustable 0-50% base speed.
 - 3. Acceleration time, adjustable 2-60 seconds.
 - 4. Deceleration time, adjustable 2-60 seconds with override circuit to prevent nuisance trips if deceleration time is set too short.
 - 5. Current limit, adjustable 0-110%.

2.05 SERVICE CONDITIONS

- A. The VSMC shall be designed to operate within the following service conditions:
 - 1. Ambient temperature, 0-40 degrees C.
 - 2. 0-95% relative humidity, non-condensing.
 - 3. Elevation to 3300 feet without derating.
 - 4. AC line voltage variation, -5% to 10% of nominal.

2.06 SPECIAL FEATURES

- A. The following special features shall be included in the VSMC enclosure. The unit shall maintain its U.L. or ETL listing.
 - 1. A motor starter shall be included in the bypass circuitry for constant speed motor control when the VSMC is taken out of service. Manual bypass shall provide all the circuitry necessary to transfer the motor from the VSMC to the power line, or from the line to the controller while the motor is at zero speed. The bypass circuitry shall be mounted in a separate section of the VSMC enclosure. Two motor contactors, electrically interlocked, shall be utilized. One contactor is to be between the controller and the motor. The other contactor is to be between the bypass power line and the motor providing across-the-line starting for motors 50 hp and less, and part-winding or "soft start" starting for motors greater than 50 hp. Motor overload protection is to be provided in both the controller mode and the bypass mode. The bypass section door shall include a "drive/line" switch, "on/off-reset" switch, and a "load transferred to line" pilot light.
 - 2. The VSMC shall include a main fused disconnect switch or circuit breaker to provide a means of disconnecting all power to both the bypass circuitry and the controller. The disconnect switch or circuit breaker shall be door interlocked and padlockable. The fuses or circuit breaker shall be sized to provide short circuit protection for the motor when in the bypass mode per the NEC.
 - 3. A second disconnect switch, circuit breaker, or contactors shall be provided to disconnect input power to the controller but not the bypass circuitry. This disconnect will allow troubleshooting and testing of the VSMC, both energized and de-energized while operating in the bypass mode.
 - 4. Plug-in test meter shall provide a quick means for monitoring the different signals within the VSMC for start-up and troubleshooting. Where the meter is capable of operating with different horsepower VSMCs, only one meter needs to be supplied.
 - 5. A critical frequency avoidance circuit shall be provided to avoid operation at speeds which cause excessive vibration in the driven equipment.

PART 3 EXECUTION

3.01 INSTALLATION

- A. The manufacturer of the VSMC equipment shall provide a competent, factory trained service technician to supervise the installation, start-up and testing of the VSMC.
- B. Install VSMCs in locations shown on the drawings in strict accordance with the manufacturer's published installation instructions.
- C. Contractor shall provide such materials and assistance as required by the manufacturer's representative.
- D. Division 26 shall provide necessary electrical connections.
- E. Contractor shall provide coordination of the necessary controls not provided by the VSMC manufacturer.

3.02 START-UP, TESTING, DEMONSTRATION

- A. The manufacturer's factory-trained service technician, assisted by contractor, shall verify correct installation, start-up equipment, and test it as a unit and a part of the system it serves. Verify by adjustments, tests, etc., that the equipment is functioning as specified. Provide three copies of test data to the Owner. As a minimum, check the following items:
 - 1. Motor voltage and frequency.

2. Control input and automatic start/stop.
 3. Calibration and adjustment for minimum and maximum speed setpoints and acceleration and deceleration rates.
 4. Wire terminations.
- B. VSMC manufacturer shall provide a minimum of 4 hours instruction to Owner to demonstrate the operation of the system. Provide three copies of operation and maintenance manual to Owner at completion of instructions.
- C. A copy of the variable frequency drives certified startup sheets for all AHUs shall be provided to the construction manager / Cx team for record purposes within one week of start up.

END OF SECTION 23 29 23

SECTION 23 31 10
SHEET METAL DUCTWORK - LOW PRESSURE

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Low pressure ductwork refers to systems operating at 2.00" w.g. total static pressure with velocities up to 2000 FPM. It is the intent of this specification to provide an installed duct system which will supply the air quantities indicated by the plans and have the lowest possible friction loss with the least possible leakage loss. Friction loss for each system shall not exceed that which is indicated in the A.C. unit schedule as external static pressure or in the fan schedule as static pressure and shall include the losses of all accessories. Friction losses shall be minimized by reduction in the number of offsets and elbows by pre-planning the duct system installation and coordination with other trades to prevent interferences. Access to all accessories requiring maintenance, service and inspection shall be maintained. Radius elbows are preferred for all turns to minimize friction, noise and vibration; and, especially, for sections having large volume or higher velocities and sections which may have turbulences.
- B. The contractor shall provide and/or construct all materials, ductwork, joints, transitions, splitters, dampers, access doors, etc., as set forth in these specifications necessary to install the Low Pressure Sheet Metal Ductwork required by the Mechanical Drawings.
- C. Low pressure ductwork shall be constructed to meet the following pressure class:
 - 1. Supply ductwork downstream of terminal units: 1.0" pressure class.
 - 2. Supply and return duct connections to fan coil units (ESP ≤ 1.0): 1.0" pressure class.
 - 3. Supply and return duct connections to single zone air systems (ESP > 1.0 , ≤ 2.0): 2.0" pressure class.
 - 4. Exhaust and return ductwork (Fan ESP ≤ 2.0): 2.0" pressure class.
 - 5. Supply ductwork and plenums downstream of supply fans up to terminal boxes: 4.0" pressure class.

1.02 QUALITY CONTROL AND REGULATORY STANDARDS

- A. SMACNA Manual: Sheet Metal Tradesman is to have access on the construction site to the Latest Edition of SMACNA "HVAC Duct Construction Standards", (Metal and Flexible). The Manual is referred to in specifications for required construction methods and details. Contractor shall comply with provisions of the SMACNA Manual and more stringent requirements of this specification.
- B. Quality control involves not only the general performance requirements for all air ducts, but also quality workmanship which includes layout preplanning so that offsets, rises, falls, elbows, fittings, etc., are minimized or eliminated. General performance requirements for all ducts include:
 - 1. Dimensional stability (shape deformation and strength).
 - 2. Containment of the air being conveyed (leakage control).
 - 3. Vibration (fatigue and appearance).
 - 4. Noise (generation, transmission or attenuation).
 - 5. Exposure (to damage, weather, temperature extremes, flexure cycles, wind, corrosive atmospheres, biological contamination, flow interruption or reversal, underground or other encasement conditions, combustion, or other in-service conditions).
 - 6. Support (alignment and position retention).
 - 7. Thermal conductivity (heat gain or loss and condensation control).
- C. Provide galvanized duct materials which meet applicable requirements of SMACNA manual and local and state codes, whichever is the most stringent.
- D. Support ductwork in accordance with applicable requirements of SMACNA manual, local and state codes, and details on plans, whichever is the most stringent.
- E. Emboss fittings with material gauge, manufacturer, and type material.

- F. Materials used as sealers, pre-insulated jackets and flexible ducts shall comply with a flame spread rating of 25 or less and a smoke developed rating of not over 50.
- G. Joint sealer shall meet the requirements of UL181A or UL181B as applicable.
- H. Duct sealant classification: Seal all transverse joints, longitudinal joints and duct wall penetrations in accordance with SMACNA Class A. The sealant used to seal the longitudinal joints of low pressure ductwork must be visible or the joints shall require resealing in the field.

1.03 SUBMITTALS AND SHOP DRAWINGS

- A. Submit material/product data to designer for approval ONLY when it deviates from products specified in Part 2 herein.
- B. Shop Drawings: Contractor to submit to owner for approval complete sheet metal shop drawings of all ductwork, including equipment rooms, shafts, and especially congested areas and areas with possible conflicts. No installation shall proceed without owner stamped approval of shop drawings. Submittal to reflect space requirements coordinated with other trades such as Electrical, Plumbing, Mechanical and Structural. Prior to submission to owner, shop drawings to have stamped approval of all major trades which occupy ceiling space (HVAC, plumbing, piping, sprinkler, and electrical), to substantiate adequate coordination as to space, accessibility and to ensure no conflict exists between contractors.
- C. The General Contractor shall be responsible for coordination between trades and shall stamp and sign the duct drawings to substantiate that the coordination has been accomplished. Non-critical piping and conduit shall give way to ducts.
- D. Provide grease duct and kitchen hood shop drawings for review of code officials.

PART 2 PRODUCTS

2.01 MATERIAL

- A. Sheet Metal, Angles, Bar Slips, Hangers, and Straps: Galvanized steel.
- B. Screws: Cadmium plated.
- C. Joint Sealer: Hardcast Iron Grip 601 or equal, Single Stage Sealant Process.

2.02 FABRICATION

- A. Provide a rectangular or round duct where required on drawings of prime quality galvanized steel sheets, thickness and reinforcement as required by latest edition of SMACNA, or local and state codes, whichever is more stringent. When fabricating low pressure ductwork, largest duct dimension governs the entire duct and complete joint. **Ductwork to be no lighter than 24 gauge.** Contractor may substitute heavier gauge at no additional cost.
- B. Duct dimensions shown on drawings indicate inside clear dimensions.
- C. In addition to the requirements above, add supplemental bracing as necessary to prevent sagging, drumming, and vibration.
- D. Round prefabricated slip joint duct may be used on exhaust and return duct 12" and smaller and for runout duct to boxes, diffusers, registers, and grilles.
 - 1. Secure duct sections and fittings with sheet metal screws.
 - 2. Make connections of round duct to rectangular duct using "spin-in" collars with manual volume damper.
 - 3. Transverse and longitudinal slip joints shall be sealed with approved sealer.
- E. Provide transverse joints of "s" and drive construction at least every eight feet on duct whose larger side is less than 18". Seal all transverse joints with joint sealant material.
- F. Provide transverse joints, or equivalent supplemental angle reinforcing on 4 foot centers on duct whose larger side is greater than 18". At the contractor's option, duct mate or equal joint system may be substituted for "s" and drive construction. Seal all transverse joints with joint sealant material.

- G. Longitudinal seams shall be Pittsburgh Lock or grooved seams closed tightly and evenly. Button punch snap lock longitudinal seam construction shall not be allowed. Seal longitudinal joints which prove to leak with joint sealant material.
- H. Cross break ductwork over 10" dimension, either side.
- I. Do not exceed 20 degree angle of slope for increase-in-area transitions.
- J. Do not exceed 20 degree angle of slope for decrease-in-area transitions.
- K. Do not exceed 30 degrees on the entering side or 45 degrees on the leaving side for angle of transitions at connections to equipment without the use of approved vanes. 20 degree angle is preferred and should be used space permitting.
- L. Provide Ells fabricated to one of the following specifications in order of preference (SMACNA Figures 4-2 through 4-4 and Figure 4-9 and Chart 4-1):
 - 1. Unvaned elbow with the throat radius equal to 3/4 of the width of the duct and with a full heel radius.
 - 2. Six inch throat radius with full radius, single thickness vanes and full heel radius. Maximum unsupported length of vanes shall be 36". Vanes shall be securely fastened to runners. All vanes shall be secure and stable in installed operating position. Construct vane edges to project tangents parallel to duct sides.
 - 3. Square elbows with single thickness turning vanes. Maximum unsupported length of vanes shall be 36". Vanes shall be securely fastened to runners. All vanes shall be secure and stable in installed operating position. Construct vane edges to project tangents parallel to duct sides.
 - 4. Radius elbows are the preferred fitting. Square elbows are to be used only when available space prevents the use of radius elbows.
- M. Provide offsets as necessary in accordance with SMACNA Figure 4-7.
- N. Make branch connections and tees in one of the following manners:
 - 1. Converging radius elbow with MVD. (SMACNA Figure 4-5).
 - 2. 45-degree entry with MVD. (SMACNA Figure 4-6).
 - 3. Round spin-in fitting with MVD.
- O. Space duct joints to avoid cutting them for branch take offs and outlet collars.

PART 3 EXECUTION

3.01 INSTALLATION, APPLICATION, ERECTION

- A. Support ductwork on each side of the duct with suitable sheared strips of galvanized metal or 1" x 1/8" galvanized steel band iron hangers.
- B. Attach hangers to the ductwork using sheet metal screws.
- C. Secure hangers to concrete structure with approved anchor shields and to steel structure by means of C-clamps.
- D. Space hangers approximately eight feet along the duct except as noted below.
- E. For ducts 60" and larger and heavy sections, such as welded duct and sound absorbers, space hangers at approximately four foot intervals.
- F. Obstructions shall not be located within ducts.
- G. Do not exceed 45 degrees for easement transition angle.
- H. All ductwork, including supply, return and exhaust shall have circumferential joints, longitudinal joints, and duct wall penetrations externally sealed in accordance to SMACNA Class A. The sealant used to seal the longitudinal joints of low pressure ductwork must be visible or the joints shall require resealing in the field.
- I. Insulation: Where drawings and insulating specifications indicate that ducts are to be insulated make provisions for neat insulation finish around damper operating quadrants, splitter adjusting clamps, access doors, and similar operating devices. Metal collar equivalent in depth to

insulation thickness and of suitable size to which insulation may be finished to be mounted on duct.

- J. Counterflashing: Counterflash all ducts where they pierce the roof.
- K. Pitot Ports: Pitot ports for measuring airflow to be located in each main duct at the downstream end of the straightest run of the main and before the first branch take-off. Pitot ports to be formed by drilling 7/16" holes in the duct, lined up perpendicular to airflow on maximum 8" centers and at least three to a duct, evenly spaced. Holes to be plugged with plastic plugs. Provide access to these for future rebalancing.

3.02 CLEANING

- A. Clean ductwork thoroughly to assure all foreign matter, dirt, etc. is removed.

3.03 LEAKAGE TESTING OF INSTALLED SYSTEMS

- A. Test Low Pressure Ductwork as follows:
 - 1. Follow procedure published by United Sheet Metal Division of United McGill Corporation entitled "System Pressure Testing for Leaks" using prescribed test kit containing test blower, two U-tube manometers, and calibrated orifice tube.
 - 2. Leak test at least 50% of the low pressure supply (from the terminal de-vice to the air devices or supply ductwork from a low pressure AHU), and 50% of the return and exhaust ductwork to ensure duct tightness and air handler system performance. Leak test the supply duct from the AHU to the terminal boxes.
 - 3. Leak test all duct that is enclosed in a chase or above a drywall ceiling.
 - 4. Installed low pressure duct system to be pressurized to maximum amount for the appropriate pressure class. Air leakage at test pressure to be measured by a calibrated orifice type flow meter. Ductwork shall be tested in accordance with the 2012 Second Edition of SMACNA HVAC Air Duct Leakage Test Manual. Low pressure duct shall be considered a Seal Class "A" with a leakage class of 8 for rectangular duct and 4 for round duct. Allowable leakage rate shall be in accordance with the Figure 5-1L.
 - 5. Leakage concentrated at one point may result in objectionable noise even if system passes leakage rate criteria; correct to satisfaction of Designer.
 - 6. Orifice flow measurement device to be individually calibrated against a primary standard and calibrated curve permanently attached to orifice tube assembly.
 - 7. Leak testing shall be observed by the General Contractor's on-site quality control representative. The contractor shall have on site at all times the duct leak test training video distributed by the Owner. Maintain on site a set of prints to identify, in different colors, the duct sections isolated for each test, as well as the date of the leak test and final leakage rate recorded for each duct section.
 - 8. For low pressure ductwork where both longitudinal and transverse seams are fully sealed, leakage test described herein may be omitted.
 - 9. If system is tested in sections, leakage rates may be totaled to give performance of the whole system.

END OF SECTION 23 31 10

SECTION 23 31 11
SHEET METAL DUCTWORK - MEDIUM PRESSURE

PART 1 GENERAL

1.01 WORK INCLUDED

- A. The contractor shall provide and/or construct all materials, ductwork, joints, transformations, fittings, access doors, etc., as set forth in these specifications necessary to install the medium pressure sheet metal ductwork required by the drawings.
- B. Medium pressure - sheet metal ductwork with air velocity greater than 2000 feet per minute and static pressure 4" or less, but greater than 2".
- C. It is the intent of this specification to provide an installed duct system which will supply the air quantities indicated by the plans and have the lowest possible friction loss with the least possible leakage loss. Friction loss for each system shall not exceed that which is indicated in the A.C. unit schedule as external static pressure or in the fan schedule as static pressure and shall include the losses of all accessories. Friction losses shall be minimized by reduction in the number of offsets and elbows by pre-planning the duct system installation and coordination with other trades to prevent interferences. Access to all accessories requiring maintenance, service, and inspection shall be maintained. Radius elbows are preferred for all turns to minimize friction, noise and vibration; and, especially, for sections having large volume or higher velocities, and sections which may have turbulences.
- D. Medium pressure ductwork is required from the outlet of AHU to each variable volume terminal box and shall be constructed to meet a 4" pressure class minimum or higher as required to meet air handling unit design external static pressure.

1.02 QUALITY CONTROL AND REGULATORY STANDARDS

- A. SMACNA Manual: Sheet metal tradesman to have access, on the construction site, to "HVAC Duct Construction Standards, Metal and Flexible, Latest Edition. The Manual is referred to in the specifications for required construction methods and details. The Contractor shall comply with applicable provisions of the SMACNA Manual and the more stringent requirements of this specification.
- B. Quality control involves not only the general performance requirements for all air ducts; but also, quality workmanship, which includes layout preplanning so that offsets, rises, falls, elbows, fittings, etc., are minimized or eliminated. General performance requirements for all ducts include:
 - 1. Dimensional stability (shape deformation and strength).
 - 2. Containment of the air being conveyed (leakage control). (See Part 3 of this specification for leakage testing.)
 - 3. Vibration (fatigue and appearance).
 - 4. Noise (generation, transmission or attenuation).
 - 5. Exposure (to damage, weather, temperature extremes, flexure cycles, wind, corrosive atmospheres, biological contamination, flow interruption or reversal, underground or other encasement conditions, combustion, or other in-service conditions).
 - 6. Support (alignment and position retention).
 - 7. Thermal conductivity (heat gain or loss and condensation control).
- C. Provide galvanized duct materials which meet requirements of SMACNA manual and local and state codes, whichever is the most stringent. Ductwork to be no lighter than 24 ga.
- D. Support duct in accordance with SMACNA manual, local and state codes, and details on plans, whichever is the most stringent.
- E. Emboss fittings and duct sections with material gauge, manufacturer, and type material.
- F. Materials used as sealers, liners, pre-insulated jackets and flexible ducts shall comply with a flame spread rating of 25 or less and a smoke developed rating of 50 or less.
- G. Joint sealer shall meet the requirements of UL181A or UL181B as applicable.

- H. Duct sealant classification: Seal all transverse joints, longitudinal joints and duct wall penetrations in accordance with SMACNA Class A.

1.03 SUBMITTALS AND SHOP DRAWINGS

- A. Submit material/product data to owner for approval.
- B. Shop Drawings: The Contractor is to submit to Owner for approval complete sheet metal shop drawings of all ductwork, including equipment rooms, shafts, and especially, congested areas and areas with possible conflicts. No installation shall proceed without owner stamped approval of shop drawings. Submittal to reflect space requirements coordinated with other trades such as Electrical, Plumbing, Mechanical, and Structural. Prior to submission to Owner, shop drawings to have stamped approval of major trades which occupy ceiling space (HVAC, plumbing, piping, sprinkler, and electrical), to substantiate adequate coordination as to space and accessibility and to ensure no conflict exists between contractors.
- C. The General Contractor shall be responsible for coordination between trades and shall stamp and sign the duct drawings to substantiate that the coordination has been accomplished. Noncritical piping, low pressure ducts, and conduit shall give way to medium pressure ducts.

PART 2 PRODUCTS

2.01 MATERIAL

- A. Sheet Metal, Angles, Bar Slips, Hangers and Straps: Galvanized steel.
- B. Screws: Cadmium plated.
- C. Joint Sealer: Hardcast Iron Grip 601 or Equal Single-Stage Sealant Process.

2.02 GENERAL FABRICATION REQUIREMENTS

- A. Medium-pressure duct and fittings to be manufactured by a company who has had as its principal business the manufacture of spiral duct and welded fittings for at least five years.
- B. Medium-pressure fittings to be manufactured by same manufacturer of ductwork to assure tight fit of all ductwork and components.
- C. Supplier of medium-pressure ductwork to provide to Designer certified copies of test data made by independent United States laboratory covering all duct and fittings as manufactured by supplier.
- D. Duct test data to cover leakage rate, bursting strength, collapsing strength, seam strength, and friction loss. Friction loss test data to cover both duct and assembled coupling joints. Fitting test data to cover friction loss tests of all fittings shown on drawings.
- E. Installation manuals to be included by the Contractor with submittals. Manuals to provide detailed instructions on assembly, joint sealing, erection, reinforcement of flat-oval duct, and system pressure testing for leaks.

2.03 SPECIFIC FABRICATION REQUIREMENTS

- A. Round Duct and Fittings:
 - 1. Round duct to be manufactured using galvanized steel meeting ASTM A-525. Construction shall be in accordance with SMACNA manual and manufacturer's standards.
 - 2. Round duct is to have appropriate seams made to eliminate leakage based on pressures for which the system has been designed. Longitudinal seam duct to have fusion welded butt seam.
 - 3. Fittings and couplings shall have the minimum gauges specified by SMACNA Manual. Fittings to have continuous welds along all seams.
 - 4. Divided flow fittings (90 degree and 45 degree branches, wyes, crosses, etc.) to be manufactured as a separate fitting, not as a tap collar or saddle tap welded into spiral duct sections. Entrances to be free of weld buildup, burrs, or irregularities.
 - 5. Elbows in diameters 3" thru 8" to be stamped elbows. Other elbows to be gored construction with all seams continuously welded. Elbows to be fabricated to center line radius of 1.5 times the cross-sectional diameter. Two-piece mitered elbows shall not be used unless specifically shown on plans.

6. Spun bellmouth connections to be used at each round take-off from medium pressure plenum.
7. Galvanized areas damaged by welding to be coated with corrosion resistant aluminum paint.

2.04 COUPLINGS FOR ROUND MEDIUM-PRESSURE DUCT

- A. Diameters up to 60":
 1. Duct-to-Duct joints to be sleeve couplings, reinforced by rolled beads.
 2. Duct-to-fitting joints to be slip-fit of projecting collar fitting into duct.
 3. Insertion length of sleeve coupling and fitting collar to be 2" minimum.
- B. Diameters 61" and up:
 1. Duct-to-Duct and duct-to-fitting connections to be made by angle ring flanges. Flange on pipe to be a 2" x 2" x 3/16" angle attached to duct with continuous weld.
 2. Fittings to have loose ring "Van Stone" flange.
 3. Provide 5/8" flange to act as gasketing surface for sealing with the angle ring. Angle ring to be rolled, welded ring 2" x 2" x 3/16".
 4. Bolt hole spacing for angle rings to be on 6" centers.
 5. If longitudinal seam duct greater than 60" diameter is supplied in lengths greater than 5', one angle ring must be welded to duct on 5' centers. Welding can be an intermittent weld of 1" in 12".
- C. Flat-Oval Duct and Fittings:
 1. Provide flat-oval duct and fittings where indicated on drawings by symbol accompanying minor and major axis dimensions.
 2. Provide spiral-seam, flat-oval duct manufactured from galvanized steel in the following U.S. Standard gauges:

FLAT OVAL DUCT CONSTRUCTION, SPIRAL SEAM	
MAXIMUM WIDTH (IN.)	GAUGE
0 - 24	24
25 - 48	22
49 - 70	20
70 and up	18

3. Provide reinforcement and bracing in accordance with SMACNA manual and published details of spiral flat-oval duct manufacturer for size and pressure conditions applicable.
4. Matching flat-oval fittings to be manufactured from galvanized steel with continuous weld seams in the following U.S. Standard gauges:

FLAT OVAL FITTING CONSTRUCTION	
MAXIMUM WIDTH (IN.)	GAUGE
0 - 36	20
37 - 60	18
61 and up	16

5. Construct flat-oval duct for sizes not available in spiral construction to the following minimum gauges:

FLAT OVAL DUCT CONSTRUCTION, LONGITUDINAL SEAM	
MAXIMUM WIDTH (IN.)	GAUGE
0 - 36	20
37 - 60	18
61 and up	16

6. Flat-oval duct not of spiral construction to be adequately braced on 4' centers by reinforced couplings or angle ring flanges to limit amplitude of wall vibration to plus or minus 0.008" and maximum wall deflection to 0.52" at 6" static pressure. Provide angle flanges when maximum width exceeds 41" or when maximum height exceeds 26".
7. Spun bellmouth connection shall be used at each flat oval duct connection to medium pressure plenum.

- D. Rectangular Ductwork:
1. Reinforce rectangular duct with angles or internal tie rods. Joints to be double "S" slip up to 60" in width and companion angle flanged joint above 60" in width. Sheet metal gauges for medium pressure duct shall be as required by SMACNA 2005 manual.
 2. Fabricate elbows using one of the following methods:
 - a. Radius elbows are the preferred fitting. Square elbows are to be used only when available space prevents the use of radius elbows.
 - b. Six inch throat radius with full radius, single thickness vanes and full heel radius. Maximum unsupported length of vanes shall be 36". Vanes shall be secure and stable in installed operating position. Construct vane edges to project tangents parallel to duct sides.
 - c. Unvanned elbow with the throat radius equal to 3/4 of the width of the duct and a full heel radius.
 - d. Square elbows with H-E-P: High Efficiency Profile turning vanes as manufactured by Aero/Dyne Company. Turning vanes shall be double thickness airfoil design with smoothly-rounded entry nose and extended trailing edge. Turning vane assemblies shall be fabricated with side rails and installed on design centers across the full diagonal dimension of the elbow. Vanes are to be installed in strict accordance with manufacturers' recommendations.
 3. Contractor may request round or oval duct be substituted for any rectangular duct shown. Size substitutions to be based on equivalent airflow resistance.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Support round ducts from building structure with galvanized steel hangers as recommended in SMACNA manual. Secure hangers to masonry portion of building by means of inserts or other acceptable anchors. Secure hangers to steel structure members by means of C-clamps. Vertical risers and other duct runs where methods of support specified above are not applicable, to be supported by angle brackets as shown in SMACNA manual.
- B. Support rectangular and flat oval ducts by 1" x 1/8" galvanized band iron or 3/8" galvanized rod hangers attached to reinforcing angles and spaced same as reinforcing angles. Secure hangers to concrete beam or slab by inserts, anchor shield and bolt, toggle bolt, or expansion bolt.
- C. Attach hangers to ductwork using sheet metal screws.
- D. Space hangers approximately 8' along the duct for ducts under 60". For ducts 60" and larger and heavier sections, such as welded duct, space hangers at approximately 4' intervals.
- E. Hangers and bracing used with ductwork to be galvanized.
- F. Obstructions shall not be located within ducts.
- G. Provide smooth insulation finish around dampers, access doors, and similar operating devices. Provide metal collar equivalent in depth to insulation thickness.
- H. Provide pitot ports for measuring airflows in each main supply duct downstream of straightest run of main and before first branch takeoff. Form pitot ports by drilling 7/16" holes in the duct, lined up perpendicular to airflow on maximum of 8" centers. Provide minimum of 3 per duct evenly spaced. Plug holes with plastic plugs. Provide access to pitot ports for future re-balancing.
- I. Seal duct joints as follows:
 1. Apply sealer to male end of couplings and fittings. After joint is slipped together, place sheet metal screws 3" on center, 1/2" from joint bead. Apply sealer to the outside of the joint extending 1" on each side of the joint bead and covering screw heads.
 2. Duct sealer to be specifically formulated for the sealing of high-pressure duct systems. Submit sealer specifications for approval. Flame spread rating of sealer to be less than 25, smoke development rating of sealer to be less than 50. Apply joint material in strict accordance with manufacturers' published installation instructions.

3. Flanged joints to be sealed with neoprene rubber gaskets.
4. The sealant on longitudinal seams of field fabricated duct and fittings shall be visible on the exterior of the duct or the joints shall require resealing in the field.

3.02 LEAKAGE TESTING OF INSTALLED SYSTEMS

- A. Test medium pressure ductwork as follows:
 1. Follow procedure published by United Sheet Metal Division of United McGill Corporation entitled "System Pressure Testing for Leaks" using prescribed test kit containing test blower, two U-tube manometer, and calibrated orifice tube.
 2. Medium pressure duct to be pressure tested from the AHU to the terminal boxes.
 3. Installed medium-pressure duct system to be pressurized to 50% over design operating pressure to 6" w.g. maximum. Air leakage at test pressure to be measured by a calibrated orifice type flow meter. Ductwork shall be tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual. Medium pressure duct shall be sealed to a Seal Class "A" with a leakage class of 4 for rectangular duct and 2 for round or flat oval ductwork. Allowable leakage rate shall be determined in accordance with the SMANA Figure 5-1L.
 4. Leakage concentrated at one point may result in objectionable noise even if system passes leakage rate criteria; correct to satisfaction of Designer.
 5. Orifice flow measurement device to be individually calibrated against a primary standard and calibrated curve permanently attached to orifice tube assembly.
 6. Leak testing shall be observed by the General Contractor's on-site quality control representative. The contractor shall have on site at all times the duct leak test training video distributed by the Owner. Maintain on site a set of prints to identify, in different colors, the duct sections isolated for each test, as well as the date of the leak test and final leakage rate recorded for each duct section.

END OF SECTION 23 31 11

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Specialties to be submitted and approved before starting installation.
- B. Items to be installed approximately as shown on drawings taking into account differences in mechanical equipment submitted and that shown on contract documents. Each item to be installed so that it is readily accessible for maintenance, repair, and/or setting and balancing.
- C. Refer to drawings for diffuser, register, and grille sizes and number of airflow directions.

PART 2 PRODUCTS

2.01 FIRE DAMPERS

- A. Fire dampers to be U.L. listed in accordance with UL-555. Fire dampers to be held in an open position with a 165 degree F fusible link and arranged to lock in position on closure.
- B. Fire dampers for rectangular duct to be type "B" and for round duct to be Type "C". Fire dampers located behind sidewall registers and grilles and others specifically indicated on drawings to be Type "A". Fire dampers to be multi-leaf type with spring closing for horizontal mounting and weighted-gravity closing for vertical mounting. Dampers to be steel construction with rust resistant finish and provided with a factory-installed mounting sleeve suitable for structure. Mount per manufacturer's published U.L. approved installation instructions.
- C. See Architectural drawings for hour-rating of walls and/or floors. Dampers to be compatible with hour ratings.

2.02 COMBINATION SMOKE/FIRE DAMPERS

- A. Combination smoke/fire dampers to be U.L. listed both as 1-1/2 hour fire damper under UL-555 and as smoke damper under UL-555S as Minimum Leakage Category II and Elevated Temperature Category B (350 degrees F).
- B. Dampers to be steel construction with rust resistant finish and provided with 165 degree F electronic resettable fuse link (EFL) and factory-installed mounting sleeve suitable for structure. Mount damper per manufacturer's published U.L. approved installation instructions.
- C. Damper operator to be electric type compatible with electrical characteristics used for smoke detection and/or fire alarm system.
- D. Dampers to be Ruskin Model FSD36 with crimped type blades for low-pressure duct systems and Ruskin Model FSD60 with airfoil blades for medium- and high-pressure duct systems.

2.03 DAMPERS

- A. Automatic Control Dampers: All automatic control dampers to be furnished by Control Subcontractor and installed by this Contractor (except unit mounted dampers).
 - 1. Automatic control dampers to be low-leak, galvanized steel or aluminum construction parallel blade type, Ruskin Model CD50, or approved equal.
 - 2. Dampers to be complete with minimum 4" deep, 16-gauge hat-shaped channel frame, minimum 16 gauge blades on maximum 6" centers, 1/2" diameter shafts, and corrosion resistant bearings.
 - 3. Dampers to have extruded vinyl blade seals and stainless steel or aluminum flexible metal compression type jamb seals to limit leakage to a maximum of 1/2% (maximum of 5.4 cfm/sq. ft. leakage for 48" x 48" size damper) when tested in accordance with AMCA Standard 500.
 - 4. Motor actuator to be oil immersed gear train, 120-volt line voltage type with spring return to closed position on power interruption. Provide Honeywell Model M445/845, Barber-Colman MA-5210/5330 or approved equal complete with damper linkages.

- B. **Manual Volume Dampers (MVD):** Manual volume dampers to be hand-operated type dampers constructed of galvanized steel, minimum 22-gauge for duct widths 18" and less, minimum 16-gauge for duct widths greater than 18". Dampers for ducts to 12" height and 12" diameter to be single blade carried on a 3/8" round steel rod mounted inside of duct without frame and fitted with locking type quadrant and brass end bearing plate accurately drilled and secured to duct. Dampers for ducts greater than 12" height to be multi-blade type, 12" maximum blade width up to 30" blade length and 10" maximum blade width over 30" blade length. Blades to be mounted on frame with brass sleeve bearings interconnected for operation from one locking type hand quadrant. Round pivot rods to have section faced flat to receive locking setscrew in locking quadrant. Refer to SMACNA manual Figures 2-14 and 2-15.
1. For manual damper locations above a rigid or non-accessible ceiling or where damper access is limited, a remote damper operator shall be used. Damper operator to be self-locking worm gear designed for 3/8" damper shaft. Shaft extension to be 3/8" square rod with coupler. Remote operator to be provided with wrench operated shaft adjustment, position indication and lock nut. Where straight shaft extension cannot be used due to accessibility, a flexible cable operator with compatible damper operator and regulator may be utilized. Damper operator, shaft and regulator shall be designed for minimum 35 in-lb torque. Remote operator in non-sterile areas to be ceiling mounted with removable cover plate or mounted above access door. Sterile area installations such as surgery rooms or elsewhere as indicated on drawings shall use bracket mount installation above access door. Where multiple operators are routed to single or multiple access locations, provide markings to identify the associated air device for future use. The damper operator, shaft extension and ceiling termination/regulator shall be manufactured by Young Regulator, Inc. or approved equal.
 2. Ductwork manual volume damper (MVD) handles in externally wrapped ductwork shall be supplied with a stand-off bracket and locking quadrant to ensure that the handle can be adjusted without disturbing the insulation vapor barrier.
- C. **Backdraft Dampers (BDD):** Backdraft dampers to be Ruskin Model BD2-A2 or approved equal low-leak counterbalanced backdraft dampers. Dampers to be heavy-duty type suitable for air velocities to 2500 fpm with all extruded aluminum construction, minimum 0.81" thick frame, and minimum .050" thick blades on maximum 4" centers. Provide blades with vinyl edge seals. Provide dampers with aluminum linkage and corrosion resistant type bearings. Provide dampers with adjustable counterbalances on blades to assist closing.

2.04 SQUARE CEILING DIFFUSERS

- A. Provide Titus TDC or approved equal round or square neck, louvered face ceiling diffusers at all locations designated by schedule on drawings. Diffusers to be all aluminum construction. Frame to be flush mount for diffusers in "hard" ceilings and lay-in T-bar mount for diffusers in lay-in ceilings. Finish to be baked-on, off-white enamel.

2.05 LAMINAR FLOW DIFFUSERS

- A. Provide Titus TLF-AA or equal by Price, Anemostat, or Precision Air Products laminar flow, aluminum, perforated face ceiling diffuser at all locations designated by schedule on drawings. Diffuser to have round neck, deflector ring, 3/32" diameter holes on 1/4" centers in a 60 degree staggered pattern, retainer cable and suitable for either surface-mounted or laid-in T-bar ceiling system. Finish to be baked-on, off-white enamel.

2.06 SIDEWALL AND LOW-WALL RETURN REGISTERS

- A. Provide Titus 33-RS heavy duty registers at all locations designated on drawings. Registers to be minimum 16-gauge steel construction complete with minimum 38 degree deflection fixed blades spaced 1/2". Finish to be baked-on, off-white enamel. Blades to be parallel to floor.

2.07 CEILING RETURN & EXHAUST REGISTERS

- A. Provide Titus Model 50-F or approved equal at locations designated by schedule on drawings. Registers to be complete with 1/2" cube egg-crate aluminum grid. Finish to be baked-on, off-white enamel. Border to be flush mounted frame style.

2.08 AIR LOUVERS

- A. [Air louvers shall be Florida Building Code Approved and Miami-Dade Qualified, wind driven rain, extruded aluminum blades equal to Greenheck model EHV-901D, Construction Specialties model DC-9614 or approved equal. The exposed exterior wall face of the louver shall be horizontal blade type. The louvers shall be tested and have passed the following: AMCA POOL Air Performance and Wind Driven Rain, AMCA 540 Test Method for Louvers Impacted by Wind Borne Debris (Missile Level D and Missile Level E), AMCA 550 Test Method for High Velocity Wind Driven Rain Resistant Louvers, TAS 201 (Large and Small Missile Impact), TAS 202 (Uniform Static Air Pressure), TAS 203 (Cyclic Wind Loading). Louvers to have minimum 0.050" thick aluminum frame and blades. Louver depth to be 9". Blade construction to be horizontal rain resistant style. Finish shall be Kynar color selected by Architect. Louver shall be rated at: the beginning point of water penetration (0.01 oz. of water (penetration) per sq. ft. of louver free area is above 974 fpm, minimum 54% free area (48"x48" test sample), 0.25" S.P. resistance at 850 fpm. Provided 1/2" mesh expanded aluminum screen with removable frame mounted on inside inside face of louver. Provide minimum 10 year finish warranty.]

2.09 FLEXIBLE CONNECTORS

- A. Install UL listed flexible duct connectors between duct and fan/equipment connections. Flexible duct connectors to be made of 28-ounce, heavy glass fabric double coated with neoprene.

2.10 FLEXIBLE DUCT

- A. Flexmaster Type 1M Acoustical Attenuating or Approved equal. Submit acoustical performance of any alternate product for prior approval.
 - 1. Characteristics of flexible duct:
 - a. Approved as UL-181 Class 1 air duct.
 - b. Flame spread rating less than 25 and smoke developed rating less than 50.
 - c. Rated for 6" w.g. positive pressure, 4" w.g. negative pressure, and 5000 fpm air velocity.
 - d. Tear and puncture resistant reinforced CPE inner liner mechanically locked together with a corrosive resistant galvanized steel helix.
 - e. Insulated with minimum 1/2" thick fiberglass insulation with vapor barrier jacket.
- B. Seal off the insulation jacket at its ends and at joints with mastic, Hardcast, or similar material. Replace flexible duct if jacket is punctured.
- C. Flexible duct is NOT to be used for runouts where it must pass through walls or through smoke or fire partitions. Flexible duct is not to be used in exposed application. Flexible duct lengths shall not exceed 6 feet at each connection.
- D. No bends shall be made in flexible duct with the center line radius less than one and one-half duct diameter and only one bend may occur per 6 foot length of duct material.

2.11 DUCT ACCESS DOORS

- A. Duct access doors to be provided for access to all coils, fire, fire/smoke, and smoke dampers, automatic and backdraft dampers, duct smoke detectors, static pressure and air volume sensing devices, and other equipment installed in ducts and at other points indicated on drawings.
- B. Access door construction and airtightness must be suitable for the duct pressure class used (low, medium, or high).
- C. Access doors to be double-panel, galvanized steel construction with minimum 1" rigid insulation between panels. Access doors in exhaust duct and unlined return duct may be uninsulated single panel, galvanized steel construction. Doors to mount in rigid frame constructed of formed galvanized steel. Angle iron bracing to be used as required to provide rigid assembly. Doors to hinge on one side with door latch on opposite side.
- D. Access doors in ductwork shall fully comply with Figure 7-2, 7-3 and 7-2M of SMACNA manual. Casing access doors shall fully comply with Figure 9-15 and 9-16 of SMACNA manual. Minimum size shall be 12" x 12" per NFPA 80.

- E. Doors to close against gasket seal.
- F. Ductwork and/or equipment access doors shall be required at all motorized dampers, fire/smoke dampers, smoke detectors, airflow monitoring stations, duct-mounted temperature/pressure sensors and/or transmitters, vaned elbows, duct-mounted heat transfer coils, sound attenuators and any other mechanical and/or control device requiring inspection, maintenance or test access. In addition, 24" x 24" access doors should be utilized wherever possible to facilitate adequate access for maintenance and/or testing.
- G. Access doors for fire dampers, fire/smoke dampers, and smoke dampers shall be permanently identified on the exterior by a label having letters not less than 0.5 inches in height reading: "Fire Damper" "Fire/Smoke Damper" or "Smoke Damper" as required by 2012 International Mechanical Code.

2.12 DUCT MOUNTED SMOKE DETECTOR

- A. Duct mounted smoke detectors shall be furnished by Division 26. Coordinate power and control wiring. Installation of smoke detector shall by Division 23.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation to be in accordance with manufacturers' published installation instructions as well as applicable sections of SMACNA manual.
- B. Provide all screws, bolts, nuts, and inserts required for attaching sheet metal specialty items to ducts, walls, floors and ceilings.

END OF SECTION 23 33 00

SECTION 23 33 20
ACOUSTICAL BARRIER WRAP

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide barrier wrap equal to Kinetics Model KNM-100AL materials at locations indicated on the drawings or as otherwise directed.

PART 2 PRODUCTS

2.01 BARRIER WRAP

- A. Barrier wrap to be a single composite material consisting of a mass loaded limp, flexible, vinyl sheet noise barrier bonded to reinforced aluminum foil on exterior and 1" quilted fiberglass decoupling layer on interior.
- B. The barrier wrap to be nominal 1 lb/sq ft density and to have a minimum 28 STC rating as a free hanging barrier when tested according to ASTM E-90-90.

OCTAVE BAND TRANSMISSION LOSS (dB)					
125	250	500	1K	2K	4K
13	16	24	33	43	49

- C. The barrier wrap to have maximum flame spread rating of 10 and smoke developed index of 40 when tested in accordance with ASTM E-84.
- D. The composite material to have the following minimum insertion loss when adhered to 20 gauge sheet metal duct when tested according to ASTM E-222-90.

OCTAVE BAND INSERTION LOSS (dB)					
125	250	500	1K	2K	4K
6	7	18	24	27	28

PART 3 EXECUTION

3.01 INSTALLATION

- A. Wrap barrier around sheet metal completely covering the area indicated. Quilted fiberglass is to be placed against the sheet metal to decouple the outer limp barrier material from the metal. Securely fasten wrap with proper adhesive, kinetics acrylic based tape and/or bands.
- B. All joints are to be sealed with a 6" minimum overlap of limp barrier material similar to that used in the composite to form a continuous air tight barrier around the duct. This to be adhered with 100% coverage of adhesive.
- C. Seal all joints where the barrier wrap abuts the building construction with non-setting acoustical sealant such as DAP Acoustical Sealant or approved equal.

END OF SECTION 23 33 20

SECTION 23 34 00
CENTRIFUGAL FANS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section includes requirements for all centrifugal fans. Refer to drawings and schedules for style of fan and accessories to be provided.
- B. Provide fan type, capacity, direction of rotation, discharge direction, and arrangement as shown on drawings.
- C. Fans shall be Florida Building Code approved and Miami Dade qualified, with a current NOA approval. All manufacturer NOA Installation details to be included in equipment submittal.

1.02 PERFORMANCE

- A. Certify fan performance in accordance with AMCA Certified Air and Sound Rating Criteria Standard 210, 300, and 301.
- B. Fans shall be UL or ETL listed.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. ACME, Greenheck, Barry Blower, Twin City, Cook, or approved equal.

2.02 CENTRIFUGAL EXHAUST FANS

- A. Non-overloading, backward inclined, aluminum centrifugal fan wheel.
- B. Variable pitch V-belt drive or direct drive as scheduled.
- C. Roof or wall mounting as scheduled.
- D. Removable heavy gauge aluminum fan housing enclosing motor outside airstream.
- E. Permanently lubricated, ball bearing fan motor.
- F. Isolate fan motor, wheel, and drive from base with rubber vibration isolators.
- G. Electrical junction box.
- H. Gravity backdraft damper.
- I. Birdscreen around fan discharge.
- J. Upblast housing when scheduled on drawings.
- K. Solid state variable speed controller when scheduled on drawings.
- L. Sparkproof construction with explosionproof motor when scheduled on drawings.
- M. See fan schedule on drawings for other required accessories.

2.03 BELTED VENT SETS

- A. Belted vent sets shall be a completely packaged unit including fan assembly, motor, adjustable belt drive, and adjustable motor base.
- B. Wheels and Housings: Wheel diameters and discharge areas shall be sized in accordance with AMCA Standards.
- C. Housing Construction: Heavy gage continuously welded steel. Housings shall be suitably braced to prevent vibration and pulsation. Housings shall be field rotatable to different discharge positions. Inlets shall be fully streamlined. Provide inlet and discharge flanges.
- D. Painting: Factory applied, corrosion-resistant paint.
- E. Shaft: Solid hot rolled steel, ground accurately for a smooth bearing fit.
- F. Provide heavy duty, anti-friction, self-aligning ball or roller type bearings. Position bearing supports to directly oppose drive belt tensions and transmit loads to the fan base. Bearings to have a minimum L10 life of 40,000 hours.

- G. Mount motor on an adjustable slide rail base.
- H. Provide steel fan base.
- I. Motor horsepower and outlet velocities shall not exceed that scheduled on drawings.
- J. Fans shall be statically and dynamically balanced at the factory.
- K. Provide fans with OSHA approved expanded metal beltguards with tach hole for checking fan shaft speed.
- L. Provide fans which all use same type grease.
- M. Provide fan housing drain.
- N. Provide housing access door.
- O. Fans for outdoor mounting to be completely weatherproofed, with a fan motor and drive weather cover, and complete epoxy coating.
- P. Exhaust fans serving airborne infection isolation (All), decontam room, emergency department waiting rooms, shall discharge a minimum of 10'-0" above the finished roof. Refer to details on the drawings.

2.04 SQUARE CENTRIFUGAL IN-LINE FANS

- A. Non-overloading, backward inclined, aluminum centrifugal fan wheel.
- B. Variable pitch V-belt drive or direct drive as scheduled.
- C. Heavy gauge aluminum or galvanized steel housing with duct connection at fan inlet and outlet and removable access panels to access all interior components without removing ductwork or wiring.
- D. Permanently lubricated, ball bearing fan motor.
- E. Electrical junction box.
- F. Gravity backdraft damper.
- G. Belt guard/motor cover.
- H. Internally insulated housing when scheduled on drawings.
- I. Solid state variable speed controller when scheduled on drawings.
- J. Spring vibration isolators.
- K. See fan schedule on drawings for other required accessories.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install fans in locations shown on drawings in accordance with manufacturers' published installation instructions.
- B. Connect fans to ductwork by means of flexible connections.
- C. Fan and curb shall be installed per manufacturer's installation instructions to meet attachments for high wind and hurricane installation.

3.02 TEST AND ACCEPTANCE

- A. Start-up and checkout fan for proper motor phasing, alignment, and vibration free operation. Correct improperly aligned fans. Change unmatched belts.
- B. Demonstrate system operation to Owner's maintenance personnel and instruct them in operational and maintenance requirements.
- C. Verify that, where applicable, fans are interlocked with other fans as required by control drawings.

END OF SECTION 23 34 00

SECTION 23 36 00
AIR TERMINAL UNITS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Variable volume air terminal units to be pressure independent, single duct, DDC control type with hot water reheat coil pre-assembled unit with factory installed piping and controls (with individual transformer) and shall be pre-commissioned.
- B. Air terminal unit airflow and sound performance ratings to be certified in accordance with AHRI Standard 880. Unit maximum NC level shall not exceed NC 26 at 3.0" of static pressure at the inlet.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with requirements, provide products by the following:
 - 1. Johnson Controls Metasys
Contact: Kevin P. Tolbert
507 E. Michigan St, M-30
Milwaukee, WI 53202
email: BE-HCA@jci.com
478-952-8740

2.02 EQUIPMENT REQUIREMENTS

- A. Provide terminal units with minimum 22-gauge welded galvanized steel housing, slip and drive duct connection, hanger holes or brackets, and 1/2 inch thick internal fiber-free, closed-cell. Insulation shall comply with Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21. Insulation to be UL listed and meet NFPA-90A and UL-181 requirements.
- B. For terminals units with a 6" inlet or greater, airflow to be monitored by an integral, multiple point, averaging airflow sensing ring or cross to maintain constant airflow within 5 percent of rated cfm down to 25 percent of nominal cfm, independent of changes in system static pressure. Sampling points to be evenly spaced across the air terminal box inlet for better readings. Factory set, field adjustable settings for terminal unit maximum and minimum airflows to be provided in accordance with schedule on drawings. Integral flow taps and calibration chart to be provided for each terminal unit.
- C. On terminal units with inlets less than 6", a single point flow measuring device is acceptable.
- D. Internal resistance of terminal unit shall not exceed that scheduled on drawings when handling maximum scheduled air volumes.
- E. Terminal unit leakage rate to be maximum 2 percent of nominal catalog rated cfm at 3.00" w.g. inlet static pressure when tested according to ASHRAE 130.
- F. Maximum room N.C. due to discharge or radiated sound shall not exceed NC-35 when terminals are either in throttled or full open position with inlet static pressure ranging from 0.5 to 2" w.g. Correction of noise excesses not to constitute additional charges.
- G. Terminal units to be complete with factory installed, direct digital control actuator for connection to DDC controls provided by controls contractor.
- H. Provide factory mounted hot water reheat coils for terminal units scheduled on drawings in accordance with Section 23 82 13 Heating Coils. Minimum tube thickness of 0.016".
- I. Provide a discharge air temperature on each terminal unit. Temperature measurement to be 1000 Ohm RTD, 2-wire sensing element with +/- 0.3°F accuracy and a stability of less than 0.1°F in five years.

- J. Where box supplier has an offering for a constant volume box or a variable volume box controlled to a constant volume, provide the latter to obtain the most data points and for flexibility.
- K. An 8 inch diameter or 7.75 inch by 7.75 inch gasketed hinged access door shall be provided on the terminal unit. Door frame may be bolted, sealed or flanged to the casing. The door shall be double wall construction, gasketed and insulated. The Door shall be held in place with a cam lock latch allowing quick access without the use of tools.
- L. Shipping: All components to be adequately protected during shipping, pipes to be plugged to keep debris from getting into the pipe and fittings, pipe ends to be prevented from damage during shipping.
- M. Warranty: 1-year parts and labor warranty for all the parts of the pre-assembled air terminal box unit, with the exception of the controls contractor's scope of work.

2.03 PRE-PIPED VAV TERMINAL ASSEMBLY REQUIREMENTS

- A. Terminal box assembly shall consist of factory fabricated terminal unit, integral controls, coil, piping of the sizes, capacities and configurations shown on the drawings with catalogued part numbers. All controls and hydronics piping shall be accessible from the same side of the unit. All hydronics piping packages shall be piped in the opposite direction of the control panel, downstream of the VAV terminal unit. Controls Contractor shall be responsible for proper selection/sizing of the VAV based on scheduled performance parameters and the supplying of the VAV.
- B. The entire VAV assembly (terminal unit, coil, hydronics piping packages, controls hardware, electrical components and wiring) shall be seismically certified per IBC 2010 code with a 2.5 allowance factor and carry the OSHPD (OSP) certification.
- C. If required for single-side access, single duct terminal units with hot water coils shall be shipped with a factory supplied 16 inch duct extension attached downstream of the coil. The construction of the duct extension shall be equal to the quality of materials and workmanship to that of the terminal unit. All connections to be sealed with silver foil tape rated at 6" of total pressure. The insulation shall match the insulation of the VAV box.
- D. A control panel manufactured with a minimum 20 gauge sheet metal shall be supplied. The enclosure cover design shall allow for the following motions with a single universal design: a 180 degree hinged motion, a sliding motion from left to right and right to left including full removal of the enclosure cover without tools. The controls cover shall reside in a set position without the use of mechanical fasteners or screws. "Quick Release" sheet metal tabs/guide stops shall be supplied to allow the cover from slipping off when in the fully open position. The "Quick Release" tabs/guide stops shall be designed in such a way to allow the complete removal of the cover. A handle shall be supplied on the controls cover for opening and closing the controls cover. The control enclosure shall have factory installed knock outs for mounting all the electrical and controls components required. All electrical and electronic components including both line voltage and low voltage shall be mounted in the metal controls enclosure per applicable codes. The control panel shall include stand-offs to allow mounting of the controls and electrical items without penetrating the VAV terminal box casing.
- E. A single point power connection shall be provided to the VAV unit. Low voltage wire from the ATC control valve actuator to the DDC controller shall be wired in 3/8 inch flexible conduit in accordance with UL-1995 and the National Electric Code. An electrical junction box with a disconnect switch, 24 volt transformer with low voltage wiring shall be provided and mounted on the VAV by the VAV manufacturer. All relays required shall be installed and wired in the electrical enclosure.
- F. Hot water coils shall be factory installed with a maximum of ten (10) aluminum fins per inch and rated in accordance with ARI 410. The coil circuiting shall be a multi circuited header with corrosion free brass manual air vent piped in at the highest and lowest point of the piping header to ensure efficient drainage and air removal from the coil. A metal coil-u-bend cover shall be factory installed on the coil u-bends to protect the coil u-bends during shipment and installation.

Upstream and downstream coil casing connections to terminal unit and duct extension to be sealed with silver foil tape rated at 6" TSP. Tube thickness shall be a minimum of 0.016"

- G. VAV boxes serving operating rooms and C-section rooms shall have a minimum of two-rows for rapid room warm-up. Two-row coils are preferred in all applications to reduce fan power requirements and sound transmission.
- H. Two (2) 90 degree copper pipes formed on a tube bender shall be sweated directly to the header of the coil with a minimum distance of 6 inches from the coil inlet and to the coil outlet regardless of the coil size. Sweated copper elbows and fittings are not acceptable to achieve the same result.
- I. A minimum of two adjustable Universal Handle Brackets with built in handles shall be supplied for every VAV furnished. Handles shall be constructed with a minimum of 14 gauge metal shall be painted to avoid corrosion and stress fractures of hydronics. Handle opening shall be able to accept a minimum of the following lifting devices through the handle portion of the bracket without damaging the product: human hand, forklift, Unistrut, pipe or other lifting devices. The handle shall have a 180 degree – "rolled up edge" to prevent injury to the human hand: raw edges or non-rolled edges shall not be accepted.
- J. The shipping handle brackets shall use 4 military grade rubber grommets for elimination of galvanic corrosion and isolation between copper piping and support handles. The rubber grommets shall be made of Buna-N and be resistant to petroleum-based oils and fuels, water and alcohols.
- K. The piping assembly and coil shall be field reversible. The hydronics piping structure and 2 handle shipping brackets shall be attached to the coil inlet and outlet connections as one assembly integral to the VAV. All piping assemblies for the VAVs supplied shall be identical and interchangeable for inlet sizes of four (4) inch through 24 inch. The supply and return aspect ratios of the inlet and outlet piping shall be 6 inch on center of the coils. The piping aspect ratio is identical for all VAVs supplied regardless of VAV box/coil size.
- L. The following minimum factory installed piping components shall be supplied; a valve package consisting of a stainless steel ball valve with a #20 stainless steel screen to act as a strainer, a union, P/T (pressure temperature) port, drain or blow-down with integrated stainless ball valve and removable brass end cap to seal the drain connection. Union with P/T port. All P/T ports require an extension of a minimum of 1.5 inches. Stainless steel isolation valve, union, and P/T readout ports. Pressure gauge to confirm 100% leak free product delivery. Type "L" ¾ inch copper pipe.
- M. Memory stops shall not be provided with VAV boxes, but shall be available from the manufacturer for field retrofit without the need to replace the entire valve, should the need arise.
- N. A ½ inch control valve with stainless steel ball and stem shall be provided and factory installed in the piping trim at the factory. A 24 volt electric non-spring return modulating valve actuator shall be provided. The actuator wires shall be terminated to the VMA controller. Both the actuator and control valve shall be tested before leaving the factory.
- O. Four aircraft cables shall be factory installed on the VAV with the job specific platform fastening mechanism at the end of the aircraft cables. Cables shall be a minimum of 10 feet long. Cables shall be rated for a minimum of 100 lbs each with a 5:1 safe working load allowance.
- P. A transformer with primary and secondary transformer fusing with a toggle disconnect switch shall be provided and installed at the factory. All secondary wiring from the toggle switch and transformer to the VMA vav controller shall be factory installed and tested before shipment.
- Q. A platinum 1k ohm DAT (Discharge Air Temperature) Sensor shall be provided. The DAT sensor shall have a stainless steel mounting flange with two hex-head self-drilling mounting screws and come equipped with a 10 ft plenum rated cable with ¼" female insulated quick-connect terminator leads. Cable must meet UL 1995 requirements for installation within an air plenum. The DAT sensor shall be factory installed in the duct extension at the farthest point downstream of the coil.

The DAT sensor shall be factory checked for proper resistance range and factory-wired to the VMA- 1630 controller.

- R. A VAV box controller shall be provided and factory installed. All wiring from the DAT, transformer and control valve shall be connected and tested at the factory. The pneumatic tubes from the air flow sensor shall be connected to the controller transducer at the factory

2.04 QUALITY ASSURANCE

- A. The hydronics piping structure and coil shall be charged with nitrogen or other appropriate dry gas at the factory before shipment at greater than sea level pressure at the assembly area; seal the gas in the piping structure: Test the sealed piping structure and coil for a minimum of 12 hours to determine whether the gas stays within the hydronics Piping Structure and coil through the use of a pressure gauge. If the gas leaks from the hydronics piping structure per the pressure gauge identify the leak, fix it and re-test upon verification of the piping structure having zero leakage of the gas prior to shipment.
- B. Transport the sealed and pressurized piping structure with coil from the factory to the construction site; determining a pressure of the gas at the construction site. If hydronics structure and coil arrives without holding pressure, then Contractor to trouble shoot and fix leak.
- C. Inside of terminal unit and duct extension to be cleaned and wiped down. Inlet and discharge shall be wrapped with a protective cover. All VAVs shall be individually tagged, strapped down, palletized, enclosed in cardboard boxes and shrink wrapped with a pallet stretch machine. Labels with bar codes shall be adhered to the to each unit with the following information: Tag numbers, Model no, Serial no., Date of manufacture, Manufacturer, Inlet size, MFG, ID # and Job Name. Electrical wiring schematic shall be adhered to the outside of each control enclosure. Additional tagging to be placed on the outside of the cardboard box shrink wrapping. Shipping boxes shall list all relative shipping information including reference ID no., telephone number and name of person/entity receiving the product(s), and tags of individual VAV units on the pallets
- D. Inlet of terminal unit and outlet of duct extension to be sealed with a plastic wrap to keep air borne particles out of the inlet and outlet of the VAV. In addition, the entire assembly shall be wrapped and secured to the shipping pallet.
- E. Factory Commissioning of Controls and Software
 1. Load appropriate VAV program into the DDC controller and program all the performance parameters commensurate for each zone/VAV unit per schedule supplied by the controls contractor
 2. Properly address each controller with the correct address in order for the BAS system to identify each DDC controller.
 3. Power up the VAV and run the program through full cycle operation. Stroke the damper actuator to full open and then to closed position. Stroke the temperature control valve to full open and full closed.
 4. Set and Ship all actuators in the open position
- F. Digital Data Retrieval System – VAV manufacturer shall provide the following as part of the Operational and maintenance manuals in digital form:
 1. Digital images of each individual VAV shipped including the hydronic piping packages, controls hardware, electrical, coil and terminal unit taken before shipment.
 2. Controller software and individual VAV performance files specific for each VAV by tag number.
 3. Approved Submittals
 4. Operational and maintenance instructions
 5. Drawings
 6. Part numbers

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install terminal units in strict accordance with manufacturers' published installation instructions.

- B. Terminal units to be supported directly from unit to structure with appropriate supports.
- C. Refer to section 01 91 13 for terminal box commissioning requirements and methodologies.
- D. The HCA standard is that heating coils on VAV boxes are not provided with individual balancing valves. Balancing valves are instead to be provided at every floor, wing, and at every branch serving a minimum of 3 VAV boxes. Confirm balancing of individual terminal box is not included in the base scope of work of the Test and Balancing agent.
- E. Provide shutoff valves as required for maintenance and replacement without a large-scale shutdown of equipment.

END OF SECTION 23 36 00

SECTION 23 40 00
HVAC AIR CLEANING DEVICES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Furnish and install filters as scheduled on drawings with appropriate draft gauge(s).

1.02 QUALITY ASSURANCE

- A. All filters to meet NFPA 90A requirements for flammability.
- B. Filters with a 90% efficiency and less shall be tested in accordance with ASHRAE Standard 52.
- C. Filters with a 95% efficiency and higher shall be rated under the D.O.P. test requirements.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. American Air Filter, Flanders, CamFilFarr, TriDim, Koch, and 3M.

2.02 MANOMETER

- A. Provide a Dwyer magnehelic gauge across each filter bank.
- B. Mark gauge to indicate design clean and dirty loading conditions.

2.03 MEDIUM-EFFICIENCY DISPOSABLE FILTERS

- A. Provide medium efficiency, disposable, pleated media filters at locations shown on drawings.
- B. Each filter shall consist of a non-woven cotton media, media support grid, and enclosing frame.
- C. Filter shall be listed by UL as Class II.
- D. Provide MERV 11 (60% efficiency) per ASHRAE Test Standard 52.
- E. 2-Inch Thick Media: Effective filter media area shall not be less than 4.6 square feet of media per square foot of face area.

2.04 HIGH-EFFICIENCY CARTRIDGE FILTERS

- A. Provide MERV 14 (90% efficiency) per ASHRAE Standard 52 to locations shown on drawings.
- B. 12-Inch Thick high-efficiency cartridge type filter.
- C. Filters to have average velocity through media of not more than 25 fpm.
- D. Filters to be selected in accordance with schedule for face velocity in order to produce efficiency and not exceed initial and final resistance as indicated on drawings.

2.05 HOLDING FRAMES

- A. Frames to be constructed of 16-gauge galvanized steel.
- B. Designed to provide a positive seal against leakage of unfiltered air.
- C. Pre-drilled for convenient assembly into banks.
- D. Integral spring type latches for holding filter against sponge rubber gaskets.
- E. Install frames to provide service from the dirty air side.
- F. The Cx authority shall inspect the filter arrangement for tight fit and absolute minimal bypass leakage around frame assembly and it shall be the responsibility of the contractor to correct any deficiencies prior to acceptance by the Owner.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide filters and housings of size and capacities scheduled on drawings.
- B. Mount filters and housings at locations shown on drawings.

- C. Provide one complete change of filter media for each air handling unit, delivered to job site and turned over to Owner at final inspection.
- D. Install filters in accordance with manufacturers' published installation instructions.
- E. Install draft gauge(s) outside of air stream for each bank of filters.
- F. Protect heating coils, cooling coils, and ductwork with filter media during construction.
- G. Upon completion of ductwork and fan system, thoroughly clean systems and install specified filter media prior to placing system in operation.
- H. The installing contractor shall be responsible for providing a new set of clean filters during initial system startup and at the start of TAB fieldwork for all air handling units. In addition, temporary filter media shall be removed and final unit filters shall be installed prior to final unit setup by the TAB agency (i.e., prior to final unit traverse).

END OF SECTION 23 40 00

SECTION 23 51 00
BREECHINGS, CHIMNEYS, AND STACKS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Furnish and install factory-fabricated, UL listed, double wall, type "B" gas vent piping and fittings for combustion air duct.
- B. Furnish and install factory-fabricated, UL listed, double wall, positive pressure vent piping and fittings for forced/induced draft heating systems for condensing exhaust flues.
- C. Furnish and install windproof vent caps at all flue outlets.

1.02 QUALITY ASSURANCE

- A. Double Wall Type "B" Gas Vent Systems shall comply with the following standards:
 - 1. UL 441.
 - 2. UL 795.
 - 3. NFPA 54.
 - 4. NFPA 221.
- B. Double Wall Positive Pressure Systems shall comply with the following standards:
 - 1. UL 103.
 - 2. NFPA 37.
 - 3. NFPA 54.
 - 4. NFPA 211.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Selkirk Metalbestos.
- B. American Metal Products Co (AMPCO).
- C. Metal-Fab Inc.
- D. Stacks Inc.
- E. AERCO International.
- F. Cleaver Brooks.
- G. Fulton Boiler Works, Inc.
- H. Lochinvar Corporation.
- I. Superior.
- J. Approved equal.

2.02 EQUIPMENT

- A. Type "B" Gas Vent:
 - 1. Provide AGA and UL listed double wall, gas vent pipe and fittings for gas-fired appliances at locations shown on drawings.
 - 2. Maximum 400 degrees F operating temperature.
 - 3. Inner Shell:
 - a. 0.014 inch thick aluminum for pipes up to 18 inch diameter.
 - b. 0.018 inch thick aluminum for pipes 20 inch through 30 inch diameter.
 - 4. Outer Shell:
 - a. 28 gauge galvanized steel for pipes up to 18 inch diameter.
 - b. 26 gauge galvanized steel for pipes 20 inch through 30 inch diameter.
 - 5. Shell Separation: 0.5 inch air space.
 - 6. Minimum rated clearance to combustible construction: 1 inch.
 - 7. Insulating Characteristics: 0.5 BTU/hr-sq. ft.-degrees F.
 - 8. Couplings: Snap Lock.

9. AMPCO Model R or approved equal.
- B. Double Wall Positive Pressure System:
 1. Provide UL tested and listed double wall pipe and fittings suitable for forced/induced draft boilers, diesel exhaust, industrial ovens and process ducting at locations shown on drawings.
 2. Suitable for use with natural gas, #2 fuel oil, LP, and wood.
 3. Maximum 1000 degrees F continuous operating temperature, or 1400 degrees F intermittent.
 4. Inner Shell:
 - a. 20 gauge 304 stainless steel for wood, LP, natural gas and #2 fuel oil.
 - b. 20 gauge 316 stainless steel for all other fossil fuels.
 5. Outer Shell: 24 gauge aluminum coated steel.
 6. Shell Separation: 1 inch air space.
 7. Minimum rated clearance to combustibles: 10 inches.
 8. Couplings: Flanged containment band.
 9. AMPCO Model VSI-2, Metalbestos Model PS, or approved equal.
- C. Triple Wall Positive Pressure System:
 1. Provide UL tested and listed double wall pipe and fittings suitable for forced/induced draft boilers, diesel exhaust, industrial ovens and process ducting at locations shown on drawings.
 2. Suitable for use with heating equipment burning gas, liquid, or solid fuels as described in NFPA 211, Chapter 2.
 3. Maximum 1000 degrees F continuous operating temperature, or 1400 degrees F intermittent.
 4. Inner Shell:
 - a. 20 gauge 304 stainless steel for wood, LP, natural gas and #2 fuel oil.
 - b. 20 gauge 316 stainless steel for all other fossil fuels.
 5. Center & Outer Shells:
 - a. 24 gauge aluminum coated steel for 6 inch to 24 inch diameters.
 - b. 20 gauge aluminum coated steel for 26 inch to 36 inch diameters.
 6. Shell Separation:
 - a. Inner ring: 1 inch air space.
 - b. Outer ring: 0.5 inch air space.
 7. Minimum rated clearance to combustibles: 4 inches.
 8. Couplings: Flanged containment band.
 9. AMPCO Model VSI-3 or approved equal.
- D. Vent Caps:
 1. Provide windproof flue vent caps for all gravity vent systems.
 2. Caps to be designed with an integral baffling system to maintain a negative draft in the system irregardless of wind velocity or direction.
 3. Galvanized steel construction with birdscreen outlet covers.
 4. Vent caps to be manufactured by Breidert Company or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install all vent piping and fittings in strict accordance with manufacturers' published installation instructions.
- B. Type "B" Gas Vent Systems:
 1. Terminate vent piping at least 5 feet above draft diverter.
 2. Attach vent piping to draft hood with sheet metal screws.
 3. Securely strap vent piping in position and maintain at least 1 inch air space clearance to combustibles.
 4. Install an approved roof thimble at each roof penetration, sized to provide minimum 1" clearance from flue pipe.

5. Terminate gas vent piping at least 3 feet above the roof and 2 feet higher than any portion of the roof located within 10 feet horizontally.
 6. Vent piping terminating more than 5 feet above the roof shall be guyed or braced.
 7. Terminate all gas vent piping with a Breidert windproof cap unless noted otherwise.
- C. Double Wall Positive Pressure Systems:
1. Provide necessary angle iron frames and support plates to support weight of vertical stacks.
 2. Seal inner pipe joints by use of Containment Bands and RTV silicon sealant for flue gas temperatures up to 600 degrees F.
 3. Above 600 degrees F, joints to be sealed with high temperature joint cement.
 4. Terminate vent piping for medium heat appliances (Boilers operating over 50 psig) not less than 10 feet higher than any portion of the building within 25 feet.
 5. Provide an approved roof support and penetration assembly for each stack penetration of the building roof structure.
- D. All parts exposed to the outdoors shall be protected with one base coat and one finish coat of paint, equal to Series 4200 - 4300 heat resistant paint manufactured by Rust-O-Leum Corp.

END OF SECTION 23 51 00

SECTION 23 52 16
BOILER, CONDENSING HIGH EFFICIENCY

PART 1 GENERAL

1.01 INCLUDED WORK

- A. Furnish labor, materials, tools, equipment, and services for boilers as specified herein, sized and located in accordance with mechanical drawings.

1.02 RELATED WORK

- A. Section 23 09 23: Direct Digital Control / Building Automation System (DDC/BAS)
- B. Section 23 21 13: Hydronic Piping
- C. Section 23 21 16: Hydronic Piping Specialties
- D. Section 23 51 00: Breechings, Chimneys, and Stacks

1.03 QUALITY ASSURANCE

- A. Design, construct, and factory test boiler in accordance with ASME Code for Boilers and Pressure Vessels, Section 1, Power Boilers, and state and local boiler codes.
- B. Boiler shall receive authorized boiler inspection and bear ASME Stamp, and be UL 795 listed.
- C. Fire test boiler at factory with the specified fuel(s) to check operation and function of controls. Provide source and field quality control test reports to owner.
- D. Gas train assembly shall meet the requirements of Industrial Risk Insurers (IRI) or Factory Mutual (FM).
- E. Boiler shall be provided with a minimum 10 year warranty (or manufacturer standard whichever is greater) against failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.

1.04 SUBMITTALS

- A. Submit product data for Designer's approval as required by Section 23 05 00.

1.05 DOCUMENTS

- A. Provide the following documents to be delivered upon completion of work:
 - 1. Certificates/Permits
 - a. ASME Certificate
 - b. National Board of Pressure Vessels Inspectors Certificate
 - c. Guarantee
 - d. Construction and Operating Permits (where required by state or local regulations) from Air Pollution Control Authorities.
 - e. Certificate of Acceptance or Boiler Operating Permit from State Boiler Inspector.
 - 2. Operation and Maintenance Data:
 - a. Boiler Emergency Manual
 - b. Boiler Operation Manual
 - c. Boiler Maintenance Manual

1.06 PERMITS

- A. Contractor shall obtain construction and operating permits from local Air Pollution Control Authorities and boiler and/or insurance inspectors.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers are:
 - 1. Aerco.
 - 2. Lochinvar.
 - 3. Cleaver Brooks
 - 4. Approved Equal.

- B. Boilers submitted as alternate to that scheduled on the drawings must be of a size to fit in the space allowed. Boilers are to be provided with a minimum of 3'-0" clear to all sides unless boiler is UL listed to be mounted as a single module with additional units.
- C. Boilers submitted must contain the following information: performance data, dimensions and clearances for service, operating characteristics, furnished specialties and accessories, efficiency curves @ 100%, 50% and 7% firing rates and water temperatures ranging from 60F to 160F, pressure drop curve from boiler minimum flow to max flow, and vent requirements.
- D. [If boiler submitted is an alternate manufacturer or model from the basis of design, contractor and manufacturer are responsible for submitting a coordinated package with all modifications required for the alternate model to work within the as designed system. This will include piping modifications, pump modifications, vent modifications, control modifications, and electrical circuiting requirements. Specific attention is to be given to flow rates of the boiler and any requirements for constant volume boiler flow with variable volume secondary or building flow.]

2.02 BOILERS – GENERAL CONSTRUCTION

- A. Condensing high efficiency heating water boiler, complete with all controls and accessories ready to operate on natural gas as primary fuel, and propane as back up fuel.
- B. Capacity and working pressure: As scheduled on drawings. Boiler shall be factory fabricated, factory-assembled and factory-tested, fully condensing boiler with heat exchanger sealed pressure-tight, built on a steel base, including insulated jacket, flue-gas vent, combustion air intake connection, water supply, return, and condensate drain connections and controls.
- C. The boiler shall be manufactured in accordance with ASME Boiler and Pressure Vessels Code. The pressure vessel shall have flanged 150 pound ANSI rated water connections sized for the appropriate flow of the boiler. Pressure vessel shall be constructed of carbon steel or stainless steel.
- D. The heat exchanger shall be stamped with the appropriate ASME working pressure not less than 160 psi and manufactured of stainless steel. Pressure vessel/heat exchanger shall be of welded construction. Access to the heat exchanger shall available for inspection and removal.
- E. Burner and Modulating air/fuel valve shall be capable of turn down scheduled on the drawings without the loss of combustion efficiency or staging of gas valves. A VFD controlled blower shall be used to ensure the optimum mixing of air and fuel.
- F. Exhaust manifold shall be corrosion resistant cast aluminum or 316 Stainless Steel. Manifold to have gravity drain for condensate.
- G. Blower to include VFD control and operate during the burner firing sequence and pre-purge the combustion chamber. Blower motors shall not operate in the service factor of the motor.
- H. Ignition shall be via regulated staged spark ignition with 100 percent main valve shut off and electric flame supervision.
- I. The boiler shall be completed with a metal jacket consisting of a rust resistant alloy steel casing with a two coats hard enamel finish. Jacket shall be readily removable by section.
- J. Provide electrical voltage as scheduled on the drawings. Provide factory installed and wired all require controllers, switches, devices and wiring with single point power connection. All wired in conformance with applicable provisions of the National Electric Code.
- K. Ceramic fibers that may be potentially carcinogenic to humans is unacceptable as a combustion liner.

2.03 BOILER CONTROLS AND SAFETY CIRCUITS

- A. Control panel shall be UL listed and include LED display. Controls shall annunciate boiler and sensor status and include extensive self diagnostic capabilities the incorporate separate status and fault messages. Combustion safeguard/flame monitoring system shall use spark ignition and a rectification type flame sensor. Controller is to automatically restart after a loss of power in the same mode as before interruption.

- B. Controls shall incorporate the following self governing modes where it receives and external control signal to eliminate nuisance faults due to over temperature, improper external signal or loss of external signal. 1) Set point High Limit 2) Set point Low Limit 3) Failsafe Mode
- C. Boiler control system shall include the following:
 - 1. System Start Temp
 - 2. Pump Delay timer
 - 3. Auxiliary start delay timer
 - 4. Auxiliary temperature sensor
 - 5. Analog output feature to enable simple monitoring of temperature set point, outlet temperature or fire rate
 - 6. Remote interlock circuit
 - 7. Delayed interlock circuit
 - 8. Fault Relay for remote fault alarm
 - 9. Supply temperature reset based on outdoor ambient temperature
- D. Boiler shall include and electric, single seated combination safety shut off valve/regulator with proof of closure switch in its gas train. Each boiler shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD-1
- E. Boiler shall include a oxygen monitoring system that will measure the oxygen content of the exhaust gasses in real-time. Output of monitor shall be available through display.
- F. The control system for the combination natural gas and propane firing system shall be IRI or FM approved.
- G. Safety provisions in the control circuit shall cause the burner to shut off and prohibit restart until normal condition in the event of the following:
 - 1. High Discharge Temp
 - 2. High Internal pressure
 - 3. Low Water Flow
 - 4. High Water Flow
 - 5. Forced draft fan failure or loss of pressure
 - 6. Ignition pilot flame failure
 - 7. Main flame failure
 - 8. Low fuel pressure
- H. In the event of a pilot or main flame failure, the burner shall automatically shut off and can not begin operation until it is manually reset.
- I. Modulating fire control shall provide low fire start and step modulation up to needed capacity firing rate.

2.04 BOILER BURNER

- A. Combination type burner shall be an integral part of the boiler, and shall be approved for operation with natural gas and propane.
- B. The burner shall be capable of scheduled turn down modulating capacity control without loss of combustion efficiency or staging of gas valves.
- C. The burner shall be a metal-fiber mesh cover a stainless steel body with spark ignition and flame rectification. All burner material exposed to combustion to be stainless steel.
- D. Modulating burner air and fuel valve to be controlled by a single linkage. Linkage shall not require field adjustment.
- E. Ignition shall be a via regulated staged spark ignition with 100 % main valve shut off and electronic flame supervision.
- F. Burner to be capable of limiting excess oxygen in flue gas to less than 7%.

2.05 BOILER VENTING

- A. The exhaust vent must be UL Listed for use with Category II, III and IV appliances and compatible with operating temperatures up to 230 F. positive pressure, condensing flue gas service. Refer to section 23 51 23 Prefabricated Vent System.
- B. Provide exhaust vent flue size as shown on the drawings.
- C. Combustion-Air Intake: Boilers shall be capable of drawing combustion air from the outdoors via a sealed combustion duct work constructed of PVC or metal between the boiler and building exterior.
- D. Follow all requirements for maximum length and slope of manufacturer's venting guide for installation

2.06 GAS PIPING

- A. Provide all necessary gas piping properly valved between main and connection to burner and pilot.
- B. Gas pilot train shall include a three-way two-position plug cock to facilitate the use of propane as a standby pilot fuel. See drawings for propane tank size, location, and piping.
- C. Size in accordance with national, state, and local ordinances and codes, and NFPA recommendations.
- D. Gas cocks: Lubricated plug cocks with operating handles.
- E. Gas burner piping assembly, including pilot, shall meet requirements of IRI or FM.

2.07 ASSEMBLY AND TESTING

- A. Boiler, control panel and all components to be factory assembled and tested.
- B. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions and carbon monoxide in flue gas and demonstrate submitted combustion efficiency. Perform hydrostatic test.
- C. Test and Inspect factory assembled boilers, before shipping according to ASME Boiler and Pressure Vessel Code. Provide testing documentation and results to owner as part of owner engineering manuals.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Boilers are to be installed per submitted and approved shop drawings. Refer to specification section 23 01 00 for requirements.
- B. Install boilers in accordance with NFPA, ASME, local codes, and manufacturer's instructions, and Factory Mutual requirements. All boilers are to be installed with a minimum 3'-0" clear in all dimensions.
- C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Coordinate concrete, reinforcement and formwork requirements with division 3.
- D. Boilers and accessories shall be installed and piped per manufacturer's recommendations and under his supervision. Drain valves on boiler shell and condensate neutralization receivers shall be piped to the nearest drain, full size of the connection. Relief valves and vents shall be piped to outside the building using either the connection size. Relief lines turning up through the roof shall be provided with gooseneck fittings to prevent water entry. Pipe gas vent connections on gas controls to outside of the building.
- E. Boilers shall receive factory start-up supervision tests to check construction, operation, and function of controls and to ensure proper preparation for use. (See the following paragraphs.)

3.02 DUTIES OF SERVICE REPRESENTATIVE

- A. Boiler and burner manufacturers' factory trained service representative(s) to perform services described below:
 - 1. Instruct designated maintenance personnel in operation and maintenance of equipment.

2. Test operation of safety valves.
 3. Adjust firing equipment. Representative shall have the test equipment, tools, and instruments necessary to accomplish this work.
 4. Conduct boiler performance demonstration, demonstrate firing on both fuel sources.
- B. Provide option for separate (additional) boiler operating training, if required.

3.03 START-UP

- A. Leak Test: Perform hydrostatic test.
- B. Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
- C. Test and adjust controls and safety's. Replace damaged and malfunctioning controls and equipment. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
- D. Set field-adjustable switches and circuit-breaker trip ranges as required.

3.04 OPERATING DEMONSTRATION

- A. Demonstrate to Owner the operation of the system over entire range, using both primary fuel and back up fuels.
- B. Demonstrate to Owner the operation and maintenance of total system as a unit - boiler, circulating pumps and condensate neutralization system. Demonstration is to be videotaped for owner records.

END OF SECTION 23 52 16

SECTION 23 75 13
PACKAGED DX OUTDOOR ROOFTOP UNIT

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide rooftop units as shown on schedule and where located on drawings. Units to be manufactured by York, or equal form Carrier/AAON. For pricing contact:

1.02 QUALITY ASSURANCE

- A. Unit cooling capacity shall be in accordance with and tested to AHRI Standard 210/240 or 360.
- B. Units up to 20 tons capacity shall carry the AHRI compliance label.
- C. Units shall be safety certified in accordance with UL Standard UL465 and ANSI Standard Z21.47.
- D. Unit shall be safety certified by an accredited testing laboratory. Unit nameplate shall carry the label of the certification agency.
- E. Unit shall be shipped completely assembled by the manufacturer including all standard items and accessory items.
- F. Unit shall be 100 percent run tested by the manufacturer with a copy of the run test report shipped with the unit.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. Unit Construction:
 - 1. Unit shall be completely factory assembled, piped, wired and shipped in one piece.
 - 2. Unit shall be specifically designed for outdoor application with a fully weatherproof cabinet.
 - 3. Unit shall be designed for mounting on a roof curb.
 - 4. Cabinet shall be constructed entirely of G90 galvanized steel with the exterior constructed of 18 gauge or heavier material.
 - 5. The unit roof shall be cross broken and/or sloped to assure drainage.
 - 6. Access to compressor(s), controls, filters, fan(s), heating section, and other items needing periodic checking or maintenance shall be through hinged access doors with a quarter turn latch (door fastening screws are not acceptable).
 - 7. Air side service access doors shall be fully gasketed with rain break overhangs. Air side access doors shall have an internal metal liner to protect the door insulation.
 - 8. Unit exterior shall be painted with 2-part polyurethane paint over a wash primer and a paint grip type galvanized steel.
 - 9. The interior side of all exterior panels shall be entirely insulated with 1" thick, one pound density, neoprene coated, fiberglass insulation.
 - 10. Unit shall be provided with interior insulation liners to provide double wall construction.
 - 11. All openings through the base pan of the unit shall have upturned flanges of at least 1/2" in height around the opening through the base pan.
 - 12. Unit shall have decals and tags to indicate unit lifting rigging, service areas, and caution areas.
 - 13. Wiring diagrams shall be both "point-to-point" and "ladder" diagrams. Wiring diagrams shall also be laminated in plastic and permanently fixed to the control compartment door.
 - 14. Wiring shall be color coded and marked with identification on each end.
- B. Fans:
 - 1. Fan(s) shall be entirely self-contained on a slide deck for service and removal from the cabinet.
 - 2. All motors 1 horsepower and larger shall have belt-driven fans. Belt-driven fan(s) shall have backward inclined airfoil blades. Adjustable v-belt drive shall be provided with a

- minimum rating of 140 percent of the motor nameplate brake horsepower when the adjustable pulley is at the minimum RPM.
3. Fans, drives, and motors shall be dynamically balanced.
 4. Provide high-efficiency fan motors and variable frequency drive. Mount VFD inside electrical section.
- C. Condensing Section:
1. The condensing section shall be equipped with direct-drive, vertical discharge condenser fan(s).
 2. The condenser coil shall be sloped at least 30 degrees from horizontal to protect the coil from damage. If condenser coil is not sloped for protection, louvered coil guards shall be provided.
 3. Condenser coil(s) shall be copper tubes with aluminum fins mechanically bonded to the tubes.
 4. Condenser coil(s) to be sized for a minimum of 10 degrees sub-cooling.
- D. Evaporator Coil:
1. Evaporator coil shall be minimum 6 rows.
 2. Evaporator coil(s) shall be copper tubes with aluminum fins mechanically bonded to the tubes.
 3. Evaporator coil(s) shall have galvanized steel end casings.
 4. Evaporator coil(s) shall have equalizing type vertical tube distributors with a top suction connection.
 5. Evaporator coil(s) for multi-compressor units shall be circuited with one circuit and expansion valve per compressor.
 6. Unit shall be provided with stainless steel drain pan.
- E. Refrigeration System:
1. Compressor(s) shall be of the hermetic scroll type with internal thermal overload protection.
 2. All units over 7-ton capacity shall be multiple stage and shall have a minimum of two stages of capacity control.
 3. Compressor(s) shall be mounted in an isolated compartment to permit operation of the unit without affecting airflow when the compressor compartment is open.
 4. Compressor(s) shall be isolated from the base pan and supply air to avoid any transmission of noise from the compressor into the building area.
 5. System shall be equipped with thermostatic expansion valve type refrigerant flow control.
 6. System shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant controls.
 7. Unit shall be equipped with Schrader type service fittings on both the high side and low pressure sides of the system.
 8. Unit shall be equipped with refrigerant liquid line filter driers.
 9. Unit shall be fully factory charged with refrigerant R-410.
 10. 5-year compressor warranty shall be provided.
 11. Unit shall be provided with 35 degree F low ambient control.
 12. Unit shall be provided with hot gas bypass on each refrigerant circuit.
 13. All circuits shall be equipped with liquid line sight glass.
 14. Unit shall be provided with 5-minute anti-short cycle time delay relay for each compressor unless thermostat or microprocessor control provides this feature.
 15. Multi-compressor unit shall be provided with 20-second time delay relay to prevent both compressors from starting simultaneously unless thermostat or microprocessor control provides this feature.
- F. Outside Air:
1. Outside air shall be a modulating dry bulb activated economizer with multi-stage integrated economizer and compressor operation controlled for maximum benefit. The economizer shall consist of a motor-operated outside air damper and return air damper constructed of extruded aluminum blades with rubber edge seals and aluminum end

seals. Damper blades shall be gear driven and designed to have no more than 25 cfm of leakage per square foot of damper area when subjected to 2" w.g. air pressure differential across the damper. Damper motor shall be spring return to ensure closing of outside air damper during periods of unit shutdown or power failure.

2. Modulating damper power exhaust with all controls provided as part of the economizer.
3. Provide controls to maintain constant volume of minimum outside air regardless of supply air volume.

G. Filters:

1. Unit shall be provided with 2" thick, 65 percent high-efficiency pleated, throwaway supply air filters.
2. Provide clogged filter switch.
3. Provide filter gauge.

H. Electrical:

1. All disconnects to be by Division 26, coordinate with electrical contractor for unit connections.

I. Controls:

1. Provide unit mounted variable air volume programmable microprocessor controller to control discharge air temperature and supply duct static pressure. Provide with discharge air temperature sensor, return air temperature sensor, outside air temperature sensor, zone temperature sensor and supply air duct static probe.
2. Provide BACNET gateway for DDC controller integration into Energy Management System. Refer to control drawings for all points to be mapped to front end controls systems.

- J. Roof Curb: Roof curbs shall be constructed of galvanized steel. Roof curbs shall be minimum 14" high above the roof. Curbs shall be fully gasketed between the curb top and unit bottom. Curbs shall provide full perimeter support, cross structure support and air and water tight seal for the unit.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install unit in accordance with manufacturers' published installation instructions.
- B. Manufacturers' representative service technician to provide start-up supervision for each unit.
- C. Duct connections to units to allow for straight and smooth airflow. Connections to unit to be made with flexible duct connections. Sleeve duct penetrations through roof. Provide three 2" layers of neoprene coated fiberglass duct liner to completely fill inside of roof curb.
- D. Drain lines to be trapped and run full size from drain pan connection to discharge into nearest roof drain as indicated on plans.

END OF SECTION 23 75 13

SECTION 23 81 29
VRF VARIABLE REFRIGERANT FLOW SYSTEM

PART 1 GENERAL

1.01 SYSTEM DESCRIPTION

- A. Simultaneous Heating and Cooling Heat Pump: The VRF (Variable Refrigerant Flow) system shall be a simultaneous cooling and heating heat pump. The simultaneous heating and cooling VRF system shall consist of an outdoor unit, high efficiency heat recovery units designed for minimum piping and maximum design flexibility, indoor units, and controls by the equipment manufacturer. Every indoor unit shall be independently capable of operating in either heating or cooling mode regardless of the mode of other indoor units. The system shall be capable of changing mode of individual indoor units (cooling to heating or heating to cooling) within a maximum time of 5 minutes to ensure indoor temperature can be properly maintained.

1.02 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Basis of Design: Mitsubishi.
 2. Daikin, Mitsubishi, LG, or Sanyo other manufacturers may be approved as part of the alternate/substitution process.
- B. All manufacturers other than the basis of design are required to coordinate any changes from the basis of design with all associated trades. Any additional costs associated with the alternate equipment including but not limited to electrical wiring costs, piping costs, and engineering design costs shall be covered by the equipment manufacturer. No additional costs shall be incurred by the owner or designer.

1.03 QUALITY ASSURANCE

- A. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
- B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
- C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
- D. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.
- E. The VRF system shall be installed by a licensed mechanical contractor trained by the VRF equipment manufacturer or certified manufacturer's agent.
- F. Commissioning shall be performed by the manufacturer or certified manufacturer's agent.

1.04 STORAGE AND HANDLING

- A. All VRF equipment shall be stored protected from weather, extreme temperature, etc. as suggested by the manufacturer. All VRF equipment shall be moved, lifted, etc. as suggested by the manufacturer.

1.05 WARRANTY

- A. VRF equipment shall be warranted by the manufacturer's limited warranty for a period of one year from date of substantial completion. Manufacturers shall provide an extended warranty including 1 additional year parts and 5 additional year's compressor.

PART 2 PRODUCTS

2.01 SIMULTANEOUS HEATING AND COOLING OUTDOOR UNIT

- A. General: The outdoor unit shall be used specifically with manufacturer approved piping components and air handling units. The outdoor units shall be equipped with multiple circuit boards that interface to the VRF controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.

1. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor.
 2. Outdoor unit shall have a sound rating no higher than 60 dB(A) individually or 64 dB(A) twinned. Units shall have a sound rating no higher than 50 dB(A) individually or 53 dB(A) twinned while in night mode operation. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
 3. All refrigerant lines from the outdoor unit to the BC (Branch Circuit) Controller (Single or Main) or heat recovery box shall be insulated.
 4. Outdoor unit shall be able to connect to up to 50 indoor units depending upon model.
 5. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
 6. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
 7. The outdoor unit shall have the ability to operate with a maximum height difference of 164 feet and have total refrigerant tubing length of 1804-2625 feet. The greatest length is not to exceed 541 feet between outdoor unit and the indoor units without the need for line size changes or traps.
 8. The outdoor unit shall be capable of operating in heating mode down to -4 degrees Fahrenheit ambient temperature or cooling mode down to 23 degrees Fahrenheit ambient temperature, without additional low ambient controls. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.
 9. The outdoor unit shall be capable of operating in cooling mode down to -10°F with optional manufacturer supplied low ambient kit.
 10. Manufacturer supplied low ambient kit shall be provided with predesigned control box rated for outdoor installation and capable of controlling kit operation automatically in all outdoor unit operation modes.
 11. Manufacturer supplied low ambient kit shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
 12. Manufacturer supplied low ambient kit shall be factory tested in low ambient temperature chamber to ensure operation. Factory performance testing data shall be available when requested.
 13. The outdoor unit shall not cease operation in any mode based solely on outdoor ambient temperature.
 14. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
 15. Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend "no or reduced heating" periods shall not be allowed.
 16. Unit Cabinet: The casing(s) shall be fabricated of galvanized steel, bonderized and finished. Unit cabinets shall be able to withstand 960 hours per ASTM B117 criteria for seacoast protected models.
- B. Fan:
1. Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.
 2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
 3. All fan motors shall be mounted for quiet operation.
 4. All fans shall be provided with a raised guard to prevent contact with moving parts.
 5. The outdoor unit shall have vertical discharge airflow.
- C. Refrigerant
1. R410A refrigerant shall be used for all systems.

2. Contractor shall provide sufficient refrigerant to properly charge system.
- D. Coil:
1. Each outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
 2. The coil fins shall have a factory applied corrosion resistant blue-fin finish.
 3. The coil shall be protected with an integral metal guard.
 4. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
 5. The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.
- E. Compressor:
1. Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors shall not be allowed.
 2. A crankcase heater(s) shall be factory mounted on the compressor(s).
 3. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 19%-5% of rated capacity, depending upon unit size.
 4. The compressor will be equipped with an internal thermal overload.
 5. The compressor shall be mounted to avoid the transmission of vibration.
 6. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.
- F. Electrical:
1. The outdoor unit electrical power shall be 208/230 or 460 volts, 3-phase, 60 hertz.
 2. The outdoor unit shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz), 207-253V (230V/60Hz) or 414-506V (460V/60Hz).
 3. The outdoor unit shall be controlled by integral microprocessors.
 4. Provide all manufacturer required control wiring between each unit outdoor unit and system controller. Control wiring shall be 2 conductor twisted pair shielded cable.
- G. Multiple Condensing unit Sections
1. The outdoor unit shall be completely factory assembled, piped and wired. Dual and triple frame outdoor units will be field piped with factory designed and supplied Y-branch kits to manifold them together into a single refrigerant circuit.
 2. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimal spacing.
 3. Multiple modules shall have duty cycling function to ensure sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours of runtime.

2.02 Branch CIRCUIT (BC) controllers / HEAT RECOVERY Boxes / SOLENOID VALVE KITS

- A. General: Unit manufacturer shall provide branch circuit controller / heat recovery box / or solenoid valve kit as required by system to allow for simultaneous heating or cooling operation of any indoor fan coil unit.
- B. The BC (Branch Circuit) Controllers shall be specifically used with manufacturer provided fan coil units. These units shall be equipped with a circuit board that interfaces to the VRF controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The BC Controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of rated capacity.
1. BC Unit Cabinet:
 - a. The casing shall be fabricated of galvanized steel.
 - b. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.

- c. The unit shall house two tube-in-tube heat exchangers.
- 2. Refrigerant: R410A refrigerant shall be required.
- 3. Refrigerant valves:
 - a. The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and up to three indoor units. Branches may be twinned to allow more than 54,000 BTUH.
 - b. Each branch shall have multiple two-position valves to control refrigerant flow.
 - c. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.
 - d. Linear electronic expansion valves shall be used to control the variable refrigerant flow.
- 4. See drawings for required quantity of zones for each system. All system alternate manufacturers shall provide identical quantity of cooling and heating zones per BC controller as shown on drawings. If alternate manufacturer unable to provide identical quantity then manufacturer shall provide additional BC controllers, wiring, and piping to provide same number of zones shown on the drawings at no additional cost.
- 5. Integral Drain Pan: An integral condensate pan and drain shall be provided.
- 6. Electrical:
 - a. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
 - b. The unit shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253V (230V/60Hz).
- 7. The BC Controller shall be controlled by integral microprocessors.
- 8. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.03 WALL-MOUNTED INDOOR UNIT

- A. General: Unit shall be a wall-mounted indoor unit section and shall have a modulating linear expansion device and a flat front. Unit shall support individual control using manufacturer provided DDC controller.
- B. Indoor Unit: The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
- C. Unit Cabinet:
 - 1. All casings, regardless of model size, shall have the same white finish
 - 2. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard.
 - 3. There shall be a separate back plate which secures the unit firmly to the wall.
- D. Fan:
 - 1. The indoor fan shall be an assembly with one or two line-flow fan(s) direct driven by a single motor.
 - 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - 3. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
 - 4. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.
- E. Filter: Return air shall be filtered by means of an easily removable, washable filter.
- F. Coil:
 - 1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 - 2. The tubing shall have inner grooves for high efficiency heat exchange.

3. All tube joints shall be brazed with phos-copper or silver alloy.
 4. The coils shall be pressure tested at the factory.
 5. A condensate pan and drain shall be provided under the coil.
 6. Both refrigerant lines to indoor unit shall be insulated.
- G. Electrical:
1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
 2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz)
- H. Controls:
1. This unit shall use controls provided by manufacturer to perform functions necessary to operate the system.
 2. The unit shall be able to control external backup heat.
 3. The unit shall have a factory built in receiver for wireless remote control.
- I. Condensate Pump: Unit manufacturer shall provide condensate pump to lift condensate a minimum of 80". Condensate pump shall be integral to unit or wired through low voltage circuit of unit. Contractor shall provide all wiring and installation for pumps not integral to unit.

2.04 HIGH STATIC CEILING-CONCEALED DUCTED INDOOR UNIT

- A. General: High Static unit shall be a ceiling concealed ducted indoor fan coil that mounts above the ceiling with a fixed rear return and a horizontal discharge supply, and shall have a modulating linear expansion device. Unit shall feature external static pressure settings up 0.80 in. WG. Units shall have the ability to control supplemental heat via connector CN24 and a 12 VDC output.
- B. Indoor Unit: The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
- C. Unit Cabinet:
1. The cabinet shall be ceiling-concealed, ducted.
 2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
- D. Fan:
1. The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 3. The indoor unit shall have a ducted air outlet system and ducted return air system.
- E. Filter: Provide optional rear return filter box with long-life filter indoor units. Provide return filter grille where shown on drawings. Provide clean set of filters and one spare set of filters at substantial completion.
- F. Coil:
1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 2. The tubing shall have inner grooves for high efficiency heat exchange.
 3. All tube joints shall be brazed with phos-copper or silver alloy.
 4. The coils shall be pressure tested at the factory.
 5. A condensate pan and drain shall be provided under the coil.
 6. The condensate shall be gravity drained from the fan coil.
 7. Both refrigerant lines to the indoor unit shall be insulated.
- G. Condensate Pump: Unit manufacture shall provide condensate lift mechanism to lift condensate a minimum of 21".

- H. Electrical:
 - 1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz. or 208/230 volts, 3-phase, 60 hertz as scheduled on drawings.
 - 2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
- I. Controls: This unit shall use controls provided unit manufacturer to perform functions necessary to operate the system.

2.05 CONTROLS

- A. General:
 - 1. The unit shall have controls provided with the unit by the manufacturer to perform input functions necessary to operate the system.
 - 2. Computerized PID control shall be used to maintain room temperature within 1 F of setpoint.
 - 3. The unit shall be equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature.
 - 4. The fan coil circuit board shall be wired to enable auxiliary heating when coil thermistor temperature drops below 104 degrees F in heating mode.

2.06 CONTROLLERS

- A. Physical Characteristics: General: control system devices shall be a neutral color plastic material with a Liquid Crystal Display (LCD).
- B. Electrical Characteristics:
 - 1. General: From each circuit board to the controls, the electrical voltage shall be low voltage.
 - 2. Wiring: Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit then to the outdoor unit. Control wiring shall run from the indoor unit terminal block to the specific controller for that unit.
 - 3. Wiring Size: The wire shall be a shielded, size AWG18-2.

2.07 INDIVIDUAL ZONE CONTROLLER – WIRED REMOTE CONTROLLER

- A. The wired remote controller shall be able to control 1 group (maximum of 16 fan coil units) and shall be able to function as follows:
 - 1. The controller shall have a self diagnosis function that constantly monitors the system for malfunctions (total of 80 components).
 - 2. The controller shall be able to immediately display fault location and condition.
 - 3. An LCD digital display shall allow the temperature to be set in 1 degree Fahrenheit units.
 - 4. The controller shall be equipped with a thermostat sensor in the remote controller making possible more comfortable room temperature control.
- B. The wired remote controller shall have the following features:
 - 1. Operation: Start/Stop, Operation Mode, Temperature Setting, 60 degrees Fahrenheit - 90 degrees Fahrenheit, Set Point Range, Fan Speed, Airflow Direction.
 - 2. Monitoring: Status, malfunction flashing, malfunction content, filter sign, operation mode, temperature setting, permit/prohibit selection, fan speed, airflow direction.
 - 3. Scheduling: ON/OFF Timer
 - 4. Control Management: Field Setting Mode, Group Setting, Auto Re-start
 - 5. The controller shall also be able to switch an external dry contact via a 12 volt DC relay (field supplied).

2.08 SYSTEM REMOTE CONTROLLER

- A. The controller shall control up to 64 units in 4 zones and shall be able to be used in conjunction with all room controller types. Provide as many system controllers as required to control the system. Collective and individual group commands are available with permit/prohibit individual remote controller function.. The system controller shall use the following connections for power and remote monitoring:
 - 1. L1: Power supply (60 Hz, 208-230 VAC)

2. C1: Inter-unit control wiring (Low voltage)
3. C3: Auxiliary
4. C4: Ground for inter-unit control wiring
5. A1: Input for turning ON air conditioners concurrently
6. A2: Input for turning OFF air conditioners concurrently
7. A3: Common input for turning air conditioners ON or OFF
8. B1: On operation state indicator output
9. B2: Alarm indicator output
10. B3: Common indicator output

2.09 WEB ENABLED INTELLIGENT CONTROLLER

- A. This controller shall be wall mounted and hard wired, either directly to the VRF control system or via RS485 gateway. It will be manufactured in ABS plastic with an LCD display and will be the manufacturer's standard color. The controller will be capable of individually controlling the following functions on 256 indoor fan coil units:
 1. On/off.
 2. Operating mode.
 3. Set point.
 4. Fan speed.
 5. Louver position.
 6. Timer settings.
 7. Test run.
- B. The controller shall also be capable of displaying the following information individually for 256 indoor fan coil units:
 1. On/off.
 2. Operating mode.
 3. Set point.
 4. Fan speed.
 5. Louver position.
 6. Timer settings.
 7. Test run.
 8. Fault diagnosis.
- C. Each Intelligent controller unit can be accessed either locally or remotely via standard Internet Explorer IE6 or IE7 software. The Intelligent controller will be able to indicate system alarms via volt free contacts as well as providing control points for other D0 devices. Additionally, the intelligent controller shall be able to monitor individual tenant's usage of heating and cooling demands, report alarm and conditions to nominated email address, and enable remote alteration of systems set points to registered users.

2.10 GATEWAY:

- A. Provide BACnet or LONworks Gateway to fully interface system function into building DDC control system. Manufacturer shall coordinate gateway requirements with control contractor prior to bid.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation, Operation and Maintenance manual shall be supplied with the unit.
- B. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation and Maintenance manual instructions. All refrigerant piping shall be ACR hard drawn copper with brazed joints. Flared fittings will not be acceptable. Installation must be per the manufacturer's piping tree diagram for the project. Before any pipe or length changes are made, proposed changes must be forwarded to the manufacturer's engineering representative and manufacturer's new piping tree diagram re-issued for installation, because any change made requires the review of the entire tree and verification that the change did not

impact the size of piping segments in other parts of the system. No oil traps, solenoid valves, sight glasses, filter dryers, or any other unauthorized refrigerant specialties are to be used.

- C. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit. Engage manufacturer or factory-authorized service representative to perform startup service. Manufacturer shall provide on-site startup and commissioning assistance through job completion. Complete installation and startup checks according to manufacturer's written instructions.
- D. Unit manufacturer to provide services of factory trained personnel to verify operation of system installation and control hardware.
- E. Provide all labor, refrigerant, and material required for a complete installation. Work to be performed shall be in accord with local codes, regulations, and OSHA standards.
- F. Install all piping, fittings, and insulation to meet manufacturer's requirements. Install units level and plumb. Evaporator-fan components shall be installed using manufacturer's standard mounting devices securely fastened to building structure. Install and connect refrigerant tubing and fittings.
- G. All lines from outdoor unit to BC controller / heat recovery box and all lines from BC controller to indoor fan coil unit shall be insulated. Refer to Section 23 07 10 Insulation for specific requirements.
- H. Installer shall supply isolation ball valves for zoned refrigerant isolation. Installer shall supply Isolation ball valves with Schrader connection for isolating refrigerant charge and evacuation at each connected air handling unit and condensing unit. Isolation ball valves, with Schrader connection, are required for instances of air handling unit isolation for troubleshooting, repair or replacement without affecting the remainder of the system. Isolation ball valves with Schrader connection are also required at condensing unit connection to isolate unit for troubleshooting, repair or replacement and as required to provide partial capacity Heating/Cooling in the instance of a failure of one of the multiple outdoor unit (condensing unit) compressors.
- I. Contractor shall install and pressure test piping system in accordance with manufactures instructions. Provide written documentation of all pressure tests. Perform the leak/pressure check at 150 psig for (5) five minutes (standing pressure check). Perform the leak/pressure check at 300 PSI for (15) fifteen minutes (second standing pressure check). Perform the leak/pressure check at 550 PSI fir (24) twenty-four hours to make sur ethe system is leak free.

3.02 OWNER TRAINING

- A. The manufacturer that provides the VRV system for this project will include in his price the cost to have a "Factory Service Representative" provide onsite training for the VRV system to include, but not limited to:
 - 1. System rebooting.
 - 2. Identifying error codes.
 - 3. Resetting filter indicators.
 - 4. Basis system operation.
 - 5. Explanation of service indicators.
 - 6. How the manufacturer can support with system issues.
- B. This training will be a minimum of:
 - 1. 8 hours during equipment startup.
 - 2. 8 hours at Substantial Completion.
 - 3. 8 hours and the end of the Manufacturer Warranty period.
- C. Training shall be by a representative from the Factory. Training by local sales representative is not acceptable.
- D. Prior to beginning of training, Manufacturer shall provide written material and outline of training for approval by Owner, Cx agent, and design team.
- E. Contractor shall schedule training in advance with Owner.

END OF SECTION 23 81 29

SECTION 23 82 13
HEATING COILS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Hot Water Coils.

1.02 CERTIFICATION

- A. Certify coil capacities, pressure drops, and selection procedures in accordance with AHRI Standard 410.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Coils shall be the product of manufacturer regularly engaged in production of coils who issues complete catalog data on such products.

2.02 CONSTRUCTION

- A. Tubes: Copper.
- B. Fins: Aluminum or copper.
- C. Headers: Heavy gauge cast iron or steel.
- D. Casing: Minimum 16-gauge galvanized steel.
- E. Testing: Proof test and leak test each coil at minimum 300 psig and 200 psig air pressure respectively with coil submerged in water.

2.03 HOT WATER COILS

- A. Design for minimum 200 psig at 220 degrees F.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Mount coil in accordance with SMACNA standards including a maximum transition angle of 30 degrees on the entering air side of coil and 45 degrees on leaving air side. Transitions on both entering and leaving side to be 20 degrees if space permits. Provide air-tight seal between coil and duct or unit casing.
- B. Provide access door on entering air side of coil for cleaning and inspection purposes.
- C. See drawings for required piping connections to hot water coils.
- D. Externally insulate coil casing including return bends with 1" thick, blanket-type fiberglass insulation to prevent condensation.
- E. Hot water reheat coils required for variable volume boxes or fan-powered boxes to be furnished factory mounted to boxes by terminal box manufacturer.

END OF SECTION 23 82 13

SECTION 23 82 39
UNIT HEATERS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Unit heaters noted as horizontal projection type to be Trane Model S or approved equal.
- B. Unit heaters noted as vertical projection type to be Trane Model P or approved equal.
- C. Unit heaters noted as cabinet type to be Trane Force-Flo or approved equal.

PART 2 PRODUCTS

2.01 EQUIPMENT REQUIREMENTS

- A. Coils to be copper tube with aluminum fins for hot water service.
- B. Cabinet unit heaters to be horizontal ceiling-suspended exposed style,[style as scheduled on the drawings].
- C. Design coils for minimum of 150 psig working pressure. Fan motors to be direct drive, permanent split capacitor type complete with built-in thermal overload protection. Fans to be propeller type for horizontal and vertical projection unit heaters and centrifugal type for cabinet unit heaters.
- D. Provide 4-way adjustable discharge louvers for horizontal projection unit heaters.
- E. Provide adjustable louver cone discharge diffuser for vertical projection heaters.
- F. Provide wall mounted line voltage thermostat with locking guard for each horizontal and vertical projection unit heater.
- G. Provide unit mounted thermostat and high/low/off fan speed switch for unit heaters.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install unit heaters at locations shown on drawings in accordance with manufacturers' published installation instructions.
- B. Unit heaters to be piped per diagrams on drawings.
- C. Coordinate mounting height, throw, and thermostat locations with job conditions.

END OF SECTION 23 82 39

SECTION 23 82 40
ELECTRIC HEATERS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide UL listed electric heaters of the type and capacities specified on drawings.
- B. Heaters to have a five-year warranty.
- C. Heaters to be by Markel, Berko, Q-Mark, or approved equal.

PART 2 PRODUCTS

2.01 UNIT HEATERS

- A. Heaters to be Markel Series 5100 heavy-duty industrial service unit heaters for horizontal or vertical mounting.
- B. Enclosure to be heavy gauge steel with baked enamel finish.
- C. Heaters to be equipped with individually adjustable outlet louvers.
- D. Elements to be high mass, all steel finned tubular type.
- E. Motor to be equipped with permanently lubricated bearings and internal overload protection.
- F. Fan to be propeller type with fan speed not exceeding 1550 rpm.
- G. Heaters to be equipped with manual reset thermal cutouts to disconnect both heating elements and fan.
- H. Heaters to be designed for single point power connection, with elements, motor, and control circuits subdivided with factory installed and wired fuses.
- I. Thermostats to be low-voltage, wall mounted as scheduled on drawings, heavy-duty, tamperproof type. Manufacturer to furnish necessary contactors, relays, transformers, etc., for complete installation.
- J. Provide factory engineered bracket for attachment to wall or ceiling.

2.02 WALL-MOUNTED HEATERS

- A. Heaters to be Markel Series 3420 commercial service, wall-mounted, forced-air heaters.
- B. Enclosure to be minimum 16 ga. galvanized steel with baked enamel finish.
- C. Elements to be high mass, all steel finned tubular type.
- D. Motor to be equipped with permanently lubricated bearings and internal overload protection.
- E. Fan to be propeller type with fan speed not exceeding 1550 rpm.
- F. Heaters to be equipped with manual reset thermal cutouts to disconnect both heating elements and motor.
- G. Heaters to be designed for single point power connection, with elements, motor, and control circuits subdivided with factory installed and wired fuses.
- H. Thermostats to be low-voltage, wall mounted as scheduled on drawings, heavy-duty, tamperproof type. Manufacturer to furnish necessary contactors, relays, transformers, etc., for complete installation.
- I. See drawings for surface or recessed mounting requirements.
- J. Provide plaster trim for heaters installed in "hard" ceilings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Heaters to be installed in accordance with manufacturers' published installation instructions.

END OF SECTION 23 82 40

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Secondary power wiring and distribution system.
- B. Emergency power generation system.
- C. Lightning protection system.
- D. Fire alarm and smoke detection system.
- E. Lighting control equipment.
- F. Electrical control systems and interlock wiring.
- G. Medical Imaging equipment rough-in.
- H. Medical gas alarm wiring.

1.02 RELATED WORK

- A. Foundations and pads required for equipment furnished under this division of the specifications.
- B. Field painting, except such painting as is required to maintain shop coat painting and factory finish painting.
- C. Electrical control systems and interlock wiring as required by mechanical drawings, specifications or manufacturer's schematics.
- D. Flashing of conduits into roofing and outside walls.
- E. Heating, ventilating, and air conditioning equipment.
- F. Plumbing equipment.
- G. Fuel oil storage tank and fuel transfer pumping system.
- H. Laboratory equipment.
- I. Nurses call system equipment.
- J. Code Blue system equipment.
- K. Television system equipment.
- L. Intercommunication and sound paging system equipment.
- M. Telephone system equipment.
- N. Patient monitoring equipment.
- O. Medical Imaging equipment.

1.03 QUALITY ASSURANCE

- A. Comply with applicable local, state and federal codes.
- B. Comply with applicable requirements of recognized industry associations which promulgate standards for the various trades.
- C. Employ only qualified journeymen for this work. Employ a competent qualified electrician to supervise the work.

1.04 STANDARDS

- A. Perform work specified in Division 26 in accordance with standards listed below including amendments or revisions. When these specifications are more stringent, they take precedence. In case of conflict, obtain a decision from the Designer.
- B. National Fire Codes (NFPA) including, but not limited to following:
 - 1. NFPA-70 - National Electrical Code. 2020 Edition.
 - 2. NFPA-72 - National Fire Alarm Code. 2019 Edition.

3. NFPA-99 - Health Care Facilities. 2021 Edition.
 4. NFPA-101 - Life Safety Code. 2021 Edition.
 5. NFPA-110 - Power Systems, Emergency and Standby 2019 Edition.
 6. NFPA-780 - Lightning Protection Code. 2020 Edition.
- C. Applicable Codes:
1. Florida Building Code 2023 Edition.
 2. Local Codes and Amendments.
 3. The Guidelines for Design and Construction of Health Care Facilities 2022 Edition.
- D. Should any work be construed as being contrary to or not conforming to aforementioned codes, such alleged confliction to be brought to attention of Architect in writing ten (10) days prior to bid date for review so that such point in question may be resolved. All work to be installed in strict conformity with applicable codes without additional cost to Owner.
- E. Contractor to submit and/or file with proper authorities all necessary specifications and drawings as required by governing authorities.

1.05 DESIGN REQUIREMENTS

- A. Complete Short Circuit, Protective Device Coordination, and Arc Flash Study to meet requirements of NFPA 70 and NFPA 70E. Refer to Section 26 05 73 – Power System Analysis for additional requirements.

1.06 SUBMITTALS

- A. Within fifteen (15) days after contract has been awarded, Contractor to submit to Designer for review a complete list of materials, equipment, and accessories proposed for use, listing the item and manufacturer's name only.
- B. Based upon aforementioned approved listing, Contractor to submit an electronic copy of COMPLETE BROCHURES AND SHOP DRAWINGS OF ALL MATERIALS, FIXTURES, AND EQUIPMENT that he proposes to use giving the names of manufacturers, trade name and specific catalog numbers.
- C. Brochures to be submitted in time to allow fifteen (15) days from date of receipt in Engineer's office before final approval or disapproval is required to meet construction schedule. Submittals to bear Contractor's stamp of approval evidencing he has examined and checked same and information contained therein is in accordance with contract requirements, and any deviations to be clearly marked. Approval of shop drawings not to be construed as permitting departure from the contractual documents.
- D. Above-mentioned brochures to be submitted and approved before any materials are ordered.
- E. In the event that within time stated above contractor fails to submit complete list of materials, equipment and accessories in proper form, the Designer reserves the right to select a full line of materials, fixtures, and equipment, which shall be binding upon Contractor for these materials, fixtures, and equipment as the case may be and which shall be used in his work.
- F. Brochures: Submit complete descriptions, illustrations, specification data, etc. of all materials, fittings, devices, fixtures, special systems, etc., including the following:
1. Panelboards.
 2. Wiring devices and plates.
 3. Motor starters and contactors.
 4. Disconnect switches.
 5. Enclosed circuit breakers.
 6. Transformers.
 7. Lighting, including lamps.
 8. Short-circuit study, protective device coordination study, arc flash study calculations and printout of arc flash labels.
- G. Proposed items to be clearly indicated when other items are shown on same sheet. When proposing items other than those specified, brochures to contain both specified item sheets and

proposed item sheets for ease of comparison. On request from Designer, samples shall be submitted and/or set up, as directed, for inspection and approval. Samples will be returned to Contractor.

- H. Shop Drawings: Submit specific shop drawings for major materials including the following:
 - 1. Motor starters and contactors including custom wiring diagrams.
 - 2. Fire alarms and smoke detection systems, including point-to-point wiring diagrams.
 - 3. Emergency power generator system including automatic transfer switches.
 - 4. Lightning protection system.
 - 5. Dimensional layout of all electrical rooms, drawn to scale, with equipment location shown therein. Clearances to be in accordance with NEC and local codes.
 - 6. Electrical Coordination Study submitted by equipment manufacturer to include time-current curves and all related breaker data information. Coordination Study must be approved by the engineer prior to order of equipment.

1.07 OPERATING AND MAINTENANCE MANUALS

- A. Prior to final acceptance of the project, furnish to Owner complete bound sets and electronic copies of operation and maintenance manuals of instructions for operation and maintenance of all pieces of equipment and systems provided under this division of specifications.
- B. Manuals to also include all submittal data on all materials and equipment. Clearly indicate items provided on this project. A list giving name and address of nearest supply house carrying spare parts and name of Installation Contractor to be given to Owner.
- C. Verbally instruct Owner's representatives. Contractor to obtain letter signed by the owner's representative indicating that the in-service training has been completed.
- D. Three sets of the following data are required:
 - 1. Operating and maintenance instructions.
 - 2. Spare parts lists.
 - 3. Copies of approved submittal data.
- E. Short Circuit, Protective Device Coordination and Arc Flash Study.
- F. Arc Flash Hazard/Risk Category Chart, from NFPA 70E, identifying required protective clothing and Personal Protective Equipment (PPE).
- G. Infrared scan reports.

1.08 DELIVERY AND STORAGE

- A. Insofar as possible, deliver items in manufacturers' original unopened packaging. Where this is not practical, cover items with protective materials, to keep them from being damaged. Use care in loading, transporting, unloading, and storage to keep items from being damaged.
- B. Store items in a clean dry place and protect from damage.
- C. All damaged painted surfaces of equipment to be touched up to match original paint.

1.09 RECORD DRAWINGS

- A. Keep a set of prints at the job site exclusively for recording deviations from the drawings.
- B. Record locations and depths of buried and concealed conduits from fixed easily identifiable objects, such as building walls. Where conduits are concealed in walls, indicate distances off of building corners or other building features not likely to be disturbed by future alterations.
- C. Mark deviations in colored pencils so that work of various systems can be easily identified.
- D. When work is completed, record all deviations on clean copies of drawings.
- E. Submit three copies of completed "record drawings" to Owner's Representative for distribution.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. All materials and equipment used in carrying out these specifications to be American made unless approved otherwise by the Owner and to be new and have UL listing, or listing by other recognized testing laboratory when such listings are available.
- B. Contractors shall contact Graybar-Nashville to obtain pricing for all electrical products included in the specifications sections listed below, per HCA's purchasing agreement:
 - 1. Jess Hoover, Charlie Shannon
Graybar-Nashville
825 8th Avenue South
Nashville, TN 37217
HCA@graybar.com
239-494-2088
615-743-3226
HPG Contract No. 5892
 - a. 26 0519 Low-Voltage Electrical Power Conductors and Cables-600 Volt and Below
 - b. 26 0526 Grounding and Bonding for Electrical Systems
 - c. 26 0529 Hangers and Supports for Electrical Systems
 - d. 26 0533 Raceways and Conduit Systems
 - e. 26 0913 Energy and Resource Metering
 - f. 26 2200 Low-Voltage Transformers
 - g. 26 2416 Panelboards
 - h. 26 2726 Wiring Devices
 - i. 26 2816 Enclosed Switches and Circuit Breakers
 - j. 26 2913 Enclosed Controllers
 - k. 26 4313 Transient Voltage Surge Suppression
 - l. 26 5100 Interior Lighting
 - m. 26 5600 Exterior Lighting

PART 3 EXECUTION

3.01 COORDINATION

- A. Intent:
 - 1. These sections of specifications and drawings form a complete set of documents for the electrical work of this project. Neither is complete without the other. Any item mentioned in one shall be as binding as though mentioned in both.
 - 2. The intent of these specifications and drawings is to form a guide for a complete electrical installation. Where an item is reasonably necessary for a complete system but not specifically mentioned, such as pull boxes, fittings, expansion fittings, support hangers, etc., provide same without additional cost to Owner.
 - 3. Electrical layouts indicated on drawings are diagrammatical only. Exact location of outlets to be governed by project conditions. The Designer reserves the right to make any reasonable changes (approximately 6 feet) in location of junction boxes, or equipment prior to roughing-in of such without additional cost to Owner.
- B. Deviations:
 - 1. No deviations from specifications and drawings to be made without full knowledge and consent of Designer.
 - 2. Should Contractor find during progress of work that existing conditions make desirable a modification of the requirements of any particular item, report such item promptly to Designer for his decision and instructions.
- C. Insofar as it is possible to determine in advance, leave proper chases and openings. Place all outlets, anchors, sleeves, and supports prior to pouring concrete or installation of masonry work. Should contractor neglect doing this, any cutting and/or patching required to be done is at this contractor's expense.

- D. Visit site and be informed of conditions under which work must be performed. No subsequent allowance will be made because of error or failure to obtain necessary information to completely estimate and perform work involved.
- E. Designer to be mediating authority in all design related deviations and disputes arising on the project.
- F. Coordinate to assure that proper points of service transformer locations, voltage characteristics and capacity of service are in accordance with contract drawings.

3.02 CUTTING AND PATCHING

- A. Repair or replace routine damage caused by cutting in performance of this contract.
- B. Correct unnecessary damage caused due to installation of electrical work, brought about through carelessness or lack of coordination.
- C. Repairs to be performed with materials which match existing materials and to be installed in accordance with appropriate sections of these specifications.

3.03 TRENCHING, EXCAVATION, BACKFILLING, AND REPAIRS

- A. Provide trenching, excavation, and backfilling necessary for performance of electrical work.
- B. Trenching and excavation to be unclassified. No extra will be paid in event that rock is encountered.
- C. Backfilling to be carefully done using only clean earth thoroughly tamped and compacted below and above embedded items.

3.04 FOUNDATIONS AND PADS

- A. Provide foundations and pads required for equipment provided under this division of specifications. Coordinate proper size and location of foundations, pads, anchor bolts, and other items to be built into structure.
- B. Concrete to be in accordance with concrete division of these specifications.

3.05 TESTS

- A. On completion of work, installation to be entirely free from grounds, short circuits, and open circuits. Perform a thorough operational test in presence of Owner or his representative. Balance all circuits so that feeders to panels be not more than 10% out of balance between phases with all available load energized and operating. Furnish all labor, materials and instruments for above tests.
- B. On completion of work, perform equipotential ground test in all patient care areas as described in NFPA 99. Contractor to record highest mV and ohm readings observed for each room on a chart. Furnish all labor, materials and instruments for above tests.
- C. Furnish Owner, as a part of closing file, a copy of such tests including identification of each circuit and readings recorded, also the main service ground test as described in Section 26 05 26 of these specifications. Test information to be furnished to Owner includes ampere readings of all panels and major circuit breakers, insulation resistance reading of motors and transformers.
- D. Prior to final observation and acceptance, test, leave in satisfactory operating condition all electrical systems and equipment including but not limited to the following:
 - 1. Electrical distribution system.
 - 2. Ground fault protection system.
 - 3. Emergency power generation system.
 - 4. Transformers.
 - 5. Fire alarm and smoke detection system.
 - 6. Electric motors for all equipment.
 - 7. Electric safety devices.
 - 8. Any alarm system, including narcotics, generator, door security, etc.
 - 9. CCTV system.

3.06 INSPECTION FEES AND PERMITS

- A. Obtain and pay for all necessary permits and inspection fees required for electrical installation.

3.07 IDENTIFICATION OF EQUIPMENT

- A. Properly identify all starters, contactors, relays, safety switches and panels with permanently attached black (normal power), yellow (life safety power), orange (critical power), green (equipment power), and purple (essential distribution) phenolic plates with 1/4" engraved lettering on the face of each attached, with two sheet metal screws. Starters and relays connected by the electrical tradesman to be identified by him whether furnished by him or others.

3.08 TEMPORARY LIGHTS AND POWER

- A. Provide a temporary electrical lighting and power distribution system of adequate size to properly serve the following requirements, including adequate feeder sizes to prevent excessive voltage drop. Temporary work to be installed in a neat and safe manner in accordance with the National Electrical Code, Article 590, and as required by OSHA or applicable local safety codes.
- B. Provide service and panelboards required for above lighting and power outlets.
- C. Power consumption will be paid for by the Contractor.
- D. Check with the Contractor prior to installation to determine whether single phase or three phase service is desired.

3.09 OBSERVATIONS

- A. When field observation services are a part of the project scope, Engineer's office will provide periodic observation of the progress of work specified herein. Purpose of the observation is to ensure compliance of Contractor's work with specifications and drawings. Engineer's office will also observe tests required of Contractor as called for in other sections of specifications.
- B. Specifications and drawings represent work to be done in view of total project requirements. Final location of conduits, fixtures, panels, switchboards, etc., to eliminate possible conflict with other trades is responsibility of Contractor. Contractor to provide all supervision required for his personnel to ensure that installation is made in accordance with specifications and drawings and all safety rules and regulations are observed. In event of conflicts of work on project with other trades, Contractor to make every reasonable effort to resolve conflict through meetings and discussions with other parties involved, by preparation of drawings or other appropriate action. Only after this has been done shall the Engineer's assistance be requested.

3.10 WARRANTY-GUARANTEE

- A. Designer reserves right to accept or reject any part of installation which does not successfully meet requirements as set out in these specifications.
- B. Contractor shall and hereby does guarantee all work installed under this division shall be free from defects in workmanship and materials for a period of one year from date of final acceptance, whichever is earliest. The above parties further agree that they will repair and replace any defective material or workmanship which becomes defective within the terms of this warranty-guarantee.

END OF SECTION 26 05 00

SECTION 26 05 19

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES 600 VOLT AND BELOW

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide a complete system of conductors for lighting, power, and controls throughout building.
- B. Refer to drawings for sizes of conductors.
- C. Within 60 days of substantial completion, perform an infrared scan of each termination and splice in conductors #3 AWG and larger. Infrared scan reports shall be provided to HCA Facility Group Engineer.

PART 2 PRODUCTS

2.01 CONDUCTORS - POWER AND LIGHTING

- A. Provide 98% conductivity copper conductors with 600-volt insulation.
- B. Interior conductors shall be Type THHN-2/THWN-2 insulation.
- C. 600-volt insulation for conductors installed in underground raceways shall have XLP (cross-linked polyethylene) insulation, Type XHHW-2.
- D. Stranded cables are acceptable for conductors #14 AWG and larger. Solid cables shall be utilized for conductors smaller than #14 AWG.
- E. For all control and motor circuits, and all conductors No. 8 AWG and larger, provide stranded type.
- F. Conductors shall be manufactured by Southwire, General Cable or approved substitute.
- G. Provide white or gray colored neutral conductors; provide black or color coded phase conductors.
- H. Provide No. 14 AWG stranded type THHN fixture conductors, for conductors entering fixtures and in stems of pendant fixtures.
- I. Provide type THHN stranded conductors, 90° Degrees C for conductors running through continuous rows of fixtures.

2.02 ALUMINUM ALLOY CONDUCTORS

- A. Normal power service and feeder wiring 200 amps and over shall be aluminum alloy unless prohibited elsewhere in this specification. Contractor may substitute copper at no additional cost.
- B. Aluminum alloy conductors shall be compact strand, Southwire or Stabiloy Type XHHW-2 (90° Degrees C). Conductors shall be AA-8000 series.
- C. Aluminum alloy conductors shall be in compliance to NEMA WC 70 and per ASTM B-800, B-801.
- D. Connectors shall be dual rated (AL7CU or AL9CU) and listed by UL 486B for use with aluminum alloy and copper conductors and sized to accept aluminum alloy conductors of the ampacity specified.
- E. Using a suitable stripping tool, to avoid damage to the conductors, remove insulation from the required length of the conductor.
- F. Wire brush the conductor and apply a listed joint compound.
- G. Tighten the connection per the connector manufacturer's recommendation.
- H. Wipe off any excess joint compound.
- I. All feeders connected directly to motors, including but not limited to chillers and fire pumps shall be copper.
- J. All essential power system (life safety, critical, equipment) circuits shall be copper.

2.03 HCF (METAL CLAD CABLE – HEALTH CARE FACILITIES)

- A. Multi-conductor Cables: Comply with NEMA WC 70; Exterior sheath color coded to differentiate cable voltages and quantity of phase conductors. Health Care Facilities armored cable, Type HCF; Comply with UL 4 and UL 1479; with green grounding conductor(s) in addition to Armor/Bond Wire ground combination; with exterior sheath colored green or appropriately marked and identified.
- B. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway and Type HCF in limited locations where indicated. Type HCF is acceptable for the following applications.
 - 1. Feeders for lighting fixture whips and for branch circuits concealed in walls and partitions only. Locate junction box and convert to single conductors in rigid raceway within the same room as where the cable enters/exits the wall.
 - 2. Use only for single-circuit cable (i.e. two wire plus ground). For devices in the same wall connected to different circuits, install separate single circuit cable for each circuit.
 - 3. The HCF length for power circuits shall be limited to 30' from the junction box to the wiring device located in the wall. If the circuit continues outside the wall, the circuit must immediately transition to conduit.
 - 4. The HCF length for lighting circuits shall be limited to 30' from the junction box to the first fixture and from that point only those fixtures above the enclosed space/room shall be served by this HCF circuit.
- C. Type HCF is not acceptable for the following applications; instead provide single conductors in rigid raceway.
 - 1. Homeruns to Panelboard.
 - 2. Branch circuits serving Essential Electrical System (Emergency & Standby) loads; including Life Safety branch, Critical branch and equipment emergency system.
 - 3. Branch circuits serving HVAC, elevator/escalator, medical and kitchen equipment loads.
 - 4. Within mechanical, electrical or telecommunication equipment rooms.
 - 5. Exposed Branch Circuits within areas that do not have a ceiling (i.e. open to structure).
 - 6. Wet locations.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Wiring in a homerun conduit shall be limited to two, 3-phase homeruns.
- B. Each circuit shall have a separate neutral conductor.
- C. Install pull boxes in circuits or feeders over 100' long.
- D. All conductors shall be continuous from origin to panel or equipment termination without splices where possible. Where splices and taps are necessary or are required for branch circuits, they shall be made in splice boxes with suitable connectors. Feeder conductors shall not be spliced.
- E. Make all splices or connections only at outlet, pull or junction boxes.
- F. Use pulling compound to pull conductors.
- G. Install instrument and data connection conductor in separate raceways from all other conductors. Separate control wiring from power wiring in separate raceways. Separation distances shall be as specified by control system manufacturer or as listed in IEEE Standard 518, whichever is greater.
- H. Bend radius on conductors shall be less than the limitations listed by the cable manufacturer.
- I. Deliver all conductors to job site new and in original wrapping, package or reel.
- J. All conductors and connections shall test free of grounds, shorts, and opens.

- K. For 20-amp, 120-volt branch circuits, provide No. 10 wire in lieu of No. 12 wire for any branch circuit in excess of 90 linear feet to prevent excessive voltage drop. Where branch circuit exceeds 175 linear feet, use No. 8 wire.
- L. Use Ideal wing nuts, Scotchlok Type Y, R, G, or B, or approved equivalent connectors for fixture connections at outlet boxes.
- M. Make feeder taps and joints with OZ type T, PT, PM or PTS, or approved equivalent clamp connectors as manufactured by Kupler, or with approved compression sleeves. Wrap connectors with No. 10 electro-seal or approved equivalent plastic filler and vinyl tape.
- N. Leave a minimum of 8" slack wire in every outlet box whether it be in use or left for future use.
- O. Color code conductors as follows:

CONDUCTOR COLOR CODE		
	120/208 Volt	277/480 Volt
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green

- P. If the above conflicts with existing color coding, match existing.
- Q. Use factory color coded conductors where commercially available. If not, use black wire and band with color tape.

END OF SECTION 26 05 19

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. The entire system of raceways and equipment to be grounded and bounded in accordance with Article No. 250 and No. 517 of latest edition of National Electrical Code and any local regulation or governmental governing authority.

PART 2 PRODUCTS

2.01 EQUIPMENT REQUIREMENTS

- A. Main service disconnect means panelboard shall be connected to the grounding electrode system via the grounding electrode conductor. The grounding electrode conductor shall be sized in accordance with Table 250.66 of N.E.C. An additional ground wire of same size shall be run to a tripod grounding rod system driven in ground outside foundation of building. This system shall consist of three 3/4" x 10' copperweld ground rods driven in ground in an equilateral triangular configuration with a minimum of 15' spacing between each. Connection of each ground rod to one another shall be made using a conductor of same size as being run for main service ground. For new facilities, a ground grid (loop) installed around the building bonded by each corner column and every 2nd column in between. This system shall be in lieu of the tri-pod system. All grounding electrodes, as defined by Article 250 of N.E.C., present in the building or structure shall be bonded together to form the grounding electrode.
- B. Feeder circuits to panels, motor control centers, etc., shall have a separate green grounding conductor in conduit sized in accordance with Table 250.122 of N.E.C.
- C. All branch circuits shall have a separate green grounding conductor installed in same conduit as phase and neutral conductor from panel ground bus to device. The grounding conductor shall be sized in accordance with Table 250.122 of N.E.C.
- D. Ground all electrically operated equipment utilizing separate code size grounding conductors run in feeder conduits or contained within outer jacket enclosing the circuit conductors contained in flexible cords.
- E. Flexible conduit will not be approved as achieving continuity of ground. All flexible conduit shall have a jumper wire sized to ampacity of branch breaker and shall be connected to conduit system on both ends; this applies to fixtures, motors, controls, etc.
- F. Division 26 to provide grounding system testing of all receptacles and exposed fixed electrical equipment with conductive surfaces located within a patient care vicinity in accordance with NFPA-99. Results of the tests shall be recorded for each space with a report included in the closeout documents. Grounding to be corrected where results of test do not comply with the minimum requirements of NFPA-99.
- G. Receptacle testing in patient care rooms shall be provided in accordance with NFPA 99; including: visual inspection for physical integrity, continuity of grounding, polarity and retention force. Results shall be recorded and included as part of the closed out documents. Corrections shall be made to devices that do not comply with the NFPA 99 requirements.
- H. Bonding for other systems such as lightning protection, communications, cable TV, medical gas piping, etc. where required by N.E.C. or other codes shall be bonded per Article 250 of N.E.C.

2.02 GROUND CLAMPS

- A. O-Z Gedney, Steel City, or approved substitute.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Effectively bond all grounding conductors to grounding electrodes, equipment enclosures and ground busses.

- B. Provide a shunt path around main water meter by bonding around both sides of meter to assure continuity.
- C. Locate all grounding attachments away from areas subject to physical damage. Provide protective covering as required.
- D. Clean all non-conductive surfaces on equipment to be grounded, to assure good electrical continuity.
- E. Ground on main service shall be tested to obtain no greater than 10 ohms using 3-Point Fall of potential test. Test data shall be submitted to Engineer for review and such test data shall become a part of the final brochure.
- F. Tie ground bus in both normal and emergency panels serving the same patient care areas together with an insulated continuous copper conductor not smaller than No. 10 AWG in accordance with National Electrical Code Article No. 517-14.

END OF SECTION 26 05 26

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide a system of supporting devices and hangers to ensure secure support or bracing for conduit, electrical equipment, including safety switches, fixtures, panelboards, outlet boxes, junction boxes, cabinets, etc.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Provide appropriate supporting devices and hangers as manufactured by Erico Products, Inc., Steel City, Hubbell, or approved substitute:
 - 1. Vertical flange clamps (beam clamps).
 - 2. "Z" purlin clips.
 - 3. Conduit clips.
 - 4. Universal clamps (Beam clamps).
 - 5. Beam clamps (set screw type).
 - 6. Combination push-in conduit clips.
 - 7. Combination conduit hanger clamps.
 - 8. Flexible conduit clips.
 - 9. Special combination conduit clips.
 - 10. One hole steel straps.
 - 11. Minerallac conduit hangers.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Secure conduits to within 3' of each outlet box, junction box, cabinet, fitting, etc., and at intervals not to exceed ten feet (10') for EMT and IMC conduit and in accordance with Table 344.30 (B) (2) for Rigid Steel conduit.
- B. Install clamps secured to structure for feeder and other conduits routed against the structure. Use drop rods and hangers or racks to support conduits run apart from the structure.
- C. Furnish and install suitable angle iron, channel iron or steel metal framing with accessories to support or brace electrical equipment including safety switches, fixtures, panelboards, outlet boxes, etc.
- D. Paint all supporting metal not otherwise protected, with rust inhibiting primer and then with a finish coat if appropriate to match the surrounding metal surfaces. (Prepainted or galvanized support material is not required to be painted or repainted.)
- E. Use of chains, perforated iron, bailing wire, or tie wire for supporting conduit runs will not be permitted.
- F. Where HCF is allowed under other sections of this specification, it shall be fully supported per the installation requirements of N.E.C.

END OF SECTION 26 05 29

SECTION 26 05 33
RACEWAYS AND CONDUIT SYSTEMS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide a complete conduit system with associated couplings, connectors, and fittings.
- B. Conduits shall be mechanically and electrically continuous from outlet to outlet and from outlets to cabinets, pull or junction boxes.
- C. Provide each fixture, switch, receptacle, communication devices, and other wiring devices with a galvanized outlet box of appropriate size and depth for its particular location and use unless indicated otherwise.
- D. Provide pull and junction boxes of appropriate size and depth or as indicated on the drawings and as specified hereinafter.

1.02 SUBMITTALS

- A. Submittal for products furnished under this section is not required.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. IMC, RGS and EMT conduit shall be hot-dip galvanized, or electrogalvanized steel by Allied, Wheatland Tube, Republic Conduit, Western Tube, or approved substitute.
- B. Erickson couplings for IMC and RGS, shall be used where neither length of conduit can be rotated.
- C. IMC/RGS conduit connectors from 1/2" to 4" trade sizes shall use compression type.
- D. EMT conduit connectors from 1/2" to 2" trade sizes shall use set screw type. EMT conduit connectors from 2-1/2" to 4" trade sizes shall use two set screw type.
- E. Weatherproof hub shall be complete with sealing "O" ring or sealing locknuts.
- F. Provide polyvinyl chloride (PVC) conduit, Type 40, and associated couplings, connectors, and fittings. PVC conduit shall be UL listed and 90 degrees C UL rated.
- G. Provide aluminum conduit in areas requiring non-ferrous materials.
- H. Outlets and junction boxes shall be Steel City or approved substitute.
- I. Provide 4" square x 1-1/2" deep boxes for switches and receptacles in drywall partitions. Use square cut plaster rings of proper gauge and depth.
- J. Provide 4" x 1-1/2" octagonal boxes for ceiling outlets. For increased cubic capacity provide 4" x 2-1/8" octagonal, 4" x 1-1/2" square or 4" x 2-1/8" square boxes for ceiling outlets.
- K. Provide 4" x 3-1/2" octagonal concrete rings with removable back plates and fixture studs for ceiling outlets in prestressed or reinforced concrete slabs.
- L. Provide 2-1/2" x 3-3/4" one gang masonry boxes for switches and receptacles installed in concrete block walls not plastered. For increased cubic capacity provide 3-1/2" x 3-3/4" one gang masonry boxes. Where more than two conduits enter the box from one direction, provide 4" square boxes with square cut device covers not less than 1" deep specifically designed for this purpose. Use round edge plaster rings only if the block walls are to be plastered. Use sectional or gangable type outlet boxes only in dry wall construction.
- M. For all systems boxes, provide 4-11/16" square outlet boxes with square cut device corners for block walls or round edge plaster rings for plastered walls. Single gang device boxes are not acceptable.
- N. Permanent barriers shall be furnished in multi-gang boxes if the voltage between adjacent wiring devices exceeds 300 volts.

- O. Provide galvanized malleable iron fittings with threaded hubs for screw connections and with the proper type covers for switches and receptacles served by exposed conduit. Use pressed steel outlet only for ceiling fixture outlets.
- P. Provide galvanized malleable iron condulets with threaded hubs and covers and with proper configurations for all changes of direction of exposed conduits. Standard conduit ells may be used if they do not interfere or damage or mar the appearance of the installation.
- Q. Pull and junction boxes shall be by Hoffman or approved substitute.
- R. For interior work, provide galvanized sheet metal boxes of code thickness with lapped and welded joints, 3/4 inch flanges, screw covers, etc.
- S. For exterior work, provide galvanized sheet metal boxes of code thickness with lapped and welded joints, 3/4 inch flanges, bolted covers with full gaskets forming a completely water-tight assembly, equal to Hoffman, Concept Series.
- T. For exterior work in graded areas outside the building, provide heavy duty sidewalk junction boxes externally flanged for flush mounting. Covers to be fully gasketed, watertight and secured with plated screws or bolts. Crouse-Hinds Type WJB or approved substitute.
- U. Conduit is to be color coded from the factory in accordance with facility's current color coding standard, where no standard exists for color coding, provide in accordance with FacilityGroup guidelines. As an alternative, contractors may submit for evaluation a deduct to omit use of factory-painted conduit. Tape or paint are to be used to identify circuits and junction boxes and/or fittings are to be painted in accordance with facility standard or color table.

2.02 ELECTRICAL METALLIC TUBING (EMT)

- A. Use Electric Metallic Tubing (EMT) for:
 - 1. Indoor branch circuits and feeders where concealed or where exposed and not subject to physical damage.

2.03 INTERMEDIATE METAL CONDUIT (IMC)

- A. Use Intermediate Metal Conduit (IMC) for:
 - 1. Panelboard feeders where subject to damage.
 - 2. Branch circuits installed in hazardous areas.
 - 3. Branch circuits and feeders installed in concrete slabs at ground floor.
 - 4. Branch circuits installed exposed below 6 feet above finished floor.
 - 5. Branch circuits installed in wet locations.
 - 6. Branch circuit and feeders installed on crawl spaces.
 - 7. Branch circuit concealed in masonry walls.

2.04 RIGID GALVANIZED STEEL (RGS)

- A. Conduit Use:
 - 1. Exterior exposed primary service conduit.
 - 2. Interior and exterior exposed secondary service conduit.

2.05 POLYVINYL CHLORIDE (PVC)

- A. Use PVC for:
 - 1. Service entrance conduits for power encased in concrete.
 - 2. Service entrance conduits for telephone.
 - 3. Exterior feeders encased in concrete.
 - 4. Exterior underground branch circuits.
 - 5. Primary power conduits encased in concrete.
- B. PVC conduit shall not be used for feeders or branch circuits inside the building.

2.06 FLEXIBLE METAL CONDUIT

- A. Provide a flexible metal conduit system for the termination points at equipment that may possibly vibrate such as motors, etc. The length shall not exceed 6 feet.
- B. Conduit shall be electrically continuous from outlet or conduit end to the utilization equipment.

- C. The total length of flexible conduit in any circuit shall not exceed 6 feet.
- D. Where exposed to continuous or intermittent moisture, conduit shall be liquid tight flexible type, U.L. Type EF.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Minimum size of conduits shall be 1/2 inch (12.7 mm) for controls circuiting and 3/4 inch (19.05mm) for feeder circuits and multiple branch circuits.
- B. Conduit joints shall be cut square, threaded, reamed smooth, and drawn up tight so conduit ends will butt in couplings, connectors, and fittings.
- C. Make bends or offsets with standard ells or field bends with an approved bender.
- D. Run conduits concealed in floor slabs, below slabs, or in walls in direct line with long sweep bends or offsets. Run exposed conduits and conduits run above lay-in ceilings parallel to and at right angles to building lines. Group multiple conduit runs in banks.
- E. Secure conduits to all boxes and cabinets with two locknuts and bushings so system will be electrically continuous from service to all outlets.
- F. Provide grounding bushings on all feeder conduits in critical care areas in accordance with NEC Article 517.
- G. Cap ends of conduits to prevent entrance of water and other foreign material during construction.
- H. Complete conduit systems before pulling conductors.
- I. Conduits shall be divided according to voltage and amperage service level. Conduits of different voltage levels shall be physically separated by the following distances unless otherwise specified on the drawings by the electrical engineer or control system supplier.
 - 1. Level 1 conduits shall contain low level input/output signal conductors including RTD cables, thermocouple cables, and 4-20 mA d.c. cables from field transmitters.
 - 2. Level 2 conduits shall contain all conductors for 24 volts d.c. power and signal.
 - 3. Level 3 conduits shall contain all conductors for 120 volt a.c. power to the PLC control cabinets, motor control circuits, field devices requiring 120-volt power, etc.
 - 4. Level 4 conduits shall contain all conductors for 120 volts d.c. control power greater than 3 amps, all 120 volts a.c. power greater than 20 amps, and all power circuits with voltage ratings higher than 120 volts a.c. (277, 480, 4160, 13,200 volts etc.). Examples include 480-volt motor feeds, 5-kV feeders, and 120-volt lighting circuit and input/output devices such as limit switches and solenoid valves.
 - 5. Conduits shall be physically separated from each other by the following distances:

SPACING REQUIREMENTS (IN INCHES) FOR METALLIC CONDUITS			
From Level	To Level 2	To Level 3	To Level 4
Level 1	Minimum 1"	Minimum 6"	Minimum 26"
Level 2	0"	Minimum 6"	Minimum 26"
Level 3	Minimum 6"	0"	Minimum 18"

- 6. Levels 1, 2, and 3 conductors shall additionally be routed away from sources of high voltage or RF radiation such as switchgear, transformers, radio transmitters, and repeaters. Minimum separation from these sources of interference shall be 5 feet.
- 7. Data highway communications cable are generally considered Level 1 conductors; however, special requirements apply for routing to assure a low noise environment. Refer to electrical drawings and controls supplier requirements for special considerations before routing these conduits.
- J. Where conduits of different levels must cross, the minimum separations shall be maintained, and they shall cross at right angles.
- K. Provide cable supports in conduits rising vertically in accordance with the National Electrical Code, Article 300-19.

- L. Provide nylon pull cord in all empty conduits. Steel wire not acceptable as pull wire.
- M. Conduits which pass through floor slabs (except ground floor) shall be sealed with concrete grout. Seal around conduits or other wiring materials passing through partitions, which extend to the underside of the slab above, and those passing through smoke partitions and fire-rated walls. Refer to appropriate details on architectural and mechanical drawings.
- N. Where IMC or RGS conduit is installed in a cabinet, junction box, pull box, or auxiliary gutter, conductors shall be protected by an insulated bushing. Locknuts shall be installed on conduit outside and inside enclosure.
- O. In areas where enclosed and gasketed fixtures and weatherproof devices are specified, where rigid conduit enters a sheet metal enclosure, junction box and outlet box, and not terminated in a threaded hub, a steel, or malleable iron nylon insulated hub, complete with recessed sealing "O" ring or sealing locknut shall be used.
- P. Where conduits stub up in conduit space beneath switchgear and do not connect directly to equipment enclosures, use malleable iron nylon insulated ground bushing with a lay-in lug design complete with bonding screw, Raco 1212-1296.
- Q. In concrete slabs, block up conduit from forms and securely fasten in place. All conduits in slabs shall have a minimum of 1-1/2 inches concrete coverage above and below.
- R. Encase in 4 inches of 1:2:4 mix concrete on all sides all feeder conduits laid below ground outside building foundation line.
- S. Conduits for feeders and branch circuits shall be terminated directly into panelboard enclosure without the use of pull boxes, junction boxes, wireways, or auxiliary gutters, unless the panelboard enclosure does not provide sufficient surface area for all conduits. Where such cases exist, the contractor shall notify the Designer. In no case will splices in such boxes, wireways, etc., be permitted.
- T. Failure to route conduit through building without interfering with other equipment and construction shall not constitute a reason for an extra charge. Equipment, conduit, and fixtures shall fit into available spaces in building and shall not be introduced into building at such times and manner as to cause damage to structure. Equipment requiring servicing shall be readily accessible.
- U. Standard HCA color coding:
 - 1. Purple: Essential Distribution not listed herein
 - 2. Yellow: Life Safety Branch
 - 3. Orange: Critical Branch
 - 4. Green: Equipment Branch
 - 5. Red: Fire Alarm System
- V. If the above conflicts with existing color code, use existing.
- W. No conduit shall be installed in elevated slabs.

3.02 EMT

- A. Do not use electric metallic tubing in cinder concrete or cinder fill where subject to permanent moisture unless protected on all sides by a layer of noncinder concrete at least 2 inches thick or unless the EMT is at least 18 inches under the fill. Use of set-screw fitting is not acceptable in concrete or in fill under slab.

3.03 PVC

- A. Use threaded fittings for all connectors and adapters.
- B. Provide code sized ground conductors in all power conduit runs.
- C. Provide 1/4-inch nylon pull rope in all primary power and incoming telephone service entrance conduits.
- D. Encase all PVC conduit in reinforced concrete with a minimum of 4-inch encasement on all sides except exterior branch circuits.

- E. No PVC shall emerge from the ground or the concrete slab or encasement. PVC shall convert to galvanized rigid metal prior to its emergence.
- F. Make bends with standard ells or with an approved heat bender.

3.04 FLEXIBLE METAL CONDUIT

- A. Conduits shall be 1/2 inch minimum size.
- B. 3/8 inch flexible conduit may be used for light fixture whips.
- C. Where fittings for liquidtight flexible conduit are brought into an enclosure with a knock-out, a gasket assembly, consisting of one piece "O" ring, with Buna-N sealing material, Raco Series 3500, shall be installed on outside of box. Fittings shall be made of either steel or malleable iron only, and shall have insulated throats or insulated bushings.
- D. In dry locations, where final connections to motors and other equipment may be made with flexible metal conduit, fittings shall be of steel or malleable iron only with insulated throats or insulated bushings, and shall be of wedge and screw type having an angular wedge fitting between convolutions of conduit.
- E. An additional copper ground wire shall be installed inside of flexible conduit and bonded at each end to assure continuity of ground to lighting fixtures, controls, and other utilization equipment.
- F. All recessed lighting fixtures shall be connected with flexible metallic conduit from outlet box to fixture. Rigid conduit connections to lighting fixtures are not acceptable.
- G. Install liquidtight flexible conduit in such a manner as to prevent liquids from running on the surface toward fittings.
- H. Allow sufficient slack conduit to reduce the effect of vibration.

END OF SECTION 26 05 33

SECTION 26 05 73
POWER SYSTEM ANALYSIS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes short circuit, protective device coordination and Arc Flash study encompassing portions of electrical distribution system from normal and emergency power sources to the largest breakers in each panelboard.
- B. Contractor shall engage services of a licensed engineer for purpose of performing electric power system studies as specified.
- C. Contractor shall field verify all new and existing feeder sizes and lengths, as existing breaker types and settings associated with the studies.

1.02 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).
 - 2. IEEE 1584 – Guide for Performing ARC – Flash Hazard Calculations.
- B. National Fire Protection Association: NFPA 70 - National Electrical Code, NFPA 99 – Health Care Facilities Code.

1.03 DESIGN REQUIREMENTS

- A. Complete Short Circuit, Protective Device Coordination, and Arc Flash Study to meet requirements of NFPA 70 and NFPA 70E.
- B. Short Circuit Report Preparation:
 - 1. Prepare study prior to ordering distribution equipment to verify equipment ratings required.
 - 2. Perform study with aid of computer software program.
 - 3. Calculate short circuit interrupting and, when applicable, momentary duties for assumed 3-phase bolted fault short circuit current and phase to ground fault short circuit current at each of the following:
 - a. Utility supply bus.
 - b. Medium voltage air interrupter switchgear.
 - c. Medium voltage circuit breaker switchgear.
 - d. Secondary unit substations.
 - e. Automatic transfer switch.
 - f. Manual transfer switch.
 - g. Engine generator.
 - h. Medium voltage motor controllers.
 - i. Medium voltage oil switchgear.
 - j. Low-voltage switchgear.
 - k. Switchboards.
 - l. Motor control centers.
 - m. Distribution panelboards.
 - n. Branch circuit panelboards.
 - o. Each other significant equipment location throughout system.
- C. Short Circuit Report Contents Include the following:
 - 1. Calculation methods and assumptions.
 - 2. Base per unit value selected.
 - 3. One-line diagram.
 - 4. Source impedance data including power company system available power and characteristics.
 - 5. Typical calculations.
 - a. Fault impedance.

- b. X to R ratios.
 - c. Asymmetry factors.
 - d. Motor fault contribution.
 - e. Short circuit kVA.
 - f. Symmetrical and asymmetrical phase-to-phase and phase-to-ground fault currents
 - g. Tabulations of calculation quantities and results.
- 6. One-line diagram revised by adding actual instantaneous short circuits available.
- 7. State conclusions and recommendations.
- D. Overcurrent Protective Device Coordination Study
 - 1. Prepare time-current device coordination curves graphically indicating coordination proposed for system, centered on conventional, full-size, log-log forms.
 - 2. Prepare with each time-curve sheet complete title and one-line diagram with legend identifying specific portion of system covered by that particular curve sheet.
 - 3. Prepare detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.
 - 4. Plot device characteristic curves at point reflecting maximum symmetrical fault current to which device is exposed. Include on curve sheets the following as applicable:
 - a. Power company relay characteristics.
 - b. Power company fuse characteristics.
 - c. Medium voltage equipment protective relay characteristics.
 - d. Medium voltage equipment protective fuse characteristics.
 - e. Low voltage equipment circuit breaker trip device characteristics.
 - f. Low voltage equipment fuse characteristics.
 - g. Cable damage point characteristics.
 - h. Pertinent transformer characteristics including:
 - 1) Transformer full load current
 - 2) Transformer magnetizing inrush.
 - 3) ANSI transformer withstand parameters.
 - 4) Significant symmetrical fault current
 - i. Pertinent motor characteristics.
 - j. Generator characteristics including:
 - 1) Phase and ground coordination of generator protective devices.
 - 2) Decrement curve and damage curve.
 - 3) Operating characteristic of protective devices.
 - 4) Actual impedance value.
 - 5) Time constants.
 - 6) Current boost data.
 - 7) Do not use typical values for generator.
 - k. System shall fully coordinate at 0.1 seconds and higher per NFPA 70 and NFPA 99.
 - l. Coordination curves include generator's inherent protection.
- E. Arc Flash Study: Perform Arc Flash Analysis to include the following at each distribution bus:
 - 1. Bolted fault current.
 - 2. Arc fault current.
 - 3. Protective device characteristic and arc fault duration.
 - 4. System voltages and equipment class.
 - 5. Working distances.
 - 6. Calculated incident energy.
 - 7. Calculated arc flash protective boundary.

1.04 SUBMITTALS

- A. Product Data: Submit the following report and summarize results of study in report format including the following:
 - 1. Descriptions, purpose, basis, and scope of study.

2. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short-circuit duties, and commentary regarding same.
 3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
 4. Fault current calculations including definition of terms and guide for interpretation of computer printout.
 5. Arc flash calculations and printout of labels.
- B. Submit five (5) copies of final report signed by professional engineer. Make additions or changes required by review comments.

1.05 QUALIFICATIONS

- A. Perform study under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location with a minimum of five (5) years experience in power system analysis.
- B. Demonstrate company performing study has capability and experience to provide assistance during system start up.

1.06 SEQUENCING

- A. Submit short circuit and protective device coordination study to Engineer prior to receiving final approval of distribution equipment shop drawings and prior to releasing equipment for manufacturing.
- B. When formal completion of study will cause delay in equipment manufacturing, obtain approval from Engineer for preliminary submittal of study data sufficient in scope to ensure selection of device ratings and characteristics will be satisfactory.

1.07 SCHEDULING

- A. Schedule work to expedite collection of data to ensure completion of study for final approval of distribution equipment shop drawings prior to release of equipment for manufacturing.

PART 2 PRODUCTS– NOT APPLICABLE

PART 3 EXECUTION

3.01 ADJUSTING

- A. Perform field adjustments of protective devices and modifications to equipment to place equipment in final operating condition. Adjust settings in accordance short circuit and protective device coordination study.

3.02 ARC FLASH SIGN INSTALLATION

- A. Implement the Arc Flash sign installation requirements for electrical equipment as specified in NEC Article 110.16 Flash Protection, NFPA 70E and OSHA.
- B. Signs shall be adhesive vinyl for indoor use and engraved plastic for outdoor use.

3.03 ARC FLASH TRAINING

- A. Provide training for the Owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours).
- B. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.
- C. Include in Project Close-out Documents training notes, outlines, and Power Point presentation of training session. Also include attendance record of personnel attending the training session.
- D. Training session shall be videotaped. Include copy of DVD of training session in Project Close-out Documents.

END OF SECTION 26 05 73

SECTION 26 12 19
LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Service will be underground and will be a 480/277-volt, 3-phase, 4-wire, wye system.
- B. System will be serviced by FPL.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Service shall be grounded in accordance with latest edition of National Electric Code, Article No. 250, and any special requirements as required by municipal, state, or federal authorities having jurisdiction.
- B. Metering shall be provided as required by the power company. Coordinate final location with utility company, provide mounting support system as required for CT cabinets, metering cabinets, etc.
- C. Transformers shall be provided by power company and shall be a pad-mounted type of transformer.
- D. Transformer shall be mounted on a reinforced concrete pad, sized and detailed in accordance with utility company requirements.
- E. Primary conduits shall be provided by Division 26 as shown on drawings, including pull rope, excavation, backfill, and a 4" concrete envelope. Conduits shall be run up pole as directed by power company (approximately 30 feet). Any spare conduits shown shall be capped off 12 inches above grade with plumber's pipe cap.
- F. Conduits shall be terminated with OZ Type R, G & W Type CS, or equal cable terminator.
- G. Primary conduits shall be provided by power company.
- H. Secondary conduits, wire, excavation, and backfill to be provided by Division 26 as shown on drawings from transformer to main distribution point.
- I. Division 26 to provide secondary lugs on transformer and shall coordinate with power company as to proper drilling and lugs required.
- J. Coordinate any utility required disconnects with power company prior to rough-in exact requirements and location shall be per the utility's guidelines.

PART 3 EXECUTION

3.01 INSTALLATION/COORDINATION

- A. Division 26 shall coordinate with power company to determine final exact location of transformers, exact sizes required, and conduit stub-up points for primary and secondary entrances within transformer.
- B. Division 26 shall coordinate with power company to determine final exact location of disconnects, metering cabinets, CT cabinets, etc.
- C. Division 26 shall be responsible for furnishing a breakdown listing the loads as shown on the drawings for the power company.

END OF SECTION 26 12 19

SECTION 26 22 00
LOW VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. All work specified in this section shall comply with the provisions of Section 26 05 00.
- B. Provide dry type transformers as specified herein, and as shown on the contract drawings.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Transformers shall be as manufactured by Square D, per HCA's purchasing agreement.
 - 1. Contact is as follows:
Jess Hoover, Charlie Shannon
Graybar-Nashville
825 8th Avenue South
Nashville, TN 37217
HCA@graybar.com
239-494-2088
615-743-3226
HPG Contract No. 5892

2.02 EQUIPMENT REQUIREMENTS

- A. Single-phase and three-phase general purpose dry type transformers shall be of the two-winding type, self-cooled, with ratings (KVA) as indicated on the drawings. Transformers shall be built in accordance with applicable NEMA, ANSI, IEEE, OSHA, UL standards, and regulations on listings.
- B. Transformers shall contain aluminum windings. Copper not required.
- C. Sound levels shall not exceed the following ranges:
 - 1. 0-9 KVA: 40 db.
 - 2. 10-50 KVA: 45 db.
 - 3. 51-150 KVA: 50 db.
 - 4. 151-300 KVA: 55 db.
 - 5. 301-500 KVA: 60 db.
 - 6. 501-700 KVA: 62 db.
- D. Transformers with single phase ratings through 10 KVA shall have a voltage ratio of 240/480 volts primary-120/240 volts secondary with a maximum temperature rise of 115 degrees C at full load rating for the non-ventilated type, suitable for indoor or outdoor use.
- E. Transformers with three phase ratings through 9 KVA shall have a voltage ratio as indicated on drawings. Provide six 2-1/2% full capacity voltage adjusting taps, 2 above and 4 below primary rated voltage; Maximum full load temperature rise to be 115 degrees C; for the non-ventilated, HARDSHELL, encapsulated type, suitable for indoor or outdoor use.
- F. Single and three phase transformers rated above 9 KVA to be insulated with UL listed Class 220 rated materials; and have a maximum average full load temperature rise of 150 degrees C.
- G. Transformers to have voltage ratios as indicated on drawings. Transformers between 15 KVA and 300 KVA to be provided with six (6) 2-1/2% full capacity taps--two above and four below primary rated voltage.
- H. Transformer core to be of low loss type, high quality, grain oriented steel. Core clamping members shall cover a minimum of 90% of the top and bottom core yoke laminations; and vertical framing members shall be contained within the insulated coil form, to minimize external flux path.
- I. Coils to be wound of electrical grade, edge-conditioned aluminum strip on preformed rigid coil base; and be provided with corrugated aluminum positive spacing air duct forms, to increase air

circulation and reduce hot spot temperature rise. Each coil to have a final protective outer wrap of electrical insulating material. Coils with exposed magnet wire will not be acceptable. Coil leads to be terminated to suitable solderless lugs (thru 75 KVA), fully approved for use with either copper or aluminum cable and located on a solidly-braced, insulated terminal board.

- J. Immediately prior to initial varnish impregnation, entire core and coil assembly to be thoroughly dried in a preheat cycle, and then thoroughly baked to ensure that all volatiles have been driven off in process. Core and coil assembly to be internally isolated from enclosure through use of an effective vibration dampening system.
- K. Transformers shall have a terminal bar for all grounding and bonding conductors secured to the inside of the enclosure per NEC 450.10.
- L. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide flexible conduit to and from transformer.
- B. Install transformers in accordance with manufacturers' recommendations.
- C. Provide trapeze type hangers for transformers supported from the structure or mount on the floor as shown on the drawings. Floor mounted transformers shall be securely anchored to a 4" reinforced concrete housekeeping pad. Provide working clearances as required by NEC.
- D. Ground secondary neutral of all transformers to grounding conductor in primary feeder and to building steel or other approved electrode using grounding electrode conductor sized in accordance with NEC. Ground transformer enclosure with bonding jumper.
- E. Transformers 45 KVA or less may be floor mounted or suspended. 75 KVA transformers may be floor mounted or rack mounted. Transformers above 75 KVA shall be floor mounted.

END OF SECTION 26 22 00

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide circuit breaker type panelboards as indicated on drawings and as specified in this section.
 - 1. Refer to drawings for numbers of branch circuits, their ratings, number of poles, arrangements, etc.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS/EQUIPMENT

- A. Provide panelboards by Square D, per HCA's purchasing agreement.
 - 1. Contact is as follows:
Jess Hoover, Charlie Shannon
Graybar-Nashville
825 8th Avenue South
Nashville, TN 37217
HCA@graybar.com
239-494-2088
615-743-3226
HPG Contract No. 5892
- B. Lighting panelboards for 120/208-volts, 3-phase, 4-wire service shall be Square D type NQOD.
- C. Lighting panelboards for 277/480-volts, 3-phase, 4-wire service shall be Square D type NF.
- D. Power panelboards for 120/208-volt, and 480/277-volt, 3-phase, 4-wire service shall be Square D I-Line distribution type.
- E. Lighting and power panelboards and their associated circuit breakers shall be furnished with a short-circuit current rating greater than the available fault current shown on the panel schedules.
- F. Series rated panelboards are not acceptable.
- G. Provide panelboards of circuit breaker, dead-front safety type, UL labeled and meeting all applicable requirements of the National Electrical Manufacturers Association.
- H. Provide panelboards with lugs (both main lugs and branch circuit lugs) suitable and UL approved for aluminum and copper 75 degree C rated conductors.
- I. Provide shunt trip and GFI breakers where indicated on panel schedule.
- J. Provide electrically isolated neutral bars.
- K. Provide separate ground bars complete with lugs or connectors on bar.
- L. Provide panelboards with sequence phased bus bars or distributed phase bussing for: 3-phase, 4-wire, 277/480-volts wye and 120/208-volts wye.
- M. Provide panel doors equipped with chrome-plated locks and catches, all keyed alike. Provide two keys for each lock. Provide fronts with adjustable indicating trim clamps.
- N. Provide thermal magnetic circuit breakers which are fully rated and temperature rated for a 40 degree C ambient. Breakers shall be quick-make, quick-break type with trip indication shown by handle position other than ON or OFF and with a common trip on all multi-pole breakers.
- O. Where specific panelboard types, breaker types, or adjustable breaker devices are shown on the drawings, and the contractor elects to use another manufacturer or type, contractor will be responsible for additional cost incurred by the designer for evaluation of breaker coordination.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Ground separate ground bars to panel boxes and to the main service entrance ground bus with a code-sized grounding conductor installed in the same conduit as the phase and neutral conductors.
- B. Balance all circuits to achieve not greater than 10% unbalanced neutral current in panel feeders.
- C. Provide six circuit breaker handle lock-on devices for each lighting panelboard for installation by the contractor on circuits as directed by the Owner to prevent unauthorized personnel from turning off circuits. Circuits serving fire alarm equipment and circuits serving exterior signage shall be provided with locking devices. Turn the spare lock-on devices over to the Owner for his use.
- D. Provide typed directory cards mounted under plastic on the doors of all panelboards. The directories shall indicate the type of devices being served, including the space number or space names in which the devices or fixtures are located. For areas of renovation, new typed directory cards shall be provided in existing panelboards where changes have occurred as a result of renovation or remodeling work.
- E. Provide engraved Bakelite nameplates for all the circuit breakers in use on power panelboards. Indicate the device, panel, or motor being served with 1/4" high letters. Provide nameplates without engraving for the spare breakers and/or spaces. Secure all nameplates to the panelboard trim with two roundhead sheet metal screws.
- F. Provide engraved Bakelite nameplates on the visible face of all lighting and power panels indicating the panel and essential system branch designation in 3/8" letters. Secure the nameplates with a minimum of two round-head sheet metal screws. Nameplates shall be yellow for life safety branch equipment, orange for critical branch equipment, green for equipment branch equipment, purple for essential distribution and black for normal branch equipment.
- G. Provide No. 10 continuous ground conductor to bond the ground busses of the normal and emergency power panels which serve the same patient care areas in accordance with NEC Article 517.
- H. Contractor to spot paint panel backbox per the following color code:
 - 1. Purple: Essential Distribution not listed herein
 - 2. Yellow: Life Safety Branch
 - 3. Orange: Critical Branch
 - 4. Green: Equipment Branch
- I. Surge protection shall be provided for all life safety branch panels per Section 26 43 13 of these specifications.
- J. The panelboard design shall allow access to solid state breaker displays and settings without removal of the dead front.
- K. Surge protection shall be provided for all panelboards serving circuits which exit the building per Section 26 43 13 of these specifications.

END OF SECTION 26 24 16

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide switches, receptacles, device plates, and other wiring devices as indicated on drawings.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Acceptable manufacturers include Leviton, Acuity Controls or approved equal.

2.02 SWITCHES

- A. 20-Amp, 120/277 VAC:
1. Single pole: Leviton No. 1221-2I (normal branch).
 2. Single pole: Leviton No. 1221-2R (emergency branch).
 3. Three-way: Leviton No. 1223-2I (normal branch).
 4. Three-way: Leviton No. 1223-2R (emergency branch).
 5. Single pole, weatherproof: Leviton No. 1221-2W or 1221-2R with Steel City No. SW1-C weatherproof plate.
- B. Universal Dimmers:
1. Acuity Controls No. SPODMRD-EZ-IV (Normal Branch)
 2. Acuity Controls No. SPODMRD-EZ-RD (Emergency Branch)
- C. Vacancy Sensors:
1. Wall Mount: Acuity Controls No. WSX-PDT-VA-IV (normal branch)
 2. Wall Mount: Acuity Controls No. WSX-PDT-VA-RD (emergency branch)
 3. Ceiling Mount, single branch load: Acuity Controls No. CMPDT-9
 4. Ceiling Mount, multiple branch loads: Acuity Controls No. nCMPDT-9-RJB
 5. Wall Mount with dimming: Acuity Controls No. WSX-PDT-EZ-D-SA-IV (normal branch)
 6. Wall Mount with dimming: Acuity Controls No. WSX-PDT-EZ-D-SA-RD (emergency branch)
- D. Power Packs
1. Power Pack, single branch load: Acuity Controls No. PP20
 2. Power Pack, multiple branch loads: Acuity Controls No. nPP16-SA
 3. Power Pack, multiple dimming locations: Acuity Controls No. nPP16-D-SA
- E. Low Voltage Switches
1. Wall Mount for use with nPP16 power pack: Acuity Controls No. nPODM-IV (normal branch)
 2. Wall Mount for use with nPP16 power pack: Acuity Controls No. nPODM-RD (emergency branch)
 3. Wall Mount 3-way switch single branch load with vacancy sensor: Acuity Controls No. SPODM-SA-3X-IV (normal branch)
 4. Wall Mount 3-way switch single branch load with vacancy sensor: Acuity Controls No. SPODM-SA-3X-RD (emergency branch)
 5. Wall Mount 3-way switch dimming single location: Acuity Controls No. SPODM-SA-3X-D-IV (normal branch)
 6. Wall Mount 3-way switch dimming single location: Acuity Controls No. SPODM-SA-3X-D-RD (emergency branch)

2.03 RECEPTACLES

- A. 20-Amp, 125-VAC, NEMA 5-20R:
1. Duplex type, hospital grade: 8300-I (ivory) for normal power devices and 8300-R (red) for emergency devices.
 2. Ground fault circuit interrupter, 20-amp hospital grade: Leviton No. GFNT2-HGI (ivory) for normal power and GFNT2-HGR (red) for emergency power.

3. GFCI Duplex type, heavy-duty industrial grade, Weather and Tamper-Resistant: Leviton G5362-WTW (White).
4. Duplex type, hospital grade, tamper resistant: Leviton No. 8300-SGI (ivory) for normal power and 8300-SGR (red) for emergency power devices.
5. Duplex type, weather resistant, GFI: Leviton No. WT899-HGI (ivory) for normal power and WT899-HGR (red) for emergency power devices.
6. GFCI Duplex type, heavy-duty industrial grade, Weather and Tamper-Resistant: Leviton G5362-WTW (White).
7. While-in-use, Weatherproof Cover: Leviton No. 5980-UCL.

2.04 DEVICE PLATES

- A. Provide Leviton Series 80 nylon plates, red for emergency circuits and ivory for normal circuits, or approved substitute. Provide cast alloy or stamped metal plates on all exposed switches and receptacles.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Mounting:
 1. Mount all switches 46" above the finished floor to centerline of switch unless noted otherwise.
 2. Mount all receptacles 18" above the finished floor to centerline of receptacle unless noted otherwise.
 3. Mount weatherproof receptacles vertically.
 4. Work devices to nearest block course using proper type outlet boxes as specified under Section 26 05 33. Check architectural and furniture drawings for counter (desk, special booth etc.) locations. Mount devices above work counters. Verify other special mounting conditions and locate devices as required.
- B. Polarity: Properly wire all convenience outlets so that the hot wire, the neutral wire and the ground wire connect to the proper terminal on all receptacles.
- C. Grounding: Install all receptacles in boxes specified under Section 26 05 33, and install a No. 12 green ground wire from device grounding terminal back to the grounding bus in the panelboard and bond to outlet box.
- D. Receptacles shown on the drawings as "special mounting height" shall be installed at mounting height as indicated on drawings. Where no mounting height is given and receptacles are above counters (or casework), they shall be mounted with centers 4" above top of counter. If the counter has a backsplash, receptacles shall be mounted with centers 4" above top of backsplash. Where special mounting height receptacles are not above counters and no mounting height is indicated, receptacle mounting heights shall match adjacent light switches or above counter receptacles. The Contractor shall coordinate the installation of all special mounting height receptacles with architectural design.
- E. Install device plates in full contact with wall surface. Plates shall not project out from the wall.
- F. Install device plates in full contact with surface-mounted box. Plates shall not project out from the edge of the box.
- G. Provide engraved faceplates for all receptacles identifying the panel and circuit designation.
- H. Provide engraved faceplates for all receptacles in critical care patient locations identifying the panel and circuit designation. All other device plates shall be labeled to identify panel and circuit designation using an adhesive tape method similar to p-touch by Brothers.

END OF SECTION 26 27 26

SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide horsepower-rated, quick-make, quick-break, safety switches provided with the number of poles and fuses as required.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS/EQUIPMENT

- A. Safety switches and enclosed circuit breakers shall be as manufactured by Square D.
- B. For 208- and 240-volt circuits, use general-duty type switches with Class R fuse clips. For 480-volt circuits, use heavy-duty type switches with Class R fuse clips.
- C. Switches shall have arc shields, shall be of enclosed construction and fusible or non-fusible as indicated. Switches shall be rated for either 250-volt AC or 600-volt AC service as required.
- D. Safety switches for all part-winding or two-speed motors requiring remote disconnect to be similar to Square D Series HLL-660, six-pole.
- E. All switches shall be capable of interrupting locked rotor current of motor which it serves.
- F. Enclosures to be NEMA-1 for interior use and NEMA-3R for exterior use unless noted otherwise.
- G. Provide dual-element Bussman type FRN (250 volt) or type FRS (600 volt) fuses for any fusible safety switch serving a motor circuit.
- H. For non-motor loads, provide dual element Bussman type LPN (250 volt) or type LPS (600 volt).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide non-fusible switches at remote motor locations (raintight where required) as indicated on drawings.
- B. Mount switches to walls or adjacent to equipment enclosures using unistruts with a minimum of four bolts using toggle anchors for masonry construction, Phillips "Red Head" anchors for poured concrete construction and bolts, jumbo washers, lock washers and nuts for equipment enclosure mounting.
- C. All safety switches to be identified with Bakelite nameplates.
- D. All safety switches and enclosed circuit breakers shall be capable of being locked in the open position.

END OF SECTION 26 28 16

SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide conduit, wiring and electrical connections to motors, safety switches, starters, relays, electrical interlock circuits, valves, unit heaters, fan coil units, pumps, air handling units, etc., complete and ready for operation. The Division 26 contractor shall review the electrical requirements of other sections and divisions of these specifications and drawings and provide the required power and control wiring.
- B. Provide starters as shown on mechanical drawings and as scheduled on Electrical Drawings except custom designed starter such as chiller machine, those physically mounted on the unit such as a deaerator, or any piece of equipment where starter is furnished as an integral part of the equipment.
- C. Control Wiring:
 - 1. Division 23 shall furnish and install line- and low-voltage control wiring, including conduit, conductors, and terminations for same. Division 23 shall also furnish and install control components associated with the line- and low-voltage control systems and shall wire and connect components in accordance with approved wiring diagrams.
 - 2. Division 26 shall furnish and install power wiring including conduit, conductors, and terminations to motors, safety switches, starters, relays, valve and damper actuators, and other components requiring power as indicated on the electrical drawings, by the specifications, and in accordance with approved wiring diagrams. Division 26 shall also furnish and install starters as scheduled on the electrical drawings.
- D. Thermocouples and special cables may be provided by the manufacturer of the special equipment. Contractor shall check Division 23 specifications for these requirements.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS/MATERIALS

- A. Starters shall be as manufactured by Square D.
- B. Starters used on 208-volt systems shall have two cartridge fuses in the control circuit.
- C. Starters used on 480-volt systems shall have an individual 480/120-volt control transformer with two cartridge fuses in the primary and one in the secondary.
- D. All starters to be provided with melting alloy overloads.
- E. Starters used inside shall have NEMA 1 enclosures; starters used in damp locations or exposed to the weather to have NEMA 3R enclosures.
- F. See starter schedule on electrical drawings for listing of starters to be provided.
- G. Manual Motor Starter with Heater Unit: Square D Class 2510 or equal.
- H. Provide H-O-A selector switch with one (1) green and one (1) red pilot light and two normally open and two normally closed auxiliary contacts in each starter.
- I. Reduced voltage starters shall be auto-transformer, closed transition, or wye-delta starters, closed transition type.
- J. Provide built-in power factor correction capacitors on load side of contractor in starters for motors 50 hp and larger.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Connect all pumps, fans, and heating and air-conditioning equipment and have equipment complete and ready for operation. Contractor shall be responsible for checking with equipment manufacturer to obtain exact requirements. Electrical drawings showing mechanical

requirements are diagrammatic only to indicate size, type, number of control items, and approximate location.

- B. A short section of flexible conduit shall be used at each motor. Watertight flexible conduit shall be used on any motors in damp or exterior locations.
- C. Flexible metallic conduit for motor connections shall be 1/2" minimum size.
- D. Identify starters and controls as required by Section 26 05 00.

END OF SECTION 26 29 13

SECTION 26 29 23
VARIABLE FREQUENCY MOTOR CONTROLLER

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Furnish complete variable frequency motor controllers (VFMC or VFD) as specified herein for the fans and pumps designated. All standard and optional features shall be included within the VFD enclosure unless otherwise specified.
- B. All VFD's provided to be of the same manufacturer.

1.02 QUALITY ASSURANCE

- A. To ensure quality and minimize infantile failures at the job site, the VFD shall be burned in at an ambient of 40 degrees Celsius minimum for at least 120 hours. The VFD shall be operating a dynamometer and the load and speed shall be cycled during the test. All optional and special features shall be functionally tested at the factory for proper operation.

1.03 WARRANTY

- A. The VFD shall be warranted by the manufacturer for a period of 24 months from date of start-up. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized on-site service.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. VFD to be as manufactured by Johnson Controls Inc., Eaton Corp., ABB, Danfoss-Graham, Square D/Schneider or Yaskawa. No substitutions.
- B. VFD's motor transfer circuit shall include three contactors for bypass switching from line to VFD and vice versa.
- C. VFD's for all motors up to and including 50 hp shall be 6-pulse drives. VFD's for all motors greater than 50 hp shall be 18-pulse drives.
- D. Provide VFDs with RFI/EMI filters.
- E. VFDs serving fans and pumps (e.g. AHU's, chilled water, & cooling towers) shall have the ability to lock out critical speeds.
- F. The VFD shall convert 3-phase, 60-Hz utility power to adjustable voltage and frequency, 3-phase, AC power for stepless motor speed control from 5% to 100% of the motor's Hz speed. Input voltage shall be as indicated on the equipment schedules on drawings.
- G. Converter Section: Full wave diode bridge rectifier.
- H. Inverter Section: Insulated Gate Bipolar Transistor (IGBT) sine coded pulse width modulated (PWM) type for stepless motor speed control.
- I. Silicon-controlled rectifiers (SCRS) or GTOs shall not be used in the circuitry.
- J. The VFD maximum output current rating shall be 110 percent of the motor nameplate full load current.
- K. The VFD and options shall be tested to ANSI/UL Standard 508. The complete drive including all options shall be listed by a nationally recognized testing agency such as U.L. or ETL.
- L. The VFD and options shall comply with the applicable requirements of the latest standards of ANSI, IEEE, and the National Electrical Code. The VFDs full load amp rating shall meet or exceed NEC Table 430-150.
- M. Provide 3% line reactors sized to limit line notching. 5% DC link chokes will also be acceptable.
- N. The VFD shall not emit either conducted or radiated RFI in excess of the limitations set forth in the FCC Rules and Regulations, Part 15, Subpart J, for class A computing devices. The VFD shall have an FCC compliance label. Provide RFI filters if required.

- O. The increase in audible motor noise with the VFD operating shall not exceed 3 decibels. VFD shall include adjustable carrier frequencies to help reduce audible motor noise.

2.02 BASIC FEATURES

- A. The VFD shall include the following basic features:
 - 1. The VFD shall be housed in a NEMA 1 wall-mounted enclosure.
 - 2. The following operator controls shall be located on the front of the enclosure:
 - a. Hand/Off/Auto selector switch or keypad mounted soft touch button to start and stop the motor. In the auto position, the drive will start/stop from a remote contact closure.
 - b. Auto/Manual selector switch or keypad mounted soft touch button. In the auto position, motor speed is determined by the follower signal. In the manual position, motor speed is determined by the manual speed potentiometer or keypad speed control buttons.
 - c. Manual speed potentiometer or keypad mounted speed control buttons.
 - d. Power on pilot light to indicate that the AFC is being supplied by the power line.
 - e. Fault pilot light or keypad indicator to indicate that the AFC has tripped on a fault condition.
 - f. Digital meter or keypad display to indicate percent speed and percent load.
 - 3. Two programmable form C, dry contacts to indicate VFD status such as "Running", "Faulted", "Ready", "At Speed", "Over temperature", etc.
 - 4. One programmable form A, dry contact to indicate VFD status such as VFD status such as "Running", "Faulted", "Ready", "At Speed", "Over temperature", etc.
 - 5. When input power returns to normal following a fault trip for under-voltage, over-voltage, or phase loss, the VFD shall have the ability to automatically restart. The VFD shall not automatically restart following fault trips due to overload or over-current.
 - 6. The VFD shall include a door interlocked, pad lockable, input power disconnect switch.
 - 7. Speed Control: The output frequency may be adjusted in proportion to any one of the following:
 - a. 0-10 VDC Analog Signal.
 - b. 4-20 MA DC Analog Signal.
 - 8. Coordinate with controls supplier for exact input signal and type to provide proper input follower (i.e., grounded or floating).
 - 9. Provide open protocol BACnet interface card to connect to Building Automation System. Coordinate with controls system provider for preferred interface type and language.

2.03 PROTECTIVE FEATURES

- A. The VFD shall include the following protective features:
 - 1. Molded case circuit breaker, or manual motor protector for the power input.
 - 2. Separate overload relay for each motor controlled on multiple motor applications.
 - 3. Protection against input power under-voltage, over-voltage, and phase loss.
 - 4. Protection against output current overload and over-current.
 - 5. Protection against over-temperature within the VFD enclosure.
 - 6. Protection against over-voltage on the DC bus.
 - 7. In the event of a power loss, shutdown without component failure. Upon return of power, automatically return drive to normal operation, if the start is in the "ON" condition, being able to restart into a rotating motor regaining positive speed control without shutdown or component failure.
 - 8. In the event of a phase-to-phase short circuit, shutdown safely without component failure.
 - 9. In the event that an input or output power contactor is opened or closed while the drive is activated, no damage to the VFD shall result.
 - 10. Any disconnect switches between the VFD and the motor shall include an auxiliary contact interlocked to the VFD fault trip circuit. In the event that a disconnect switch is opened while the drive is running, the drive shall shut down.
 - 11. DC bus discharge circuit for protection of service personnel.
 - 12. Insensitive to incoming power phase sequence.

2.04 ADJUSTMENTS

- A. The VFD shall include the following adjustments available via potentiometers inside the enclosure:
 - 1. Maximum speed, adjustable 50-100% base speed.
 - 2. Minimum speed, adjustable 0-50% base speed.
 - 3. Acceleration time, adjustable 2-60 seconds.
 - 4. Deceleration time, adjustable 2-60 seconds with override circuit to prevent nuisance trips if deceleration time is set too short.
 - 5. Current limit, adjustable 0-110%.

2.05 SERVICE CONDITIONS

- A. The VFD shall be designed to operate within the following service conditions:
 - 1. Ambient temperature, 0-40 degrees C.
 - 2. 0-95% relative humidity, non-condensing.
 - 3. Elevation to 3300 feet without derating.
 - 4. AC line voltage variation, -5% to 10% of nominal.

2.06 SPECIAL FEATURES

- A. The following special features shall be included in the VFD enclosure. The unit shall maintain its U.L. or ETL listing.
 - 1. Bypass Switch: VFD's serving AHU-[] shall be provided with a bypass. A motor starter shall be included in the bypass circuitry for constant speed motor control when the VFD is taken out of service. Manual bypass shall provide all the circuitry necessary to transfer the motor from the VFD to the power line, or from the line to the controller while the motor is at zero speed. Two motor contactors, electrically interlocked, shall be utilized. One contactor is to be between the controller and the motor. The other contactor is to be between the bypass power line and the motor providing across-the-line starting for motors 50 hp and less, and part-winding or "soft start" starting for motors greater than 50 hp. Motor overload protection is to be provided in both the controller mode and the bypass mode. The bypass section door shall include a "drive/line" switch, "on/off-reset" switch, and a "load transferred to line" pilot light.
 - 2. The VFD shall include a main fused disconnect switch or circuit breaker to provide a means of disconnecting all power to both the bypass circuitry and the controller. The disconnect switch or circuit breaker shall be door interlocked and pad lockable. The fuses or circuit breaker shall be sized to provide short circuit protection for the motor when in the bypass mode per the NEC.
 - 3. A second disconnect switch, circuit breaker, or contactors shall be provided to disconnect input power to the controller but not the bypass circuitry. This disconnect will allow troubleshooting and testing of the VFD, both energized and de-energized while operating in the bypass mode.
 - 4. Plug-in test meter shall provide a quick means for monitoring the different signals within the VFD for start-up and troubleshooting. Where the meter is capable of operating with different horsepower VFDs, only one meter needs to be supplied.

PART 3 EXECUTION

3.01 INSTALLATION

- A. The manufacturer of the VFD equipment shall provide a competent, factory trained service technician to supervise the installation, start-up and testing of the VFD.
- B. Install VFDs in locations shown on the drawings in strict accordance with the manufacturer's published installation instructions.
- C. Contractor shall provide such materials and assistance as required by the manufacturer's representative.
- D. Division 26 shall provide necessary electrical connections.

- E. Contractor shall provide coordination of the necessary controls not provided by the VFD manufacturer.

3.02 START-UP, TESTING, DEMONSTRATION

- A. The manufacturer's factory-trained service technician, assisted by contractor, shall verify correct installation, start-up equipment, and test it as a unit and a part of the system it serves. Verify by adjustments, tests, etc., that the equipment is functioning as specified. Provide three copies of test data to the Owner. As a minimum, check the following items:
 - 1. Motor voltage and frequency.
 - 2. Control input and automatic start/stop.
 - 3. Calibration and adjustment for minimum and maximum speed setpoints and acceleration and deceleration rates.
 - 4. Wire terminations.
- B. VFD manufacturer shall provide a minimum of 4 hours instruction to Owner to demonstrate the operation of the system. Provide three copies of operation and maintenance manual to Owner at completion of instructions.
- C. A copy of the variable frequency drives certified startup sheets for all AHUs shall be provided to the construction manager / Cx team for record purposes within one week of startup.

END OF SECTION 26 29 23

SECTION 26 32 13
ENGINE GENERATORS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This specification defines requirements for an emergency standby engine/generator system to be installed as per plans and specifications. System shall provide for completely automatic unattended operation, for the duration of any loss of normal utility power. System to be capable of reaching operating range within 10 seconds of initial start signal (NFPA 99). Unit shall be of a continuous standby KW/KVA capacity as shown on plans. System voltage to be 480/277-volts, 3-phase, 4-wire, 60 Hz., .8 power factor.
- B. Full service responsibility for satisfactory operation and performance of this system shall rest with Division 26 contractor supplying the emergency power system. Engine/generator to be furnished with all necessary features and options to comprise a complete operable system when installed as per manufacturers' recommendations.
- C. Unit to meet requirements of NFPA-99 and NFPA-110.
- D. Warranty to be furnished on all equipment covered by specifications for a period of one (1) year from date of Owner's acceptance of equipment. Warranty to cover all components and consist of repair and/or replacement of all parts judged defective due to faulty material or workmanship, at no charge to the Owner.
- E. Unit to be equipped for outdoor installation as shown on drawings.

1.02 SUBMITTALS

- A. Contractor shall provide as part of submittal data: Complete, composite electrical and mechanical drawings indicating control wiring routing, quantity and size, as well as size and suggested routing of coolant, fuel lines and exhaust lines. If options or special equipment other than those specified below are required, they shall be included in the submittals.
- B. Submittal drawing for an outdoor installation shall include a plan view of the enclosure indicating entrance areas through pad for control, power, and service wiring conduit, as well as fuel line entrance locations.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS/EQUIPMENT

- A. Emergency generator shall be by Caterpillar, Cummins, Generac, or Kohler per HCA's purchasing agreement.
- B. Contacts are as follows:
 - 1. Keith Kraemer
Kohler
1515 JP Hennessy Dr.
LaVergne, TN 37086
email: HCASALES@NixonPower.com
(615) 664-1487
HPG Contract No. 66551

2.02 ENGINE

- A. Engine shall be full diesel, compression ignition, liquid-cooled, domestically manufactured and capable of producing the rated KW at a governed speed of 1800 rpm as specified under job site conditions. Engine to be equipped with electric starting, battery charging generator, electronic governor, fuel filters, oil filters, air cleaners, cooling system, and other equipment to provide a complete operable system. Selling distributor to be a factory authorized distributor of the diesel engine utilized in the standby engine generator system.

2.03 COOLING

- A. Engine shall be cooled by plant mounted radiator with engine driven fan, jacket water pump, and fan guard.
- B. Engine shall be cooled by remote radiator with electric motor driven fan.
- C. Engine shall be equipped with thermostatically controlled water jacket heater to maintain minimum 80 degree F. water jacket temperature under ambient conditions. Vendor shall consult with and coordinate special extreme cold weather needs with Electrical Engineer.
- D. Complete cooling system shall be filled with anti-freeze coolant (0 degrees F. or less as required by the extreme of local weather conditions) supplied by the vendor at start-up.

2.04 OUTDOOR INSTALLATIONS

- A. Complete engine/generator and associated accessories shall be installed in an enclosure for outdoor installation and service. When located within 60 miles of the coastline, enclosures shall be aluminum. Enclosure shall be mounted directly to engine/generator base and shall be of sheet steel construction. Hinged access doors shall be provided for access to control gear and areas of unit requiring periodic maintenance and/or service. Intake and outlet louvers shall be furnished to allow proper flow of cooling and combustion air with all doors closed, but arranged to prevent entrance of rain.
- B. Mufflers shall be installed on enclosure top in a horizontal position. Discharge pipe, batteries, day tank, battery charger, control gear and water jacket heater, shall be completely installed, wired and piped prior to delivery to job site.
- C. A.C. wiring inside enclosure shall be neatly routed and enclosed in same type conduit used in building.
- D. In addition to the above devices, a duplex, grounded, 120-volt, weatherproof convenience receptacle shall be provided for maintenance, servicing and lighting. This receptacle shall be connected to a life safety branch circuit.

2.05 SILENCERS AND BATTERIES

- A. Furnish and install exhaust silencer with a minimum dBA reduction of 25 decibels. VEE-type engines shall have dual inlet, single outlet. Condensate trap, pet cock drain shall be installed in the silencer. A flexible section, 36 inches minimum, shall be provided between the engine exhaust manifold and the silencer. This section shall be carbon steel bellows type. All exhaust system fittings shall be flanged n.p.t. connections. The silencer shall be provided with mounting brackets for ceiling suspension. The silencer shall be installed from the equipment room ceiling in a horizontal position.
- B. Engine/generator manufacturer shall specify exhaust line size required for acceptable back pressure. Exhaust line shall be Schedule 40 pipe and be connected to engine manifold through seamless, flexible, carbon steel bellows type connection. Exhaust systems installed inside structure shall be fully insulated (under Division 23) and lines passing through walls shall pass through sleeves.
- C. Provide starting batteries capable of starting unit in time specified under installed conditions and capable of 60-seconds of engine cranking. Batteries to be installed in steel, insulated rack(s).
- D. Battery heater pads to be furnished on outdoor installations.
- E. Provide batteries of the heavy-duty lead acid type (maintenance-free batteries not acceptable), Group 8 shipped dry with electrolyte installed at start-up.
- F. Provide an automatic battery charger. Charger shall operate on 120-volt input and shall be a.c. line compensated. Input and output shall be fused. Charger shall provide continuous taper charging and provide float and equalize function. Charger shall be in NEMA-1 cabinet and equipped with d.c. ammeter, d.c. voltmeter, high/float switch, and low d.c. voltage alarm relay. Minimum continuous d.c. output shall be 10 amperes.

2.06 ABOVEGROUND FUEL STORAGE TANK:

A. GENERAL

1. Provide and install an aboveground tank with secondary containment for each pump station. The primary tank shall have a total useable volume to accommodate 96 hours of generator runtime at full load. The primary tank shall maintain 25psi of pressure for two hours with no loss for leak testing purposes.

B. DESIGN CRITERIA

1. The tanks shall be double-wall steel in accordance with UL142.
2. Integral secondary containment shall provide at minimum 150% containment of the primary storage tank. The interstitial space shall allow liquid to migrate through it to a monitoring point. A leak detection access tube shall be located in the interstitial space between the primary tank and the secondary barrier. Leak detection shall be provided as specified herein.
3. Venting: Provide properly sized emergency and standard vents to satisfy code requirements. Emergency relief vents shall bear a stamp indicating opening pressure and flow capacity. Vent pipe outlets shall be 5 feet from building openings and located such that eaves or other obstructions will not trap vapors.
4. Low and Pre-Low alarms shall be configured based upon Florida Building Code Requirements. Fuel probe lengths and fuel calculations shall be provided as part of the systems submitted for engineering approval.

C. ABOVEGROUND STORAGE TANK ACCESSORY EQUIPMENT

1. Inspection Port Adapter Cap: Tank shall be equipped with a 4-inch adapter and lockable cap for inspection and manual gauging of fuel level.
2. Venting: Provide properly sized UL listed emergency and standard vents to satisfy code requirements.
3. Steel Fill Pipe: ASTM A53 or A120, or ASME B36.10, Schedule 40 black.
4. Fittings: ASTM B16.3, 150 lb. malleable iron, or ASTM A234, forged steel welding type.
5. Disconnect Coupling: Stainless steel assembly with dust cap for supply delivery connection. Fitting shall be coordinated with fuel supplier to assure compatibility. Installed fitting shall be at a 45-degree angle pointing upward to minimize drippage.
6. Product Label Marker: Stainless steel band clamp with API color-coded plaque for product being stored.
7. Provide decal or placard affixed to the tank fill box that gives a detailed, step-by-step tank filling procedure as well as the tank calibration chart. The decal or placard must be readily visible during tank filling operations and must be of a material that does not deteriorate when exposed to weather.
8. Foot Valve: 2-inch size double poppet type with cast iron body, replaceable bronze seats and 20 mesh screen, similar to "Model #86" by OPW Division - Dover Corp or Preferred Utilities model 900.
9. Vent Cap: 2-inch size, vertical type aluminum body with brass screen (Preferred Model #23).
10. Overfill Alarm Sign: 20 inches wide x 14 inches high, 18-gauge steel with porcelain enameled finished bright yellow background and minimum 2-inch high black lettering reading "Caution: When alarm sounds, oil tank filled to capacity. Do not overfill"; similar to: "Model FA-S" by Preferred Utilities.

D. FUEL DISTRIBUTION PIPE – ABOVEGROUND

1. General
 - a. Provide and install steel piping aboveground as indicated on the drawings. Fuel pipe connections shall be welded except where required to be threaded at tanks or specialized valves.
2. Design Criteria
 - a. Pipe: The pipe shall be ASTM A53 schedule 40 black with socket welded connections. Threaded connections shall be kept to an absolute minimum, typically where pipe must be joined to a threaded connection on a day tank or pump.

- b. The pipe shall be supported as shown on the drawings.
 - c. Product compatibility: All the components of the piping system shall be compatible with the products to be stored.
 - d. All piping shall be sloped.
 - e. All piping must be pressure tested as per NFPA 30.
 - f. Piping shall include priming tees at the high point of any suction piping. Priming tees shall be line size and shall extend approximately one foot above the piping high point. There shall be a minimum of 3 feet between the priming tee opening and the ceiling. Each priming tee shall include a ¼ turn ball valve and threaded plug.
 - g. Finish: Prime and finish paint with industrial enamel. Finish: Prime and finish paint with industrial enamel.
3. Accessory Equipment
- a. Unions: 150 lb. malleable iron threaded unions.
 - b. Ball Valves: Carbon steel or brass construction, two piece body, chrome plated steel ball.
 - c. Swing Check Valves: Carbon steel or brass body, steel swing disc, threaded ends.
 - d. Swing Check Valves with Integral Pressure Relief Valves: Carbon steel body, steel swing disc, teflon seat, steel stem and springs, automatic, direct, pressure actuated at maximum 40 PSI, threaded ends, UL listed for fuel.
 - e. Anti-Siphon Valves: Bronze or Brass body, brass plug, spring loaded, normally closed, threaded ends, size to resist static siphon head, UL listed for fuel. Locate on all suction lines and where shown on the drawings.
 - f. Emergency Shut-Off Valves: Provide a fusible link Emergency Shut-Off Valve exterior wall penetration as indicated.
 - g. Flexible Connectors: Stainless steel inner hose and braided exterior sleeve, suitable for minimum 200 psi WOG and 250 degrees F. All flexible connectors must have welded (not swaged or crimped) ends. All flexible connectors must be vacuum rated.
 - h. Sight Glasses: Carbon steel or brass body, 150 psi rated glass, delrin or nylon wheel, as manufactured by Ernst or McMaster Carr. Furnish on day tank(s) supply and return to main tank and generator supply and return lines to the day tank.

E. FUEL OIL SPILL KITS

- 1. Manufacturers: Fuel Oil Systems and Chemtrec
- 2. General: Provide a spill kit contained in 2 barrels in each room that has diesel fuel storage.
- 3. Barrel one of the spill kit shall contain a 20 pound bag of particulate absorbent, 2 packages of absorbent "socks" 12 feet long and 100 absorbent pads. Barrel two of the spill kit shall contain 12 gallon wet/dry shop vacuum, 100 foot extension cord, 2 tarpaulins, dust pan and broom, disposal bags and ties, 1 box contractor towels, 1 box of rubber gloves, 4 pair protective glasses.

2.07 GENERATOR

- A. Alternator shall be four pole revolving field, twelve lead, reconnectable, single bearing, brushless type.
- B. Entire insulation system shall be Class F or better and temperature rise to be within NEMA MG-1-22.40 for all nameplate voltages at full rated load.
- C. All load connections shall be made up in rear mount junction box. Generator construction to allow load connections to be made on top, bottom or either side of junction box.
- D. Rotating rectifier shall employ three phase sensing. Voltage regulation shall be plus or minus 1% from no load to full load with steady state modulation of 1/2%. Voltage regulator shall be static-type and a voltage adjusting rheostat to be furnished in the control panel. Voltage change to not exceed 15% upon application of full rated load with recovery to steady state conditions within 1-second. Frequency regulation by engine governor to be within 1% steady state with a

maximum 2% drop, no load to full load. Generator/regulator system shall be capable of producing 250% of a full load rated current for a minimum of 10 seconds under a three phase short circuit.

- E. Provide a line circuit breaker on generator output, 3-pole, with LSI adjustable settings. Refer to drawings for additional information.
- F. Provide ground fault sensing at the generator output terminals. This sensor to annunciate at the generator-mounted control panel and remote annunciator.
- G. Generator shall be UL2200 listed.

2.08 GENERATOR CONTROL PANEL

- A. Generator control panel shall be NEMA-1, dead front construction and includes following:
 - 1. A.C. ammeter (2%), with phase selector switch.
 - 2. A.C. voltmeter (2%), with phase selector switch.
 - 3. Frequency meter.
 - 4. Elapsed time meter.
 - 5. Panel illumination lamps.
 - 6. Voltage adjusting rheostat.
 - 7. Governor speed control switch.
 - 8. Automatic start/stop control (solid state, cycle crank, four cycles of 10-seconds rest).
 - 9. Mode selector switch for "off", "manual", "automatic", "test."
 - 10. Automatic engine shutdown with indicating lamps to indicate that a shut-down took place for:
 - a. "excessive engine temperature."
 - b. "low oil pressure."
 - c. "overcrank" (failed to start).
 - d. "overspeed."
 - 11. Red lamp to function when mode selector switch is in a position other than "automatic."
 - 12. Adjustable timer shall provide up to 30-minute unload running of engine after automatic transfer switch returns to normal. Factory to preset timer to 5 minutes unload time.
 - 13. Engine oil pressure gauge.
 - 14. Engine water temperature gauge.
 - 15. Battery charging ammeter.
 - 16. A sensor device, plus visual warning device with alarm horn and silence switch indicating "low fuel level", "low water temperature" and visual pre-shutdown alarms for "low oil pressure", "high water temperature", and "ground fault".
 - 17. Generator control panel shall be shock mounted on unit unless otherwise shown on drawings.

2.09 REMOTE ANNUNCIATOR

- A. Provide solid state remote annunciator panel, storage battery powered, shall comply with NFPA 99 and NFPA 110.
- B. Remote annunciator shall indicate day tank low level fuel alarm in addition to the requirements of NFPA 99 and NFPA 110.

2.10 WARRANTY

- A. Provide manufacturer's warranty for 18 months from date of shipment from factory or 12 months from startup (whichever date is later), covering parts and labor required to remedy defects in materials or workmanship for the entire generator.

PART 3 EXECUTION

3.01 INSTALLATION REQUIREMENTS

- A. Entire unit shall be installed in accordance with manufacturers' recommendations.
- B. Mounting: Complete engine/generator and all mounted accessories shall be assembled on a common channel steel base. Fuel oil lines and lube oil drain shall terminate in base. Lube oil drain line shall be brought out to beyond the base to facilitate changing of the oil. Flexible fuel

line sections (18" long) to be installed between base and fuel lines. Heavy-duty, steel spring vibration isolators shall be installed between the base and mounting pad. Isolators shall be sized and located as recommended by generator manufacturer.

- C. Contractor shall provide the services of a factory-trained engineer for periodic job site visits during installation to ensure that the system is being installed in accordance with manufacturers' recommendations.
- D. Complete engine/generator system shall be tested after installation to ensure that the engine/generator, automatic transfer switch, alarm annunciators, and all other equipment function in accordance with the specifications. Testing shall include a full Level 1 NFPA 110 Installation Acceptance Test. Documentation of test shall be provided by the design team and Owner as part of the Contractor's close out documents.
- E. After Owner acceptance, Contractor and/or vendor, shall conduct a minimum 4-hour training session in operation and maintenance for Owner's personnel. After installation, a 4-hour full load test shall be conducted by the distributors' engineer. This test shall be conducted using available building load, plus temporary load bank capacity so that full nameplate reading is utilized during test. Temporary load banks shall be furnished by generator distributor and connected by Division 26 contractor. Test data shall be recorded and become a part of the three (3) Owners Manuals to be supplied.
- F. Contractor shall receive, store, uncrate and temporarily connect resistive type load(s) furnished by the generator supplier for full-load testing of the system. After completion of this testing, the Contractor shall disconnect, crate and load for shipment, the temporary load banks.
- G. Ground the engine generator frame and enclosure in accordance with the NEC.

END OF SECTION 26 32 13

SECTION 26 36 00
TRANSFER SWITCHES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide automatic transfer switch(es) as shown on the drawings.

1.02 RELATED SECTIONS

- A. Section 26 09 13 – Energy and Resource Metering

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Provide automatic transfer switch as manufactured by ASCO, Cummins or Zenith.

2.02 EQUIPMENT

- A. Switch shall be UL listed and CSA certified. It shall meet the voltage impulse withstand test in accordance with the proposed NEMA Standard 109ICS-109.21 and voltage surge withstand capability in accordance with ANSI C37.90A/IEEE 472. Switch(es) shall have ampere rating and voltage rating as shown on drawings.
- B. Transfer switch(es) to be in NEMA-1 wall-mounted enclosures unless otherwise indicated. All control relays to be accessible from front of enclosure for maintenance and repair. Transfer mechanism to be electrically operated, mechanically held. Failure of the emergency source shall result in retransfer to the normal source. The transfer switch to be equipped with a manual operator to allow for manual transfer.
- C. Engine starting contacts to be provided to start engine, should the voltage of the normal source drop below the preset value, after a time delay of 1-3 seconds to allow for momentary dips. Coordinate all wiring and raceway requirements with generator manufacturer.
- D. After restoration of normal power, transfer switch shall remain in emergency position for an adjustable period of 0-30 minutes (set for 15 minutes unless directed otherwise). After retransfer to normal, engine/generator to continue to run for an adjustable period of 0-20 minutes to allow for cool down. A voltage/frequency relay to be provided to prevent transfer to the emergency source until operating level is attained.
- E. In addition to position indicating lamps, auxiliary contacts to be provided (one normally open, one normally closed).
- F. Provide test switch to simulate a power failure, under load conditions.
- G. Provide an automatic exerciser to operate the unit for a period of 30 minutes every 168 hours. During exercise period, transfer switch(es) shall not transfer to the emergency source.
- H. Transfer switches used with ground-fault equipment, 4-wire systems to be 4-pole switched neutral.
- I. Switch(es) to be double throw actuated by a single operator, momentarily energized. Main contacts may be replaced without major disassembly. Transfer switch(es) with magnetic blow outs to be provided on each pole.
- J. Normal voltage sensing to be on 3-phase with pick-up at 95 percent and drop-out at 90 percent of normal voltage.
- K. Interlocked molded case circuit breakers, contactors or transfer devices with dual solenoid operators are not acceptable.
- L. All transfer switches shall be delayed/programed transition unless otherwise noted.
- M. Switches shall have provisions for manual transfer with cabinet doors closed.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Switch shall be installed as shown on the drawing complete with all controls for engine starting and transfer.
- B. All transfer switch adjustable settings shall be coordinated with the Owner and design team as part of the equipment start-up process.

END OF SECTION 26 36 00

SECTION 26 41 13
LIGHTNING PROTECTION FOR STRUCTURES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Contractor shall provide all labor, materials and items of service required for the completion of a functional and unobtrusive system of air terminals, conductor, grounds and other components necessary for the protection of the building against damage by lightning.
- B. The system shall be completely concealed where possible, with only the air terminals and roof conductor visible, and complying in all respects with the following Standards:
 - 1. Underwriters' Laboratories, Inc. - No. UL96A.
 - 2. National Fire Protection Association - No. NFPA780.
 - 3. Lightning Protection Institute-No. LPI-175.

1.02 QUALITY ASSURANCE

- A. The installing contractor shall be actively engaged in the installation of lightning protection systems and shall be listed and published by Underwriters' Laboratories as such at www.ul.com, under "Certifications" (Category Code OWAY). He shall have a minimum of five years experience in this work.
- B. The installing contractor shall be a Lightning Protection Institute Certified Master Installer as recognized and published at www.lightning.org.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All materials used shall be new and be the product of a manufacturer member of Lightning Protection Institute, approved and labeled by Underwriters Laboratories (UL96 Standard).
- B. Cable downlead conductors, terminals and fittings at the roof line shall be aluminum and all components below the roof line shall be copper. When structural steel is utilized as the downlead system an aluminum cable connection below the roof to the top of the steel is acceptable.
- C. All conductors, terminals and fittings shall be copper or bronze.
- D. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the project include, but are not limited to the following:
 - 1. Erico, Inc.
 - 2. Preferred Lightning Protection.
 - 3. National Lightning Protection.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Submit a list of materials and system shop drawings to Architect for review. System design shall be by a certified Lightning Protection Institute Master Installer/Designer.
- B. Install lightning protection components and system in accordance with NFPA 780, UL96A and LPI-175 Standards. Electrical service entrance surge protection device(s) (SPD) shall meet the requirements of UL96A, Para. 13.1.
- C. Do not combine incompatible metals. Acceptable metal combinations shall be in accordance with UL96A Follow Up and Inspection Instructions.
- D. Coordinate installation of lightning protection system with other building systems and components including electrical wiring, supporting structures, building materials/finishes and HVAC metal bodies requiring strike termination devices (air terminals) and/or bonding to the system.
- E. Coordinate installation of strike termination devices and cable fasteners with roof system(s) manufacturer and roofing contractor.

- F. Provide NFPA-780 Potential Equalization for buildings exceeding sixty (60') feet in height above grade.
- G. Lightning protection system shall be bonded to the building's grounding electrical system per Article 250 of NFPA 70.
- H. A UL Master Label Certificate shall be furnished for new structures with no connections to existing structures.
- I. A UL Certificate of Inspection shall be furnished for new structures connected to existing structures where the connection between them (at all elevations) meets UL requirements for firewalls and fire doors.
- J. Per the Florida Building Code, where the new lightning protection system is connected to the existing system, the existing system shall be inspected and brought into compliance with current standards.

END OF SECTION 26 41 13

SECTION 26 43 13
(TVSS) TRANSIENT VOLTAGE SURGE SUPPRESSION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide 3-phase, 4-wire Surge Protective Devices (SPDs) at electrical panels as indicated on the panelboard schedules and on the riser diagram.
- B. Provide single-phase type SPDs to protect specific circuit as scheduled or noted on the drawings.
- C. Provide individual circuit surge protection devices, as required by the Florida Building Code, for all circuits exiting or entering the building structure.

1.02 RELATED WORK

- A. Section 26 24 16 - Panelboards.
- B. Section 26 24 13 - Switchboards
- C. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
- D. Section 26 41 13 – Lightning Protection for Structures

1.03 STANDARDS

- A. UL compliance: Listed to UL 1449 current edition by an OSHA approved Nationally Recognized Test Lab (NRTL)
- B. ANSI/IEEE compliance: Comply with ANSI/IEEE test procedures.
- C. National Electric Code - Section 280 and 285.
- D. UL96A.
- E. NFPA 760.

1.04 SUBMITTALS

- A. Submit product data and shop drawings as required by Section 26 05 00.
- B. Submittals shall include the following:
 - 1. Complete manufacturers' data for each suppressor indicating part numbers and rated voltages and currents.
 - 2. Product performance analysis with graphic display of let-thru waveforms and peak clamping voltages for ANSI C62.41 tests, Categories A3 & B3 ringwaves and C1 & C3 impulses.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. SPDs shall be as manufactured by Square D, per HCA's purchasing agreement..
 - 1. Contact is as follows:
Jess Hoover, Charlie Shannon
Graybar-Nashville
825 8th Avenue South
Nashville, TN 37217
HCA@graybar.com
239-494-2088
615-743-3226
HPG Contract No. 5892
- B. The suppressor manufacturer shall offer factory repair service for all units, which will include replacement for non-repairable sealed units.

2.02 WARRANTY

- A. SPD devices shall be warranted for a minimum of 10 years.

2.03 SPECIFICATIONS

A. General:

1. SPD shall be internally fused, capable of allowing the suppressor's maximum rated transient current to pass through the suppressor without fuse operation. SPD shall be listed as a Type1 SPD without the need for upstream over current protection for safe operation.
2. Proper operation of the suppressor elements on each phase shall be indicated by a normally-on LED or lamp. Also, normally closed contacts shall be used for remote annunciation of suppressor failure.
3. The SPD shall be compatible with the electrical system voltage, current, and distribution configuration.
4. The SPD maximum continuous operating voltage shall be 115% of the nominal RMS voltage with no degradation. The MCOV value shall be a tested value as outlined in UL1449. The MCOV shall not be a claimed value based solely on the MCOV of the surge component used in the design, nor based solely on the 115% over voltage test outlined in UL1449.
5. The SPD shall be sine-wave tracking to provide added protection against oscillatory transients, such as Category A and B Ringwaves.
6. Failure of the SPD shall not cause any disruption of power.
7. Unit shall operate without the need for an external overcurrent protection device and be listed as such.
8. Protection Models – The SPD multi protect all models if the electrical system being utilized.

B. Service Entrance SPD Devices:

1. The SPD shall have a surge current capacity of 100,000 amps (8 x 20 microsec) minimum per mode.
2. SPD devices shall meet or exceed the following operating characteristics and ratings: (Series Ratings)
3. The SPD shall be a Type1 listed SPD per UL1449.
4. The SPD shall meet the requirements of UL96A.
5. The unit shall not have more than 10% deterioration or degradation of the UL1449, 3rd Edition Voltage Protection Rating (VPR) due to repeated surges. Acceptable clamping values are shown below based on test procedures outlined in UL1449.

System Voltage	Mode	MCOV	UL 1449 Fourth Edition VPR Rating
120/208	L-G		800
	N-G		800
	L-L		1200
277/480	L-N	320	1200
	L-G	320	1200
	N-G	0	1200
	L-L	550	2000

C. Distribution Panel SPD Devices:

1. The SPD shall have a surge current capacity of 60,000 amps (8 x 20 microsec) minimum per mode.
2. SPD devices shall meet or exceed the following operating characteristics and ratings: (Series Ratings)
3. The SPD shall be a Type1 or Type2 SPD per UL1449.

4. The unit shall not have more than 10% deterioration or degradation of the UL1449, Voltage Protection Rating (VPR) due to repeated surges. Acceptable clamping values are shown below based on test procedures outlined in UL1449.

System Voltage	Mode	UL 1449 Fourth Edition VPR Rating
120/208	L-G	800
	N-G	800
	L-L	1200
277/480	L-N	1200
	L-G	1200
	N-G	1200
	L-L	2000

PART 3 EXECUTION

3.01 WORK INCLUDED

- A. The SPD shall be internally mounted to the panelboard or switchboard. Individual circuit devices may be installed external to the panelboard.
- B. Ground the SPDs and cabinets in accordance with the manufacturer's instructions, the National Electrical Code (section 280 and 285), and wiring diagrams shown on the drawings.
- C. Provide wiring to the remote monitor(s) in accordance with the manufacturer's instruction and as shown on the drawings.
- D. The SPD shall not include multiple replacement modules.
- E. All conductors associated with SPDs shall be installed in conduit. Minimum conductor size shall be #8 AWG copper. Conductors shall be as short and as straight as possible with no unnecessary length or turns. A maximum length of 12 inches is required where possible.
- F. SPDs shall be connected in parallel with main conductors. Service entrance SPDs shall incorporate the use of an internally mounted disconnect. Panelboard surge protectors shall be installed behind a overcurrent/disconnecting device. Where 12 inches of lead length is not possible utilization of a low impedance preassembled cable assembly is required to lower the clamping voltages of the installed system to acceptable levels. Lead length must include phase connection plus neutral or ground.
- G. Mounting position of the SPD and overcurrent protection device shall be coordinated to minimize the total phase, neutral and ground cable lengths to achieve minimum installed system clamping voltages.

END OF SECTION 26 43 13

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide labor, material, equipment and services necessary to provide all interior lighting fixtures, necessary hangers and lamps. Fixtures include all interior fixtures plus all exterior fixtures mounted to exterior wall or to structures connected directly to building.

1.02 SUBMITTALS

- A. Submit for approval prior to purchasing fixtures complete fixture lists of fixtures proposed to be used. Include cuts of both specified fixture and proposed equivalent fixtures if fixtures other than those specified are submitted.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Lighting fixtures shall be by Acuity, per HCA's purchasing agreement.
 - 1. Contact:
Toneah Ley
Acuity Brands
toneah@delightlight.net
615-329-6700
- B. Provide lighting fixtures indicated by type on lighting fixture schedule on drawings.
- C. Electrical contractors must contact Graybar Electric Supply TN for all lighting fixture and lighting control quotations. Fixtures are to be quoted and ordered through Graybar Electric Supply Nashville without exception.
 - 1. Contact:
Charlie Shannon
Graybar-Corporate Accounts
HCA@graybar.com
615-743-3226
HPG Contract No. 5892

2.02 EQUIPMENT REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Standards:
 - 1. ENERGY STAR certified.
 - 2. California Title 24 compliant.
 - 3. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
 - 4. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
 - 5. UL Listing: Listed for damp location.
 - 6. Recessed luminaires shall comply with NEMA LE 4.
 - 7. User Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with ANSI C81.61.
- C. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- D. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as

defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

- E. Provide luminaires from a single manufacturer for each luminaire type.
- F. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- G. Rated lamp life of 50,000 hours to L70.
- H. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- I. Internal driver.

PART 3 EXECUTION

3.01 INSTALLATION REQUIREMENTS

- A. Comply with NECA1.
- B. Fixtures shall be securely mounted as required by Section 410, NEC and as specified herein.
- C. Fixtures mounted in a suspended ceiling shall be secured to the grid with approved clips as required by the NEC.
- D. Fixtures shall be mounted in locations as shown on architectural reflected ceiling drawings.
- E. Mount fixtures as called for in schedule on electrical drawings. Determine type of ceiling to be installed in each space from architectural drawings and schedules and furnish fixtures suitable for the exact type.
- F. Receive, store, uncrate, and install lighting fixtures shown in schedule on drawings to be furnished by others.
- G. Recessed fixtures in dropped ceiling areas shall be connected using Greenfield and No. 14 THHN wire. Greenfield shall be connected to fixture and outlet box. Each piece of Greenfield shall include in it a separate insulated green grounding conductor not smaller than No. 14 AWG for grounding continuity between fixture and conduit system. Grounding conductor shall be mechanically connected in a permanent and effective manner to fixture and conduit system and shall be electrical continuous. No conduit shall enter a recessed fixture directly as this would prevent removal of fixture without disturbing balance of circuit.
- H. Joints in fixture wiring shall be made using wire nuts, preinsulated Scotch locks, Ideal No. 30-410 crimps and No. 30-415 wrap caps, or other approved mechanical means of connection.
- I. Adjustable type fixtures shall be adjusted by the Contractor to illuminate intended area to satisfaction of Owner.
- J. Any adjustable outside area lights or lights mounted on building shall be adjusted at night by the contractor to satisfaction of Owner.
- K. Recessed fixtures installed in exposed or concealed tee bar ceilings may not use ceiling grid to support fixtures. Fixtures shall be securely fastened to ceiling framework per NEC Article 410, and shall be supported as described in seismic detail.
- L. All light fixtures shall be grounded in accordance with the NEC. Any fixtures suspended from ceiling which do not include a separate ground wire shall be grounded in a method approved by section 250 of the NEC. Where the conduit is utilized as the ground with a hook pendant style mounting system, a separate ground conductor shall be bonded to the conduit where the conduit ceases to be continuous and routed to the fixture.

END OF SECTION 26 51 00

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide labor, materials, equipment and services necessary for installation of all exterior lighting fixtures, lamps, poles, pole bases etc. for:
 - 1. Parking lot and access roads.
 - 2. Exterior signage.
 - 3. Walkways and exterior building lights.
- B. Refer to details and arrangements shown on drawings.
- C. Provide concrete bases for pole manufacturers as required, refer to details for additional information.
- D. Provide concrete base for bollards, flood lights, etc. as required for manufacturers recommended installation on grade or in landscaped areas.
- E. Fixtures, poles, and appurtenances, shall be suitable for exterior use, shall be UL listed, and shall be of standard design for intended application.

1.02 SUBMITTALS

- A. Submit for approval prior to purchasing fixtures complete shop drawings and brochures including photometrics for each type of exterior lighting system specified. Shop drawings and brochures shall be specific and shall include all pertinent data and accessories. If substitute fixtures are proposed, include cuts of both specified fixture and proposed equivalent fixtures including photometrics of both fixtures.
- B. If requested by Architect or Designer, submit a sample fixture which will be returned after inspection by Architect or Designer.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Lighting fixtures shall be by Acuity, per HCA's purchasing agreement.
 - 1. Contact:
Toneah Ley
Acuity Brands
toneah@delightlight.net
615-329-6700
- B. Provide lighting fixtures indicated by type on the lighting fixture schedule on drawings.
- C. Electrical contractors must contact Graybar Electric Supply in Nashville, TN for all lighting fixture and lighting control quotations. Fixtures are to be quoted and ordered through Graybar Electric Supply Nashville without exception.
 - 1. Contact:
Charlie Shannon
Graybar – Corporate Accounts
HCA@graybar.com
615-743-3226
HPG Contract No. 5892
- D. Contactors and selector switches shall be Square D.
- E. Lighting Contactors: Square D.

2.02 MATERIALS

- A. Provide luminaire and pole assemblies as scheduled.

- B. Luminaires, including all components, shall be designed to meet extreme temperature (low), moisture, and wind conditions in area.
- C. Poles: Aluminum, round, designed for wind load in the area of installation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install parking lot/roadway luminaires and poles on concrete bases. Provide all anchor bolts and bolt hole circle templates. Adjust luminaires to correct tilt and lamp all fixtures.
- B. Adjust or rotate area and roadway lighting at night to maximize light utilization in intended areas.
- C. Contractor to adjust or rotate area and roadway lighting at night to maximize light utilization in intended areas.
- D. Ground all luminaires to poles and all poles to equipment grounding conductor or to separate 3/4" diameter x 10' copperweld ground rod driven at base of each pole.
- E. Each pole mounted outside lighting luminaire shall have its conductors spliced to the branch circuit connectors in the pole base. Provide a Tron waterproof fuse holder with time delay fuse (1.5 X luminaire current) in the pole base for each ungrounded conductor for each luminaire.

END OF SECTION 26 56 00

SECTION 26 70 00
CONNECTION TO OWNER FURNISHED EQUIPMENT

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Owner-furnished equipment such as X-ray Equipment, Sterilizers, Blood Refrigerator and Alarm, Surgical Lights, Surgical Light Controllers, Laboratory Equipment, etc, shall be connected by this Contractor in accordance with manufacturers brochures and instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Conduit, wire, outlet boxes, disconnect switches, etc. to be provided and installed by this contractor to conform with applicable section of these specifications.
- B. All materials and equipment shall be factory listed as complying with applicable standards of Underwriter's Laboratories, Inc. or other similarly established standards of a nationally recognized testing laboratory (NRTL) that has been certified by the Occupational Safety and Health Administration (OSHA) for that referenced standard.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Electrical equipment as noted above shall be assembled, installed, and connected by this Electrical Contractor.
- B. In Patient Care Rooms, the effectiveness of the grounding system shall be evaluated before acceptance, and a report shall be submitted for review by the engineer of record prior to final acceptance and made available at the time of AHJ inspections.
- C. All equipment to be connected and left in satisfactory operating condition by the Contractor.

END OF SECTION 26 70 00

SECTION 27 05 00
COMMON WORK RESULTS FOR TELECOMMUNICATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. The requirements contained in this Section apply to all Section of this Division.
- B. Section Includes:
 - 1. Common terminology
 - 2. Submittal requirements used throughout this Division.
 - 3. Communication equipment coordination and installation.
 - 4. Contractor Qualifications
 - 5. Attachment A for Low Voltage Bid Form.

1.02 DEFINITIONS

- A. AHJ: Authorities Having Jurisdiction.
- B. ITG: Information Technology Group. Owner's IT representative.
- C. RCDD: Registered Communications Distribution Designer
- D. BICSI: Building Industry Consulting Service International
- E. TIA: Telecommunications Industry Association
- F. ANSI: American National Standards Institute
- G. NEC: National Electrical Code
- H. UTP: Unshielded twisted pair
- I. EMT: Electrical metallic conduit
- J. WAP: Wireless Access Point
- K. Telecommunication Space: Room or space dedicated to serving telecommunication equipment and infrastructure.
- L. HORIZONTAL CABLING: Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the Telecommunication Space.
- M. ITG: HCA IT Group. Owner IT representative.

1.03 SUBMITTAL PROCEDURES

- A. Common Requirements for Submittals:
 - 1. Provide product data submittals as required under Division 01 Section "Submittal Procedures".
- B. Common Requirements for Shop Drawings:
 - 1. Provide product data submittals as required under Division 01 Section "Submittal Procedures".
 - 2. Submit hardcopy of Shop Drawings in the quantity as required under Division 01 Section "Submittal Procedures".
 - 3. In addition to Shop drawings required by Division 01 provide the following shop drawings and leave within the Telecommunication space:
 - a. Provide one copy of Shop Drawings in electronic format. Files shall include both AutoCAD compatible source files (.dwg) and files printed to Portable Document Format (.pdf). Files to be stored on a portable disc labeled "Maitland FSER Telecommunications as Built Drawings".
 - b. Provide one hard copy of Shop Drawings. Pages shall be neatly folded and located within a folder labeled "Maitland FSER Telecommunications as Built Drawings".
 - 4. Shop Drawings shall be of appropriate scale but shall not be smaller than a scale of 1/4-inch equals one foot.

5. Shop drawings shall include all telecommunication devices.

1.04 QUALITY ASSURANCE

- A. Contractor shall be, with no exception, a current Belden certified partner and familiar with working in a healthcare environment. A list for current preapproved contractors for each project can be received by contacting HCA's Belden representative:
 1. Jake Jordan
Jake.Jordan@belden.com
513-520-0016
- B. Sub-subcontracting by the Division 27 subcontractor is not permitted. Awarded contractor's personnel shall perform all work.
- C. Common Requirements for Material Quality: Materials, equipment and devices shall be new and be free from defects.
- D. Common Requirements for Code Compliance: In case where differences occur between building codes, state laws, local ordinances, industry standards, utility company regulations and the contract Documents, the most stringent shall govern. Perform the following:
 1. Promptly notify the Architect in writing of any such difference.
 2. Obtain approval from Architect before proceeding with the Work.
 3. Should the Contractor perform any work that knowingly does not comply with local codes, laws and ordinances, industry standards, or other governing regulations; the Work shall be corrected at no cost to the Owner.

1.05 UNIT PRICES

- A. Contractor shall be, with no exception, a current Belden certified partner and familiar with working in a healthcare environment. A list for current preapproved contractors for each project can be received by contacting HCA's Belden representative:
 1. Jake Jordan
Jake.Jordan@belden.com
513-520-0016
- B. Sub-subcontracting by the Division 27 subcontractor is not permitted. Awarded contractor's personnel shall perform all work.
- C. Provide pricing breakdown showing unit pricing for material and labor for each type of system installed along with bid documents. An example Appendix A form is included at the end of this section.
 1. Match all part numbers to those used in the project and called out with in the Division 27 specifications.
 2. Unit Pricing for material to include part numbers for each item proposed.
 3. An Electronic copy of the Appendix A can be requested through:
 - a. Matt Dunaway
matt.dunaway@hcahealthcare.com
- D. Material Sourcing/Pricing. Healthcare Corporation of America (HCA), has a group pricing arrangement for all low voltage and structured cabling materials through HealthTrust Group Purchasing (HPG), with vendor Accu-Tech (<http://www.accu-tech.com/>).
 1. The Contractor shall utilize Accu-Tech for all pricing of materials. Accu-Tech's HPG Contract #6715. Only when previous approvals have been made should you purchase outside of HPG pricing.
 2. Accu-Tech contact: Tim Flannagan, Director of Healthcare, 615-585-3972;
tim.flannagan@accu-tech.com

1.06 COORDINATION

- A. Coordinate arrangement, mounting, and support of telecommunication cable, supports and pathway:
 1. To provide for ease of access to installed equipment and cable.

2. To allow right of way for piping, ductwork and conduit installed at required slope.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area. Work area outlet locations shall be located near an adjacent electrical outlet no more than 3 feet away and installed at the same height.
- C. Any electrical devices, mechanical equipment or fixtures (e.g., water/drainage piping, ductwork, pneumatic tubing) not directly related to the support of the communications space shall not be installed in, pass through, or enter the communications space.

1.07 WARRANTY

- A. Special Warranty: BELDEN standard form in which manufacturer agrees to repair or replace components of telecommunications equipment and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Twenty Five years parts and labor from date of Substantial Completion.
 2. Contact Mr. Jake Jordan at 513-520-0016, jake.jordan@belden.com , at 50% project completion, to schedule a site visit.

1.08 COMMON REQUIREMENTS FOR TELECOMMUNICATIONS INSTALLATION

- A. All materials, equipment and devices shall be installed in accordance with the recommendations of the manufacturer.
- B. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period
- C. Comply with NECA 1 - Standard Practices for Good Workmanship in Electrical Construction, as published by the National Electrical Contractors Association.
- D. Use certified technicians and installers skilled in their respective trades.

1.09 EXAMPLE ATTACHMENT A

ATTACHMENT A			
STRUCTURED CABLING BID SUMMARY			
Vendor			
Contact			
Telephone			
ITG DATA/VOIP			
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
ITG WAP Data Cable – CAT 6a Yellow 10GXS12004			
ITG Data/VOIP Cable – CAT 6 Black 2412010			\$ -
ITG Data CAT 6 Jack – Black RV6MJKUBK-S1			\$ -
ITG WAP CAT 6a Jack – Yellow RV6MJKUYL-S1			
2-Port Surface Mount Box White AX105253-EW			\$ -
4 Port Faceplate White AX102249			\$ -
ITG Data Patch Panels – CAT 6 RV6PPF2U48BK			\$ -
ITG WAP Patch Panels – CAT 6a RVAPPF2U48BK			
Two Post Equipment Rack – 84" – BHRR194			\$ -
Four Post Equipment Rack – 84" – XDR8419-3M62836			
Horizontal Wire Management – BHH192U			\$ -
Vertical Wire Management 3" – BHVHH03			\$ -
Vertical Wire Management 6" – BHVHH06			\$ -
Telecommunication Space Overhead Cable Tray 18"			\$ -
Overhead Cable Tray Mounting Accessories			\$ -
Misc material (Blanks, Labels, Grounding, Etc.)			\$ -
Material Total	\$	-	
Labor Total			
Tax	\$	-	
ITG Data/VOIP TOTAL	\$	-	

UNIT PRICES		
COMPONENT	ON SITE DURING CONSTRUCTION	RETURN TRIP REQUIRED AFTER CONSTRUCTION
One Jack Outlet		
Two Jack Outlet		
Three Jack Outlet		
Four Jack Outlet		

CATV			
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
CATV Data Cable – CAT 6 Blue 2412006			\$ -
CATV Data CAT 6 Jack – Blue RV6MJKUBL-S1			\$ -
CATV Coax Cable - RG6 5339Q5			\$ -
4 Port Faceplate White AX102249			\$ -
CATV Data Patch Panels – CAT 6 RV6PPF2U48BK			\$ -
Horizontal Wire Management – BHH192U			\$ -
Material Total	\$ -		
Labor Total			
Tax	\$ -		
CATV TOTAL	\$ -		

NURSE CALL			
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
Nurse Call Data Cable "A" 1212005			\$ -
Nurse Call Data Cable "B" 5000UE			\$ -
Nurse Call Data Cable "C" 5501UE			\$ -
Material Total	\$ -		
Labor Total			
Tax	\$ -		
NURSE CALL TOTAL	\$ -		

PHYSIOLOGICAL MONITORING			
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
PM Data Cable – CAT 6 Orange 2412003			\$ -
PM Data CAT 6 Jack – Orange RV6MJKUOR-S1			\$ -
4 Port Faceplate White AX102249			\$ -
PM Data Patch Panels – CAT 6 RV6PPF2U48BK			\$ -
Horizontal Wire Management – BHH192U			\$ -
Material Total	\$ -		
Labor Total			
Tax	\$ -		
PHYSIOLOGICAL MONITORING TOTAL	\$ -		

OVERHEAD PAGING			
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
18 AWG 2 Conductor Speaker Cable 5300UE			\$ -
1x2 Lay in Ceiling Speaker			\$ -
Cut in style Speaker with Back Can			\$ -
Wall Mounted Volume Control			\$ -
Amplifier 100 Watts			\$ -
Misc Material (Hardware, Labels, Etc.)			\$ -
Material Total	\$ -		
Labor Total			
Tax	\$ -		
OVERHEAD PAGING TOTAL	\$ -		

CCTV			
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
CCTV Data/VOIP Cable – CAT 6 Black 2412010			\$ -
CCTV Data CAT 6 Jack – Black RV6MJKUBK-S1			\$ -
2-Port Surface Mount Box White AX105253-EW			\$ -
CCTV Data Patch Panels – CAT 6 RV6PPF2U48BK			\$ -
Horizontal Wire Management – BHH192U			\$ -
Material Total	\$ -		
Labor Total			
Tax	\$ -		
CCTV TOTAL	\$ -		

DIVISION TOTALS		
DIVISION 27	SECTION NUMBER	SECTION TOTALS
ITG DATA/VOIP		\$ -
SLEEVES & CABLE SUPPORTS		\$ -
OVERHEAD PAGING		\$ -
CATV		\$ -
CCTV		\$ -
PHYSIOLOGICAL MONITORING		\$ -
NURSE CALL		\$ -
DIVISION 27 TOTAL		\$ -

HOURLY LABOR RATES		
COMPONENT	ON SITE DURING CONSTRUCTION	RETURN TRIP REQUIRED AFTER CONSTRUCTION
Regular Time/HR		
Overtime/HR		
Holiday Time/HR		

END OF SECTION 27 05 00

SECTION 27 05 26
GROUNDING AND BONDING FOR TELECOMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section **provides all services, labor, materials, tools, and equipment required for the complete and proper installation of telecommunications grounding and bonding for the Structured Cabling System as called for in these specifications and related drawings.**
Includes:
 - 1. Bonding conductors.
 - 2. Grounding connectors.
 - 3. Grounding busbars.
- B. Related Sections:
 - 1. Section 260526 "Grounding and Bonding for Electrical Systems" for main grounding conductor types/sizes, grounding rods, grounding clamps and testing.

1.02 SYSTEM DESCRIPTION

- A. **Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Bonding and grounding systems within the building are to have one electrical potential. Telecommunications grounding and bonding infrastructure shall start at the electrical service entrance ground and extend to all the metal telecommunications equipment.**

1.03 DEFINITIONS

- A. BCT: Bonding Conductor for Telecommunications. BCT bonds the TMGB to the AC electrical service entrance.
- B. **TBB (Telecommunications Bonding Backbone): An insulated copper conductor that bonds all TGBs in the TDR communications spaces with the TMGB in the TEC (i.e. MDF) communications space.**
- C. TEBC: Telecommunications Equipment Bonding Conductor. TEBC bonds the equipment racks, cable tray and other metal components inside the Telecommunication space to the TMGB **or TGB as applicable.**
- D. TMGB: Telecommunications main grounding busbar.
- E. **TGB: Telecommunications grounding busbar.**

1.04 SUBMITTALS

- A. **Submit product data for the following:**
 - 1. **TGB.**
 - 2. **TMGB.**
 - 3. **Two-hole and one-hole (with backstop) lugs.**
 - 4. **Conductors, as sized in this specification and drawings.**
 - 5. **Grounding pigtails or leads.**

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. **All material must be UL listed.** Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Bonding and grounding systems within the building are to have one electrical

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potential. Telecommunications grounding and bonding infrastructure shall start at the electrical service entrance ground and extend to all the metal telecommunications equipment.

B. A single manufacturer shall be used for all grounding material.

2.02 CONDUCTORS

- A. Telecommunications Equipment Bonding Conductor (**TEBC**): Stranded copper wire, green or green with yellow stripe insulation.
 - 1. No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
- B. Bonding Conductor for Telecommunications (BCT): Stranded copper wire.
 - 1. Stranded, UL-listed, minimum size No. 3/0 AWG or as indicated on drawings.
- C. Telecommunications Bonding Backbone (TBB): Stranded copper wire.
 - 1. Stranded, UL-listed, size No. 3/0 AWG or as indicated on drawings.

2.03 CONNECTORS

- A. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor.
 - 1. Electroplated tinned copper.
 - 2. Two holes spaced on 5/8" or 1" centers.
 - 3. Long barrel for two crimps.
 - 4. Sized to fit a specific size conductor.
 - 5. UL Listed as wire connectors.

2.04 GROUNDING BUSBARS

- A. Coordinate arrangement, mounting, and support of telecommunication cable, supports and pathway:
 - 1. To provide for ease of access to installed equipment and cable.
 - 2. To allow right of way for piping, ductwork and conduit installed at required slope.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area. Work area outlet locations shall be located near an adjacent electrical outlet no more than 3 feet away and installed at the same height.
- C. Manufacturers:
 - 1. Chatsworth Products, Inc.
 - 2. Or **approved** equal
- D. Telecommunications Main Grounding Busbar (TMGB) :
 - 1. Predrilled, wall-mounted, 1/4-inch by 4-inch, by 20-inch in length.
 - 2. Predrilling shall be with holes for use with lugs specified in this section.
 - 3. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a standoff from the wall.
 - 4. Chatsworth part number 10622-020 or **approved** equal.
- E. **Telecommunications Grounding Busbar (TGB) :**
 - 1. **Predrilled, wall-mounted, 1/4-inch by 4-inch, by 12-inch in length.**
 - 2. **Predrilling shall be with holes for use with lugs specified in this section.**
 - 3. **The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a standoff from the wall.**
 - 4. **Chatsworth part number 10622-012 or approved equal.**

2.05 LABELING

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

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PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with TIA-607-B.
- B. Conductors:
 - 1. General:
 - a. Shall be routed the shortest distance possible.
 - b. Shall not include splices.
 - c. Secured/supported at a minimum of 36-inches intervals.
 - d. Separated a minimum of 2-inches from any other power or telecommunication cables.
 - e. Separated a minimum of 2-inches from any ferrous metals where achievable. If separation can't be accomplished then the ferrous metal shall be bonded to the telecommunication grounding bonding infrastructure.
 - f. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
 - g. Install within EMT conduit until conduit enters a telecommunications space.
 - h. If installed in ferrous metallic conduit conductor shall be bonded, on each end, to the conduit.
 - i. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend shall exceed 90 degrees.
 - 2. Telecommunications Equipment Bonding Conductor (TEBC).
 - a. Meant to connect equipment racks, overhead cable tray and other metallic telecommunications equipment to the TMGB or TGB.
 - b. Shall be a minimum No. 6 AWG size.
 - 3. Bonding Conductor for Telecommunications (BCT).
 - a. Meant to bond the TMGB to the AC electrical service equipment.
 - b. Shall be a minimum No. 1/0 AWG size.
- C. Grounding Bussbar
 - 1. Telecommunications Main Ground Bussbar (TMGB) **and/or Telecommunications Ground Bussbar(TGB).**
 - a. Install horizontally a minimum of 24-inches above finished floor and a maximum of 84-inches above finished floor.
 - b. Located within the telecommunication space.
- D. Conductor Connections:
 - 1. General:
 - a. All metallic telecommunications equipment within the telecommunications space shall be bonded to the TMGB **and/or TGB.**
 - b. When connecting conductors to TMGB **and/or TGB** stacking of multiple connections/conductors shall not be allowed.
 - 2. Telecommunications Equipment Bonding Conductor (TEBC) connection to TMGB/**TGB.**
 - a. Irreversible two hole bolted compression connector except where noted below.
 - b. Antioxidant compound shall be applied to all bolted and compression connections.
 - c. Each equipment rack within the telecommunications space shall have a dedicated TEBC to the TMGB/**TGB.**
 - d. Overhead cable tray that is classified as a ground and bonding conductor may include one TEBC to the TMGB/**TGB.**
 - e. Provide TEBC from TMGB/**TGB** to building structural steel.
 - 1) Exothermic welding connections on both ends.

3. Bonding Conductor for Telecommunications (BCT) connection to TMGB and AC electrical service equipment.
 - a. Exothermic welding connections at TMGB.

3.02 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 1. Label the BCT, **TBB**, and each TEBC conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.03 TESTING AND INSPECTION

- A. Visually inspect telecommunications grounding infrastructure to ensure all connections were made properly.
- B. Test for ground loop currents using a digital clamp-on ammeter, with a fullscale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 1. With the grounding infrastructure completed and the communications system electronics operating, measure the current in TMGB **and TGB**. Maximum acceptable ac current level is 1 A.
 2. Excessive Ground Resistance: If resistance to ground exceeds 100 milliohms, notify Architect promptly and include recommendations to reduce ground resistance.
- C. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements:
 1. TMGB/**TGB** to electrical ground in telecommunication space.
 2. TMGB/**TGB** to structural building steel.
 3. Structural building steel to electrical ground.
- D. Prepare test and inspection reports. All testing shall be performed in the presence of the Architect or owner's representative and the results shall be submitted to the Engineer for review and approval.

END OF SECTION 27 05 26

SECTION 27 05 28
PATHWAYS FOR TELECOMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Products
 - 1. Conduit and Outlet Boxes for Telecommunications.
 - 2. Non-continuous Cable Supports.
 - 3. Sleeves.
- B. Related Sections:
 - 1. Section 26 05 33 "Raceways and Conduit Systems" for exterior duct banks, manholes, and underground utility construction.
 - 2. Section 27 11 00 "Telecommunications Equipment Room Fittings" for overhead cable support within the telecommunication space.

PART 2 - PRODUCTS

2.01 CONDUIT AND OUTLET BOXES

- A. General Requirements for Metal Conduits and Outlet Boxes:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-C.
 - 3. Comply with section 26 05 33 "Raceways and Conduit Systems".
 - 4. Flexible metal conduit shall not be used.
 - 5. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 3-1/2 inches deep.
 - 6. For Tracker Monitor locations, the Electrical Contractor shall provide a special recessed backbox that will house power and data. Arlington Part Number TVBS505. Refer to Telecommunications Drawings for Tracker Monitor locations.
 - 7. For HCA "Vision" locations the Electrical Contractor shall provide a special recessed back box that will house power, data, and coax.

2.02 NON-CONTINUOUS CABLE SUPPORTS

- A. Manufacturers: provide products by one of the following:
 - 1. Caddy.
 - 2. Cooper B-Line.
 - 3. Or preapproved equal.
- B. General Requirements: Comply with TIA-569-C.
- C. Description: J-Hook Style Cable Support NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

2.03 SLEEVES

- A. General Requirements:
 - 1. Comply with Section 07 84 00 "Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
 - 2. Comply with TIA-569-C
- B. Sleeves for pathway and cable penetration of non-fire-rated construction walls.
 - 1. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - a. Galvanized-steel sheet; round tube closed with welded longitudinal joint.
 - b. Fitted with plastic Bushings.

- C. Sleeves for pathway and cable penetration of fire-rated construction walls.
1. Manufacturers: provide products by one of the following:
 - a. Hilti.
 - b. STI.
 2. Description: Enclosed fire rated cable management device. Contains integrated intumescent firestop materials sufficient to maintain the hourly rating of the barrier being penetrated.
 3. 2" Sleeve:
 - a. Hilti Speed Sleeve Part Number 2008603.
 - b. STI EZPath Sleeve Part Number EZD22.
 4. 4" Sleeve:
 - a. Hilti Speed Sleeve Part Number 2008604.
 - b. STI EZPath Sleeve Part Number EZDP44.

PART 3 - EXECUTION

3.01 INSTALLATION

A. CONDUIT AND OUTLET BOXES

1. General Requirements:
 - a. Comply with NECA 1, NECA 101, and TIA-569-C for installation requirements except where requirements on Drawings or in this article are stricter.
 - b. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
 - c. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes.
 - d. Install horizontal pathway runs above water and steam piping.
 - e. Fasten junction and pull boxes to or support from building structure.
 - f. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 3-1/2 inches deep. Refer to contract documents for backbox sizes.
 - g. Flexible metal conduit shall not be used.
 - h. No single bend shall be greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points.
 - i. Conduits shall not contain any continuous sections longer than 100 feet between pull points.
 - j. Conduits shall be bonded to ground on one or both ends in accordance with AHJ.
 - k. Conduits that penetrate through the structural floor shall protrude a minimum 3 inches above the finished floor.
 - l. All conduit ends shall be reamed and fit with plastic bushings to prevent cable damage.
 - m. Pull boxes shall not be used in lieu of a conduit bend.
 - n. Conduits entering opposite sides of a pull box shall be aligned
 - o. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated.
 - p. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 24-inches of slack at each end of pull wire.
2. Stub-ups to Above Recessed Ceilings:
 - a. Use EMT for pathways.
 - b. Use a conduit bushing or insulated fitting to terminate stub-ups.
 - c. Minimum Pathway Size: 3/4-inch trade size. Refer to contract drawings for conduit sizes.
3. Outlet Boxes:
 - a. Comply with section 26 05 33 "Raceways and Conduit Systems".
 - b. Mount boxes at heights indicated on Drawings.

B. Non-Continuous Cable Supports

1. General Requirements:
 - a. Comply with TIA-569-C.
 - b. Material: Steel, pre-galvanized.
 - c. Size not to exceed a 40% fill ratio based on present needs.
 - d. Locate a minimum of 8 inches above ceilings not more than 60 inches apart.
 - e. Design fasteners and supports to carry supports and the cables.

C. Sleeves

1. General Requirements:
 - a. Comply with TIA-569-C
 - b. Comply with Section 07 84 00 "Firestopping" for penetration firestopping installed in fire-resistance-rated walls and smoke barriers.
 - c. Conduit sleeves shall be sized not to exceed a 40% fill ratio based on present needs.
 - d. Provide STI EZ-Path or Hilti speed sleeves where applicable and shown on contract drawings. Shall be installed per manufacturer's specifications.
 - e. For locations that STI EZ-Path and Hilti Speed sleeves can't be used, use EMT metal conduit, equipped with plastic bushings and sized not to exceed a 40% fill.
 - f. EMT shall be reamed and equipped with plastic bushing on each end to prevent cable damage.
 - g. EMT sleeves to be used for not rated penetrations. Insert conduit filler material and sealant around outside of conduit to create an air dam.
 - h. EMT Sleeves shall protrude a minimum 3 inches on both sides of barrier being penetrated.
 - i. Sleeves shall be located that they are in line with the cable pathway being served.
 - 1) Locate a minimum of 8 inches above ceilings measured from the bottom of the sleeve.
 - j. When EMT sleeves are used for vertical cable pathways through floors sleeves are to extend a minimum of 3-inches above finished floor.

D. PROTECTION

1. Separation from EMI Sources:
 - a. Comply with BICSI TDMM and TIA-569-C for separating unshielded copper voice and data communication cable from potential EMI sources.
 - b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 - c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 - d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
 - e. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
 - f. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

END OF SECTION 27 05 28

SECTION 27 11 00
TELECOMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Telecommunications equipment racks.
 - 2. Cable Management.
 - 3. Overhead Runway.

PART 2 - PRODUCTS

2.01 EQUIPMENT RACKS

- A. Manufacturer:
 - 1. Belden
- B. General Frame Requirements:
 - 1. Freestanding, modular-aluminum units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - 2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch panel mounting.
 - 3. Finish: Manufacturer's standard, baked-polyester powder coat.
- C. Floor-Mounted Racks: Modular-type.
 - 1. Two Post rack with tapped and threaded rails. Belden Part Number BHRR194.
 - 2. Four Post rack with square hole pattern for M6 clip nuts. Belden Part Number XDR8419-3M62836.

2.02 CABLE MANAGEMENT

- A. Manufacturer:
 - 1. Belden
- B. Vertical Cable Manager
 - 1. Double sided 6" wide vertical cable manager. Belden Part Number BHVHH06.
- C. Horizontal Cable Manager
 - 1. 2RU Horizontal manager. Belden Part Number BHH192UR.
 - 2. 1RU Horizontal manager. Belden Part Number BHH191UR.

2.03 OVERHEAD RUNWAY

- A. Manufacturer:
 - 1. WBT
- B. Description:
 - 1. Cable tray will consist of continuous, rigid, welded steel wire mesh.
 - 2. Finish shall be standard manufacturer's black powder coating.
 - 3. All accessories shall be by same manufacturer.
- C. Straight Section:
 - 1. Width: 18 inches. Height: 2 inches.
 - 2. WBT Part Number WBT2X18SBL.
- D. Cable radius drop:
 - 1. 6-inch-Wide cable drop out radius: WBT Part Number Radius Down 6.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General Requirements:
 - 1. Comply with NECA 1.
 - 2. Comply with TIA-569-C.
 - 3. Coordinate layout of patch panels and horizontal wire managers within equipment racks with owner's IT representative.

4. Coordinate location of lighting within telecommunication space so that lighting is located within equipment isles.
 - a. Lighting within the telecommunication space shall be minimum of 500 lux in the horizontal plane and 200 lux within the vertical plane when measured 3 feet above finished floor in the middle of isles between cabinets and equipment racks.
 5. Coordinate location of mechanical equipment so that cool air is being distributed at the front of equipment racks.
 6. Coordinate location of fire protection piping and devices so that piping and devices are not installed or routed over equipment racks and active communication equipment.
 - a. All sprinkler heads shall include cages to prevent accidental discharge.
 7. Systems that are not directly related to supporting the telecommunication space shall not be permitted to pass through the room.
- B. Equipment racks:
1. Mount in orientation as shown on the contract drawings.
 2. Racks shall be secured to building structure per manufacturers recommendations. Each rack shall be secured.
- C. Overhead Runway:
1. Install as a complete system, including fasteners, support systems, splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, and bonding.
 2. Install so that the runway is accessible for cable installation and all splices are accessible for inspection and adjustment.
 3. Locate a minimum of 4 inches above equipment racks.
 4. Remove burrs and sharp edges.
 5. Fasten hanging supports to building structure.
 6. Design fasteners and supports to carry cable runway and the cables.
 7. Place supports so that spans do not exceed maximum spans allowed per manufacturer.
 8. Construct supports from channel members, threaded rods, and other appurtenances furnished by the manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
 9. Do not install more than one splice between supports.
 10. Make changes in direction and elevation using manufacturer's recommended fittings.
 11. Make runway connections using manufacturer's recommended fittings.
 12. Install cable waterfalls in locations cable exits runway.
 13. Runway to be attached to communication equipment racks using manufacturer's recommended fittings.
- D. Cable Management:
1. Mount in orientation as shown on the contract drawings.
 2. Cable management shall be secured to equipment racks per manufacturer's recommendations.
 3. Horizontal wire manager to be mounted above and below each installed patch panel as a starting point. Contractor to request rack mounted equipment orientation from owner's IT representative.
- E. Grounding:
1. Comply with requirements in Section 270526 "Grounding and Bonding for Telecommunications Systems" for grounding conductors and connectors.

3.02 IDENTIFICATION

- A. Identify system components complying with TIA-606-B.
1. Administration Class: "1".
- B. Labels shall be preprinted or computer-printed type.

- C. Equipment Racks
 - 1. Each Rack shall be labeled using letters and numbers no smaller than 1 inch at the top of each rack.
- D. Contractor to coordinate labeling scheme with owner's IT representative.

END OF SECTION 27 11 00

SECTION 27 15 00

STRUCTURED VOICE AND DATA CABLING INFRASTRUCTURE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Equipment, materials, labor, and services to provide telephone and data distribution system including, but not limited to:
 - 1. Cable raceway, boxes, and cable tray.
 - 2. Telephone and data cabling terminations.
 - 3. Optical fiber and terminations.
 - 4. Telecommunications outlets.
 - 5. Terminal blocks/cross-connect systems.
 - 6. Equipment racks and cabinets.
 - 7. System testing and administration.
 - 8. Documentation and submissions.
- B. Supply and install a complete Belden Structured Cable System for this construction project at HCA Florida Westside Hospital Oakland Park, consisting of the following components:
 - 1. Belden Structured Cabling System Components:
 - a. CMR rated horizontal Unshielded Twisted Pair (UTP) Category 6 cable for voice and data applications.
 - b. Fiber and Copper termination hardware.
 - c. Modular Category 6 patch panels.
 - d. Category 6 connectors, jacks and faceplates.
 - e. Equipment racks, cable tray, ladderrack and wire supports.
 - 2. Pre-qualified bidders for this system are listed in Paragraph 1.10.F.
 - 3. Questions with regard to this section shall be directed to IT&S Manager of I.C. Thomasson. Refer to Paragraph 1.8.B.2 for contact information.
- C. Work not included:
 - 1. The following work will be done by others:
 - a. Offsite services.
 - b. Providing data concentrators, hubs, servers, computers, and other active devices.
 - c. Telephone switch (PBX) and handsets.
 - d. Painting will be done by the General Contractor.
- D. The contractor is required to utilize the pricing sheets at the end of this specification identified as "Attachment A".

1.02 RELATED WORK

- A. Low Voltage Rough-In: Section 27 37 00.
- B. Television Cable System: Section 27 51 01.
- C. Paging System 27 5116
- D. Nurse Call and Code Blue Systems 27 5223
- E. Closed Circuit TV (CCTV) 28 2300

1.03 REFERENCES

- A. Design, manufacture, test, and install telecommunications cabling networks per manufacturer's requirements and in accordance with NFPA70 (National Electrical Code®), state codes, local codes, requirements of authorities having jurisdiction, and particularly the following standards:
 - 1. ANSI/NECA/BICSI568 - Standard for Installing Commercial Building Telecommunications Cabling.
 - 2. ANSI/TIA/EIA Standards:
 - a. ANSI/TIA/EIA 568B.1 Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements.

- b. ANSI/TIA/EIA 568B.2 Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components.
 - c. ANSI/TIA/EIA 568C.3 Optical Fiber Cabling Components Standard.
 - d. ANSI/TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and Spaces.
 - e. ANSI/TIA/EIA 606A The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
 - f. ANSI/TIA/EIA 607A Commercial Building Grounding and Bonding Requirements for Telecommunications.
- B. Install cabling in accordance with the most recent edition of BICSI® publications:
- 1. BICSI Telecommunications Distribution Methods Manual.
 - 2. BICSI Cabling Installation Manual.
 - 3. BICSI LAN Design Manual
- C. Federal, state, and local codes, rules, regulations, and ordinances governing the work, are as fully part of the specifications as if herein repeated or hereto attached. If the contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the owner's representative in writing. Where the requirements of other sections of the specifications are more stringent than applicable codes, rules, regulations, and ordinances, the specifications shall apply.

1.04 PERMITS, FEES, AND CERTIFICATES OF APPROVAL

- A. The General Contractor will make application and pay for building permit.
- B. As prerequisite to final acceptance, supply to the owner certificates of inspection from an inspection agency acceptable to the owner and approved by local municipality and utility company serving the project.

1.05 SYSTEM DESCRIPTION

- A. A telecommunications cabling system generally consists of one telecommunications outlet in each workstation, wall telephones in common and mechanical areas, Intermediate Distribution Frames (IDF) located on each floor, and the Main Distribution Frame (MDF). Rate demarcation point (RDP) is located in the MDF.
- B. All Data cables will consist of Category 6 cable terminated with a RJ45 jack and terminate the cables on rack mounted modular patch panels located in the appropriate IDF. (T568B)
- C. A typical workstation will consist of three data jacks. The number of cables are indicated on the drawings.
- D. Vertical/horizontal copper backbone cabling consists of multiple pair unshielded twisted-pair installed from the main cross-connect (MC) located in the MDF to the horizontal cross-connect (HC) located in each IDF. This copper backbone will serve as the telephone riser backbone.
- E. Vertical/horizontal backbone cabling consists of 48 strands of 8 micron single mode optical fiber cable installed from the MC to the HC and will serve as the data communications fiber backbone.
- F. Non-Plenum cable is required for this facility. Plenum cable is unacceptable.

1.06 BID REQUIREMENTS

- A. Certificate of insurance. Contractor cannot begin installation of the system or be paid for any material or labor until this document is provided to the General Contractor.
- B. Bid sheets, included as Attachment A to this specification. The general contractor shall forward copies of all bids to Shelby Goolsby I.C. Thomasson Associates, Inc. 2950 Kraft Drive, Nashville, TN 37204 (615) 346-3400, for his participation in the selection of the cabling contractor.

1.07 PRE-CONSTRUCTION SUBMITTALS

- A. The following submittals must be provided thirty (30) days prior to start of construction.

1. Manufacturer product data sheets for each material and equipment specified. Mark each sheet to clearly identify the specific products and component parts, and data applicable to installation.
2. Assurance/Quality Control Submittals:
 - a. Proposed test forms for fiber riser, copper riser and horizontal UTP cable.
 - b. List of test equipment to be used for copper and fiber testing, (i.e., Fluke, PentaScanner, etc.)
 - c. List of all tests to be performed as part of the certification process.
 - d. Documentation of manufacturer's current qualification of contractor as an approved Belden Certified System Vendor (CSV) of the IBDN Plus System, IBDN 1200 System, IBDN System 2400, IBDN System 4800LX and IBDN Optical Fiber System.
 - e. Provide references of a minimum of three completed Belden installations.
 - f. Provide number of Belden certified installers. Owner may request a list by name and proof of training.
 - g. Installation work shall not begin prior to approval of all pre-construction submittals required in this section.

1.08 CONSTRUCTION SUBMITTALS

- A. Submit a Microsoft Project timeline to include, but not limited to, the following milestones:
 1. Material order date.
 2. Material receipt date.
 3. Project start date (by phase, if required.)
 - a. Rough-in (backbone cabling, horizontal cabling, all associated hardware).
 - b. Terminations.
 - c. Testing.
- B. Weekly report of work progress, shall be submitted each Friday until project is complete. Status reports should be submitted as follows:
 1. General Contractor, Representative
 2. Shelby Goolsby I.C. Thomasson Associates, Inc. 2950 Kraft Drive, Nashville, TN 37204
shelby.goolsby@salasobrien.com
- C. Invoices should be submitted to, and as directed by, the general contractor.
- D. As built drawings showing horizontal outlet and backbone cable labeling. Outlets should be numbered with a scheme that is consistent with the numbering scheme currently in use at the hospital (if renovation or addition project). This numbering scheme must be approved by the HDIS. These drawings must be provided to the PBX equipment vendor for set installation and station cross connections. The general contractor shall meet with the equipment vendor to establish an equipment installation schedule.

1.09 FINAL SUBMITTALS

- A. The following submittals must be submitted and approved prior to final billing and payment. They should be submitted within thirty days of completion of the project.
 1. Certification of level of performance as evidenced by comprehensive test results for UTP horizontal cabling, copper voice backbone cabling and single-mode fiber optic cabling as specified in this document. Electronic test results should be submitted to the HDIS at HCA Florida Westside Hospital Oakland Park.
 2. Record drawings with as-built information and finalized versions of the shop drawings. Numbered outlets in each room shall be shown on these drawings using a numbering scheme consistent with the current numbering scheme in use at the hospital. This numbering scheme shall be approved by the HDIS. These submittals shall be on the base plan as provided by the Architect or Owner. These submittals shall be four copies in reproducible print form and one in electronic format (AutoCAD or DXF file.) One copy of these drawings shall be provided to the PBX vendor, as required in Paragraph 1.5.D, and the remaining copies submitted to the HDIS.
 3. Manufacturer's system certification supporting the product warranty. It is the contractor's responsibility to arrange a job inspection by a Belden representative who is authorized to

approve the cabling system 25-year warranty. Contractor shall contact Mr. Jake Jordan at (515) 520-0016, HCA's Belden Representative, to schedule a site visit.

1.10 VENDOR QUALIFICATIONS

- A. Vendor shall be Belden certified as a Certified System Vendor (CSV.)
- B. Manufacturer must provide a 25-year system warranty for cable system installed.
- C. No sub-contractors are permitted unless specified in this document.
- D. The contractor will be responsible for any damage caused, either to the physical structure or communications cables or systems. Any damage will be repaired as a part of the basic service to be provided under this specification, at no additional cost to the owner.
- E. Since much of the work to be performed under this specification will be in the existing hospital, the contractor shall be familiar with construction standards for performing work under these conditions. The contractor shall adhere to the owners Infection Control Risk Assessment procedures.
- F. Following are pre-qualified bidders for this project and are encouraged to make a site visit, if applicable, before submitting bids:
 - 1. TBD.

1.11 QUALITY ASSURANCE

- A. The contractor shall have worked satisfactorily for a minimum of five (5) years on systems of this type and size. Installers must be certified and approved by the manufacturer with a minimum of three years' experience installing that manufacturer.
- B. Upon request by the engineer/designer, furnish a list of references with specific information regarding type of project and involvement in providing of equipment and systems.
- C. Equipment and materials of the type for which there are independent standard testing requirements, listings, and labels, shall be listed and labeled by the independent testing laboratory.
- D. Where equipment and materials have industry certification, labels, or standards (i.e., NEMA National Electrical Manufacturers Association), this equipment shall be labeled as certified or complying with standards.
- E. Material and equipment shall be new, and conform to grade, quality, and standards specified. Equipment and materials of the same type shall be a product of the same manufacturer throughout.
- F. Subcontractors shall assume all rights and obligations toward the contractor that the contractor assumes toward the owner and engineer/designer.

1.12 WARRANTY

- A. The installed system shall be a certified Belden System the Contractor to, unconditionally guarantee in writing the materials, equipment, and workmanship for a period of not less than twenty five (25) years from date of acceptance by the owner. The owner shall deem acceptance as beneficial use.
- B. Transfer manufacturer's warranties to the owner in addition to the General System Guarantee. Submit these warranties on each item in list form with shop drawings. Detail specific parts within equipment that are subject to separate conditional warranty. Warranty proprietary equipment and systems involved in this contract during the guarantee period. Final payment shall not relieve you of these obligations.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. Protect equipment during transit, storage, and handling to prevent damage, theft, soiling, and misalignment. Coordinate with the owner for secure storage of equipment and materials. Do not store equipment where conditions fall outside manufacturer's recommendations for

environmental conditions. Do not install damaged equipment; remove from site and replace damaged equipment with new equipment.

1.14 SEQUENCE AND SCHEDULING

- A. Submit schedule for installation of equipment and cabling. Indicate delivery, installation, and testing for conformance to specific job completion dates. As a minimum, dates are to be provided for bid award, installation start date, completion of station cabling, completion of riser cabling, completion of testing and labeling, cut-over, completion of the final punch list and owner acceptance.

PART 2 PRODUCTS

2.01 MATERIAL PRICING

- A. HCA has developed a strategic relationship with Accu-Tech Corporation for project material pricing. Accu-Tech is the owner of a single source pricing advantage for all HCA Hospital projects. HPG Contract # 6715. Contractors are encouraged to contact Tim Flannagan with Accu-Tech Corporation at (615) 585-3972 or tim.flannagan@accu-tech.com for pricing.

2.02 MANUFACTURERS

- A. Acceptable Manufacturer: Belden
- B. Where no manufacturer is specified, provide products of manufacturers in compliance with requirements.

2.03 FABRICATION

- A. Fabricate custom-made equipment with careful consideration given to aesthetic, technical, and functional aspects of equipment and its installation.

2.04 SUITABILITY

- A. Provide products that are suitable for intended use, including, but not limited to environmental, regulatory, and electrical. All cabling, copper riser, and fiber shall be provided with suitable insulation for installing in an air plenum.

2.05 VOICE/DATA TELECOMMUNICATIONS SERVICE BACKBONE CABLE

- A. 100 pair solid copper, 24 AWG, 100 OHM balanced twisted-pair (UTP) backbone cable, with mechanical and transmission performance specifications that meet or exceed ANSI/TIA/EIA568B.2. Belden Part Number DIW100/DPLN100.
 - 1. *Note: Listed Type CMR, CMP, MPR and/or MPP (as required in the NEC 2002 and authority having jurisdiction).
- B. 48 Strand single mode 8 mm diameter tight-buffered optical fiber, with mechanical and transmission performance specifications that meet or exceed ANSI/TIA/EIA568B.3. Belden Part Number FISD048AK.
 - 1. *Note: Listed type OFNP, OFNR, OFCR, and/or OFCP (as required in the NEC 2002 and authority having jurisdiction).
- C. 6 Strand single mode 8 μm diameter tight-buffered optical fiber, with mechanical and transmission performance specifications that meet or exceed ANSI/TIA/EIA568B.3. Belden OS2 OptiTuff Mini Fiber Cable, Part Number: FISX006W0.
 - 1. *Note: Listed type OFNP, OFNR, OFCR, and/or OFCP (as required in the NEC 2002 and authority having jurisdiction).

2.06 DATA STATION CABLE (Copper)

- A. Solid copper, 24 AWG, 100 OHM balanced twisted-pair (UTP) Category 6 cables with four individually twisted-pairs, which meet or exceed the mechanical and transmission performance specifications in ANSI/TIA/EIA568B.2 up to 250 MHz. Cable shall be black in color. Belden Part Number 2412010U1000.
 - 1. *Note: Listed Type CMR, CMP, MPR and/or MPP (as required in the NEC 2002).

2.07 DATA – WORK AREA OUTLETS

- A. Single-gang mounting plate with four (4) openings Belden Part Number AX102249 containing the following devices:
 - 1. Data Outlet 8pin modular, Category 6, unkeyed, black, pinned to T568 B standards. Belden Part Number RV6MJKUBK-S1.
- B. Surface Mount Outlet: Almond Belden Part Number A0645272.

2.08 WALL VOICE OUTLETS

- A. Single-gang stainless steel faceplate with EIGHT-conductor jack and wall telephone mounting lugs Belden Part Number AX104126 (Plate) and RV6MJKUBK-S1 (Jack).

2.09 DATA ONLY WORK AREA OUTLET

- A. Single-gang faceplate with 8-pin modular, Category 6, unkeyed, black data jack, pinned to T568 B configuration. Belden Part Number RV6MJKUBK-S1.
- B. Surface Mount Outlet: Almond Belden Part Number A0645272.

2.10 TERMINATION BLOCKS

- A. Distribution Cable: Riser cable shall be terminated on 19 inch rack mountable 48 port patch panels with rear insulation displacement (IBC) meeting Category 6 performance standards and pinned to T568B standards. Belden Part Number RV6PPF2U48BK. Terminate one pair of the riser cable per port and spare back the violet side of each 25 pair bundle.

2.11 PATCH PANELS

- A. 19 in. rack mountable, 24:48port 8pin modular to insulation displacement connector (IDC) meeting Category 6 performance standards, and pinned to T568 B standards. Belden Part Number RV6PPF1U24BK (24 Port) RV6PPF2U48BK (48 Port)

2.12 RACK MOUNTED OPTICAL FIBER TERMINATION PANEL

- A. Interconnect Units for IDF locations shall be Belden 1U FiberExpress Rack Mount Patch Panel, Part Number AX105563, equipped with double density, six (6) LC compatible optical fiber adapter strips, Part Number FFSU12LD. Interconnect Units for the MDF location shall be Belden 4U FiberExpress Rack Mount Patch Panel, Part Number AX100116, equipped with double density, twelve (12) LC compatible optical fiber adapter strips, Part Number AX101743.

2.13 OPTICAL FIBER CONNECTORS

- A. Field Terminated Pigtails or Fusion LC connectors, which meet or exceed the performance specifications in ANSI/TIA/EIA568B.3. Belden Part Number FTSLC900PR12 or FTSLC900FS01.

2.14 OPEN FRAME EQUIPMENT RACK

- A. Open frame, 19 in. equipment rack, 7 foot overall height with flange base, mounting rails drilled front and back and tapped to EIA standards, and a front-rack mountable 10 outlet multiple outlet electrical strip. Belden Part Number BHRR194.

2.15 4-POST OPEN FRAME EQUIPMENT RACK

- A. Open frame, 19 in. equipment rack, Black, 7 foot overall height with flange base, mounting rails drilled front and back and tapped to EIA Standards, 28" depth, and a front-rack mountable 10 outlet multiple outlet electrical strip. Belden Part Number XDR8419-3M62836.

2.16 LADDER RACK

- A. B-Line Cable Runway, Part Number SB-17-18-TG and SB-17-24-TG, with the associated mounting hardware, shall be installed in the communications rooms as shown on the room layout drawings. All cable runways shall be securely fastened above the freestanding racks.

2.17 CABLE SUPPORTS

- A. Cable support devices used above ceilings throughout main corridors shall be provided by a J-Hook Tree. Installation shall include all associated hardware for mounting in conjunction with

Snake Tray provide one (1) 2" J-Hook every 4 feet. Refer to detail on sheet T301. Main corridor pathways are shown on the T-series drawings. Cable support devices above the drop ceiling off of the main corridors and in the communication rooms shall be provided by the cabling contractor.

2.18 CROSS OVER CABLING

- A. In the communications room, eight Belden Cat 5E twenty five pair cables, Part Number IBDN25P, shall be extended from a forty eight port panel located at the top of the cabling equipment rack to a 100 pair 110 connecting block AX100694, located on the right side of the horizontal voice connecting blocks. Contractor to punch down 4 pairs per port.

2.19 PATCH CABLES

- A. Patch cables are NOT required for this project.

2.20 WIRE MANAGEMENT

- A. Vertical wire management shall be Part Number BHVHH06. Horizontal management shall be Part Number BHH192U

2.21 LISTED BUILDING ENTRANCE PROTECTORS

- A. Building entrance terminal utilizing a two (2) foot fuse link between the outside cable plant splice and the protector module with IDC type input and output terminals, 100pair capacity and female mounting base, equipped with 230 volt solid state protector modules. Provide sufficient protector modules to completely populate all building entrance terminals.

2.22 DATA WIRELESS CABLES

- A. Contractor shall install Category 6A cables to the locations identified on the drawings. Belden Part Number 10GXS12004A1000/10GXS13004A1000. Contractor shall leave 25' of slack on each cable. Cables shall be independently terminated on Belden RevConnect Modular Plugs. Belden part number RVAFPUBK-S1. Contractor shall provide unloaded Category 6A patch panels for the wireless cables. Belden Part Number RVAPPF1U24BK (24 port), and RVAPPF2U48BK (48 port). Contractor shall be responsible at the end of the project for the final placement of cables after the wireless survey is completed by the owner's vendor. Contractor shall be responsible for hanging owner provided wireless access points.

2.23 IN-WALL A/V CABLING

- A. Contractor shall install in-wall A/V cabling identified on the drawings. Length of cable to be determined by contractor. Rapid Run Part Number 2212-40860-XXX, 2212-40858-022 and 2212-408870-022.

PART 3 EXECUTION

3.01 PRE-INSTALLATION SITE SURVEY

- A. Prior to start of systems installation, meet at the project site with the owner's representative and representatives of trades performing related work to coordinate efforts. Review areas of potential interference and resolve conflicts before proceeding with the work. Facilitation with the General Contractor will be necessary to plan the crucial scheduled completions of the equipment room and telecommunications closets.
- B. Examine areas and conditions under which the system is to be installed. Do not proceed with the work until satisfactory conditions have been achieved.

3.02 HANDLING AND PROTECTION OF EQUIPMENT AND MATERIALS

- A. Be responsible for safekeeping of your own and your subcontractors' property, such as equipment and materials, on the job site. The owner assumes no responsibility for protection of above named property against fire, theft, and environmental conditions.

3.03 PROTECTION OF OWNER'S FACILITIES

- A. Effectively protect the owner's facilities, equipment, and materials from dust, dirt, and damage during construction.
- B. Remove protection at completion of the work.

3.04 INSTALLATION

- A. Receive, check, unload, handle, store, and adequately protect equipment and materials to be installed as part of the contract. Store in areas as directed by the owner's representative. Include delivery, unloading, setting in place, fastening to walls, floors, ceilings, or other structures where required, interconnecting wiring of system components, equipment alignment and adjustment, and other related work whether or not expressly defined herein.
- B. Install materials and equipment in accordance with applicable standards, codes, requirements, and recommendations of national, state, and local authorities having jurisdiction, and National Electrical Code® (NEC) and with manufacturer's printed instructions.
- C. Adhere to manufacturer's published specifications for pulling tension, minimum bend radii, and sidewall pressure when installing cables.
 - 1. Where manufacturer does not provide bending radii information, minimum-bending radius shall be 15 times cable diameter. Arrange and mount equipment and materials in a manner acceptable to the engineer and the owner.
- D. Penetrations through floor and fire-rated walls shall utilize intermediate metallic conduit (IMC) or galvanized rigid conduit (GRC) sleeves and shall be firestopped after installation and testing, utilizing a firestopping assembly approved for that application.
- E. Install station cabling to the nearest Intermediate Distribution Frame (IDF), unless otherwise noted.
- F. Installation shall conform to the following basic guidelines:
 - 1. Use of approved wire, cable, and wiring devices.
 - 2. Neat and uncluttered wire termination.
- G. Attach cables to permanent structure with suitable attachments at intervals of 48 to 60 inches. Support cables installed above removable ceilings.
- H. Install adequate support structures for 10 foot of service slack at each IDF.
 - 1. Support riser cables every three (3) floors and at top of run with cable grips. Limit number of four-pair data riser cables per grip to fifty (50).
- I. Install cables in one continuous piece. Splices shall not be allowed except as indicated on the drawings or noted below:
- J. Provide over-voltage protection on both ends of cabling exposed to lightning or accidental contact with power conductors.
- K. Notify the owner/engineer immediately of any horizontal cable run exceeding TIA/EIA specifications.
- L. System inspection shall be provided through pre-construction, in-progress and final inspections by Owner/Engineer. The Owner/Engineer or the Contractor may, at his/her discretion, perform tests in addition to those specified in this document if there is any reason to question the condition of the material as furnished or installed.

3.05 GROUNDING

- A. Grounding shall conform to ANSI/TIA/EIA 607(A) Commercial Building Grounding and Bonding Requirements for Telecommunications, National Electrical Code®, ANSI/NECA/BICSI568 and manufacturer's grounding requirements as minimum.
- B. Bond and ground equipment racks, housings, messenger cables, and raceways.
- C. Connect cabinets, racks, and frames to single-point ground which is connected to building ground system via #6 AWG green insulated copper grounding conductor.

3.06 LABELING

- A. Labeling shall conform to ANSI/TIA/EIA606(A) standards. In addition, provide the following:
 - 1. Label each outlet with permanent self-adhesive label with minimum 3/16 in. high characters.

2. Label each cable with permanent self-adhesive label with minimum, 1/8 in. high characters, in the following locations:
 - a. Inside receptacle box at the work area.
 - b. Behind the communication closet patch panel or punch block.
3. Use labels on face of data patch panels. Provide facility assignment records in a protective cover at each telecommunications closet location that is specific to the facilities terminated therein.
4. Use color-coded labels for each termination field that conforms to ANSI/TIA/EIA606(A) standard color codes for termination blocks.
5. Labels shall be machine-printed. Hand-lettered labels shall not be acceptable.
6. Label cables, outlets, patch panels, and punch blocks with room number in which outlet is located, followed by a single letter suffix to indicate particular outlet within room, i.e., S2107A, S2107B. Indicate riser cables by an R then pair or cable number. Contractor is to submit labeling scheme for approval.
7. Mark up floor plans showing outlet locations, type, and cable marking of cables. Turn these drawings over to the owner four (4) weeks prior to move in to allow the owner's personnel to connect and test owner-provided equipment in a timely fashion.
8. Three (3) sets of as-built drawing shall be delivered to the owner within four (4) weeks of acceptance of project by the owner. A set of as-built drawings shall be provided to the owner in electronic media form (compact disk) and utilizing AutoCAD software that is acceptable to the owner. The CD shall be delivered to the owner within six (6) weeks of acceptance of project by owner.

3.07 TESTING

- A. Testing shall conform to ANSI/TIA/EIA568B.1 standard. Testing shall be accomplished using level II or higher field testers.
- B. Test each pair and shield of each cable for opens, shorts, grounds, and pair reversal. Correct grounded and reversed pairs. Examine open and shorted pairs to determine if problem is caused by improper termination. If termination is proper, tag bad pairs at both ends and note on termination sheets.
 1. Perform testing of copper cables with tester meeting ANSI/TIA/EIA568B.1 requirements.
 2. If horizontal cable contains bad conductors or shield, remove and replace cable.
- C. Initially test optical cable with a light source and power meter utilizing procedures as stated in ANSI/TIA/EIA52614A: OFSTP14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant and ANSI/TIA/EIA5267 Measurement of Optical Power Loss of Installed Singlemode Fiber Cable Plant. Measured results shall be plus/minus 1 dB of submitted loss budget calculations. If loss figures are outside this range, test cable with optical time domain reflectometer to determine cause of variation. Correct improper splices and replace damaged cables at no charge to the owner.
 1. Cables shall be tested at 850 and 1300 nm for multimode optical fiber cables. Cables shall be tested at 1310 and 1550 nm for singlemode optical fibers.
 2. Testing procedures shall utilize the one jumper reference.
 3. Bi-directional testing of optical fibers is required.
- D. Perform optical time domain reflectometer (OTDR) testing on each fiber optic conductor. Measured results shall be plus/minus 1 dB of submitted loss budget calculations.
 1. Submit printout for each cable tested.
 2. Submit compact disk with test results and program to view results.
- E. Where any portion of system does not meet the specifications, correct deviation and repeat applicable testing at no additional cost to the owner.

3.08 FIELD QUALITY CONTROL

- A. Employ job superintendent or project manager during the course of the installation to provide coordination of work of this specification and of other trades, and provide technical information when requested by other trades. This person shall maintain current RCDD® (Registered

Communications Distribution Designer) registration and shall be responsible for quality control during installation, equipment setup, and testing.

- B. All installation personnel shall meet manufacturer's training and education requirements for implementation of extended warranty program.

3.09 REMOVAL OF UNUSED VOICE AND DATA HORIZONTAL CABLE

- A. The cabling contractor shall remove an unused voice and data cable located in the construction area. The contractor shall work with the HDIS to identify unused cable. No cable is to be removed unless approved by the HDIS.

END OF SECTION 27 15 00

ATTACHMENT A
STRUCTURED CABLING BID SUMMARY

Vendor _____
Contact _____
Telephone _____ Fax # _____ Email _____
Cabling System Proposed _____

HORIZONTAL CABLING			
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
Cable – CAT 6 PVC/Plenum Black			
Cable – CAT 6 PVC/Plenum White			
Cable – CAT 6A PVC/Plenum Yellow			
Cable – 25 Pair CAT 5e			
RJ-45 CAT 6 Jack – Black			
RJ-45 CAT 6 Jack – White			
RJ-45 CAT 6A Jack - Yellow			
Surface Mount Outlet – AO645272			
Face Plate – White – AX101784			
Stainless Wall Plate– AX104126			
Patch Panels – CAT 6 48 port			
Patch Panels – CAT 6 24 port			
Patch Panels – CAT 6A 48 port			
Patch Panels – CAT 6A 24 port			
110type hardware – 300 Pr. equipped with C4 connectors			
110type hardware – 100 Pr. equipped with C4 connectors			
Voice Block Wire Management AX100706			
Equipment Rack – 84” – BHRR194			
4 – Post Equipment Rack – XDR-8419-31228			
Horizontal Wire Management – BHH192U			
Vertical Wire Management 6” – BHVHH06			
Cable Runway (Ladder Rack) 18”			
Misc Materials			
HILTI 2” Speed Sleeve 236323			
HILTI 4” Speed Sleeve 236324			
EZ PATH #EZD22			
EZ PATH #EZDP33FWS			
EZ PATH #EZDP433GK			
J-HOOK – 2”			
Material Total			\$
Labor Total			\$
Tax			\$
HORIZONTAL CABLE TOTAL			\$
STRUCTURED CABLING BID SUMMARY			
COPPER BACKBONE CABLE	TOTAL PROJECT		
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
100 Pair D-Riser Cable			
Patch Panels – CAT 6 48 port			
110-type Hardware- 300 Preequipped with C5 connectors			

Minor materials			
Material Total			\$
Labor Total			\$
Tax			
COPPER BACKBONE CABLE TOTAL			\$
OPTICAL FIBER BACKBONE	TOTAL PROJECT		
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
24 Strand 8/125 Fiber Cable			
Inter Connect Unit - 1U			
Adapter Strip			
Inter Connect Unit - 4U			
Connector Module			
Optical Fiber LC Connector			
Minor materials			
Material Total			\$
Labor Total			\$
Tax			
OPTICAL FIBER BACKBONE TOTAL			\$
TOTAL CABLE SYSTEM PRICE			
Horizontal Cabling			\$
Copper Backbone Cable			\$
Optical Fiber Backbone			\$
TOTAL			\$

CABLE/SATELLITE DISTRIBUTION SYSTEM		SECTION 27 51 01	
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
Cable – CAT 6 PVC/Plenum Blue			
RJ-45 CAT 6 Jack – Blue			
RG6 PVC/Plenum Cable			
RG6 F Connectors			
Stainless Steel Faceplates			
Patch Panels – CAT 6 48 port			
Patch Panels – CAT 6 24 port			
Horizontal Wire Management – BHH192U			
Minor materials			
Material Total			\$
Labor Total			\$
Tax			
TELEVISION DISTRIBUTION TOTAL			\$
PAGING SYSTEM		SECTION 27 51 13	
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
Cable – 18 AWG 2-Conductor – 5300UE/6300UE			
Amplifiers – 100 watt – TPU100B			
Speakers – Lay-In – CSD1X2U			
Speakers – Hard Lid – S86T725PG8U			
Speakers – Horn – SPT115A			
Speakers – Horn – Accessories			
Misc. Cable			
Minor materials			
Material Total			\$
Labor Total			\$
Tax			
PAGING SYSTEM TOTAL			\$

INTERCOM SYSTEMS	SECTION 27 51 22		
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
Misc. Cable			
Minor materials			
Material Total			\$
Labor Total			\$
Tax			
INTERCOM SYSTEMS TOTAL			\$
PHYSIOLOGICAL/TELEMETRY MONITORING	SECTION 27 52 13		
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
Cable – CAT 6 PVC/Plenum Orange			
RJ-45 CAT 6 Jack – Orange			
Patch Panels – CAT 6 48 port			
Patch Panels – CAT 6 24 port			
Surface Mount Outlet – AO645272			
Face Plate – White – AX101436			
Face Plate – Stainless Steel – AX104230			
Face Plate – Stainless Steel – AX104231			
Face Plate – Stainless Steel – AX104232			
Horizontal Wire Management – BHH192U			
Minor materials			
Material Total			\$
Labor Total			\$
Tax			
MONITORING TOTAL			\$

NURSE CALL AND CODE BLUE SYSTEMS	SECTION 27 52 23		
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
Cable – CAT6 PVC/Plenum Green			
Misc. Cable			
Minor materials			
Material Total			\$
Labor Total			\$
Tax			
NURSE CALL/AND CODE BLUE SYSTEMS TOTAL			\$
CLOSED CIRCUIT TV (CCTV)	SECTION 28 23 00		
COMPONENT	QUANTITY	UNIT PRICE	TOTAL PRICE
Cable – Cat 6 PVC/Plenum Black			
Minor materials			
Material Total			\$
Labor Total			\$
Tax			
CLOSED CIRCUIT TV (CCTV) TOTAL			\$

DIVISION 27 & 28 BID SUMMARY		SECTION NUMBER	SECTION TOTALS
STRUCTURED CABLING		27 1500	\$
COPPER RISER CABLE		27 1500	\$
OPTICAL FIBER BACKBONE		27 1500	\$
TELEVISION CABLE SYSTEM		27 5101	\$
PAGING SYSTEM		27 5116	\$
INTERCOM SYSTEMS		27 5122	\$
PHYSIOLOGICAL PATIENT MONITORING		27 5213	\$
NURSE CALL AND CODE BLUE SYSTEMS		27 5223	\$
CLOSED CIRCUIT TV (CCTV)		28 2300	\$
INFANT PROTECTION SYSTEM		28 3600	\$
DIVISION TOTAL			\$
UNIT PRICES			
COMPONENT	ON SITE DURING CONSTRUCTION	RETURN TRIP REQUIRED AFTER CONSTRUCTION	
Wall Telephone Outlet	\$	\$	
One Jack Outlet	\$	\$	
Two Jack Outlet	\$	\$	
Three Jack Outlet	\$	\$	
Four Jack Outlet	\$	\$	
HOURLY LABOR RATES			
COMPONENT	ON SITE DURING CONSTRUCTION	RETURN TRIP REQUIRED AFTER CONSTRUCTION	
Regular Time/HR	\$	\$	
Overtime/HR	\$	\$	
Holiday Time/HR	\$	\$	

SECTION 27 51 01
TELEVISION CABLE SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

- A. All work specified in this section shall comply with the provisions of Section 27 05 00.
- B. Section Includes:
 - 1. The work includes furnishing all labor, materials, tools, equipment, mounting hardware and documentation required for the television cable distribution system (CATV).
- A. Products
 - 1. Indoor CATV Distribution Amplifiers
 - 2. Indoor/Outdoor Directional Couplers
- B. Related Sections:
 - 1. Section 27 05 00 "Common Work Results for Telecommunications" for general provisions and submittals.
 - 2. Section 27 15 00 "Telecommunications Horizontal Cabling" for infrastructure cabling related to the CATV system.

1.02 SUBMITTALS

- A. Submittals are required for this section.

PART 2 - PRODUCTS

2.01 EQUIPMENT REQUIREMENTS

- A. All TV's and mounts in this section will be provided by the owner. Contractor will be required to mount and install all owner provided equipment.

2.02 COMPONENTS

- A. All coax station cabling is to be RG6/U designed for CATV/MATV installations Model 5339Q5/6339Q8..
- B. All riser cabling shall be RG11 with banded tape, 60% braid, non-bonded tape, 60% aluminum braid shield, flame retardant Black PVC jacket Model Number: 1523Ap/7999AP
- C. Each outlet shall have an Unshielded Twisted Pair (UTP) cable in the same outlet box. Cable shall be blue category 6 cable. Belden Part Number 2412006U1000/2413D15U1000 Jack Part Number RV6MJKUBL-S1.
- D. All riser cabling shall be 6 Strand OS2 OFNP Fiber Model Number FISX006W0. Included with the Backbone Fiber: Pigtails for Termination – Part numbers FTSSB900PSI01 (Single), FTSSB900PR12 (12 Pack), and FXFUHS9T2CB25 (25 Pack); Splice Cassette – Part number FCSH12SBFS; and Wall Mount Panels – Part number AX106817.
- E. Each outlet box shall require an KeyConnect 106 adapter module with appropriate number of blank inserts. Belden Part Number AX104121.
- F. Each outlet shall require an KeyConnect Video "F" connect module. Belden Part Number AX102907.

PART 3 - EXECUTION

3.01 COORDINATION

- A. All mounting heights are to be coordinated with architectural elevations and shall meet ADA requirements of 80" AFF to bottom of any obstruction from wall.
- B. Controls of patient televisions shall be connected to the Nurse Call pillow speaker and patient bed side rails. This connection shall be coordinated between the Nurse Call supplier and this contractor and all items necessary for this feature is to be considered a part of this specification.

- C. All backing in the walls and wall bracket installation shall be coordinated with television vendor.

3.02 INSTALLATION

- A. Install system per the manufacturer's guidelines.
- B. System to be free of RF noise and loss of dB signal. Precautions are to be made to prevent and filter out any visible noise.
- C. Grounding shall be sufficient to meet manufacturer requirements.
- D. This contractor is to provide a surge suppressor on the cables entering the television head end equipment from the cable service provider and/or satellite dish.

3.03 WARRANTY

- A. The product shall be warranted to be free from defects in material and workmanship under normal use for a period of one (1) year from the date of first beneficial use of all or any part of the product, or 12 months after product shipment, whichever is earlier.
- B. Designer reserves the right to accept or reject any part of installation which does not successfully meet requirements as set out in these specifications.
- C. Contractor shall and hereby does guarantee all work installed under this division shall be free from defects in workmanship and materials. The above parties further agree that they will repair and replace any defective material or workmanship which becomes defective within the terms of this warranty-guarantee.

END OF SECTION 27 51 01

SECTION 27 51 16
OVERHEAD PAGING SPEAKER SYSTEM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract.

1.02 SUMMARY

- A. Section Includes:
 - 1. Power amplifiers.
 - 2. Volume control.
 - 3. Speakers.
 - 4. Speaker cable.

1.03 PRECONSTRUCTION SUBMITTALS

- A. Product Data: Manufacturer product data sheets for each material and equipment specified. Mark each sheet to clearly identify the specific products and component parts, and data applicable to installation.

1.04 CLOSEOUT SUBMITTALS

- A. Certification of level of performance as evidenced by comprehensive test results. Electronic and hard copy test results should be provided to the facility IT&S Director and/or person(s) overseeing system.
- B. Record drawings with as-built information and finalized versions of the shop drawings. These submittals shall be on the base plan as provided by the Architect or Technology engineer. Drawings shall be computer generated; hand drawn drawings are not acceptable. These submittals shall be in reproducible print form (PDF) and one in electronic format (AutoCAD or DWG file) provided on a CD or thumb drive. One hard copy (24 inch x 36 inch) shall be placed at each amplifier location.
 - 1. As built drawings shall include, but not limited to:
 - a. All speaker locations including types and tap settings.
 - b. All volume controls
 - c. All zone designation at each speaker, volume control, and amplifier location.
 - d. Zone descriptions explaining all inputs.
 - e. Amplifier size
 - f. Electrical circuit ID supporting all powered devices.
 - g. Elevation drawings of all equipment
 - h. One line wiring schematic showing how entire system is wired/connected.
- C. Manufacturer's system certification supporting the product warranty. It is the contractor's responsibility to have the installation certified with the Manufacturer's warranty guaranty.

1.05 QUALITY ASSURANCE

- A. Contractor Qualifications
 - 1. Contractor shall be Manufacturer certified.
 - 2. All cable and equipment shall be installed in accordance with the recommendations of the system manufacturer.
 - 3. The contractor will be responsible for any damage caused, either to the physical structure or existing system. Any damage will be repaired as a part of the basic service at no additional cost to HCA.
- B. Source Limitations: Obtain all equipment from single manufacturer.
- C. All electrical devices shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Existing system: New devices shall intergrate into the existing system to create a complete single seamless operating system.

1.06 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. System Functions:
 - 1. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
 - 2. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
- B. Zones: All speakers shall be integrated into appropriate existing zones.
- C. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
- D. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, products provided by Bogen Communications, Inc.

2.02 POWER AMPLIFIERS

- A. Output Power: 70V. 2 watts for each speaker connected in all-call mode of operation, plus a 25 percent allowance for future stations.
- B. Built in telephone paging adapter. Accept voice signals from telephone extension dialing access and automatically provide amplifier input.
- C. Wall or rack mountable.
- D. Amplifiers:
 - 1. 60 watt power amplifier, Bogen part Number TPU60B
 - 2. 100 watt power amplifier, Bogen part number TPU100B
 - 3. 250 watt Power amplifier, Bogen part number TPU250

2.03 VOLUME CONTROL

- A. Bogen Part Number AT10A.

2.04 SPEAKERS

- A. Lay-In ceiling mounted speaker:
 - 1. Cone Size: 8 inches.
 - 2. Minimum Dispersion Angle: 100 degrees.
 - 3. Matching Transformer: Full-power rated with five taps.
 - 4. Flush-Ceiling-Mounted units designed for installation within standard lay-in type ceiling.
 - 5. Dimensions: 12" Wide x 4 7/8" High x 24" Deep.
 - 6. Bogen part number CSD1X2U
- B. Hard lid ceiling mounted speaker:
 - 1. Cone Size: 8 inches.
 - 2. Minimum Dispersion Angle: 100 degrees.
 - 3. Matching Transformer: Full-power rated with five taps.
 - 4. Flush-Ceiling-Mounted units designed for installation within gypsum or metal type ceiling.
 - 5. Dimensions: 13" Diameter x 3 1/4" High.
 - 6. Bogen part number S86T725PG8U
 - 7. Required accessories: Speaker enclosure.
 - a. 1/2" and 3/4" standard electrical knockouts
 - b. Dimensions: 12 1/4" Diameter x 4 1/2" High.
 - c. Bogen part number RE84.
- C. Horn-type speakers
 - 1. Metal construction rated for indoor or outdoor use.
 - 2. Matching transformer: Full-power rated with five taps.

3. Able to wall mount, mount to structural beams or mount to standard electrical back box with available accessories.
4. Dimensions: 9" Diameter x 9 1/4" deep.
5. Bogen part number SPT15A
6. Accessories:
 - a. Horn to I-Beam flange mount. Bogen part number BC1.
 - b. Horn to electrical box mount. Bogen part number HSES10.
 - c. Conduit to horn attachment. Bogen part number TCSPT1.

2.05 CABLES

- A. Manufacturers: Provided by Belden.
- B. Description: Twisted pair and twisted multipair, untinned solid copper, covered with a thermoplastic jacket.
 1. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with NFPA 70.
 2. 14 AWG 2-conductor: Belden part number 5100UE or 6100UE for plenum.
 3. 16 AWG 2-conductor: Belden part number 5200UE or 6200UE for plenum.
 4. 18 AWG 2-conductor: Belden part number 5300UE or 6300UE for plenum.

PART 3 EXECUTION

3.01 INSTALLATION OF CABLES

- A. General:
 1. Bundle, lace, and train cables to termination points without exceeding manufacturer's limitations on bending radii.
 2. Do not install damaged cable. Do not splice cable between termination points. Remove and discard cable if damaged during installation and replace it with new cable.
 3. Install a service loop on each device as follows:
 - a. Speakers: 10 feet.
 - b. Amplifiers: 6 feet.
 - c. Volume Control: 6 feet.
 4. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
 5. Separation from EMI Sources:
 - a. Separation between open speaker/audio cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 - b. Separation between speaker/audio cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 - c. Separation between speaker/audio cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
 - d. Separation between speaker/audio cables and electrical motors and transformers, 5 kVA or HP and larger: A minimum of 48 inches.
 - e. Separation between speaker/audio cables and fluorescent fixtures: A minimum of 12 inches.
- B. Conductor Size: Unless noted otherwise conductor size shall be based on system manufacturer recommendations/requirements as related to:

1. Number of devices being supported.
 2. Total length of cable.
 3. Input/outputs being transmitted.
 4. Connection type.
- C. Cable pathway and support:
1. Speaker/Audio cable shall be supported using non-continuous j-hook style hangers when routed above accessible ceiling.
 2. When routed above no accessible ceiling EMT conduit shall be provided; minimum trade size $\frac{3}{4}$ inch.
 - a. No single bend shall be greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull boxes.
 - b. Conduits shall contain no continuous sections longer than 100 feet.
 - c. Pull boxes shall not be used in lieu of a conduit bend.
 3. Speaker/Audio cable shall not share supports, pathways, or sleeves with other cables.
 4. Sleeves:
 - a. Use EMT sleeves for speaker/audio cable pathway through rated and non-rated wall/floor partitions.
 - b. Use fire caulk and putty to obtain a fire rating that of which of the barrier being penetrated.
 - c. EMT Sleeves shall protrude a minimum 3 inches on both sides of wall being penetrated.
 - d. EMT shall be reamed free of burrs and equipped with a plastic bushing on each end to prevent cable damage.
 - e. EMT sleeves to be used for vertical cable pathways through floors. Sleeves to extend a minimum of 3" above finished floor.
 - f. Sleeves shall be located that they are in line with the cable pathway being served.
 - g. Sleeves shall be located a minimum of 8 inches above ceilings, lights and other ceiling mounted devices measured from the bottom of the sleeve.
- D. Identification of cables:
1. Speaker/Audio cables connecting amplifier to speaker distribution shall have a computer generated wrap around label to include zone identification.
 - a. Label shall be located within 6 inches of the termination point.
 2. Speaker/Audio cable connecting amplifier to input sources, such as music, telephone paging, chimes, etc.; shall have a computer generated wrap around label identifying the source. Label shall be located within 6 inches of the termination point.

3.02 INSTALLATION OF SPEAKERS

- A. Coordinate layout and installation of speaker and suspension system with other ceiling mounted equipment, including light fixtures, HVAC equipment, fire-suppression system, fire alarm devices, power conduits, plumbing piping and structural support members.
- B. Lay in ceiling style speakers:
1. Speakers shall be installed as recommended by manufacturer.
 2. Speaker shall include a minimum 12 AWG support wire attached to the structure using the appropriate attachment hardware.
 3. Speaker wire connection to speaker shall be made within speaker back box.
- C. Hard lid ceiling mounted speakers:
1. EMT conduit shall be used over inaccessible ceiling spaces to house speaker/audio cable.
 - a. $\frac{3}{4}$ " conduit shall be ran to above the location of the speaker with a 4" square electrical back box located within 18" of the speaker.
 - b. Conduit can be daisy-chained between speakers that are connected to the same zone.
 - c. Conduit shall originate from a location above an accessible ceiling space or location of amplifier/volume control.
 2. Speaker enclosure to be utilized above ceiling.
 - a. Speaker shall be attached to enclosure.

- b. Enclosure shall be attached to structural member via appropriate attachment hardware and a minimum of 12 AWG support wire.
- 3. Speaker wire connection to speaker shall be made within speaker enclosure.
- D. Horn-style speakers:
 - 1. Horns mounted on the interior shall be mounted to the wall or structural members using available accessories.
 - 2. Horns mounted to the exterior of the building shall be wall mounted.
 - 3. Exterior mounted horns shall include terminal cover and short run of liquid tight style conduit to house speaker cable. Conduit shall be ran to interior of building in a way to prevent water and other elements from making it into the interior of the building.
 - 4. Horns shall not be aimed directly at one another.
 - 5. If not specified otherwise horns shall be aimed at a 45° downward angle.
 - 6. Horns are allowed to be daisy-chained if on the same zone but shall not be daisy-chained with ceiling mounted speakers.
- E. Speaker-Line Matching Transformer Connections:
 - 1. Ceiling mounted speakers: Make initial connections using 2 watt tap settings.
 - 2. Horn style speakers: Make initial connections using 3.8 watt tap settings.

3.03 INSTALLATION OF AMPLIFIERS:

- A. Amplifier shall be mounted within close proximity of power outlet.
- B. If rack mounted, exact location within equipment rack shall be coordinated with facility IT&S director.
- C. All speaker wire connections to amplifier shall be made per manufacturer recommendations.
- D. Input and volume control shall be set based on discussions with facility IT&S director.
- E. All controls on amp shall be labeled to what it controls.
- F. Amp shall be labeled for the zone it supports.

3.04 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Schedule tests with at least seven days' advance notice of test performance.
 - 2. After installing public address system and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Operational Test: Perform tests that include originating program and page messages at TELEPHONES, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
- B. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
- C. Prepare a list of final tap settings of paging speaker-line matching transformers.
- D. Public address system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports. Reports shall be submitted as outlined in Part 1 of this section.

END OF SECTION 27 51 16

SECTION 27 52 23
NURSE CALL AND CODE BLUE SYSTEMS

PART 1 - GENERAL

1.01 REQUIREMENTS

- A. The Owner's Vendor shall provide all equipment, devices, power supplies and terminal cabinets necessary for the operation of the nurse call system.
- B. The Cabling Contractor shall provide and pull all cabling associated with the Nurse Call System. Nurse call cable termination hardware to be provided and installed by Owner's nurse call vendor.
- C. The Electrical Contractor shall provide all conduit, standard backboxes necessary in conjunction with this Owner furnished equipment for completely operational nurse call system in accordance with this specification.
- D. The systems shall conform to the current NFPA standards and shall be listed as a total system by Underwriter's Laboratories, Inc. Each major component shall bear the manufacturer's name, catalog number, and UL label.
- E. The communications vendor shall be responsible for providing a complete functional system including all necessary components, whether specifically included in this specification or not.
- F. Local service by factory-trained personnel from an authorized distributor of the equipment manufacturer, shall be available. The distributor shall have available a stock of the manufacturer's standard parts.
- G. The systems shall be guaranteed for a period of one year. Provide labor, replacement parts, and materials necessary to repair defects, unless damage or failure is caused by misuse, abuse or accident.
- H. Communications vendor shall provide two copies of maintenance and operating manuals for the Owner, upon completion of the project. These manuals shall include all operating instruction, routine test information, maintenance and trouble-shooting information, as installed wiring diagrams and parts lists for component ordering.
- I. Nurse Call Systems shall be provided as indicated on the drawings.
- J. Refer to the drawings for a nurse call device layout for each of the above listed areas.

1.02 RELATED WORK

- A. Section 27 05 00: Common Work Results for Telecommunications.
- B. Section 27 15 00: Telecommunications Horizontal Cabling.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. The system shall be a Hillrom Versacare.
- B. The system shall be a Microprocessor based system and shall provide the following features and functions as a minimum:
 - 1. Two-way signaling and communications between Control Station(s) and patient rooms or staff locations.
 - 2. Simultaneous digital display of up to four (4) incoming calls at the Control Station.
 - 3. Incoming calls displayed by room number, bed designation and priority.
 - 4. Automatic selection of calls by priority and/or time of call.
 - 5. Provisions for up to fourteen (14) call priority levels with automatic sequencing.
 - 6. Patient priority status programmable at Control Station.
 - 7. Patient privacy programmable at Control Station.
 - 8. Ability to program priority status individually on dual bed stations.
 - 9. Provisions for registering and locating staff members by sequential display.

10. Provisions for single button communications with registered staff nearest calling station. If a Network Controller is being used, during night mode, this search is only conducted in the system which the call was initiated from.
11. Solid-state waterproof membrane touchpad on Control Station.
12. User programmable, permitting simple on-site changing of room numbers in non-volatile memory.
13. Twelve or twenty-four hour clock displaying time in hours, minutes and seconds.
14. Staff follow mode permitting incoming call tones to be automatically routed to a room or rooms where staff members are registered.
15. Ability to monitor one or several rooms simultaneously.
16. Ability to set "Nurse (GREEN LEVEL)", "Nurse (AMBER LEVEL)", or "Stat" service required.
17. Ability to display all patients in "Priority" status.
18. Ability to display all patient stations in "Privacy" mode.
19. "Privacy" indicator on Control Station.
20. Ability to respond to calls out of sequence using numeric touchpad, without losing calls in progress or calls waiting.
21. Provisions for making paging announcements to one, several, or all areas. If a Network Controller is being used, during night mode, it is possible to page from one (1) to four (4), or all systems involved in the capture.
22. Visual display of zone(s) being paged.
23. Automatic page with reply to only those locations where staff have registered.
24. Automatic display of service requirements not answered within an allotted time frame (over-time display).
25. Individually programmable software timers for each of three (3) service required priorities.
26. Choice of communications via Control Station handset or "Push-to-Talk" loud-speaking communications via built-in speaker/microphone.
27. Ability to communicate with registered staff members without losing call in progress.
28. Ability to replace current call on hold while answering a higher priority call.
29. Preannounce tone to alert patient of call from Control Station.
30. Provisions for operating Control Station(s) in parallel or in day/night transfer mode.
31. Universal call cord receptacle(s) on patient stations allowing the use of a wide range of cord sets and entertainment speakers.
32. Provisions for automatic cancellation of patient call when staff member registers into patient room.
33. Full operation (including intercom and page) during power failure utilizing standard built-in battery back-up power supply for up to seven (7) minutes.
34. Color-coded plug-in terminations on all control stations, patient, staff and duty stations.
35. All solid-state plug-in modular construction.
36. Single touchpoint operation of all system functions.
37. Provisions for including optional features/functions by simply installing the appropriate system components. Software changes or special software shall not be required.

2.02 SYSTEM OPERATION

- A. The system shall operate in the following manner: Patient Station - "Normal" Call - Normal calls shall be originated at the patient station by momentarily depressing the "Call" button on the patient's entertainment speaker or call cord. This action shall cause the following to occur:
 1. The "Call Placed" indicator on the patient station shall illuminate.
 2. The corridor dome light shall illuminate steady white.
 3. An alert tone shall sound and the "Normal" indicator shall illuminate at all duty stations.
 4. An alert tone shall sound and the patient's room number, bed designation and "n" call priority shall be displayed on the Control Station(s) incoming call screen.
- B. Patient Station - "Priority" Call - When programmed in the priority status mode, a patient priority call shall be originated at the patient station by momentarily depressing the "Call" button on the patient entertainment speaker or call cord. This action shall cause the following to occur:
 1. The "Call Placed" indicator on the patient station shall illuminate.

2. The corridor dome light shall flash white.
 3. An "Emergency" alert tone shall sound and the "Emergency" indicator shall illuminate at all duty stations.
 4. A "Priority" alert tone shall sound and the patient's room number, bed designation and "P" call priority shall be displayed on the Control Station(s) incoming call screen, automatically moving ahead of all priority calls.
- C. "Priority" calls shall be answered in the same manner as "Normal" calls. When appropriate action has been initiated, the Priority call shall be automatically transferred to the "Nurse Service" mode by pressing the "Cancel" touchpoint, thus maintaining the integrity of the call while permitting the Control Station operator to handle other incoming calls.
- D. Patient station - "staff emergency call"
1. When a staff member has registered into a patient room using a staff registered station, calls placed from that station shall automatically be classified as staff emergency and shall cause the following to occur:
 - a. The "Call Placed" indicator on the Patient Station shall illuminate.
 - b. The Corridor Dome Light shall flash white.
 - c. An "Emergency" tone shall sound and the "Emergency" indicator shall illuminate on all Duty Stations.
 - d. An "Emergency" alert tone shall sound and the patient's room number, bed designation and "E" call priority will be displayed on the Control Station(s) incoming call screen, automatically moving ahead of all lower priority calls.
 2. "Staff Emergency" calls shall be answered in the same manner as patient "Priority" calls.
- E. Patient "Priority" and "Staff Emergency" calls must be canceled at the Patient Station.
- F. Patient Station - Miscellaneous Functions
1. Removal of the patient's call cord accidental or intentionally shall automatically place a "Staff Emergency" call.
 2. All other Patient Station calls may be canceled in the patient's room by depressing the "Cancel" button on the Patient Station or by a staff member registering in by means of a staff registration station.
- G. Call From Staff Stations
1. "Staff" calls shall be originated by the staff station by momentarily depressing the "Call" button. This action shall activate the same sequence that occurs when originating a "Normal" patient call, except that the Control Station shall display the room number and "S" call priority.
 2. "Staff" calls may be canceled at the Control Station by answering that call or at the staff location by depressing the "Cancel" button.
 3. Staff stations located in operating rooms may be connected to a separate explosion-proof switch for call placement.
- H. Calls From Duty Stations
1. "Staff" calls from duty stations shall be originated in the same manner as the staff stations, with the same sequence of events occurring. Duty station calls shall display the room number and "d" call priority on the Control Station.
 2. In addition to the staff communication functions, the duty station shall provide audible and visual signals to annunciate any call placed in the system by priority level.
 3. The duty station shall also have the ability to control one or more "Zone" lights for its area.
- I. Calls From Bath, Shower, Or Emergency Stations
1. Activating the switch on a Bath, Shower, or Emergency station shall cause the following to occur:
 - a. The "Call Placed" indicator on the Bath/Emergency station shall light to assure the patient that his call has been properly placed.
 - b. The corridor dome light shall flash red.
 - c. An alert tone shall sound and the "Bath" or "Emergency" indicator shall illuminate at all duty stations.

- d. A Bath or Emergency tone shall sound and the room number and "b" or "e" call priority shall be displayed on the Control Station(s) taking precedence over all unanswered except at the Bath, Shower, or Emergency stations itself.
- J. Calls From Staff/Emergency Stations
 - 1. Activating the switch on a Staff/Emergency station shall cause the following to occur:
 - a. The "Call Placed" indicator on the Staff/Emergency station shall light to indicate that the call has been properly placed.
 - b. The corridor dome light shall flash white.
 - c. An alert tone shall sound the "Emergency" indicator shall illuminate at all duty stations.
 - d. A Staff/Emergency tone shall sound and the room number and "E" call priority shall be displayed on the Control Stations(s) taking precedence over all unanswered calls of lower priority.
 - 2. It shall be possible to cancel "Staff/Emergency" calls by resetting the switch at the calling station. It shall not be possible to cancel "Staff/Emergency" calls by any other means.
- K. Call Storage - Any calls placed on the system in excess of display space available shall automatically stored in the memory of the microprocessor-based area control unit. As calls are completed, waiting calls will automatically register on the Control Station display screen in order of priority and or time placed.
- L. Answering Calls At The Control Station
 - 1. To answer a call at the Control Station, the operator shall simply lift the handset and converse in a conventional telephone manner or, if preferred, operate the "Push-to-Talk" touchpoint and converse over the built-in speaker. An indicator shall illuminate on the "Push-to-Talk" touchpoint when in use. The "Push-to-Talk" touchpoint shall not be required when conversing over the handset.
 - 2. This action shall cause all audio and visual signals for the call station to cease for the normal call level, while continuing to display the room number, bed designation and call priority in the "Current Call" screen. Hanging up the handset or pressing the "Cancel" touchpoint shall complete the call.
 - 3. All the call is answered, a preannounce tone shall sound at the patient station and a "Monitor" indicator shall light. The patient shall then be able to converse in a normal voice without the necessity of operating any switches or turning toward the speaker/microphone.
 - 4. Calls from staff or duty stations shall be handled in the same manner as described above.
 - 5. It shall be possible to answer a call using the "Push-to-Talk" method and then, if required, transfer to the handset mode by simply lifting the handset.
 - 6. It shall be possible, should the need arise, the manually control speech direction while conversing over the handset, by operating the "Push-to-Talk" touchpoint.
 - 7. Patient "Priority", "Bath/Emergency", and "Staff Emergency" calls shall automatically be placed in the "Nurse (GREEN LEVEL) Service Required" mode when answered at the Control Station.
 - 8. Calls from "Bath/Emergency" or "Staff Emergency" stations cannot be canceled at the Control Station and shall require dispatching the proper personnel to the calling station.
 - 9. Stand-Alone bath stations shall automatically be placed in the "Nurse (AMBER LEVEL) Service Required" mode when answered at the Control Station.
- M. Originating Calls From the Control Station
 - 1. The Control Station operator shall be able to place outgoing calls by simply dialing the desired room number and bed designation by means of the touchpad dial on the membrane control panel.
 - 2. It shall be possible to dial the desired room number with the handset on or off the hookswitch.
 - 3. As the call is dialed, the called station's number shall appear on the Utility Display of the Control Station. The called number shall move to the "Current Call" Screen, a preannounce tone shall sound, and the "Monitor" lamp shall illuminate at the patient station when communication is established.

4. When the call is placed with the handset on the hook, voice communications shall be established by lifting the Control Station handset and conversing in a conventional telephone manner, or by pressing the "Push-to-Talk" touchpoint and conversing over the master speaker/microphone.
 5. When the call is placed with the handset off-hook, communications will be established when the last digit is dialed.
 6. The "Privacy" indicator shall illuminate below the Utility Display if the operator dials a room has been placed in the "privacy" mode. It shall be possible to talk to the patient in this mode but it shall not be possible to hear the patient until the "Privacy" mode has been reset.
 7. It shall be possible to interrupt "Privacy" for the duration of the call by instructing the patient to press his "Call" button. "Privacy" shall be automatically re-established when the call is completed.
 8. The "Privacy" mode shall not operate when the patient initiates the call to the Control Station, making normal two-way conversations possible without the need to reset the "privacy" mode for each call.
 9. Any system which does not provide an absolute "Privacy" mode or which does not indicate "privacy" on the Control Station when the called station is in this mode will not be acceptable.
- N. Placing A Call On Hold
1. It shall be possible for the Control Station operator to place the current call on "Hold" call shall move to the end of the Calls Waiting stack and shall automatically return to the Current Call Screen when all other calls have been cleared, or it may be manually recalled at any time by simply touching the Recall touchpad.
 2. Any system forces the operator to hurriedly finish or cancel a call in progress in order to answer a higher-priority call will not be acceptable.
- O. Placing A Nurse (Green Level), Nurse (Amber Level) Or Stat Service Requirement
1. If the control station operator determines that service is required, the appropriate level of staff may be dispatched by pressing the "Nurse (GREEN LEVEL) Service", "Nurse (AMBER LEVEL) Service", or "Stat Service" buttons. This action shall cause the following to occur:
 - a. The green (Nurse Service), amber (Nurse Service), or both (Stat Service) corridor lamp(s) shall flash.
 - b. The overtime reminder circuit, if utilized, shall be activated.
 - c. The "Calling/Responding" indicator on the patient station shall illuminate. On dual patient stations, only the indicator for the patient requiring service shall illuminate.
 2. Upon responding to the service requirement, the nurse shall cancel the service requirement by pressing the "Cancel" button on the patient station, or, if staff register stations are utilized, by registering into the patient's room.
 3. Upon cancellation of the service requirement, all associated signaling shall cease and the overtime function, if utilized, shall be reset.
 4. It shall be possible, by software adjustment at the time of installation, to individually program the overtime period for each service priority from two to nine minutes or off.
 5. In the event that a service requirement is not answered within the allotted time, the patient's room number shall reappear in the incoming calls screen followed by an "O" Priority to indicate "overtime".
 - a. Stat required.
 - b. Nurse (GREEN LEVEL) required.
 - c. Nurse (AMBER LEVEL) required.
- P. Monitoring A Patient's Room(s)
1. To monitor a room, the Control Station operator shall dial the room and press the "Monitor" touchpoint. The operator may monitor one or several rooms at random without the need to monitor an entire zone.
 2. When a patient is selected for monitoring, a preannounce tone shall sound and the "Monitor" indicator on the patient station(s) shall illuminate to ensure the patient's privacy.
 3. It will not be possible to monitor a patient station in the "privacy" mode.

4. Any system that requires the operator to monitor an entire zone in order to monitor more than one station will not be acceptable.
- Q. Making Voice Announcements
1. It shall be possible for the Control Station operator to selectively make voice announcements to individual rooms, multiple room zones, multiple zones, the entire nursing unit or when using staff registration, only to those locations where staff members are located.
 2. When paging by zone, it shall be possible to monitor the zone using the handset or "Push-to-Talk" speaker. (page with reply)
 3. It shall not be necessary to operate the "Push-to-Talk" touchpoint when paging/monitoring over the handset.
- R. Placing Patient Station In "Priority" Status Mode
1. It shall be possible to place a patient station in the "Priority" status mode at the Control Station by dialing the room number and bed number and pressing the "Change Priority" touchpoint. The number dialed and priority status shall be verified on the "Utility" Screen.
 2. If the patient station is already in the "Priority" status mode, the same procedure shall be used to remove the station from the "Priority" mode.
- S. Placing Patient Station In Privacy Mode
1. It shall be possible to place a patient station or stations in the absolute "Privacy" mode using the same procedure described for changing "Priority" and pressing the "Change Privacy" button.
 2. System that require the nurse to go to the patient's room to set or cancel the "Privacy" mode will not be acceptable.
- T. Displaying Stations In "Priority" Or "Privacy" Modes
1. It shall be possible to contact the nurse registered nearest the calling patient while in communications by simply pressing the "Nurse (GREEN LEVEL)" or "Nurse (AMBER LEVEL)" touchpoint on the Control Station. This single action shall automatically register the location of the nearest nurse in the "Utility" screen and shall place the operator in voice contact with the selected staff member.
 2. Pressing the "Display Priority" touchpoint will sequentially display all stations in the "Priority" mode.
 3. It shall be possible to change "Priority" or "privacy" status during the sequential display sequence by simply pressing the "Change Priority" or "Change Privacy" touchpoint when the appropriate room number is displayed in the "Utility" Screen.
 4. Displaying stations in "Priority" or "privacy" modes shall not interfere with calls displayed on the "Calls Waiting" or "Current Call".
- U. Contacting Registered Staff
1. It shall be possible to contact the nurse registered nearest the calling patient while in communications by simply pressing the "Nurse (GREEN LEVEL)" or "Nurse (AMBER LEVEL)" touchpoint again shall automatically connect the operator to the next nearest staff member.
 2. The current time shall reappear in the "Utility" screen when no more staff members are registered.
 3. When the proper staff member has been dispatched, pressing the "Recall" touchpoint shall automatically reconnect the Control Station to the calling patient permitting the operator to assure the patient that help is on the way.
- V. Locating Nurses
1. It shall be possible to locate registered staff members at any time by simply touching the "Nurse (GREEN LEVEL)" or "Nurse (AMBER LEVEL)" touchpoint.
 2. This action shall cause registered staff members to be sequentially displayed in the "Utility" screen.

- W. Reviewing Nurse (Green Level), Nurse (Amber Level), Or "Stat" Service Requirements
 - 1. It shall be possible to review unattended service requirements at any time by pressing the "Nurse (GREEN LEVEL)", Nurse (AMBER LEVEL)", or "Stat" touchpoints.
 - 2. This action shall cause all locations awaiting service to be sequentially displayed in the "Utility" screen.
- X. Communications With Station Displayed In "Utility" Screen
 - 1. It shall be possible to communicate with any station displayed in the "Utility" screen during "Display Priority", "Staff Follow", "Nurse (GREEN LEVEL) Service", "Nurse (AMBER LEVEL) Service", "Stat Service", "Nurse (GREEN LEVEL)", or "Nurse (AMBER LEVEL)" scan (review) sequence, by simply lifting the handset or pressing the "Push-to-Talk" touchpoint.
 - 2. This single action shall cause the room number to transfer to the Current Call screen, the preannounce tone to sound at the Control Station and at the called station, and will open the voice channel for communication.
- Y. Placing The System In The Staff Follow Mode
 - 1. In the event the Control Station is to be left unattended, it shall be possible to reroute incoming call tones to rooms where Staff are located by utilizing the "Staff Follow" mode.
 - 2. "Staff Follow" shall function in either of two ways:
 - a. Automatic Staff Follow: When staff register stations are utilized, the "Staff Follow" mode shall be initiated by simply pressing the "Staff Follow" touchpoint. This single action shall cause the following to occur:
 - 1) The LED indicator on the "Staff Follow" touchpoint shall light.
 - 2) Incoming calls shall continue to annunciate in the normal manner at the Control Station.
 - 3) Incoming call tones shall annunciate by priority over the patient station(s) and/or staff station(s) in all locations where staff members have registered in.
 - b. It shall be possible for the nurse to silence the incoming call tones by simply pressing the "Cancel" button on the station.
 - c. Manual Staff Follow
 - 1) It shall be possible to manually program one or more patient staff station(s) into the "Staff Follow" mode by dialing the appropriate room number(s) and then pressing the "Staff Follow" touchpoint.
 - 2) The same sequence of events, as described in the preceding paragraph A shall occur.

2.03 EQUIPMENT

- A. To provide the preceding features and functions, the following equipment shall be provided.
 - 1. Control Station
 - a. The Control Station shall be housed in a finished steel cabinet with a moisture-proof membrane control panel.
 - b. The Control graphics shall be organized in a logical left to right sequence permitting operators with little or no training to operate the basic Control Station functions without being confused by controls and indicators with which they are unfamiliar. All operations shall be initiated by a single touchpoint operation. Systems requiring shift keys or the operation of two buttons simultaneously will not be acceptable.
 - c. In addition to the moisture-proof control panel, the Control Station shall incorporate the following features:
 - 1) A lightweight high impact telephone handset with retractable cord for privacy. Systems requiring Push-to-Talk operation when using handset will not be acceptable.
 - 2) A built-in combination tone reproducer, monitor, and intercom speaker.
 - 3) All solid state modular construction.
 - d. The Control Station shall provide two way voice communications and signaling between nursing unit locations and patient rooms or auxiliary staff locations as indicated on the plans.

- e. Calls for patients and staff shall be individually annunciated at the Control Station on digital displays by room number, bed designation and call priority. The system shall automatically display and select calling stations by priority and/or time of call placed. Subsequent higher priority calls shall automatically move ahead of lower priority calls. In the case of multiple calls, all calls shall be held in memory and automatically transferred by priority to the "Calls Waiting" display as space becomes available.
- f. The Control Station shall have the capability of indicating the following levels of priority:
 - 1) Staff emergency
 - 2) Priority patient call
 - 3) Bath/emergency
 - 4) Alarm
 - 5) Normal patient call
 - 6) Duty station call
 - 7) Staff station call
 - 8) Stat service overtime
 - 9) Nurse service overtime
 - 10) Aide service overtime
 - 11) Hold call
- g. Patient "priority" status shall be programmed at the Control Station without the use of keys or other special tools, and in such a manner that the patient station does not indicate the status electrically or mechanically. In semi-private rooms equipped with dual patient stations, it shall be possible to program each patient's status on an individual basis.
- h. It shall be possible for the control station to set the level of "service required or to cancel "normal" patient calls. "Priority" calls shall be automatically set to the "Nurse (GREEN LEVEL) Service" required mode when the "cancel" touchpoint is pressed, thus maintaining the integrity of the call while permitting the operator to answer other calls.
- i. Patient station "privacy" shall be programmed at the control station. When calling a station in the "privacy" mode, a "Privacy" indicator shall light on the Control Station.
- j. It shall be possible to monitor one (1) or more rooms simultaneously in any combination.
- k. It shall be possible to operate as many as three (3) Control Stations in parallel in the same system.
- l. It shall be possible to transfer control between Control Stations in different systems on a Day/Night transfer basis. Transfer shall be accomplished by "taking" control at the operating Control Station rather than by "giving" control at the transferring Control Station thus making it impossible to transfer control to an unattended Control Station.

2.04 AREA CONTROL UNIT

- A. The Area Control Unit shall be located as indicated in the plans.
- B. The Area Control Unit shall be modular in construction and shall provide quick disconnect circuitry for switching, storing, programming, reviewing, amplifying, signaling and interconnecting system components.
- C. The Area Control Unit shall have built in diagnostics to assist in locating and servicing component failure.
- D. In the event of power failure, the Control Station Utility screen shall display P-Fail, indicating power failure. The built-in battery supply shall provide full operation including intercom and paging during the time (up to seven minutes) required for the hospital to switch to auxiliary power.
- E. It shall be possible to reprogram room numbers in non-volatile memory whenever the need arises. It shall not be necessary to change components or order new programming from the factory to accomplish these changes.
- F. All programmable information entered from the Control Station, i.e., room number, bed number, priority, paging unit, station designation, staff search location, pocket pager assignment, etc., shall be programmed in non-volatile memory.

- G. Systems requiring external equipment for programming functions or back-up battery to retain memory will not be acceptable.

2.05 BEDSIDE PATIENT STATIONS

- A. Patient stations shall provide the following facilities:
 - 1. "Calling/Responding" and "Monitor" indicators.
 - 2. Momentary action "Cancel" button.
 - 3. Universal Call Cord Receptacle(s) designed to accept standard cord sets or entertainment speakers.
 - 4. A safety switch which automatically places a "staff emergency" call when a cord set or entertainment speaker is removed.
- B. Control circuits and indicators shall be all solid state for reliable operation; no mechanical devices requiring periodic maintenance shall be employed.
- C. Hook up shall be made by push-on connectors; solder screw or "wire/nut" connection shall not be required. The push on connectors shall contain individual wires (ribbon cables shall not be permitted) for increased reliability and flexibility.
- D. "Priority status" shall be programmed at the Control Station eliminating the change of accidental change by the patient or a visitor.
- E. "Absolute Privacy" shall be programmed at the Control Station, eliminating the need for the patient to leave the bed or require staff assistance, and the possibility of accidental or intentional change by visitors.
- F. Patient stations shall be manufactured of high-impact molded plastic in accordance with UL 1069 requirements.

2.06 BATH STATIONS

- A. The Bath Station shall be pull cord type.
- B. A water-resistance gasket shall be provided with all stations mounted in shown areas. Extension cord shall be provided, where necessary, to ensure the pull cord is within easy reach of the patient.
- C. A call placed indicator shall be located on the face plate to assure the patient that the call has been placed. The Bath station shall be equipped with a cancel capability and a pull cord with adequate tension strength to resist breakage.
- D. The Bath station shall mount in a single-gang electrical box; a face plate for flush mounting shall be provided.

2.07 STAFF/EMERGENCY STATIONS

- A. The Staff/Emergency stations shall be push-button type or approved equal.
- B. The push-button staff/emergency station shall have a Call Placed indicator, located on the face plate, to assure the patient that the call has been placed. The call shall be canceled by pressing the activating button. face plate shall be provided for flush mounting.
- C. The push-button staff/emergency station shall have separate membrane touchpads for both the Call Place and Cancel functions. Hookup shall be made by push-on connectors; solder screw or "wire/nut" connection shall not be acceptable. A Call Placed indicator, located on the face plate, shall be provided to assure the patient that the call has been placed. It shall be possible to connect a remote reset switch.
- D. The Staff/Emergency stations shall mount in a standard one (1) gang electrical boxes.

2.08 SHOWER STATION

- A. The shower station shall be pull cord type.
- B. The shower station shall pass the UL1069 water resistance test. The cancel function shall be accomplished with a membrane cancel touchpad. A color coordinated water-resistant gasket and a nylon cord shall be provided with the station. A Call Placed indicator, located on the face

plate, shall be provided to assure the patient that the call has been placed. Hook up shall be made by push on connectors; solder screw or "wire/nut" connection shall not be acceptable. It shall be possible to connect a remote reset switch.

- C. The shower station shall mount in a standard one (1) gang electrical box.

2.09 CORRIDOR DOME LIGHTS

- A. The Corridor Dome Lights shall consist of:
 - 1. A wedge shaped, temperature resistant, translucent lens of even glow polystyrene.
 - 2. A single gang submount plate complete with five lights colored white, red, green, amber and blue.
- B. The lens shall be snap fitted to the back plate assembly to facilitate changing lamps without the use of tools.
- C. The wires shall be color coded to match the lamp color to reduce installation time.

2.10 STAFF STATIONS

- A. Staff stations shall provide the following:
 - 1. "Call placed" and "monitor" indicators.
 - 2. One momentary action "call" button.
 - 3. One momentary action "cancel" button.
 - 4. One speaker/microphone.

2.11 DUTY STATIONS

- A. Duty stations shall provide the following:
 - 1. One combination "normal call/staff call" and "call placed" indicator.
 - 2. One "bath call" indicator.
 - 3. One "emergency call/priority call" indicator.
 - 4. One momentary action "call" button.
 - 5. One momentary action "cancel" button.
 - 6. One combination "intercom/tone reproducer" speaker.
 - 7. One tone volume control settable at installation.
- B. Duty stations shall be same size and of the same construction as the bedside patient stations.
- C. The Duty Station shall annunciate all calls within its zone. The priority level of the call shall be indicated both audibly and visually on the station.
- D. The Duty Station shall be capable of controlling zone lights to indicate:
 - 1. White steady for "normal" calls and "staff" call within the specified zone.
 - 2. White flashing for "emergency" calls and "priority" calls within the specified zone.
 - 3. Red flashing for "bath" calls within the specified zone.
- E. Duty Stations that do not indicate the priority level of the call will not be acceptable.

2.12 ZONE LAMP CONTROLLER

- A. The Zone Lamp Controller shall be capable of annunciating all calls or all staff registration/service requirements in this zone.
- B. The Zone Lamp Controller shall control up to four (4) parallel zone lamps. The Zone Lamp Controller shall be capable of controlling the zone lights to indicate the various call priorities indicated in section 2.03.
- C. It shall be possible to interface the Zone Lamp Controller with a remote speaker for tone annunciation. A volume control shall be provided for tone level adjustment.
- D. The Zone Lamp Controller shall be manufactured in accordance with UL1069 requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Vendor shall furnish and install all system equipment, devices, and shall perform all final system testing.

- B. The electrical contractor is to pull cable per vendor wiring schematics.
- C. Vendor shall coordinate all work and schedule the work with the General Contractor.
- D. Electrical contractor to furnish and install back boxes and conduit stub-outs for Nurse Call devices.
- E. Where open cable is run above dropped ceilings and penetrates a smoke or fire rated wall, furnish and install a minimum 1" empty sleeve, bushings on both ends. Conduit shall be sealed with fire resistant thermofibre provided and installed under other Divisions. The requirement for a sleeve applies only where the bundle of cables or single cable is greater than 1" in diameter. When the cable is smaller than 1", it may penetrate the partition without a sleeve provided the penetration hole is sealed up.

3.02 TRAINING OF PERSONNEL

- A. Nursing staff of the hospital as well as maintenance staff shall be thoroughly instructed in the use of the system by authorized distributor personnel. Such service shall be provided in conjunction with the nurse's call equipment.
- B. The vendor shall provide the hospital one in service color video of professional quality which shall provide audio and visual instructions for the proper use of the Nurse Call system by staff members after the training period.
- C. The vendor shall provide instruction to the staff by means of an actual instructional system which shall be set up in the conference room or auditorium and allow hands on experience by the staff without disrupting the staff on duty. The instruction system shall consist of a Control Station, single and dual patient stations, staff, duty and emergency stations, and assorted call-in cord sets. The instructor shall demonstrate each function on the system with all lamps, screens and tones in operation. Maintenance instruction shall be performed in the same manner as described above.

END OF SECTION 27 52 23

SECTION 28 23 00
CLOSED CIRCUIT TV (CCTV)

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes providing or installing, as indicated, the following items as part of the CCTV Systems.
 - 1. CCTV system cable.
 - 2. Refer to T2 series drawings for device locations.
- B. Products not supplied under this Section: The CCTV System will be selected and provided by the Owner.
- C. Related Sections:
 - 1. Division 26
 - 2. Sections 271500

1.02 SUBMITTALS

- A. Submittals shall be as specified in Division 27 1500.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. The CCTV System vendor, under contract with the Owner, will furnish system equipment, power unit cabinets, for a completed installation.

2.02 MATERIALS

- A. Provide system cabling for devices as shown on T2 series drawings.
 - 1. Data Cable shall be black CAT 6, Belden Part Number 2412010A1000/2413010A1000.
 - 2. Data jack shall be black CAT 6. Belden Part Number RY6MJKUBK-S1.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All system cable to be installed as shown on T2 series drawings for cable/device locations.
- B. The CCTV System is to be provided, installed and checked by the Owner's selected vendor.
- C. Owner's selected vendor will connect all equipment and leave the systems in a satisfactory operating condition.

END OF SECTION 28 23 00

SECTION 28 31 00
FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 SCOPE AND RELATED DOCUMENTS

- A. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performance of all operations associated with the installation of the fire alarm system as shown on the drawings and as herein specified.
- B. The requirements of the conditions of the Contract, Supplementary Conditions, and General Requirements apply to the work specified in this section.
- C. The complete installation shall conform to the applicable sections of NFPA-72 International Fire Code, NFPA 70, NFPA 101, NFPA 90A, ADA accessibility guidelines and local code requirements.
- D. The work covered by this section of the specifications shall be coordinated with the related work as specified elsewhere under the project specifications.
- E. Any vendor suggested modifications of the plans shall be submitted to the design team for review prior to bid.

1.02 QUALITY ASSURANCE

- A. Each and all items of the fire alarm system shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the UL label.
- B. All control equipment must have transient protection to comply with UL864 requirements.
- C. Where fire alarm circuits leave the building, additional transient protection must be provided for each circuit. Devices must be UL listed under Standard 497B, Isolated Loop Circuit Protectors.

1.03 GENERAL

- A. Furnish and install a complete fire alarm system as described herein and as shown on the plans, to be wired, connected, and left in first class operating condition. Include sufficient control unit(s), annunciator(s), initiating devices, notification appliances, controls, supervisory devices, wiring, terminations, electrical boxes, and all other necessary material for a complete addressable operating system. All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name on each component.
- B. Fire alarm system shall be by Johnson Controls, Siemens or Edwards, per HCA's purchasing agreement. Contacts are as follows:
 - 1. Kevin Tolbert
Johnson Controls
BE-HCA@jci.com
478-952-8740
HPG Contract No. 3273
 - 2. Ed Tambornino
Siemens
ed.tambornino@siemens.com
615-329-2601
HPG Contract No. 3574
- C. The fire alarm system shall allow for loading and editing special instructions and operating sequences as required. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory. Panels shall be capable of full system operation during software downloads.
- D. Resident software shall allow for full configuration of initiating circuits so that additional hardware shall not be necessary to accommodate changes in, for instance, sensing of normally

open contact devices to sensing of normally closed contact devices, or from sensing of normally open contact devices to sensing a combination of current limited and non-current limited devices on the same circuit and being able to differentiate between the two, or changing from a non-verification circuit to a verification circuit or vice-versa.

- E. The system shall have the capability of recalling alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.
- F. Panels shall automatically store all program changes to the panels non-volatile memory each time a new program is downloaded. A compare utility program shall be available to compare any two saved programs.
- G. The system shall be capable of recording all alarm, supervisory and trouble events by means of a system printer.
- H. The Fire Alarm Control Unit (FACU) shall provide the necessary hardware to provide supplemental notification, remote service and remote user access to the FACU. A standard RJ-45 Ethernet connection shall connect to Owner's Ethernet network.
- I. [Contractor shall provide sensitivity test reports for all new and re-worked smoke and duct detectors installed in the project areas at the final AHCA survey.]
- J. [Contractor shall provide an approved "Record of Completion" for the modification work performed on the fire alarm system at the final AHCA survey.]

1.04 OPERATION

- A. The system alarm operation subsequent to the alarm activation of any manual station, automatic detection device, or sprinkler flow switch shall be as follows:
 - 1. Identification of alarm condition at FACU and annunciator(s).
 - 2. Identification of the device/zone that is source of the alarm at the FACU and the annunciator(s).
 - 3. Operation of audible notification applications until silenced at the FACU or annunciator.
 - 4. Operation of visible notification appliances until system is reset.
 - 5. Closing of doors normally held open by door control devices.
 - 6. Unlocking of electric door locks in designated egress paths.
 - 7. Releasing of fire shutters.
 - 8. Initiation of air handling and fan controls per NFPA 90. Refer to mechanical controls drawings for additional information.
 - 9. Initiation of smoke control systems. Refer to mechanical drawings and specifications for additional information.
 - 10. Transmission of signal to remote alarm receiving station.
 - 11. Initiate elevator recall to primary or alternate floors.
- B. Activation of duct smoke detectors shall activate supervisory signals and shall initiate the shutdown or closing of associated fans and dampers.
- C. Upon reset of the fire alarm control panel, air handling units shall sequentially start up to minimize power demand.
- D. The alarm activation of any elevator lobby smoke detector shall, in addition to the operations listed above, cause the elevator cabs to be recalled according to the following sequence:
 - 1. If the alarmed detector is on any floor other than the main level of egress, the elevator cabs shall be recalled to the main level of egress.
 - 2. If the alarmed detector is on the main egress level, the elevator cabs shall be recalled to the predetermined alternate recall level as determined by the local authority having jurisdiction.
- E. The control panel shall have a dedicated supervisory service LED and a dedicated supervisory service acknowledge switch.
 - 1. The activation of any standpipe or sprinkler valve supervisory (tamper) switch shall activate the system supervisory service audible signal and illuminate the LED at the

- control panel and the remote annunciator. Differentiation between valve tamper activation and opens and/or grounds on the initiation circuit wiring shall be provided.
2. Pressing the supervisory service acknowledge key will silence the supervisory audible signal while maintaining the supervisory service LED "ON" indicating the off-normal condition.
 3. Restoring the valve to the normal position shall cause the supervisory service LED to extinguish, indicating restoration to normal.
- F. The method of communication between the protected premises and supervising station shall comply with communication requirements of NFPA 72. Contractor shall verify with Owner the desired communication technology prior to issuance of shop drawings. Provide all components required for fully operational communications system.

1.05 SUPERVISION

- A. The system shall contain Class "B" independently supervised signaling line device circuits. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.
- B. There shall be supervisory service initiation device circuits for connection of all sprinkler valve supervisory (tamper). Device activation shall cause a supervisory alarm at the control panel.
- C. There shall be independently supervised and independently fused notification appliance circuits. Disarrangement conditions of any circuit shall not affect the operation of other circuits.
- D. Auxiliary manual controls shall be supervised so that an "off normal" position of any switch shall cause an "off normal" system trouble.
- E. Each independently supervised circuit shall include a discrete LCD readout to indicate disarrangement conditions per circuit.
- F. The incoming power to the system shall be supervised so that any power failure must be audibly and visually indicated at the control panel and the remote annunciator. A green "power on" LED shall be displayed continuously while incoming power is present.
- G. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the control panel and the remote annunciator.
- H. The system modules shall be electrically supervised for module placement. Should a module become disconnected, the system trouble indicator shall illuminate and the audible trouble signal shall sound.
- I. The system shall have provisions for disabling and enabling all circuits individually for maintenance or testing purposes.

1.06 POWER REQUIREMENTS

- A. The control panel shall receive 120 VAC power (as noted on the plans) via a dedicated circuit.
- B. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of four (4) hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic.
- C. All external circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control panel.

PART 2 PRODUCTS

2.01 FIRE ALARM CONTROL UNIT

- A. Control unit construction shall be UL 864 listed modular with solid-state, microprocessor-based electronics. It shall display only those primary controls and displays essential to operation during a fire alarm condition. Keyboards or keypads shall not be required to operate the system during fire alarm conditions.
 1. A local audible device shall sound during alarm, trouble, or supervisory conditions. This audible device shall sound differently during each condition to distinguish one condition

from another without having to view the panel. This audible device shall also sound during each keypress to provide an audible feedback to ensure that the key has been pressed properly.

- B. The following primary controls shall be visible through a front access panel:
 - 1. Eighty character liquid crystal display.
 - 2. Individual red system alarm LED.
 - 3. Individual yellow supervisory service LED.
 - 4. Individual yellow trouble LED.
 - 5. Green "power on" LED.
 - 6. Alarm Acknowledge key.
 - 7. Supervisory Acknowledge key.
 - 8. Trouble Acknowledge key.
 - 9. Alarm Silence key.
 - 10. System Reset key.
- C. The following secondary control switches and LEDs shall be available behind an access door:
 - 1. City disconnect/switch.
 - 2. Manual evacuation (drill).
 - 3. Elevator bypass.
 - 4. Door holder release bypass.
 - 5. Future.
- D. The control panel shall provide the following:
 - 1. Setting of time and date.
 - 2. LED testing.
 - 3. Alarm, Trouble, and Abnormal condition listing.
 - 4. Enabling and disabling of each monitor point separately.
 - 5. Activation and deactivation of each control point separately.
 - 6. Changing operator access levels.
 - 7. Walk Test enable.
 - 8. Running diagnostic functions.
 - 9. Displaying software revision level.
 - 10. Displaying historical logs.
 - 11. Displaying card status.
 - 12. Point listing.
- E. For maintenance purposes, the following lists shall be available from the point lists menu:
 - 1. All points list by address.
 - 2. Monitor point list.
 - 3. Signal/speaker list.
 - 4. Auxiliary control list.
 - 5. Feedback point list.
 - 6. Psuedo point list.
 - 7. LED/switch status list.
- F. Scrolling through menu options or lists shall be accomplished in a self-directing manner in which prompting messages shall direct the user. These controls shall be located behind an access door.
- G. Primary Keys, LEDs, and LCD Display:
 - 1. The control panel shall have an 86 character liquid crystal display which shall be backlit for enhanced readability. So as to conserve battery standby power, it shall not be lit during an AC power failure unless an alarm condition occurs or there is keypad activity.
 - 2. The display shall support both upper and lower case letters. Lowercase letters shall be used for softkey titles and prompting the user. Uppercase letters shall be used for system status information. A cursor shall be visible when entering information.

2.02 SYSTEM FRONT PANEL OPERATION AND CAPABILITIES

- A. Under normal condition, the front panel shall display a "System is Normal" message and the current time and date.
- B. Should an abnormal condition be detected, the appropriate LED (Alarm, Supervisory, or Trouble) shall flash. The panel audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.
- C. The LCD shall display the following information relative to the abnormal condition of a point in the system.
 - 1. 40 character custom location label.
 - 2. Type of device (i.e., smoke, pull station, water flow).
 - 3. Point status (i.e., alarm, trouble).
- D. Alarm Silencing:
 - 1. Should the Alarm Silence button be pressed, all audible alarm signals shall cease to operate.
 - 2. Signals shall not be silenced during alarm silence inhibit mode.
- E. System Reset:
 - 1. The System Reset button shall be used to return the system to its normal state after an alarm condition has been remedied.
 - 2. Should an alarm condition continue to exist the system control relays shall not reset.
 - 3. Should the Alarm Silence Inhibit function be active, the SYSTEM RESET key press will be ignored.
- F. LED Supervision: All slave module LEDs shall be supervised for burnout or disarrangement. Should a problem occur, the LCD shall display the module and LED location numbers to facilitate location of that LED.
- G. System Trouble Reminder: Should a trouble condition be present within the system and the audible trouble signal silenced, the trouble signal shall resound at preprogrammed time intervals to act as reminder that the fire alarm system is not 100% operational. Both the time interval and the trouble reminder signal shall be programmed to suit the owner's application.
- H. RS-232-C Output: The fire alarm control panel shall support up to five (5) RS-232-C ports and one service port. All (5) RS-232-C ports shall be capable of two-way communications.
- I. Fire Alarm Control System Network:
 - 1. Each fire alarm control panel shall operate as a proprietary local system with data communication to a higher order Fire-Alarm Control Unit (FACU).
 - 2. The FACU shall monitor all alarms and troubles of each fire alarm control panel.
 - 3. The FACU shall control each fire alarm control panel as listed in this specification.
 - 4. All data communication wiring between the FACU and fire alarm control panel shall be supervised for opens, shorts, and grounds.
- J. Equipment Enclosures: Provide cabinets of sufficient size to accommodate the aforementioned equipment. Cabinet shall be equipped with locks and transparent door panel providing freedom from tampering yet allowing full view of the various lights and controls.

2.03 REMOTE ANNUNCIATOR(S)

- A. Where shown on the plans, provide and install a LCD annunciator. The LCD display shall mimic the LCD display on the control panel.
- B. The serial annunciator shall consist of:
 - 1. A minimum of four programmable control switches and associated LEDs.
 - 2. The display shall be provide the following information relative to the abnormal condition of a point in the system:
 - a. 40 character custom label location
 - b. Type of device
 - c. Point status

2.04 MULTIPLE ADDRESSABLE PERIPHERAL NETWORK (MAPNET)

- A. Communication with addressable devices. The system must provide communication with initiating and control devices individually. All of these devices will be individually annunciated at the control panel. Annunciation shall include the following conditions for each point:
 - 1. Alarm.
 - 2. Trouble.
 - 3. Open.
 - 4. Short.
 - 5. Device missing/failed.
- B. All addressable devices shall have the capability of being disabled or enabled individually.
- C. Identification of Addressable Devices: Each addressable device must be uniquely identified by an address code entered on each device at time of installation.
- D. Wiring Type, Distances, Survivability, and Configurations: Wiring types will be approved by the equipment manufacturer. Existing wiring may be utilized in retrofit applications where applicable. The system shall allow a line distance of up to 2,500 feet to the furthest addressable device on a Class B circuit. (Class A communications will be provided where shown on the drawings. Wire will be so routed to maintain sufficient distance between the forward and return loop as called for by the authority having jurisdiction.) To minimize wire routing and to facilitate future additions, t-tapping of the communications channel will be supported except where Class A wiring is required.
- E. Addressable Device Types:
 - 1. General: The system control panel, must be capable of communicating with the types of addressable devices specified below. Addressable devices will be located as shown on the drawings.
 - 2. Addressable Sensor Bases - All addressable smoke, heat and CO detectors as specified below will be pluggable into their bases. The base will contain electronics that communicate the sensor status (normal, alarm, trouble) to the control panel. Different sensor heads must be interchangeable. Upon removal of the head, a trouble signal will be transmitted to the control panel. Bases shall contain magnetically activated test switches and LED status indicators.
 - 3. Addressable Analog Smoke Sensors:
 - a. The photoelectric type detector shall be a plug-in unit which mounts to a twist-lock base, and shall comply with UL 268.
 - b. Each sensor shall self-restore after the actuation without resetting or readjustment.
 - c. Each device shall be individually monitored by the fire-alarm control unit for calibration, sensitivity and alarm condition and shall be adjustable for sensitivity by fire-alarm control unit.
 - 4. Addressable Heat Sensors:
 - a. Heat sensors shall comply with UL 521.
 - b. Sensor shall be combination fixed temperature (135F) and rate-of-rise (15F/minute) type unit.
 - c. Fixed temperature sensing shall be independent and shall be programmable at 135F or 155F with rate-of-rise defection selectable at 15F/minute or 20F/minute.
 - d. Each device shall be analog addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity and alarm condition and individually adjustable by the fire-alarm control unit.
 - 5. Addressable Pull Stations:
 - a. Addressable pull stations will contain electronics that communicate the station's status (normal, alarm, or trouble) to the fire-alarm control unit. The address will be set on the station. They will be manufactured from high impact red Lexan. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common to all system locks. Pull stations will bedouble action push top activation door.
 - b. The addressable manual station shall comply with UL 38.

6. Addressable Photoelectric Duct Sensor:
 - a. Sensors shall be photoelectric type with sampling tubes of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied.
 - b. Duct housing shall be provided with relay or relay device as required for fan shutdown.
 - c. Environmental compensation, programmable sensitivity settings, status testing and monitoring of sensor dirt accumulation shall be provided by the fire-alarm control unit.
 - d. Duct housing shall be provided with magnetic test area and status indicators and shall have transparent cover to monitor presence of smoke.
 - e. Duct housing shall have two test ports for measuring of airflow and testing. Ports shall allow for aerosol injection in order to test activation of sensor.
 - f. Each sensor shall be provided with a remote test station. Exact locations of test stations shall be coordinated with the Owner prior to installation.
7. Addressable Circuit Interface Modules: Modules shall be arranged to monitor or control system components that are not otherwise equipped for addressable communication. Modules shall be utilized for monitoring of waterflow, valve tamper, non-addressable devices, and for control of HVAC systems.
 - a. Modules shall be supervised and uniquely identified by the fire-alarm control unit. Module shall have on board status indicator.
8. Addressable CO Sensor:
 - a. The CO sensor shall be an addressable carbon monoxide (CO) sensing module providing toxic gas detection and shall comply with UL 268.
 - b. The sensor shall be provided with an integral status indicator, reporting to the fire-alarm control unit.
9. Addressable Device Supervision:
 - a. All devices shall be supervised for trouble conditions. The system control panel will be capable of displaying the type of trouble condition (open, short, device missing/failed).
 - b. Should a device fail, it will not hinder the operation of other system devices.

2.05 ONE-WAY VOICE COMMUNICATION

- A. Provide one-way voice communication and tone generating capabilities.
- B. A central audio control module shall be provided for the necessary alarm message/tone generation, main and remote microphone connections, music inputs, and mixer/pre-amplifier circuits. Continuous supervision shall be provided. Audio outputs shall have individual gain control.
- C. A hand-held, push-to-talk microphone shall be provided recessed within a protective panel-mounted enclosure.
- D. An audio control switch module shall be furnished to provide manual to the audio functions. These switches and associated LED indicators shall be supervised from disarrangement or failure.
- E. A pre-recorded digitized voice message capability shall be provided for automatic transmission to building occupants during alarm conditions. Three (3) messages shall be provided, one for alarm, one for testing. A standard evacuation message shall be provided under this contract; however, the message player must be capable of transmitting a customized message of up to 4 minutes long.
 1. A self-contained speaker will provide testing of the message(s) without disturbing the occupants of the facility.
- F. Automatic Voice Evacuation Sequence:
 1. The audio alarm signal shall consist of an alarm tone for a maximum of 10 seconds followed by automatic pre-selected voice evacuation messages. At the end of each voice evacuation message, the alarm tone shall resume. The alarm tones shall sound until the alarm silence switch at the fire alarm control panel has been operated.

2. All audio alarm operations (speaker circuit selection and alarm tone/voice message timing variations) shall be activated by the system software so that any required future changes to the evacuation sequence can be facilitated by authorized personnel without any component rewiring.
- G. Manual Voice Paging Sequence:
1. The system shall be configured to allow selective voice paging. Upon activation of any speaker manual control switch, two (2) seconds of tone shall sound over the speakers indicating an impending voice message will occur.
 2. If any speaker manual control switches are activated, the control panel operator shall be able to make announcements via the push-to-talk paging microphone over the preselected speakers.
 3. Facility for total building evacuation and paging shall be provided to allow for activation of speakers. This shall be accomplished by the means of an "All Circuit" switch.

2.06 NETWORK VOICE COMMAND CENTER

- A. Provide a network voice command center in the building's fire command center. Unit shall include all voice alarm system components required to integrate fully with individual network node voice alarm panels.
- B. All network voice command center functions shall allow network wide operation of live emergency voice communications or pre-recorded messages originating from the fire command center or other voice system nodes.
- C. System shall allow for simultaneous transmission of different announcements to different zones automatically or by use of central control microphone.
- D. All announcements shall be made over dedicated, supervised communication lines.
- E. Emergency Phone Jacks
 1. Provide emergency phone jacks as shown on the plans. Each jack shall be mounted on a stainless steel single gang plate with the words "Fire Emergency Phone" screened on each.
 2. Provide emergency phone jacks for installation in each elevator car by the elevator contractor. Required wiring from elevator controls to each elevator car shall be furnished and installed by the elevator contractor.

2.07 ALARM NOTIFICATION APPLIANCES

- A. Provide conventional alarm notification appliances as indicated in the project drawings and all associated equipment accessories as required for operation on compatible signaling line circuits.
- B. All devices shall be UL listed.
- C. Visible appliances shall be provided with the appropriate candela rating to provide full coverage of the spaces they serve.
- D. Devices located outdoors or in interior spaces subject to water shall be rated for weatherproof operations.

2.08 MAGNETIC DOOR HOLDERS

- A. Shall be listed to UL 228.
- B. Shall be equipped for wall mounting, unless indicated otherwise in project drawings, with matching door plate.
- C. Finish shall match door hardware.

2.09 DEVICE GUARDS

- A. All devices located in Behavioral Health shall be provided with tamper resistant covers listed for use with applicable initiating and notification appliances.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be installed in strict compliance with all the provisions of NEC article 760 A and C, Power-Limited Fire Protective Signaling Circuits or if required may be reclassified as non-power limited and wired in accordance with NEC-Article 760 A and B. Upon completion, the contractor shall so certify in writing to the owner and general contractor.
 - 1. All junction boxes shall be sprayed red and labeled "Fire Alarm." Wiring color code shall be maintained throughout the installation.
- B. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.
- C. The contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation.
- D. The manufacturer's authorized representative shall provide on-site supervision of installation.
- E. All wiring shall be installed in conduit.
- F. Existing fire alarm equipment shall be maintained fully operational until new equipment has been tested and accepted. After acceptance of new fire alarm system remove existing equipment and restore damaged surfaces.
- G. Identify system components, wiring, cabling and terminals.
- H. Install ground wire from FACU to main service ground.
- I. Installation shall meet pathway survivability requirements of NFPA 72

3.02 TESTING

- A. The completed fire alarm system shall be fully tested in accordance with NFPA-72 by the contractor in the presence of the owner's representative and the local Fire Marshal. Upon completion of a successful test, the contractor shall so certify in writing to the owner and general contractor.
- B. Prior to final testing contractor shall complete a series of pre-test and all deficiencies shall be corrected.

3.03 TRAINING

- A. Provide a minimum of 8 hours of demonstration and training to the Owner on operation, troubleshooting and maintenance of the fire alarm system.

3.04 WARRANTY

- A. The contractor shall warrant the completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one (1) year from the date of the completed and certified test or from the date of first beneficial use.
- B. The Contractor shall provide up to 3 visits within the warranty year to make adjustments to the system not associated with warranty issues.
- C. Update software to latest version at project completion. Provide and install software upgrades that become available within 2 years of substantial completion.

END OF SECTION 28 31 00