

DD	IN AUDIENCE (FOH) MIX POSITION	REFER TO MOUNTING KEY	LEGRAND EFB10S	A B D D D --	56 12 8 3 4 2	9451 9451 1694A 2412 2412 (\$) AVTP	YA YA YA YA BUILDING NETWORK (BY C ZY
DE	CONTROL ROOM MIX POSITION	REFER TO MOUNTING KEY	16" X 12" X 6"	A B D D D --	48 12 1 3 4 1	9451 9451 1694A 2412 2412 (\$) AVTP	YB YB YB YB BUILDING NETWORK (BY C ZY
DF	LIVE ROOM MIC FOR ARCHIVAL RECORDING	ABOVE CEILING	4" X 4" X 4"	A	2	9451	YA
DG	AUDIENCE AREA MICROPHONE INPUT	MOUNT IN FACE OF STAIR RISER	4" X 4" X 4"	A	2	9451	DG OR YB
DH	AUDITORIUM PROJECTOR LOCATION (TWO STACKED PROJECTORS)	REFER TO MOUNTING KEY	4" X 4" X 4"	D D --	2 2 4	2412 2412 (\$) AVTP	YA BUILDING NETWORK (BY C ZY
DX	WIRELESS MICROPHONE ANTENNA	12' - 0"	4" X 4" X 4"	D	4	9914	DX OR YA

LOUDSPEAKER:

EA	DIGITALLY STEERABLE COLUMN ARRAY LOUDSPEAKER	5' - 0"	4" X 4" X 4"	B D --	2 2 1	9451 2412 AVTP	YA YA ZY
EB	UNDER STAGE LIP FRONT FILL LOUDSPEAKER	UNDER STAGE LIP	4" X 4" X 4"	C	8	8471	EB OR YA
EC	LOBBY CEILING SPEAKER	REFER TO MOUNTING KEY	N/A	C	1	8471	EC OR YA
ED	GREENROOM SPEAKER	REFER TO MOUNTING KEY	N/A	C	1	8471	FB OR YA

AUDIO AND VIDEO - SCHEDULE OF TERMINATIONS AUDITORIUM PERFORMANCE SYSTEM

SCALE NTS

01

MOORE SCHOOL OF BUSINESS
UNIVERSITY OF SOUTH CAROLINA
BID PACKAGE 3
ENCLOSURE/SITE/MEPFP/INTERIOR
ADDENDUM #003

^ ^
^ ^
3 2012.06.22
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AUDIO VIDEO SCHEDULE OF TERMINATIONS
REF. DWG # 1/AV0002

SHEET TITLE :

SCALE :
NTS

SHEET NUMBER :
AV-SK-001

PROJECT NO. 655.000

				D	1	HDMI	AS
				D	2	HDMI	AE
				D	2	2412	AE OR ZC
				D	2	2412 (\$)	ZC OR BUILDING NETWORK (BY OTHER)
				-	1	AVTP	ISOLATED BUILDING POWER
AJ	PTZ CAMERA (FOR LECTURE CAPTURE IN CLASSROOMS AND AUDITORIUM, CAMERA WILL ALSO PROVIDE VIDEO FEED OF MUSIC PERFORMANCES AS REQUIRED)	REFER TO MOUNTING KEY	4" X 4" X 4"	D	2	1694A	ZA OR ZC
				D	4	2412	ZA OR ZC
				D	1	2412 (\$)	BUILDING NETWORK (BY OTHER)
				-	1	AVTP	ISOLATED BUILDING POWER
AK	INTERACTIVE WHITE BOARD	7' - 0"	4" X 4" X 4"	D	10	1694A	AE
				D	2	HDMI	AE
				D	4	2412	AE
				-	1	AVTP	ISOLATED BUILDING POWER
AL	ROOM SCHEDULE PANEL	REFER TO ARCH. DRAWINGS	1-GANG OR MANUFACTURER BACKBOX	D	1	2412 (\$)	BUILDING NETWORK (BY OTHER)
AM	INTERACTIVE INFORMATION KIOSK	REFER TO MOUNTING KEY	STEEL CITY 68D	D	1	2412 (\$)	BUILDING NETWORK (BY OTHER)
				-	1	AVTP	ISOLATED BUILDING POWER
AN	ELECTRIC SCREEN	REFER TO MOUNTING KEY	4" X 4" X 4"	D	2	5300UG	AA, ZA, ZB, ZC OR ZE
				-	1	NTP	BUILDING POWER
AO	FUTURE PROJECTOR (INFRASTRUCTURE ONLY PROVIDED WITH AV INSTALLATION)	ABOVE CEILING	4" X 4" X 4"	D	2	2412	AA, ZA, ZC OR ZE
				D	1	2412 (\$)	ZC OR BUILDING NETWORK (BY OTHER)
				-	1	AVTP	ISOLATED BUILDING POWER
AP	FUTURE SCREEN (INFRASTRUCTURE ONLY PROVIDED WITH AV INSTALLATION)	REFER TO MOUNTING KEY	4" X 4" X 4"	D	2	5300UG	AA, ZA, ZB OR ZC
				-	1	NTP	BUILDING POWER
AQ	FUTURE INTERACTIVE WHITEBOARD (INFRASTRUCTURE ONLY PROVIDED WITH AV INSTALLATION)	7' - 0"	4" X 4" X 4"	D	10	1694A	AE
				D	2	HDMI	AE
				D	4	2412	AE
				-	1	AVTP	ISOLATED BUILDING POWER
AR	LIVE ROOM MIC (FOR ADA AND CAPTURE SYSTEMS)	ABOVE CEILING	6" X 4" X 4"	A	1	9451	AA, ZA OR ZC
AS	VIDEO CONFERENCING SYSTEM (NOT OWNER PROVIDED)	7' - 0"	4" X 4" X 4"	A	2	9451	AA, AE, ZA OR ZC
				D	8	1694A	AA, AE, ZA OR ZC

AUDIO AND VIDEO - SCHEDULE OF TERMINATIONS AUDITORIUM SCHOOL OF BUSINESS

SCALE NTS

01

MOORE SCHOOL OF BUSINESS
UNIVERSITY OF SOUTH CAROLINA
BID PACKAGE 3
ENCLOSURE/SITE/MEFPF/INTERIOR
ADDENDUM #003



2012.06.22



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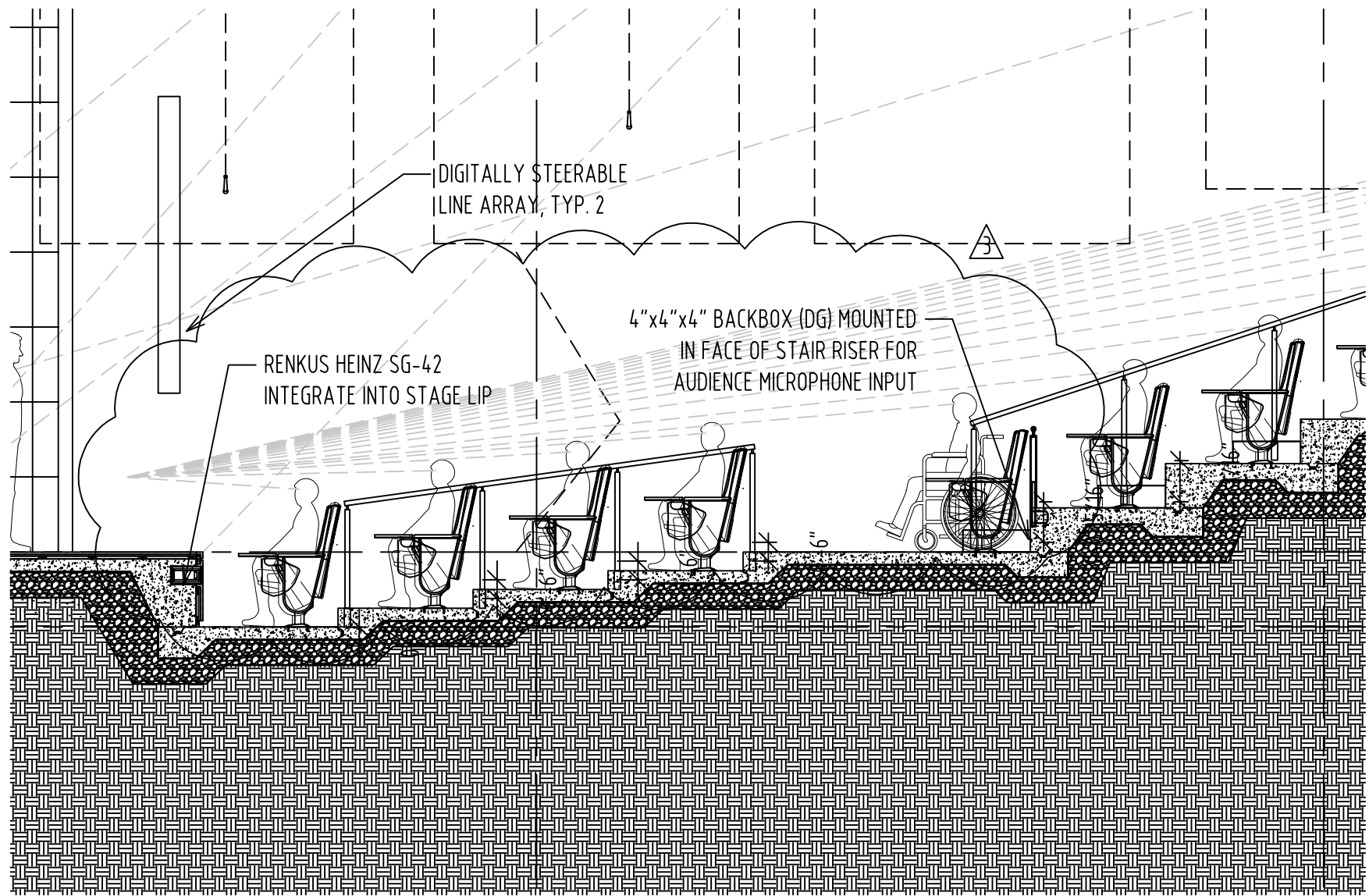
AUDIO VIDEO SCHEDULE OF TERMINATIONS
REF. DWG # 1/AV0003

SHEET TITLE :

SCALE :
NTS

SHEET NUMBER :
AV-SK-002

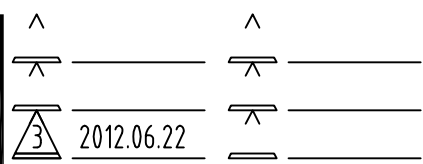
PROJECT NO. 655.000



PERFORMANCE HALL SECTION
SCALE: 1/4" = 1'-0"

01

MOORE SCHOOL OF BUSINESS
UNIVERSITY OF SOUTH CAROLINA
BID PACKAGE 3
ENCLOSURE/SITE/MEFPF/INTERIOR
ADDENDUM #003



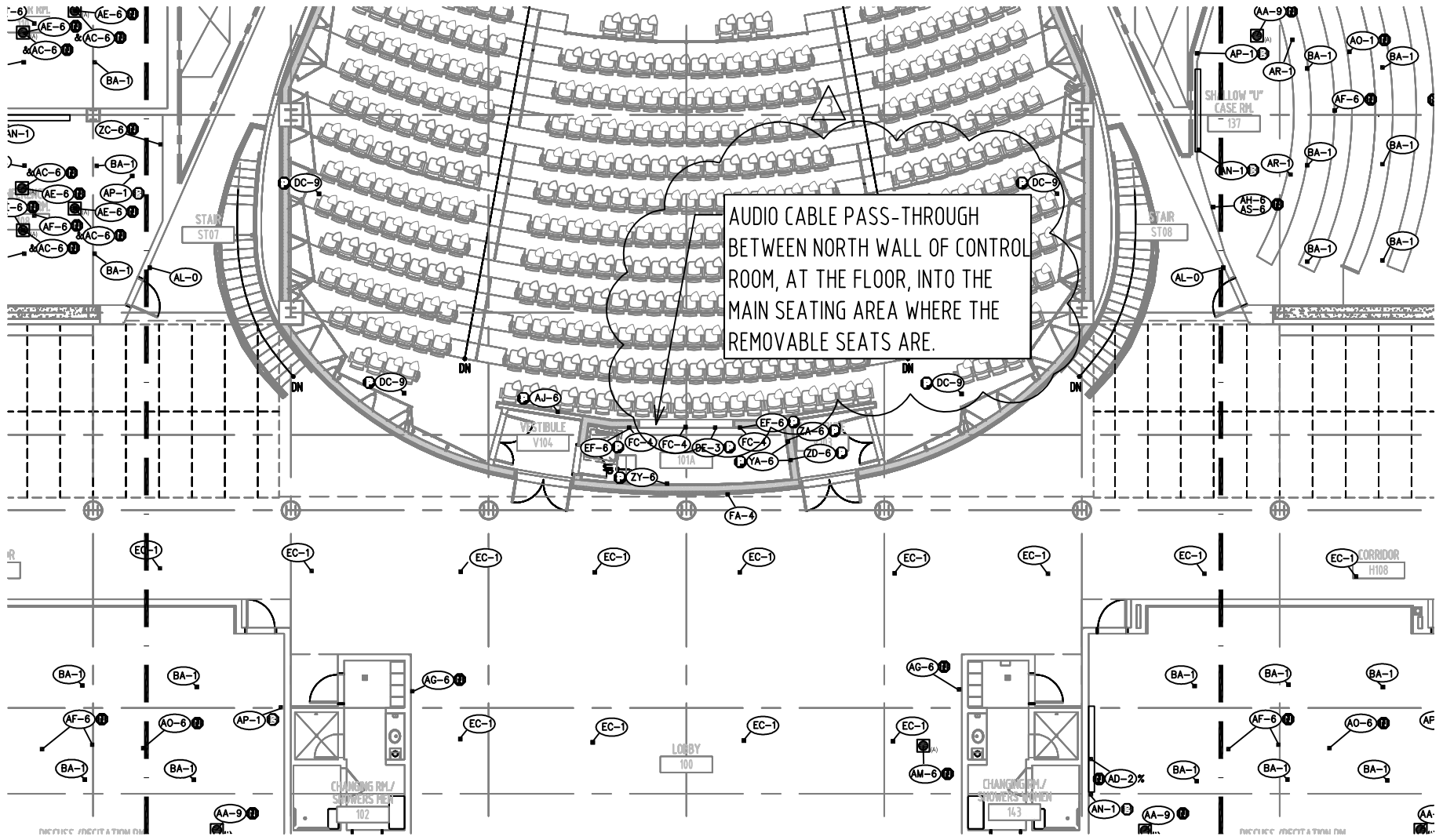
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ENLARGED SECTION - LEVEL 1 - PERF. HALL
REF. DWG # 1/AV2000

SHEET TITLE :

SCALE :
NTS
SHEET NUMBER :
AV-SK-003

PROJECT NO. 655.000



AV DEVICE LOCATIONS, LEVEL 1, ZONE C

SCALE: 1/8" = 1'-0"

01

MOORE SCHOOL OF BUSINESS
UNIVERSITY OF SOUTH CAROLINA
BID PACKAGE 3
ENCLOSURE/SITE/MEFPF/INTERIOR
ADDENDUM #003



2012.06.22
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AV DEVICE LOCATIONS, LEVEL 1, ZONE C
REF. DWG # 1/AV1110(C)

SHEET TITLE :

SCALE :
NTS
SHEET NUMBER :
AV-SK-004

PROJECT NO. 655.000

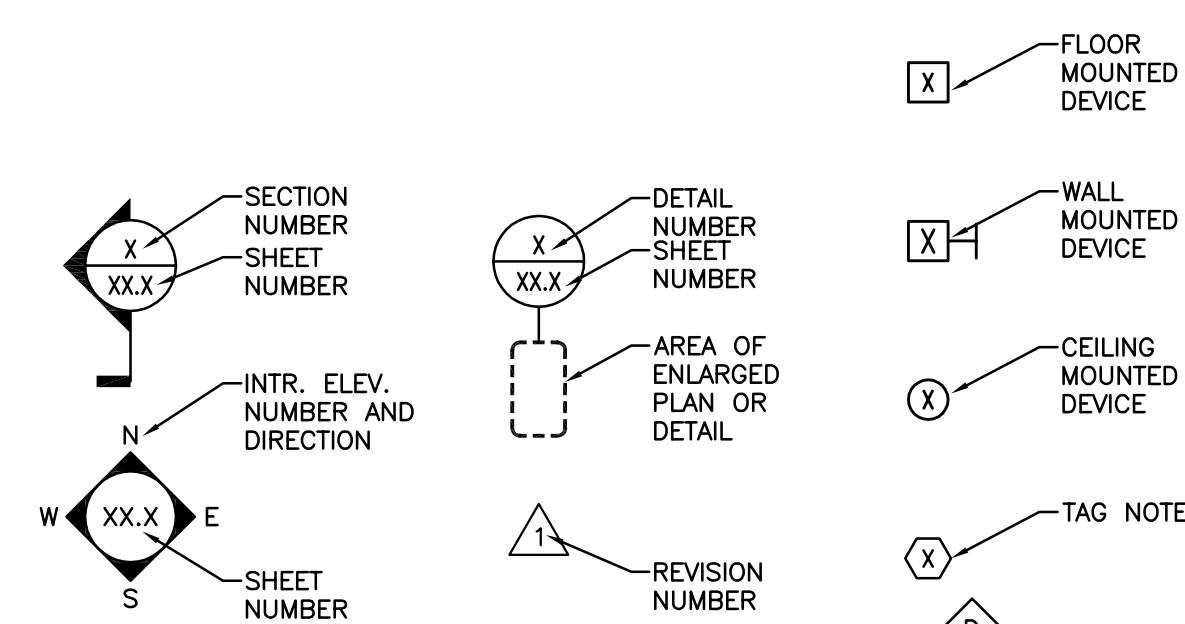
USC DARLA MOORE PERFORMANCE HALL

THEATRICAL ABBREVIATIONS

AC	ABOVE COUNTER
AFC	ABOVE FINISHED CEILING
AFB	ABOVE FINISHED FLOOR
AFP	ABOVE FINISHED PLATFORM/ RAISED FLOOR
AS	ABOVE SLAB
AV	AUDIOVISUAL
AWG	AMERICAN WIRE GAUGE
BFC	BELOW FINISHED CEILING
C	CONDUIT
CB	CIRCUIT BREAKER
CL	CENTER LINE
CLG	CEILING
COND	CONDUCTOR
CP	CONSOLIDATION POINT
CU	COPPER
DWG	DRAWING
EC	ELECTRICAL CONTRACTOR
E.C.	EMPTY CONDUIT
EX	EXISTING
GC	GENERAL CONTRACTOR
GND	GROUND
Hz	HERTZ
IDF	INTERMEDIATE DISTRIBUTION FRAME
IG	ISOLATED GROUND
JB	JUNCTION BOX
kHz	KILOHERTZ
LV	LOW VOLTAGE
MAX	MAXIMUM
MCS	MULTIMEDIA COMMUNICATION SYSTEM
MDF	MAIN DISTRIBUTION FRAME
MIN	MINIMUM
MTD	MOUNTED
MTG	MOUNTING
MTS	MANUAL TRANSFER SWITCH
NIC	NOT IN CONTRACT
No.	NUMBER
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OFE	OWNER FURNISHED EQUIPMENT
PA	PUBLIC ADDRESS
PB	PULL BOX
PBO	PROVIDED BY OTHERS
PNL	PANEL
PR	PAIR
RM	ROOM
RW	RACEWAY
RX	RECEIVE
STD	STANDARD
STP	SHIELDED TWISTED PAIR
TEMP	TEMPORARY
TX	TRANSMIT
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
UPS	UNINTERRUPTED POWER SUPPLY
UTP	UNSHIELDED TWISTED PAIR
V	VOLTS
VA	VOLT-AMPERES
VM	VOLTMETER
W	WATTS
WP	WATERPROOF
WS	WORKSTATION
WW	WIRE WAY

THEATRICAL ABBREVIATIONS
SCALE NTS 07

GRAPHIC STANDARDS



GRAPHIC STANDARDS
SCALE NTS 06

THEATRICAL COORDINATION NOTES

- WHERE EXACT DIMENSIONS ARE NOT INDICATED, THE SCALE OF THIS DRAWING IS SUFFICIENTLY ACCURATE FOR DETERMINING THE LOCATION OF EQUIPMENT, JUNCTION BOXES, OUTLET BOXES, WIREWAYS, PANELS, ETC. WHERE EXACT DIMENSIONS ARE INDICATED, THE REFERENCE SURFACE SHALL BE THE FINAL FINISHED SURFACE INCLUDING ANY ACOUSTICAL TREATMENT. ROOM DIMENSIONS ON THE DRAWINGS HAVE BEEN TAKEN FROM ARCHITECTURAL DRAWINGS. ALL DIMENSIONS MUST BE VERIFIED AND ANY DEVIATIONS CAUSING CHANGES EXCEEDING 75MM MUST BE COORDINATED WITH THE ARCHITECT.
- DIMENSIONS SHOWN ARE SUGGESTED PLACEMENTS AND ARE PROVIDED FOR INFORMATION ONLY. COORDINATE ALL ELECTRICAL DEVICES AND DIMENSIONED LOCATIONS WITH ARCHITECTURAL AND ENGINEERING DRAWINGS.
- DRAWINGS ARE NOT TO BE USED FOR ARCHITECTURAL OR ENGINEERING PURPOSES. DRAWINGS SHOULD ONLY BE USED FOR TECHNICAL THEATRICAL EQUIPMENT SYSTEM INSTALLATION & COORDINATION WITH OTHER CONTRACTORS AND SYSTEMS. COORDINATE PATHWAYS FOR ALL TECHNICAL THEATRICAL EQUIPMENT RELATED DEVICES WITH ARCHITECTURAL AND ELECTRICAL PLANS.
- ALL TECHNICAL THEATRICAL EQUIPMENT DEVICES SHALL BE SECURELY MOUNTED PLUMB AND STRAIGHT TO WALLS, FLOORS, OR RACKS, PER THE MANUFACTURER'S RECOMMENDED MOUNTING PRACTICE.
- ALL EQUIPMENT SHOWN IN GRAY IS SPECIFIED ELSEWHERE.
- INSTALL FIRESTOP TO ALL SLAB AND WALL PENETRATIONS PROVIDED FOR THE INSTALLATION OF CABLE AS REQUIRED TO MAINTAIN FIRE RATING OF SLAB OR WALL. REVIEW ARCHITECT'S PLAN FOR PARTITION TYPES.
- THE METHOD OF INSTALLATION OF BOXES IN WALLS, AND THE METHOD OF PASSAGE OF CONDUIT AND WIREWAYS THROUGH ACOUSTICALLY SENSITIVE WALLS, SHALL BE COORDINATED WITH THE ARCHITECT.
- ALL ELECTRICAL FOR TECHNICAL THEATRICAL EQUIPMENT SHALL BE INSTALLED IN ACCORDANCE WITH LOCAL ELECTRICAL CODE AND SEISMIC REQUIREMENTS.
- REFER TO ELECTRICAL SPECIFICATION FOR INSTALLATION INSTRUCTIONS FOR FLOORBOXES, JUNCTION BOXES, PLYWOOD PANELS, GROUNDING CONDUCTORS, BUSBARS, CONDUITS, CABLE TRAYS IN CORRIDORS, METALLIC ENCLOSURES, ELECTRICAL PANELBOARDS AND CIRCUITING. FIRE PROOFING SYSTEMS USED FOR ALL PENETRATIONS MUST BE APPROVED BY APPLICABLE AUTHORITIES PRIOR TO INSTALLATION.
- ELECTRICAL FEEDS ARE NOT TO BE RUN PARALLEL WITH VIDEO AND/OR AUDIO LINES OR RACEWAYS. IF ELECTRICAL FEEDS MUST BE RUN PARALLEL TO AUDIO/VIDEO LINES, A MINIMUM OF 4" OF SEPARATION MUST BE MAINTAINED.
- POWER BREAKER PANELS ARE SIZED AND SPECIFIED BY THE ELECTRICAL ENGINEER; REFER TO ELECTRICAL DRAWINGS. ALL CIRCUITS SHALL BE PROTECTED.
- POWER RECEPTACLES SHOWN ON TECHNICAL THEATRICAL EQUIPMENT DRAWINGS ARE DEDICATED TO SPECIFIC TECHNICAL THEATRICAL EQUIPMENT AND ARE SHOWN FOR REFERENCE ONLY. REFER TO ELECTRICAL DRAWINGS FOR ADDITIONAL UTILITY POWER RECEPTACLES.
- WHERE POWER CIRCUITS ARE SHOWN TERMINATING INTO JUNCTION BOXES WITHOUT RECEPTACLES, THE WIRES SHALL BE TAPED AND THE BOXES COVERED. THESE CIRCUITS WILL BE CONNECTED BY OTHERS DURING INSTALLATION OF THE TECHNICAL THEATRICAL EQUIPMENT SYSTEM EQUIPMENT.
- GROUND ALL CONDUITS, CABLE TRAYS AND JUNCTION BOXES PER THE MANUFACTURER'S RECOMMENDATIONS AND PER ALL APPLICABLE CODES.
- ALL EMPTY CONDUIT SHALL BE REAMED, CLEANED, CAPPED (WHERE APPROPRIATE), TAGGED, AND FURNISHED WITH PULL WIRES.
- THERE SHALL BE A MINIMUM OF ONE PULL BOX FOR EVERY 30480MM OF STRAIGHT EMPTY CONDUIT AND/OR ONE PULL BOX FOR MORE THAN TWO 90° BENDS OR LESSER BENDS TOTALING 180° IN A CONDUIT RUN.
- MAINTAIN MINIMUM BEND RADIUS OF 10X OD FOR ALL CONDUITS.
- PROVIDE CONNECTION HARDWARE, GROUNDING LUGS AND STRAPS, THERMAL EXPANSION PLATES, SUPPORT BRACKETS, SPLICE HARDWARE, TERMINATION KITS, END SUPPORT KITS, CEILING SUPPORT HARDWARE, RUNWAY DROPOFFS AND 180MM CABLE RETAINING POSTS FOR ALL CABLE TRAY LOCATIONS PER MANUFACTURERS RECOMMENDATIONS AND PER APPLICABLE CODES.
- ALL POWER CONDUIT, POWER WIREWAYS, AND POWER JUNCTION BOXES ARE TO BE REVIEWED BY THE ELECTRICAL ENGINEER FOR CODE COMPLIANCE.
- EMPTY CONDUIT RUNS ON THE TECHNICAL THEATRICAL EQUIPMENT DRAWINGS SHOW ONLY INTERCONNECTION BETWEEN THE TERMINATION POINTS. THE EXACT PATH OF CONDUIT ARE TO BE DETERMINED BY THE ELECTRICAL ENGINEER AND FIELD CONDITIONS.
- NOTIFY OWNER'S REPRESENTATIVES OF ANY DISCREPANCIES BETWEEN THE EXISTING CONDITIONS AND THE TECHNICAL THEATRICAL EQUIPMENT DRAWINGS. OBTAIN CLARIFICATION BEFORE PRECEDING WITH WORK.
- TECHNICAL THEATRICAL EQUIPMENT SYSTEMS CONTRACTOR SHALL RESTORE CEILING AND WALLS AND ANY OTHER SURFACES AFFECTED BY ITS WORK UPON COMPLETION OF WORK, WITH LIKE MATERIALS TO MATCH EXISTING CONSTRUCTION.
- EXCEPT WHERE NOTED OTHERWISE, THE FINISHES FOR ALL JUNCTION BOX FACEPLATES, GRILLES, FLOOR BOXES AND WALL BOXES SHALL BE BLACK UNLESS NOTED OTHERWISE. ALL ELECTRICAL BOXES SHALL HAVE THE APPROPRIATE COVERS AND SCREWS INSTALLED BY THE ELECTRICAL CONTRACTOR TO MATCH THE FIT AND FINISH SPECIFIED.
- IT SHALL BE THE RESPONSIBILITY OF THE TECHNICAL THEATRICAL EQUIPMENT CONTRACTOR TO VERIFY SIGNAL/CONDUIT PATHWAYS WITH THE ELECTRICAL ENGINEERS DRAWINGS.
- ALL LOCATION DIMENSIONS ARE TO THE CENTERLINE OF THE PLATE UNLESS OTHERWISE NOTED
- THE FIRE PROTECTION PLANS NOTE THAT SPRINKLERS MUST BE PROVIDED ABOVE & BELOW THE CEILING. SPRINKLER HEAD LOCATIONS WILL BE PROVIDED AS PART OF THE SHOP DRAWINGS BY THE NICET DESIGNER BASED UPON THEIR USE OF THE CONSTRUCTION DOCUMENTS INCLUDING THE ROPS. THE DESIGN ENGINEER WILL REVIEW THE LOCATION OF THE SPRINKLERS DURING THE SHOP DRAWING PROCESS TO ENSURE PLACEMENT IS IN ACCORDANCE WITH NFPA 13.

THEATRICAL NOTES
SCALE NTS 05

THEATRICAL LIGHTING SYMBOL LEGEND

- HOUSE LIGHT ENTRY STATION, SINGLE GANG J-BOX FLUSH MOUNTED AT 48" A.F.F. COLOR SELECTED BY ARCH. DETAIL RE:5/TEB.
- HOUSE LIGHT ENTRY STATION LOCKING, SINGLE GANG J-BOX FLUSH MOUNTED AT 48" A.F.F. COLOR SELECTED BY ARCH. DETAIL RE:5/TEB.
- HOUSE LIGHT CONTROL AT BOOTH, CUSTOM BACK BOX, LOCATION TO BE COORDINATED. DETAIL RE:6/TEB.
- HOUSE LIGHT CONTROL AT STAGE, CUSTOM BACK BOX AT 48" A.F.F., LOCATION TO BE COORDINATED. DETAIL RE:6/TEB.
- THEATRICAL LIGHTING CONSOLE RECEPTACLE AT BOOTH, 3-GANG J-BOX, LOCATION TO BE COORDINATED. DETAIL RE:7/TEB.
- SIDE LIGHT AT HOUSE LEFT/RIGHT. TORMENTOR BARS AND DISTRIBUTION LOCATIONS TO BE COORDINATED. DETAIL RE:8/TEB.
- THEATRICAL LIGHTING RECEPTACLE AT STAGE LEFT/RIGHT. CUSTOM BACK BOX AT 18" A.F.F. LOCATIONS TO BE COORDINATED W/ ARCH. LOCATION TO BE BEHIND AN ACCESS PANEL.
- DISTRIBUTION BOX ON UNISTRUT BATTEN, RE:1/TEB.
- MOTOR CONTROL STATION (20X20X8) FOR VARIABLE ACOUSTIC BANNERS (WALL MOUNTED DEVICE), COORDINATE INTO THE CRESTRON CONTROL SYSTEM AND DEVICES SPECIFIED, RE: AV, 120 VAC, 1Ø, 60 HZ, 10 AMP, 2W + GRND AND 15 AMP 1 POLE BREAKER DISCONNECT BY ELECTRICAL, MOUNT 48" A.F.F.
- THEATRICAL LIGHTING CONSOLE RECEPTACLE IN HOUSE, 3 GANG J-BOX, LOCATION TO BE COORDINATED, RE: 7/TEB

THEATRICAL LIGHTING SYMBOL LEGEND
SCALE NTS 03

FLAG NOTES

- TO DIMMER CABINET,
- TO LIGHTING CONTROL RACK

FLAG NOTES
SCALE NTS 02

DRAWING LIST

TE0	COVER SHEET
TE1	THEATRICAL LIGHTING PLAN
TE2	THEATRICAL LIGHTING REFLECTED CEILING PLAN
TE3	VARIABLE ABSORPTION REFLECTED CEILING PLAN AND DETAIL
TE4	VARIABLE ABSORPTION SECTION
TE5	THEATRICAL LIGHTING SECTION
TE6	THEATRICAL LIGHTING ONE-LINE DIAGRAM
TE7	VARIABLE ABSORPTION ONE-LINE DIAGRAM
TE8	THEATRICAL LIGHTING DETAILS

DRAWING LIST
SCALE NTS 01

NOT USED
SCALE NTS 08

SCOPE OF WORK
SCALE NTS 04

THEATRICAL LIGHTING SYMBOL LEGEND
SCALE NTS 03

THEATRICAL LIGHTING SYMBOL LEGEND

- HOUSE LIGHT ENTRY STATION, SINGLE GANG J-BOX FLUSH MOUNTED AT 48" A.F.F. COLOR SELECTED BY ARCH. DETAIL RE:5/TEB.
- HOUSE LIGHT ENTRY STATION LOCKING, SINGLE GANG J-BOX FLUSH MOUNTED AT 48" A.F.F. COLOR SELECTED BY ARCH. DETAIL RE:5/TEB.
- HOUSE LIGHT CONTROL AT BOOTH, CUSTOM BACK BOX, LOCATION TO BE COORDINATED. DETAIL RE:6/TEB.
- HOUSE LIGHT CONTROL AT STAGE, CUSTOM BACK BOX AT 48" A.F.F., LOCATION TO BE COORDINATED. DETAIL RE:6/TEB.
- THEATRICAL LIGHTING CONSOLE RECEPTACLE AT BOOTH, 3-GANG J-BOX, LOCATION TO BE COORDINATED. DETAIL RE:7/TEB.
- SIDE LIGHT AT HOUSE LEFT/RIGHT. TORMENTOR BARS AND DISTRIBUTION LOCATIONS TO BE COORDINATED. DETAIL RE:8/TEB.
- THEATRICAL LIGHTING RECEPTACLE AT STAGE LEFT/RIGHT. CUSTOM BACK BOX AT 18" A.F.F. LOCATIONS TO BE COORDINATED W/ ARCH. LOCATION TO BE BEHIND AN ACCESS PANEL.
- DISTRIBUTION BOX ON UNISTRUT BATTEN, RE:1/TEB.
- MOTOR CONTROL STATION (20X20X8) FOR VARIABLE ACOUSTIC BANNERS (WALL MOUNTED DEVICE), COORDINATE INTO THE CRESTRON CONTROL SYSTEM AND DEVICES SPECIFIED, RE: AV, 120 VAC, 1Ø, 60 HZ, 10 AMP, 2W + GRND AND 15 AMP 1 POLE BREAKER DISCONNECT BY ELECTRICAL, MOUNT 48" A.F.F.
- THEATRICAL LIGHTING CONSOLE RECEPTACLE IN HOUSE, 3 GANG J-BOX, LOCATION TO BE COORDINATED, RE: 7/TEB

THEATRICAL LIGHTING SYMBOL LEGEND
SCALE NTS 03

FLAG NOTES

- TO DIMMER CABINET,
- TO LIGHTING CONTROL RACK

FLAG NOTES
SCALE NTS 02

DRAWING LIST

TE0	COVER SHEET
TE1	THEATRICAL LIGHTING PLAN
TE2	THEATRICAL LIGHTING REFLECTED CEILING PLAN
TE3	VARIABLE ABSORPTION REFLECTED CEILING PLAN AND DETAIL
TE4	VARIABLE ABSORPTION SECTION
TE5	THEATRICAL LIGHTING SECTION
TE6	THEATRICAL LIGHTING ONE-LINE DIAGRAM
TE7	VARIABLE ABSORPTION ONE-LINE DIAGRAM
TE8	THEATRICAL LIGHTING DETAILS

DRAWING LIST
SCALE NTS 01

USC BUSINESS PARTNERSHIP FOUNDATION
ON BEHALF OF
USC CAMPUS PLANNING & CONSTRUCTION
PROJECT NAME:
UNIVERSITY OF SOUTH CAROLINA
DARLA MOORE SCHOOL OF BUSINESS CONSTRUCTION
OSE PROJECT NUMBER:
H27-6069-AC-3
743 GREENE STREET
COLUMBIA, SC 29298
TEL: 803 777 4022 FAX: 803 777 0484

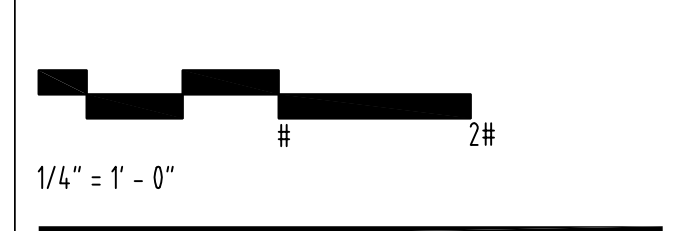
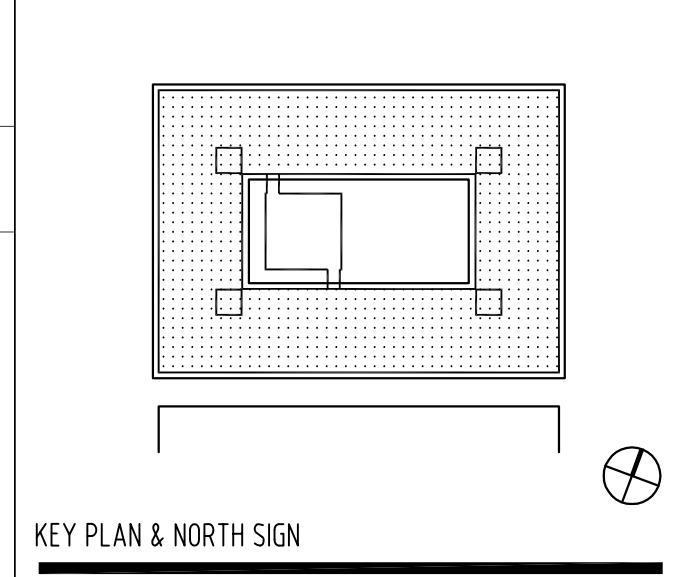
ARCHITECT:
RAFAEL VINDLY ARCHITECTS PC
50 VANDIAM STREET
NEW YORK, NY 10013
TEL: 212 924 5860 FAX: 212 924 5858
STRUCTURAL ENGINEER, MEP ENGINEER,
CIVIL ENGINEER, FIRE PROTECTION
ENGINEER:
STEVENS & WILKINSON, SC
1501 MAIN STREET, FLOOR G
COLUMBIA, SC 29201-5801
TEL: 803 765 0320 FAX: 803 254 6209
TELECOMMUNICATIONS, AUDIOVISUAL & ACOUSTICS:
JAFFE HOLDEN ACOUSTICS, INC.
114A WASHINGTON STREET
NORWALK, CT 06854-3007
TEL: 203 838 4167 FAX: 203 838 4168
LANDSCAPE ARCHITECT:
GRUMBALL-COTTELL ASSOCIATES
600 BELTLINE BOULEVARD
COLUMBIA, SC 29205
TEL: 803 738 9525 FAX:
SURVEYOR:
BP BARBER & ASSOCIATES, INC.
101 RESEARCH DRIVE
COLUMBIA, SC 29205-1116
TEL: 803 429 4028 FAX:

BUILDING CODE:
HUGHES ASSOCIATES
3610 COMMERCE DRIVE, SUITE 817
BALTIMORE, MD 21227-1652
TEL: 410 737 8677 FAX: 410 737 8688
LIGHTING DESIGNER:
ONE LUX STUDIO, LLC
39 WEST 13TH STREET
NEW YORK, NY 10011
TEL: 212 201 5792 FAX: 212 675 3700
FOOD & WASTE MANAGEMENT:
WILLIAM CARUSO & ASSOCIATES, INC.
885 EAST TURTLE AVENUE, SUITE 1520
DENVER, CO 80237
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BID PACKAGE 3
ENCLOSURE/SITE/MEFPF/INTERIOR
JUNE 22, 2012

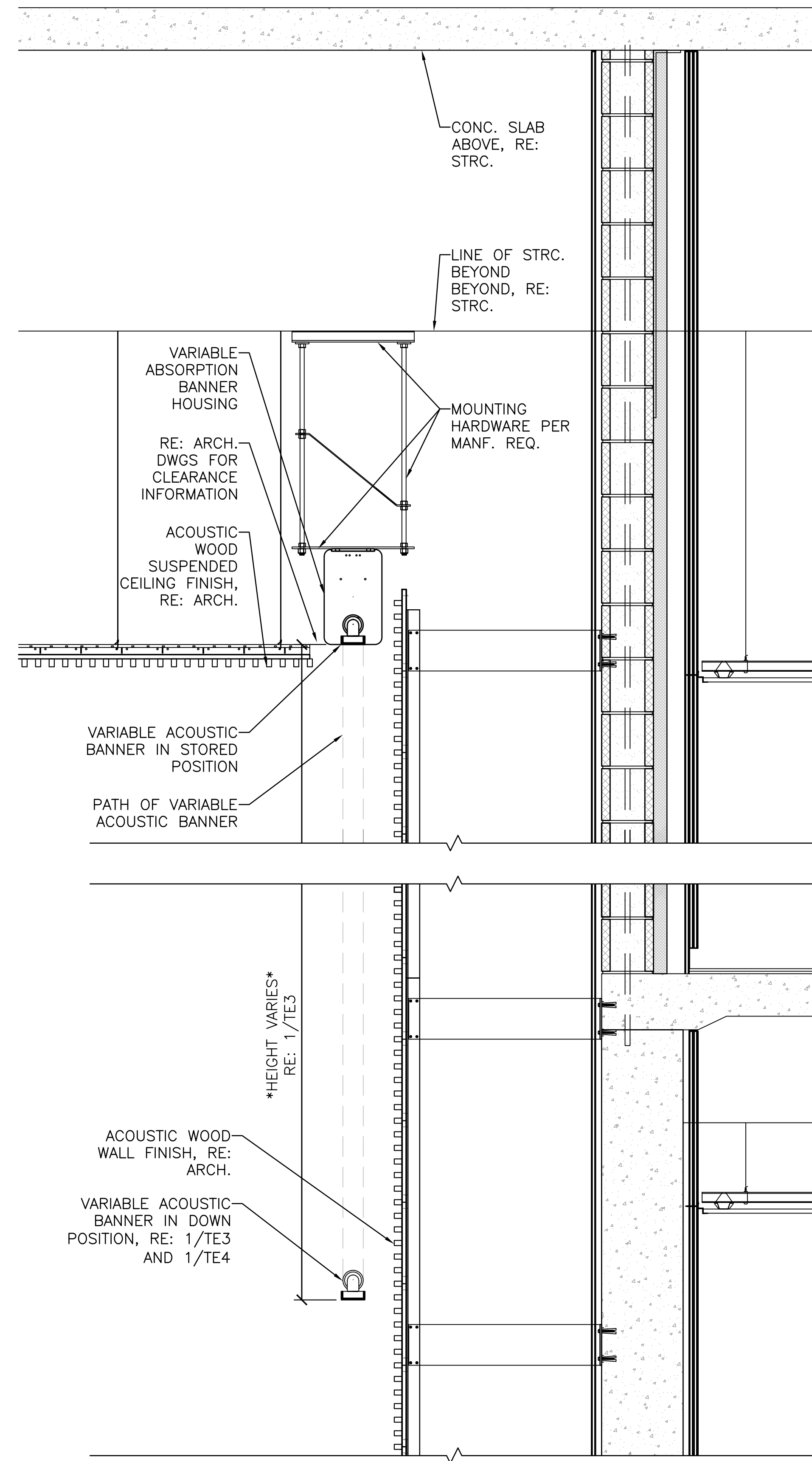
PHASE:

SEAL & SIGNATURE							
NO.	ISSUE DATE	NO.	ISSUE DATE	NO.	ISSUE DATE	NO.	ISSUE DATE
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9		10		11		12	
13		14		15		16	
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89		90		91		92	
93		94		95		96	
97		98		99		100	



USC DARLA MOORE
PERFORMANCE HALL
COVER SHEET

SHEET TITLE:
TE 0
SHEET NUMBER:



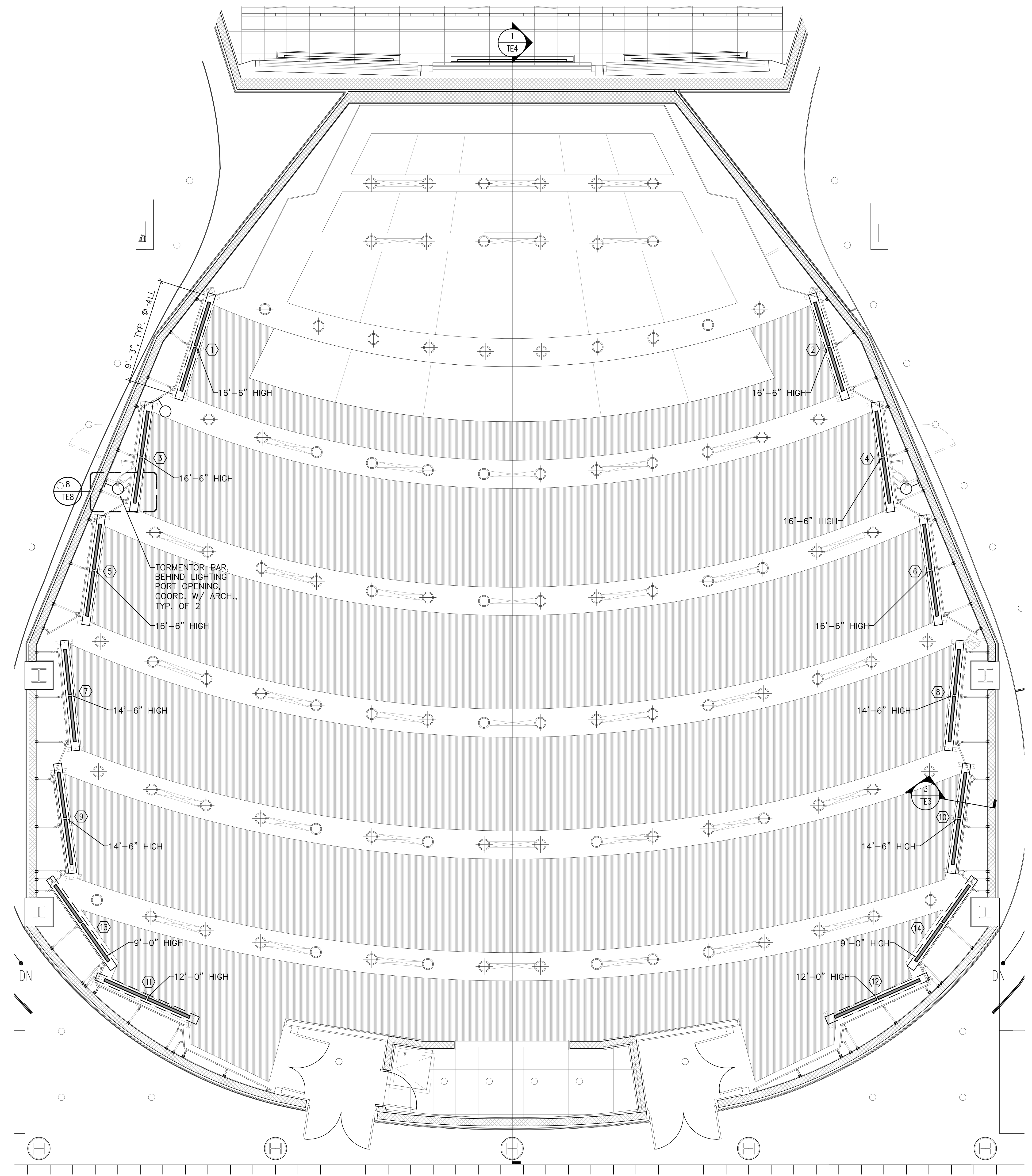
USC DARLA MOORE PERFORMANCE HALL MAIN LEVEL VARIABLE ABSORPTION DETAIL
SCALE: 1" = 1'-0" 03

VARIABLE ABSORPTION BANNER ASSEMBLIES

QUANTITY	LENGTH	WIDTH
12	16'-6"	(2X) 47.5", RE: 4/TE4
4	14'-6"	(2X) 47.5", RE: 3/TE4
8	12'-0"	(2X) 47.5", RE: 2/TE4
4	9'-0"	(2X) 47.5", RE: 5/TE4

- NOTES:
- EACH ASSEMBLY CONSISTS OF:
 - (2) 4'-4.25" WIDE HOUSINGS FOR ROLLS AND MOTORS
 - (2) BANNERS, EACH 47.5" WIDE WITH A 4" GAP BETWEEN
 - (2) COMPACT SINGLE PHASE MOTOR (RE: DETAILS 2,3,4,5/TE4)
 - WIRING INFORMATION IS AS FOLLOWS:
 - MOTOR (2) COMPACT 1Ø UNIT
 - MOTOR WIRING (1X) 3#14+G
 - ENCODER WIRING (1X) BELDEN 1056A
 - LIMIT WIRING (1X) 6#14
 - FLA 1.4 @ 208VAC

USC DARLA MOORE PERFORMANCE HALL MAIN LEVEL VARIABLE ABSORPTION SCHEDULE
SCALE: NTS 02



USC DARLA MOORE PERFORMANCE HALL MAIN LEVEL VARIABLE ABSORPTION PLAN
SCALE: 1/4" = 1'-0" 01

USC BUSINESS PARTNERSHIP FOUNDATION
ON BEHALF OF
USC CAMPUS PLANNING & CONSTRUCTION

PROJECT NAME:
UNIVERSITY OF SOUTH CAROLINA
DARLA MOORE SCHOOL OF BUSINESS CONSTRUCTION

DSE PROJECT NUMBER:
H27-6069-AC-3

743 GREENE STREET
COLUMBIA, SC 29298
TEL: 803 777 4022 FAX: 803 777 0484

ARCHITECT:
RAFAEL VINOLY ARCHITECTS PC
50 VANDIAM STREET
NEW YORK, NY 10013
TEL: 212 924 5060 FAX: 212 924 5858

STRUCTURAL ENGINEER, MEP ENGINEER,
CIVIL ENGINEER, FIRE PROTECTION
ENGINEER:
STEVENS & WILKINSON, SC
1501 MAIN STREET, FLOOR G
COLUMBIA, SC 29201-5801
TEL: 803 765 0320 FAX: 803 254 6209

TELECOMMUNICATIONS, AUDIOVISUAL & ACUSTICS:
JAFFE HOLDEN ACOUSTICS, INC.
114A WASHINGTON STREET
NORWALK, CT 06854-3007
TEL: 203 838 4167 FAX: 203 838 4168

LANDSCAPE ARCHITECT:
GRUMBALL-COTTELL ASSOCIATES
600 BELTLINE BOULEVARD
COLUMBIA, SC 29205
TEL: 803 738 9525 FAX:

SURVEYOR:
BP BARBER & ASSOCIATES, INC.
101 RESEARCH DRIVE
COLUMBIA, SC 29202-1116
TEL: 803 429 4028 FAX:

BUILDING CODE:
HUGHES ASSOCIATES
3610 COMMERCE DRIVE, SUITE 817
BALTIMORE, MD 21227-1652
TEL: 410 731 8017 FAX: 410 731 8688

LIGHTING DESIGNER:
ONE LUX STUDIO, LLC
39 WEST 13TH STREET
NEW YORK, NY 10011
TEL: 212 201 5192 FAX: 212 615 3700

FOOD & WASTE MANAGEMENT:
WILLIAM CARUSO & ASSOCIATES, INC.
805 EAST TUFTS AVE, SUITE 1320
DENVER, CO 80237
TEL: 303 649 1600 FAX: 303 649 1660

SIGNAGE & WAYFINDING:
RAFAEL VINOLY ARCHITECTS PC
50 VANDIAM STREET
NEW YORK, NY 10013
TEL: 212 924 5060 FAX: 212 924 5858

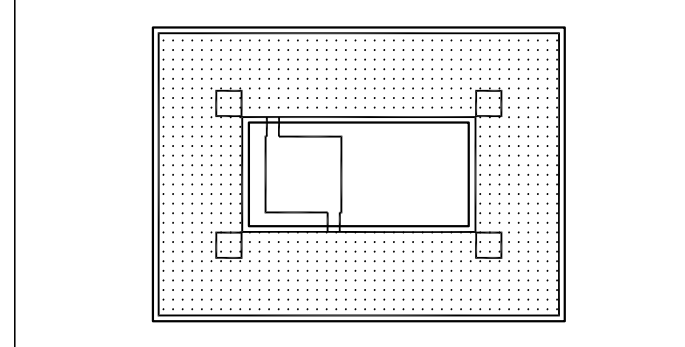
SPECIFICATIONS:
ROBERT SCHWARTZ & ASSOCIATES
589 8TH AVE., 17TH FLOOR
NEW YORK, NY 10018
TEL: 212 691 3248 FAX: 212 633 1613

BID PACKAGE 3
ENCLOSURE/SITE/MEFP/INTERIOR
JUNE 22, 2012

PHASE:

SEAL & SIGNATURE

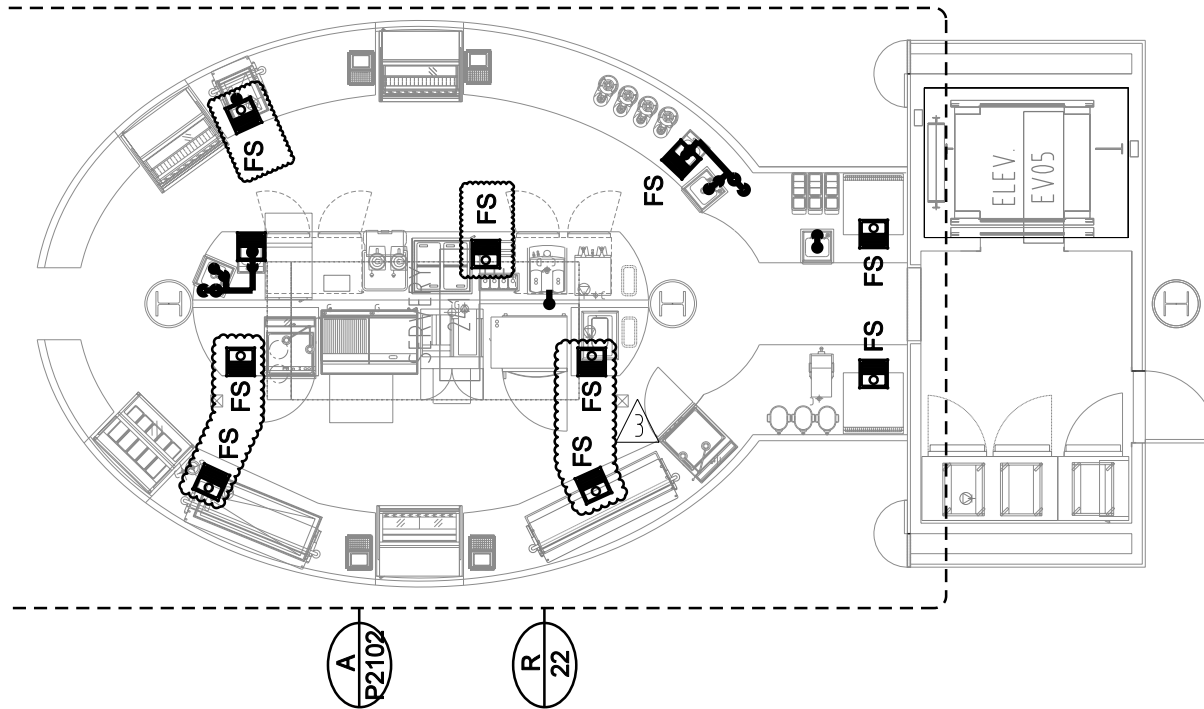
NO.	DATE	NO.	DATE	NO.	DATE
1	2012.06.22	2	2012.05.14	3	2012.04.18
4	2012.01.04				



KEY PLAN & NORTH SIGN
1/4" = 1'-0"

USC DARLA MOORE
PERFORMANCE HALL
VARIABLE ABSORPTION
REFLECTED CEILING PLAN
AND DETAIL
SHEET TITLE:

TE 3
SHEET NUMBER



MOORE SCHOOL OF BUSINESS
 UNIVERSITY OF SOUTH CAROLINA
 BID PACKAGE 3
 ENCLOSURE/SITE/MEFP/INTERIOR
 ADDENDUM #003

PROJECT NO. 655.000

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3	2012.06.22
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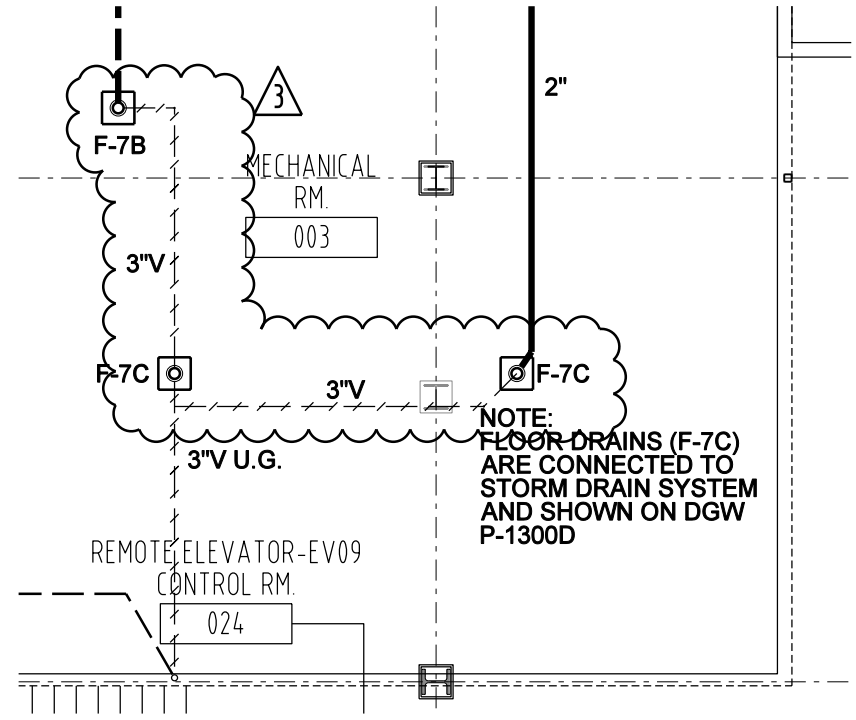
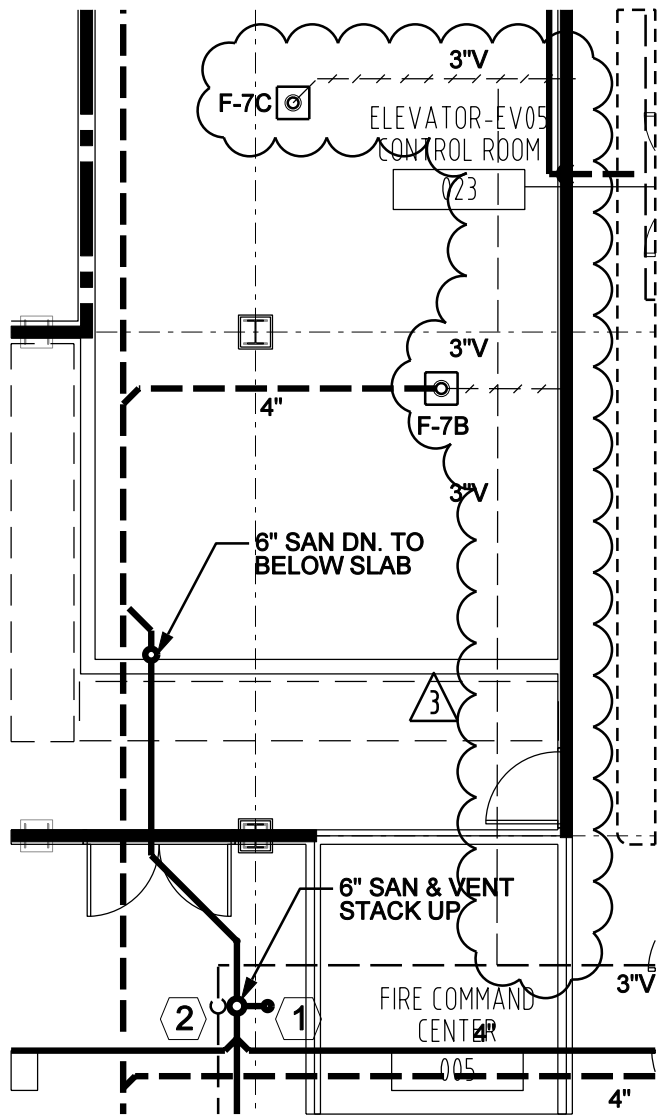
NEW LEVEL 2 CAFE FLOOR DRAIN LAYOUT

REF. DWG # P1220C

SHEET TITLE :

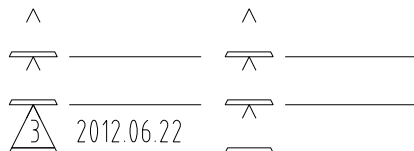
SCALE :
 1/8" = 1'-0"

SHEET NUMBER :
 P-SK-003



MOORE SCHOOL OF BUSINESS
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 BID PACKAGE 3
 ENCLOSURE/SITE/MEPFP/INTERIOR
 ADDENDUM #003

PROJECT NO. 655.000



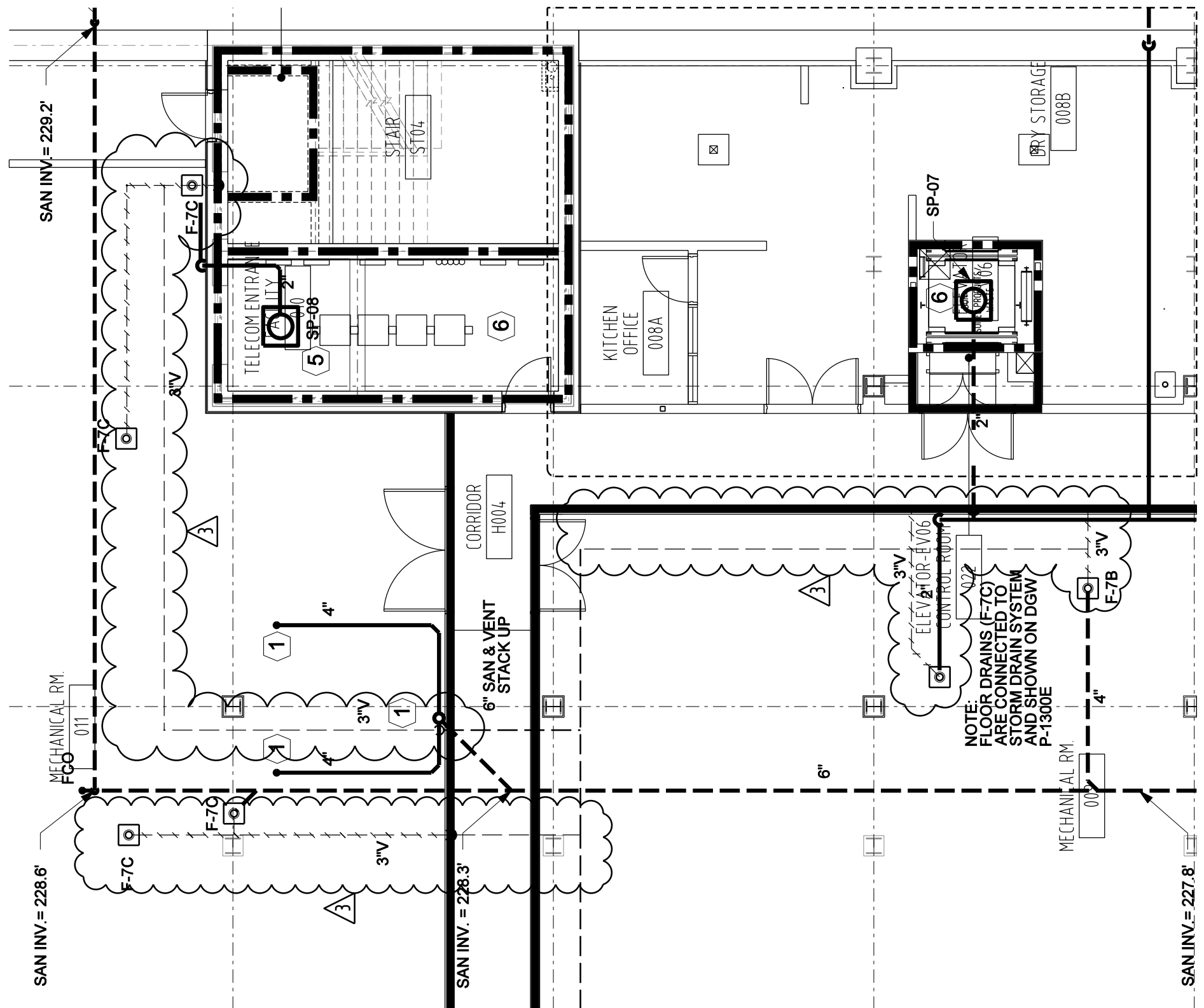
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ADD VENT LINES TO DRAINS
 REF. DWG # P1200D

SHEET TITLE :

SCALE :
 1/8" = 1'-0"

SHEET NUMBER :
 P-SK-004

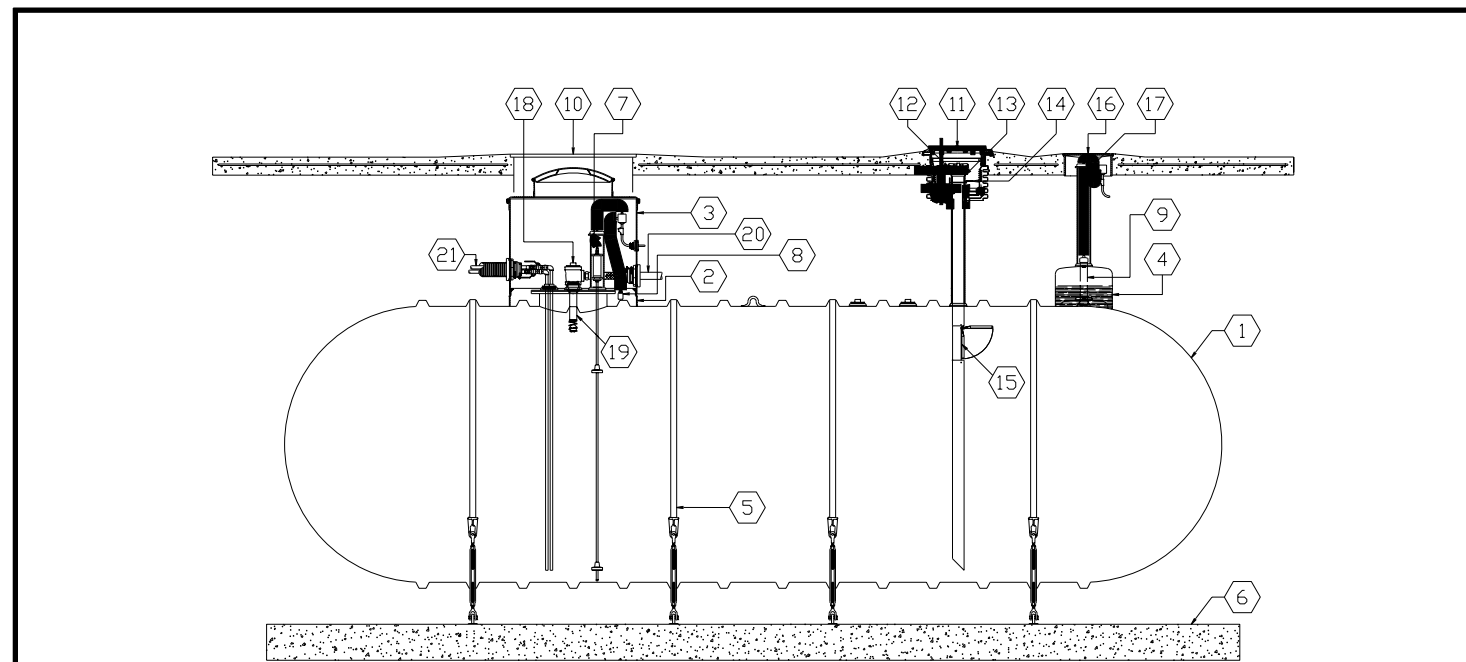


MOORE SCHOOL OF BUSINESS
 UNIVERSITY OF SOUTH CAROLINA
 BID PACKAGE 3
 ENCLOSURE/SITE/MEPFP/INTERIOR
 ADDENDUM #003
 PROJECT NO. 655.000

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 ^
 2012.06.22
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ADD VENT LINES TO DRAINS
 REF. DWG # P1200E
 SHEET TITLE :

SCALE :
 1/8" = 1'-0"
 SHEET NUMBER :
 P-SK-005



PARTS LIST			
No.	Manuf.	Model	Description
1	Xerxes		Double Wall Fiberglass Storage Tank
2	Xerxes		42" Fiberglass Attached Collar
3	Xerxes		42" Watertight Fiberglass Attached Collar Riser
4	Xerxes		Hydrostatic Monitoring System
5	Xerxes		Fiberglass hold Down Strap w/ Turnbuckle Assy.
6	Xerxes		Xerxes Precast Deadman System
7			Level Probe
8			Distinguishing Leak Sensor
9			Hydrostatic Monitoring Sensor
10			Large Round Manhole
11			Five Gallon Spill Fill Manhole
12			Fill Cap
13			Fill Adapter
14			Product Label Marker
15			Overfill Prevention Valve
16			Monitoring Manhole
17			4" Sensor Cap
18			Extractor Assembly
19			Ball Float
20			Single Wall Vent Piping
21			Double Wall Product Supply Piping
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FUEL TANK DETAIL
SCALE : NONE

11

3

SECTION 087100 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
 - 1. Swinging doors.
 - 2. Sliding Doors
 - 3. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical door hardware, power supplies, back-ups and surge protection.
 - 3. Automatic operators.
 - 4. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Section 06 10 00 – Rough Carpentry
 - 2. Section 06 20 00 – Finish Carpentry
 - 3. Section 08 01 00 – Operations and Maintenance
 - 4. Section 08 11 13 – Hollow Metal Doors and Frames
 - 5. Section 08 14 16 – Flush Wood Doors
 - 6. Section 08 41 13 – Aluminum-Framed Entrances and Storefronts.
 - 7. Section 08 81 00 – Glass and Glazing
 - 8. Section 09 90 00 – Painting
 - 9. Section 28 13 00 – Access Control
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ANSI/SDI A250.13 - Testing and Rating of Severe Windstorm Resistant Components for Swing Door Assemblies.
 - 3. ASTM E1886 - Test Method for Performance of Exterior Windows, Curtin Walls, Doors and Shutters Impacted by Missiles and Exposed to Cyclic Pressure Differentials.
 - 4. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure difference.
 - 5. ASTM E1996 - Standard specification for performance of exterior windows, curtain walls, doors and storm shutters impacted by Windborne Debris in Hurricanes.
 - 6. FEMA 361 2008 - Design and Construction Guidance for Community Safe Rooms.
 - 7. ICC 500 - ICC/NSSA Standard for the Design and Construction of Storm Shelters.
 - 8. ICC/IBC - International Building Code.
 - 9. NFPA 70 - National Electrical Code.
 - 10. NFPA 80 - Fire Doors and Windows.

11. NFPA 101 - Life Safety Code.
12. NFPA 105 - Installation of Smoke Door Assemblies.
13. TAS-201-94 - Impact Test Procedures.
14. TAS-202-94 - Criteria for Testing Impact and Non-Impact Resistant Building Envelope Components using Uniform Static Air Pressure.
15. TAS-203-94 - Criteria for Testing Products Subject to Cyclic Wind Pressure Loading.
16. State Building Codes, Local Amendments.

- E. Standards: All hardware specified herein shall comply with the following industry standards:
1. ANSI/BHMA Certified Product Standards - A156 Series
 2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.4 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.
- C. Door and Frame Preparation: Related Division 08 Sections (Steel, Aluminum and Wood) doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.5 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship

within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

D. Special Warranty Periods:

1. Ten years for mortise locks and latches.
2. Five years for exit hardware.
3. Ten years for manual door closers.
4. Two years for electromechanical door hardware.

1.6 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

B. Continuing Service: Beginning at Substantial Completion, and running concurrent with the specified warranty period, provide continuous (6) months full maintenance including repair and replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door opening operation. Provide parts and supplies as used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

1. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
 - a. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
2. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
 - a. Permanent cylinders, cores, and keys to be installed by Owner.

B. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles as specified in the Door Hardware Sets.
1. Quantity: Provide the following hinge quantity, unless otherwise indicated:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing hinges unless Hardware Sets indicate heavy weight.
 - c. Tornado Resistant Assemblies: At a minimum, provide heavy weight hinges with stainless steel screws used in accordance with and specified as part of a Severe Storm Shelter Opening meeting ICC 500 and FEMA 361.
 4. Hinge Options: Comply with the following where indicated in the Hardware Sets or on Drawings:
 - a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the following applications:
 - 1) Out-swinging exterior doors.
 - 2) Out-swinging access controlled doors.
 5. Acceptable Manufacturers:
 - a. Hager Companies (HA).
 - b. McKinney Products (MK).
 - c. Stanley Hardware (ST).
- B. Continuous Geared Hinges: ANSI/BHMA A156.26 certified continuous geared hinge with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Provide concealed flush mount (with or without inset), full surface, or half surface, in standard and heavy duty models, as specified in the Hardware Sets. Concealed continuous hinges to be U.L. listed for use on up to and including 90 minute rated door installations and U.L. listed for windstorm components where applicable. Factory cut hinges for door size and provide with removable service power transfer panel where indicated at electrified openings.
1. Acceptable Manufacturers:
 - a. McKinney Products (MK).
 - b. Pemko Manufacturing (PE).
 - c. Stanley Hardware (ST).

2.3 POWER TRANSFER DEVICES

- A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug

directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Acceptable Manufacturers:
 - a. Hager Companies (HA) - ETW-QC (# wires) Option.
 - b. McKinney Products (MK) - QC (# wires) Option.

- B. Electrified Quick Connect Continuous Geared Transfer Hinges: Provide electrified transfer continuous geared hinges with a 12" removable service panel cutout accessible without de-mounting door from the frame. Furnish with Molex™ standardized plug connectors with sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
 1. Acceptable Manufacturers:
 - a. McKinney Products (MK) - SER-QC (# wires) Option.
 - b. Pemko Manufacturing (PE) - SER-QC (# wires) Option.

- C. Provide mortar guard enclosure on steel frames installed at masonry openings for each electrical hinge specified.

- D. Electric Door Hardware Cords: Provide electric transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.
 1. Acceptable Manufacturers:
 - a. McKinney Products (MK) - Inner Door Cord 3 inches: QC-C003P.
 - b. McKinney Products (MK) - Inner Door Cord 3 foot door: QC-C206P.
 - c. McKinney Products (MK) - Inner Door Cord 4 foot door: QC-C306P.
 - d. McKinney Products (MK) - Inner Door Cord 15 feet: QC-C1500P.
 - e. McKinney Products (MK) - Hinge to Junction Panel 15 feet: QC-C1500P.

Provide one each of the following tools as part of the base bid contract:

 - f. McKinney Products (MK) - Electrical Connecting Kit: 52-3000.
 - g. McKinney Products (MK) - Connector Hand Tool: 52-0439.

2.4 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified automatic, self-latching, and manual flush bolts and surface bolts. Manual flush bolts to be furnished with top rod of sufficient length to allow bolt location approximately six feet from the floor. Furnish dust proof strikes for bottom bolts. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
 1. Acceptable Manufacturers:
 - a. Burns Manufacturing (BU).
 - b. Door Controls International (DC).
 - c. Ives (IV).
 - d. Rockwood Manufacturing (RO).
 - e. Trimco (TC).

- B. Door Push Plates and Pulls: ANS/BHMA A156.6 certified door pushes and pulls of type and design specified below or in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
1. Push/Pull Plates: Minimum .050 inch thick, 4-inches wide by 16-inches high, with square corners and beveled edges, secured with exposed screws unless otherwise indicated.
 2. Straight Pull Design: Minimum 1-inch round diameter stainless steel bar or tube stock pulls with 2 1/2-inch projection from face of door unless otherwise indicated.
 3. Offset Pull Design: Minimum 1-inch round diameter stainless steel bar or tube stock pulls with 2 1/2-inch projection and offset of 90 degrees unless otherwise indicated.
 4. Push Bars: Minimum 1-inch round diameter horizontal push bars with minimum clearance of 2 1/2-inch projection from face of door unless otherwise indicated.
 5. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
 - a. Acceptable Manufacturers:
 - 1) Burns Manufacturing (BU).
 - 2) Ives (IV).
 - 3) Rockwood Manufacturing (RO).
 - 4) Trimco (TC).

2.5 CYLINDERS AND KEYING

- A. Source Limitations: Obtain each type of keyed cylinder housing from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU).
 - b. Sargent Manufacturing (SA).
 - c. Schlage (SC).
 - d. Stanley Best (BE).
 - e. Yale Locks and Hardware (YA).
- B. Cylinders: Original manufacturer cylinders complying with the following:
1. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
 2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
 4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
- C. Permanent Cores: All permanent cylinder cores to be supplied by owner.
1. Interchangeable Cores: Core insert, removable by use of a special key; usable with other manufacturers' cylinders.
- D. Key Quantity: Provide the following minimum number of keys:
1. Construction Control Keys (where required): Two (2)
 2. Construction Change Keys (where required): Twenty (20)
- E. Construction Keying: Provide temporary keyed construction cores where specified. Provide construction master keys in quantity as required by project Contractor.

2.6 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified mortise locksets furnished in the functions as specified in the Hardware Sets. Locksets

to be manufactured with a corrosion resistant, stamped 12 gauge minimum formed steel case and be field-reversible for handing without disassembly of the lock body. Lockset trim (including knobs, levers, escutcheons, roses) to be the product of a single manufacturer. Furnish with standard 2 3/4" backset, 3/4" throw anti-friction stainless steel latchbolt, and a full 1" throw stainless steel bolt for deadbolt functions.

1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) – ML2000 Series.
 - b. Sargent Manufacturing (SA) – (R)8200 Series.
 - c. Yale Locks and Hardware (YA) – 8800FL Series.

- B. Multi-Point Locksets: Vertical rod locking devices designed for openings requiring multiple latching points within one locking mechanism. Rods are retracted by dual mounted outside lever trim controls available in a variety of ANSI/BHMA operational functions. Option for single top latching only eliminates the need for bottom strikes. Electromechanical options include solenoid activated trim and inside and outside lever monitoring.
 1. Acceptable Manufacturers:
 - a. Sargent Manufacturing (SA) - 7000 Series.

- C. Lock Trim Design: As specified in Hardware Sets.

- D. Knurling: Where required by local code provide knurling or abrasive coating to all levers on doors leading to hazardous areas such as mechanical rooms, boiler and furnace rooms, janitor closets, and as otherwise required or specified.

2.7 ELECTROMECHANICAL LOCKING DEVICES

- A. Electromechanical Mortise Locksets, Grade 1 (Heavy Duty): Subject to same compliance standards and requirements as mechanical mortise locksets, electrified locksets to be of type and design as specified below.
 1. Electrified Lock Options: Where indicated in the Hardware Sets, provide electrified options including: outside door lock/unlock trim control, latchbolt and lock/unlock status monitoring, and request-to-exit signaling. Unless otherwise indicated, provide electrified locksets standard as fail secure.
 2. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ML20900 Series.
 - b. Sargent Manufacturing (SA) - 8200 Series.
 - c. Schlage (SC) - L9000 EL/EU/RX Series.
 - d. Stanley Best (BE) - 47HW EL/EU Series.
 - e. Yale Locks and Hardware (YA) - 8890 Series.

- B. Electromechanical Multi-Point Locks: Vertical rod locking devices designed for openings requiring multiple latching points within one locking mechanism. Rods are retracted by dual mounted outside lever trim controls available in a variety of ANSI/BHMA operational functions. Option for single top latching only eliminates the need for bottom strikes. Electromechanical options include solenoid activated trim and inside and outside lever monitoring.
 1. Acceptable Manufacturers:
 - a. Sargent Manufacturing (SA) - 7073/7074 Series.

2.8 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 - 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 - 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.

- B. Standards: Comply with the following:
 - 1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 - 2. Strikes for Bored Locks and Latches: BHMA A156.2.
 - 3. Strikes for Auxiliary Deadlocks: BHMA A156.5.
 - 4. Dustproof Strikes: BHMA A156.16.

2.9 ELECTRIC STRIKES

- A. Standard Electric Strikes: Heavy duty, cylindrical and mortise lock electric strikes conforming to ANSI/BHMA A156.31, Grade 1, UL listed for both Burglary Resistance and for use on fire rated door assemblies. Stainless steel construction with dual interlocking plunger design tested to exceed 3000 lbs. of static strength and 350 ft-lbs. of dynamic strength. Strikes tested for a minimum 1 million operating cycles. Provide strikes with 12 or 24 VDC capability and supplied standard as fail-secure unless otherwise specified. Option available for latchbolt and latchbolt strike monitoring indicating both the position of the latchbolt and locked condition of the strike.
 - 1. Acceptable Manufacturers:
 - a. HES (HE)
 - b. Adams Rite (AD)
 - c. Folger Adam EDC (FA)

- B. Provide electric strikes with in-line power controller and surge suppressor by the same manufacturer as the strike with combined products having unlimited lifetime warranty.

2.10 CONVENTIONAL EXIT DEVICES

- A. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Mounting rails to be formed from smooth stainless steel, brass or bronze architectural materials no less than 0.072" thick, with push rails a minimum of 0.062" thickness. Painted or aluminum metal rails are not acceptable. Exit device latch to be investment cast stainless steel, pullman type, with deadlock feature.
 - 1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
 - b. Sargent Manufacturing (SA) - 80 Series.
 - c. Yale Locks and Hardware (YA) - 7000 Series.

- B. Conventional Drop Bar Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device crossbars to be seamless assemblies of brass, bronze, or stainless steel construction with a minimum thickness of .065". Crossbars lever arms to be drop forged and counter balanced by springs in both the center and hinge style cases.

1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ED6000 Series.
 - b. Sargent Manufacturing (SA) - 90 Series.
 - c. Stanley Precision (PR) - Olympian Series.
 - d. Von Duprin (VD) - 88 Series.
 - e. Yale Locks and Hardware (YA) - 1500 Series.

2.11 PANIC HANDLE EXIT DEVICES

- A. Panic device shall be 1-1/4" diameter with interior operating panic handle in combination with exterior fixed pull handles designated by letters. Panic mechanism shall be concealed within the brass or stainless steel tubing. Entrance from exterior by keyed cylinder, optional.
 1. Acceptable Manufacturers:
 - a. C R Laurence (CL)
 - b. Blumcraft

2.12 ***ELECTROMECHANICAL CONVENTIONAL EXIT DEVICES***

- A. ***Electrified Conventional Push Rail Devices (Heavy Duty): Subject to same compliance standards and requirements as mechanical exit devices, electrified devices to be of type and design as specified below.***
 1. ***Acceptable Manufacturers:***
 - a. ***Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.***
 - b. ***Sargent Manufacturing (SA) - 80 Series.***
 - c. ***Stanley Precision (PR) - Apex 2000 Series.***
 - d. ***Von Duprin (VD) - 35A/98/99 Series.***
 - e. ***Yale Locks and Hardware (YA) - 7000 Series.***
- B. ***Electrified Options: As indicated in hardware sets, provide electrified exit device options including: electric latch retraction, electric dogging, outside door trim control, exit alarm, delayed egress, latchbolt monitoring, lock/unlock status monitoring, touchbar monitoring and request-to-exit signaling. Unless otherwise indicated, provide electrified exit devices standard as fail secure.***
- C. ***Power supplies: Provide exit device manufacturer approved power supplies as required to integrate with electrified options specified in hardware sets.***

2.13 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
 1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.
 2. Standards: Closers to comply with UL-10C and UBC 7-2 for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use.

Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.

4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 - a. Where closers are indicated to have mechanical dead-stop, provide heavy duty arms and brackets with an integral positive stop.
 - b. Where closers are indicated to have mechanical hold open, provide heavy duty units with an additional built-in mechanical holder assembly designed to hold open against normal wind and traffic conditions. Holder to be manually selectable to on-off position.
 - c. Where closers are indicated to have a cushion-type stop, provide heavy duty arms and brackets with spring stop mechanism to cushion door when opened to maximum degree.
 - d. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics. Provide drop plates or other accessories as required for proper mounting.
 5. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates, and through-bolt or security type fasteners as specified in the door Hardware Sets.
 6. Hurricane and Tornado Resistance Compliance: Door closers to be U.L. listed for windstorm components where applicable. Provide the appropriate hurricane or tornado resistant products that have been independent third party tested, certified, and labeled to meet state and local windstorm building codes applicable to project.
- B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units and high impact, non-corrosive plastic covers standard.
1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) - DC8000 Series.
 - b. Sargent Manufacturing (SA) - 351 Series.
 - c. Norton Door Controls (NO) - 7500 Series.
 - d. Yale Locks and Hardware (YA) - 4400 Series.
- C. Door Closers, Surface Mounted (Unitrol): ANSI/BHMA 156.4, Grade 1 certified surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Unitrol arms to have door stop mechanism to absorb dead stop shock on arm and top hinge. Hold-open arms to have a spring loaded mechanism in addition to shock absorber assembly. Arms to be provided with rigid steel main arm and secondary arm lengths proportional to the door width. Provide high impact, non-corrosive plastic covers standard.
1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) - Unitrol DC8000 Series.
 - b. Norton Door Controls (NO) - Unitrol 7500 Series.
 - c. Yale Locks and Hardware (YA) - Unitrol 4400 Series.

2.14 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 - 1. Acceptable Manufacturers:
 - a. Burns Manufacturing (BU).
 - b. Ives (IV).
 - c. Rockwood Manufacturing (RO).
 - d. Trimco (TC).

- C. Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.
 - 1. Acceptable Manufacturers:
 - a. Rixson Door Controls (RF).
 - b. Rockwood Manufacturing (RO).
 - c. Sargent Manufacturing (SA).

2.15 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: :Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 - 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and UBC 7-2, Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Hurricane and Tornado Resistance Compliance: Architectural seals to be U.L. listed for windstorm components where applicable. Provide the appropriate hurricane or tornado resistant products that have been independent third party tested, certified, and labeled to meet state and local windstorm building codes applicable to project.
- G. Acceptable Manufacturers:
 - 1. Pemko Manufacturing (PE).
 - 2. Reese Enterprises, Inc. (RS).

- A. Request-to-Exit Motion Sensor: Request-to-Exit Sensors motion detectors specifically designed for detecting exiting through a door from the secure area to a non-secure area. Include built-in timers (up to 60 second adjustable timing), door monitor with sounder alert, internal vertical pointability coverage, 12VDC or 24VDC power and selectable relay trigger with fail safe/fail secure modes.
 - 1. Acceptable Manufacturers:
 - a. Security Door Controls (SD) - MD-31D Series.
 - b. Securitron Door Controls (SU) - XMS Series.

2.17 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.18 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- D. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.

- C. Clean operating items as necessary to restore proper finish, and provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SCHEDULE

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

- B. Manufacturer's Abbreviations:

1. MK - McKinney
2. RF - Rixson
3. RO - Rockwood
4. SA - Sargent
5. AD - Adams Rite
6. BE - Stanley Security Solutions Inc (BE)
7. FO - Folger Adam
8. SU - Securitron
9. LC - LCN Closers
10. PE - Pemko

Hardware Schedule

Set: 1.0

8 Hinge	as required	US15	MK
2 Multi-Point Lock	70 NB7006 ETMI	US15	SA
2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Surface Closer	4041 Series	AL	LC
2 Door Stop	as requires	US26D	RO
1 Gasketing	S88BL		PE

Set: 1.1

6 Hinge	as required	US15	MK
2 Multi-Point Lock	70 NB7006 ETMI	US15	SA

2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Door Stop	as requires	US26D	RO
2 Silencer	608		RO

Set: 1.2

8 Hinge	as required	US15	MK
2 Multi-Point Lock	70 NB7006 ETMI	US15	SA
2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Door Stop	as requires	US26D	RO
2 Silencer	608		RO

Set: 2.0

1 Cylinder	as required	US26D	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE

Set: 3.0

8 Hinge	as required	US15	MK
2 Multipoint Lock	70 NB7013 ETMI	US15	SA
2 Cylinder	as required	US26D	SA
2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Door Stop	as requires	US26D	RO
1 Gasketing	S88BL		PE
2 Door Bottom	434APKL		PE
1 Astragal	18041CNB		PE
2 Silencer	608		RO

Set: 3.1

8 Hinge	as required	US15	MK
2 Multipoint Lock	70 NB7013 ETMI	US15	SA
2 Cylinder	as required	US26D	SA
2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Silencer	608		RO

Set: 3.2

8 Hinge	as required	US15	MK
1 Flush Bolt	2845 or 2945	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Entry Lock	70 8256 LNMI	US15	SA

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1	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2	Surface Closer	4041 Series	AL	LC
1	Coordinator	2600 Series	Black	RO
2	Mounting Bracket	as required	Black	RO
2	Door Stop	as requires	US26D	RO
1	Gasketing	379CR		PE
2	Door Bottom	420APKL		PE

Set: 3.3

6	Hinge	as required	US15	MK
2	Multipoint Lock	70 NB7013 ETMI	US15	SA
2	Cylinder	as required	US26D	SA
2	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2	Door Stop	as requires	US26D	RO
1	Gasketing	S88BL		PE
2	Door Bottom	434APKL		PE
2	Astragal	18041CNB		PE
2	Silencer	608		RO

Set: 3.4

4	Hinge	as required	US15	MK
2	Flush Bolt	555	US26D	RO
1	Dust Proof Strike	570	US26D	RO
1	Classroom Lock	70 8237 LNMI	US15	SA
1	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2	Door Stop	as requires	US26D	RO
1	Gasketing	S88BL		PE
2	Door Bottom	434APKL		PE
2	Astragal	18041CNB		PE
2	Silencer	608		RO

Set: 4.0

4	Hinge	as required	US15	MK
1	Storeroom Lock	70 8204 LNMI	US15	SA
1	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Surface Closer	4041 Series	AL	LC
1	Door Stop	as requires	US26D	RO
3	Silencer	608		RO

Set: 4.1

4 Hinge	as required	US15	MK
1 Storeroom Lock	70 8204 LNMI	US15	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
1 Gasketing	S88BL		PE

Set: 4.2

4 Hinge	as required	US15	MK
1 Storeroom Lock	70 8204 LNMI	US15	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Door Stop	as requires	US26D	RO
3 Silencer	608		RO

Set: 4.3

3 Hinge	as required	US15	MK
1 Storeroom Lock	70 8204 LNMI	US15	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
1 Gasketing	S88BL		PE

Set: 4.4

3 Hinge	as required	US15	MK
1 Storeroom Lock	70 8204 LNMI	US15	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO
3 Silencer	608		RO

Set: 5.0

4 Hinge	as required	US15	MK
1 Exit Device	12 43 8815 ETMI	US32D	SA
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO
3 Silencer	608		RO

Set: 5.1

3 Hinge	as required	US15	MK
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1	Exit Device	12 43 8815 ETMI	US32D	SA
1	Surface Closer	4041 Series	AL	LC
1	Door Stop	as requires	US26D	RO
3	Silencer	608		RO

Set: 6.0

4	Hinges	by STC Assembly Supplier		
1	Exit Device	16 43 70 8813 ETMI	US32D	SA
2	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Surface Closer	4041 Series	AL	LC
1	Door Stop	as requires	US26D	RO
1	Sound Seal System	by STC Assembly Supplier		

Set: 6.1

4	Hinge	as required	US15	MK
3	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Surface Closer	4041 Series	AL	LC
1	Door Stop	as requires	US26D	RO
1	Gasketing	379CR		PE
1	Door Bottom	420APKL		PE
1	Exit Device	16 43 70 8816 ETMI	US32D	SA

Set: 6.2

4	Hinge	as required	US15	MK
1	Exit Device	16 43 70 8813 ETMI	US32D	SA
2	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Surface Closer	4041 Series	AL	LC
1	Gasketing	379CR		PE
1	Door Bottom	420APKL		PE

Set: 6.3

4	Hinge	as required	US15	MK
1	Exit Device	16 43 70 8816 ETMI	US32D	SA
3	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Surface Closer	4041 Series	AL	LC
1	Door Stop	as requires	US26D	RO
1	Gasketing	S88BL		PE
1	Door Bottom	434APKL		PE

Set: 7.0

8 Hinge	as required	US15	MK
2 Surface Vert Rod Exit	16 43 70 NB8715 ETMI	US32D	SA
2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Surface Closer	4041 Series	AL	LC
2 Door Stop	as requires	US26D	RO
2 Silencer	608		RO

Set: 7.1

8 Hinge	as required	US15	MK
2 Surface Vert Rod Exit	16 43 70 NB8713 ETMI	US32D	SA
4 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Surface Closer	4041 Series	AL	LC
2 Door Stop	as requires	US26D	RO
2 Silencer	608		RO

Set: 7.2

8 Hinge	as required	US15	MK
2 Exit Device (CVR, passage)	NB 16 43 WD8615 ETMI	US32D	SA
2 Surface Closer	4041 Series	AL	LC
2 Door Stop	as requires	US26D	RO
2 Gasketing	S88BL		PE
2 Door Bottom	434APKL		PE
1 Astragal	354C		PE
1 Astragal	354CS		PE

Set: 7.3

8 Hinge	as required	US15	MK
2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Push/Pulls	as selected by architect		
2 Surface Closer	4041 Series	AL	LC
2 Door Stop	as requires	US26D	RO
1 Gasketing	379CR		PE
2 Door Bottom	420APKL		PE
1 Astragal	354C		PE
1 Astragal	354CS		PE

Set: 7.4

8 Hinge	as required	US15	MK
2 Push/Pulls	as selected by architect		
2 Surface Closer	4041 Series	AL	LC
2 Door Stop	as requires	US26D	RO
2 Silencer	608		RO

Set: 8.0

8 Hinges	by STC Assembly Supplier		
2 Surface Vert Rod Exit	16 43 70 NB8713 ETMI	US32D	SA
2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Surface Closer	4041 Series	AL	LC
2 Door Stop	as requires	US26D	RO
1 Sound Seal System	by STC Assembly Supplier		

Set: 8.1

8 Hinge	as required	US15	MK
2 Surface Vert Rod Exit	16 43 70 NB8713 ETMI	US32D	SA
2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Surface Closer	4041 Series	AL	LC
2 Door Stop	as requires	US26D	RO
1 Gasketing	S88BL		PE

Set: 8.2

2 Continuous Hinge	MCK-12HD	CL	MK
2 Set Push/Pull	DH100D	US32D	CL
2 Surface Closer	4041 Series	AL	LC
2 Door Stop	as requires	US26D	RO

Set: 8.3

8 Raised Barrel Hinge	RB - size as required	US15	MK
2 Surface Vert Rod Exit	16 43 70 NB8713 ETMI	US32D	SA
4 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Surface Closer	4041 H	AL	LC
1 Gasketing	379CR		PE
2 Door Bottom	420APKL		PE
1 Astragal	354C		PE
1 Astragal	354CS		PE

Set: 8.4

2	Continuous Hinge	MCK-12HD	CL	MK
2	Exit Device	8893	US32D	SA
2	Surface Closer	4041 Series	AL	LC
2	Door Stop	as requires	US26D	RO
1	Gasketing	S88BL		PE

Set: 8.5

8	Hinge	as required	US15	MK
2	Surface Vert Rod Exit	16 43 70 NB8713 ETMI	US32D	SA
2	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2	Surface Closer	4041 Series	AL	LC
1	Gasketing	379CR		PE
2	Door Bottom	420APKL		PE
1	Astragal	354C		PE
1	Astragal	354CS		PE

Set: 9.0

3	Continuous Hinge	MCK-25HD	CL	MK
3	Flush Pull	95B	US26D	RO
2	Roller Caster	10600		RF
2	Surface Bolt	585-24	US26D	RO

Set: 10.0

4	Hinge	as required	US15	MK
1	Classroom Lock	70 8237 LNMI	US15	SA
1	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Surface Closer	4041 Series	AL	LC
1	Door Stop	as requires	US26D	RO
3	Silencer	608		RO

Set: 10.1

4	Hinge	as required	US15	MK
1	Entry Lock	70 8256 LNMI	US15	SA
1	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Door Stop	as requires	US26D	RO
3	Silencer	608		RO

Set: 10.2

4 Hinge	as required	US15	MK
1 Entry Lock	70 8256 LNMI	US15	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO
1 Gasketing	379CR		PE
1 Door Bottom	420APKL		PE

Set: 10.3

3 Hinge	as required	US15	MK
1 Classroom Lock	70 8237 LNMI	US15	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO
3 Silencer	608		RO

Set: 11.0

4 Hinge	as required	US15	MK
1 Privacy Set	49 8265 LNMI	US15	SA
1 Door Stop	as requires	US26D	RO
3 Silencer	608		RO

Set: 11.1

3 Hinge	as required	US15	MK
1 Privacy Set	49 8265 LNMI	US15	SA
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO
3 Silencer	608		RO

Set: 11.2

4 Hinge	as required	US15	MK
1 Dormitory Lock	70 8225 LNMI	US15	SA
1 Door Stop	as requires	US26D	RO
3 Silencer	608		RO

Set: 12.0

4 Hinge	as required	US15	MK
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1 Classroom Security Lock	70 8238 LNMI	US15	SA
2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO
3 Silencer	608		RO

Set: 12.1

4 Hinge	as required	US15	MK
1 Classroom Security Lock	70 8238 LNMI	US15	SA
2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO
1 Gasketing	379CR		PE
1 Door Bottom	420APKL		PE

Set: 14.0

4 Hinge	as required	US15	MK
1 Passage Set	8215 LNMI	US15	SA
1 Door Stop	as requires	US26D	RO
3 Silencer	608		RO

Set: 14.1

4 Hinge	as required	US15	MK
1 Classroom Lock	70 8237 LNMI	US15	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Door Stop	as requires	US26D	RO
3 Silencer	608		RO

Set: 14.2

4 Hinge	as required	US15	MK
1 Classroom Lock	70 8237 LNMI	US15	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Gasketing	379CR		PE
1 Door Bottom	420APKL		PE

Set: 17.0

4 Hinge	as required	US15	MK
1 Storeroom Lock	70 8204 LNMI	US15	SA

1	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Surface Closer	4041 SCUSH	AL	LC
1	Threshold	to architect detail		PE
1	Gasketing	Head & Jamb		PE
1	Sweep	18061CNB		PE
1	Door Position Switch	by security system supplier		

Set: 18.0

1	Continuous Hinge	MCK-25HD	CL	MK
1	Exit Device	12 43 70 8804 ETMI	US32D	SA
1	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Surface Closer	4041 SCUSH	AL	LC
1	Threshold	to architect detail		PE
1	Gasketing	Head & Jamb		PE
1	Sweep	18061CNB		PE

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches & allows for authorized entrance. Operating inside trim activates request to exit switch shunting door contacting and allowing authorized egress at all times. With loss of power door remains locked.

Set: 19.0

2	Continuous Hinge	MCK-12HD	CL	MK
2	Exit Device	8893	US32D	SA
2	Surface Closer	4041 SCUSH	AL	LC
1	Threshold	to architect detail		PE
1	Gasketing	Head & Jamb		PE
2	Sweep	18061CNB		PE
1	Astragal	18041CNB		PE

Notes: Door closed & locked at all times. Opening door from outside trips door contact sending alarm message to building security system. Operating inside trim activates request to exit switch shunting door contacting and allowing authorized egress at all times.

Set: 20.0

1	Cylinder	as required	US26D	SA
1	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	All Hardware by Assembly Supplier			

Set: 21.0

4 Hinge	as required	US15	MK
1 Mortise Lock	2190 1 3-Small Format Trim MI Strike to Match	US32D	AD
1 Cylinder	as required	US26D	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO

Set: 21.1

4 Hinge	as required	US15	MK
1 Mortise Lock	2190 1 3-Small Format Trim MI Strike to Match	US32D	AD
1 Cylinder	as required	US26D	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Thumbturn Cylinder	as required	US26D	SA
1 Door Stop	as requires	US26D	RO

Set: 21.2

4 Hinge	as required	US15	MK
1 Mortise Lock	2190 1 3-Small Format Trim MI Strike to Match	US32D	AD
1 Cylinder	as required	US26D	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Door Stop	as requires	US26D	RO

Set: 21.3

5 Hinge	as required	US15	MK
1 Mortise Lock	2190 1 3-Small Format Trim MI Strike to Match	US32D	AD
1 Cylinder	as required	US26D	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO
1 Gasketing	S88BL		PE
1 Door Bottom	234APK		PE

Set: 21.4

4 Hinge	as required	US15	MK
1 Mortise Lock	2190 1 3-Small Format Trim MI Strike to Match	US32D	AD
2 Cylinder	as required	US26D	SA
2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO

Set: 21.5

4 Hinge	as required	US15	MK
1 Mortise Lock	2190 1 3-Small Format Trim MI Strike to Match	US32D	AD
1 Cylinder	as required	US26D	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Thumbturn Cylinder	as required	US26D	SA
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO
1 Gasketing	379CR		PE
1 Door Bottom	420APKL		PE

Set: 901.0

2 Pivot Set	147	626	RF
2 Elec. Intermediate Pivot	EM19 x QC12	626	RF
2 Intermediate Pivot	M19	626	RF
1 Surface Vert Rod Exit	16 43 55 NB8710	US32D	SA
1 Surface Vert Rod Exit	16 43 55 70 NB8706 ETMI	US32D	SA
3 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Surface Closer	4041 SCUSH	AL	LC
1 Threshold	to architect detail		PE
1 Gasketing	Head & Jamb		PE
2 Door Sweep	18061CNB		PE
1 Astragal	18041CNB		PE
2 ElectroLynx Harness - Frame	QC-C1500		MK
2 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
2 Door Position Switch	by security system supplier		
1 Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times.

Set: 901.1

2 Pivot Set	147	626	RF
2 Elec. Intermediate Pivot	EM19 x QC12	626	RF
2 Intermediate Pivot	M19	626	RF
2 Multi-Point Lock	12 55 70 NB7006 ETMI	US15	SA
2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Surface Closer	4041 SCUSH	AL	LC
1 Threshold	to architect detail		PE
1 Gasketing	Head & Jamb		PE

2 Door Sweep	18061CNB		PE
1 Astragal	18041CNB		PE
2 ElectroLynx Harness - Frame	QC-C1500		MK
2 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
2 Door Position Switch	by security system supplier		
1 Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times.

Set: 902.0

3 Hinge	as required	US15	MK
1 Hinge	as required x QC12	US15	MK
1 Storeroom Lock	RX 70 8204 LNMI	US15	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO
1 ElectroLynx Harness - Frame	QC-C1500		MK
1 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1 Door Position Switch	by security system supplier		
1 Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times.

Set: 903.0

3 Hinge	as required	US15	MK
1 Hinge	as required x QC12	US15	MK
1 Exit Device	12 43 55 70 8804 ETMI	US32D	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO
1 ElectroLynx Harness - Frame	QC-C1500		MK
1 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1 Door Position Switch	by security system supplier		
1 Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times.

Set: 904.0

6 Hinge	as required	US15	MK
2 Hinge	as required x QC12	US15	MK
2 Multipoint Lock	55 70 NB7013 ETMI	US15	SA
2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Surface Closer	4041 SCUSH	AL	LC
1 Gasketing	Head & Jamb		PE
2 Door Bottom	434ANBL		PE
1 Astragal	18041CNB		PE
2 ElectroLynx Harness - Frame	QC-C1500		MK
2 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
2 Door Position Switch	by security system supplier		

Notes: Door closed & locked at all times. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times.

Set: 905.0

3 Hinge	as required	US15	MK
1 Hinge	as required x QC12	US15	MK
1 Fail Secure Electric Lock	RX 70 8271-24V LNMI	US15	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Concealed Overhead Stop	2-X36	630	RF
1 Surface Closer	4041 Series	AL	LC
1 ElectroLynx Harness - Frame	QC-C1500		MK
1 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1 Card Reader	by security system supplier		
2 Door Position Switch	by security system supplier		
1 Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches & allows for authorized entrance. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times. With loss of power door remains locked.

Set: 905.1

2 Hinge	as required	US15	MK
1 Hinge	as required x QC12	US15	MK
1 Fail Secure Electric Lock	RX 70 8271-24V LNMI	US15	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
2 Door Stop	as requires	US26D	RO
1 ElectroLynx Harness - Frame	QC-C1500		MK
1 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1 Card Reader	by security system supplier		

2	Door Position Switch	by security system supplier		
1	Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches & allows for authorized entrance. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times. With loss of power door remains locked.

Set: 906.0

1	Continuous Hinge	MCK-25HD ACC-12	CL	MK
1	Exit Device (exit only)	16 43 55 70 8810	US32D	SA
1	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Surface Closer	4041 SCUSH	AL	LC
1	ElectroLynx Harness - Frame	QC-C1500		MK
1	ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1	Door Position Switch	by security system supplier		
1	Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times.

Set: 906.1

1	Continuous Hinge	MCK-25HD ACC-12	CL	MK
1	Exit Device (exit only)	16 43 55 70 8810	US32D	SA
1	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Surface Closer	4041 SCUSH	AL	LC
1	Threshold	to architect detail		PE
1	Gasketing	Head & Jamb		PE
1	ElectroLynx Harness - Frame	QC-C1500		MK
1	ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1	Door Position Switch	by security system supplier		
1	Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times.

Set: 906.2

3	Hinge	as required	US15	MK
1	Hinge	as required x QC12	US15	MK
1	Exit Device	16 43 55 70 8804 ETMI	US32D	SA
2	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Surface Closer	4041 Series	AL	LC

1 Door Stop	as requires	US26D	RO
1 ElectroLynx Harness - Frame	QC-C1500		MK
1 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1 Door Position Switch	by security system supplier		
1 Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times.

Set: 907.0

1 Automatic Operator	w/ Exposed Arm		
1 Pivot Set	147	626	RF
1 Pivot Set	547	626	RF
2 Elec. Intermediate Pivot	EM19 x QC12	626	RF
1 Intermediate Pivot	M19	626	RF
1 Concealed Closer	0608	626	RF
3 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Exit Device (CVR, nightlatch)	NB 16 43 55 56 70 AD8410 106	US32D	SA
1 Exit device (CVR, exit only)	NB 16 43 55 70 AD8410	US32D	SA
2 Door Pull	as selected by architect	US32D	RO
1 ElectroLynx Harness - Frame	QC-C1500		MK
2 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1 Card Reader	by security system supplier		
1 Door Position Switch	by security system supplier		
1 Power Supply	by exit device manufacturer		
1 Wiring Diagram	Point to Point		
2 Door Loop	TSB-CXL		SU

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches, activates outside automatic operator switch, activates electric latch retraction & allows for authorized entrance. Operating inside trim or use of automatic operator switch activates request to exit switch shunting door contacting and allowing authorized egress at all times. Use of inside automatic operator switch activates electric latch retraction. With loss of power door remains locked.

Set: 907.1

2 Continuous Hinge	MCK-12HD ACC-12	CL	MK
3 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Door Pull	as selected by architect	US32D	RO
2 Surface Closer	4041 SCUSH	AL	LC
2 ElectroLynx Harness - Frame	QC-C1500		MK
2 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1 Exit Device (CVR, nightlatch)	NB 16 43 55 56 70 AD8410 106	US32D	SA

1	Exit device (CVR, exit only)	NB 16 43 55 70 AD8410	US32D	SA
1	Card Reader	by security system supplier		
1	Door Position Switch	by security system supplier		
1	Power Supply	by exit device manufacturer		
1	Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches & allows for authorized entrance. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times. With loss of power door remains locked.

Set: 907.2

2	Continuous Hinge	MCK-25HD ACC-12	CL	MK
1	Exit device (CVR, exit only)	NB 16 43 55 70 MD8410	US32D	SA
1	Exit Device (CVR, nightlatch)	NB 16 43 55 56 70 MD8410 106	US32D	SA
3	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2	Door Pull	as selected by architect	US32D	RO
2	Surface Closer	4041 SCUSH	AL	LC
1	Gasketing	Head & Jamb		PE
2	Door Bottom	434ANBL		PE
2	Astragal	18041CNB		PE
2	ElectroLynx Harness - Frame	QC-C1500		MK
2	ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1	Card Reader	by security system supplier		
1	Door Position Switch	by security system supplier		
1	Power Supply	by exit device manufacturer		

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches & allows for authorized entrance. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times. With loss of power door remains locked.

Set: 907.3

2	Continuous Hinge	MCK-12HD	CL	MK
2	Exit Device	PA100D	US32D	CL
2	Cylinder	as required	US26D	SA
3	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Stop Strike	ESK2		CL
2	Electric Strike	310-1		FO
1	Surface Closer	4041 SCUSH	AL	LC
1	Card Reader	by security system supplier		
1	Door Position Switch	by security system supplier		
1	Power Supply	by security system supplier		
1	Wiring Diagram	Point to Point		

1 Motion Sensor

XMS

SU

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches & allows for authorized entrance. Inside exit motion detector activates request to exit switch shunting door contact and allowing authorized egress at all times. With loss of power door remains locked.

Set: 907.4

2 Continuous Hinge	MCK-25HD ACC-12	CL	MK
1 Exit Device (CVR, nightlatch)	NB 16 43 55 56 70 AD8410 106	US32D	SA
1 Exit device (CVR, exit only)	NB 16 43 55 70 AD8410	US32D	SA
3 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2 Door Pull	as selected by architect	US32D	RO
2 Surface Closer	4041 SCUSH	AL	LC
1 Threshold	to architect detail		PE
1 Gasketing	Head & Jamb		PE
1 Astragal	18041CNB		PE
2 ElectroLynx Harness - Frame	QC-C1500		MK
1 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1 Card Reader	by security system supplier		
1 Door Position Switch	by security system supplier		
1 Power Supply	by exit device manufacturer		
1 Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches & allows for authorized entrance. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times. With loss of power door remains locked.

Set: 907.5

1 Concealed Closer	608EL	626	RF
1 Automatic Operator			
1 Bottom Pivot	370	626	RF
2 Exit Device	PA100D	US32D	CL
2 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Stop Strike	ESK2		CL
2 Electric Strike	310-1		FO
2 Cylinder	as required	US26D	SA
2 Door Pull	as selected by architect	US32D	RO
1 Card Reader	by security system supplier		
1 Door Position Switch	by security system supplier		
1 Power Supply	by security system supplier		
1 Wiring Diagram	Point to Point		
1 Motion Sensor	XMS		SU

Notes: Free operation mode: Use of automatic operator paddle either side opens door.

Secure Mode: Presenting valid credential outside shunts door position switches, activates outside operator paddle & allows for authorized entrance. Inside exit motion detector activates request to exit switch or using inside operator paddle shunting door contact and allowing authorized egress at all times. With loss of power door remains locked.

Set: 907.6

1	Automatic Operator			
1	Bottom Pivot	370	626	RF
1	Concealed Closer	608EL	626	RF
2	Exit Device	PA100D	US32D	CL
2	Cylinder	as required	US26D	SA
2	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Stop Strike	ESK2		CL
1	Electric Strike	310-1		FO
2	Door Pull	as selected by architect	US32D	RO
2	Electromagnetic Holder	998	689	RF
1	Card Reader	by security system supplier		
1	Door Position Switch	by security system supplier		
1	Power Supply	by security system supplier		
1	Wiring Diagram	Point to Point		
1	Motion Sensor	XMS		SU

Notes: Free operation mode: Doors held open with magnetic holders

Secure Mode: Presenting valid credential outside shunts door position switches, activates outside operator paddle & allows for authorized entrance. Inside exit motion detector activates request to exit switch or using inside operator paddle shunting door contact and allowing authorized egress at all times. With loss of power door remains locked.

Set: 907.7

2	Continuous Hinge	MCK-12HD ACC-12	CL	MK
2	Exit Device	PA100D	US32D	CL
2	Cylinder	as required	US26D	SA
2	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Stop Strike	ESK2		CL
1	Electric Strike	310-1		FO
2	Door Pull	as selected by architect	US32D	RO
2	Surface Closer	4041 Series	AL	LC
2	Electromagnetic Holder	998	689	RF
2	Door Position Switch	by security system supplier		

1	Wiring Diagram	Point to Point		
1	Motion Sensor	XMS		SU

Notes: Free operation mode: Doors held open with magnetic holders

Secure Mode: Presenting valid credential outside shunts door position switches & allows for authorized entrance. Inside exit motion detector activates request to exit switch shunting door contact and allowing authorized egress at all times. With loss of power door remains locked.

Set: 907.8

2	Continuous Hinge	MCK-12HD	CL	MK
2	Exit Device	PA100D	US32D	CL
2	Cylinder	as required	US26D	SA
2	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2	Door Pull	as selected by architect	US32D	RO
2	Surface Closer	4041 SCUSH	AL	LC
2	Door Position Switch	by security system supplier		
1	Wiring Diagram	Point to Point		
1	Motion Sensor	XMS		SU

Notes: Outside locked at all times. Inside exit motion detector activates request to exit switch shunting door contact and allowing authorized egress at all times.

Set: 907.9

1	Automatic Operator			
1	Bottom Pivot	370	626	RF
1	Concealed Closer	608EL	626	RF
3	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Exit Device (CVR, nightlatch)	NB 16 43 55 56 70 AD8410 106	US32D	SA
1	Exit device (CVR, exit only)	NB 16 43 55 70 AD8410	US32D	SA
2	Door Pull	as selected by architect	US32D	RO
1	ElectroLynx Harness - Frame	QC-C1500		MK
2	ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1	Card Reader	by security system supplier		
1	Door Position Switch	by security system supplier		
1	Power Supply	by exit device manufacturer		
1	Wiring Diagram	Point to Point		
2	Door Loop	TSB-CXL		SU

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches, activates outside automatic operator switch, activates electric latch retraction & allows for authorized entrance. Operating inside trim or use of automatic operator switch activates request to exit switch shunting door contacting and allowing authorized egress at all times. Use of inside automatic operator switch

activates electric latch retraction. With loss of power door remains locked.

Set: 908.0

1	Automatic Operator			
1	Bottom Pivot	370	626	RF
1	Concealed Closer	608EL	626	RF
2	Push/Pulls	as selected by architect		

Notes: Use of automatic operator paddle either side opens door.

Set: 908.1

1	Automatic Operator			
1	Bottom Pivot	370	626	RF
1	Concealed Closer	608EL	626	RF
1	Set Push/Pull	DH100D	US32D	CL

Notes: Use of automatic operator paddle either side opens door.

Set: 908.2

1	Bottom Pivot	370	626	RF
1	Door Pull	as selected by architect	US32D	RO
1	Automatic Operator			
1	Door Position Switch	by security system supplier		

Notes: Use of automatic operator paddle either side opens door.

Set: 909.0

3	Hinge	as required	US15	MK
1	Hinge	as required x QC12	US15	MK
1	Electric Exit Device	12 43 55 70 8875-24v ETMI	US32D	SA
1	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Surface Closer	4041 Series	AL	LC
1	Door Stop	as requires	US26D	RO
3	Silencer	608		RO
1	Card Reader	by security system supplier		
1	Door Position Switch	by security system supplier		
1	Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches & allows for authorized entrance. Operating inside trim activates request to exit switch shunting door

contact and allowing authorized egress at all times. With loss of power door remains unlocked.

Set: 910.0

2	Continuous Hinge	MCK-12HD ACC-12	CL	MK
1	Exit Device (CVR, nightlatch)	NB 16 43 55 56 70 AD8410 106	US32D	SA
1	Exit device (CVR, exit only)	NB 16 43 55 70 AD8410	US32D	SA
3	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Door Pull	as selected by architect	US32D	RO
1	Surface Closer	4041 SCUSH	AL	LC
1	Threshold	to architect detail		PE
1	ElectroLynx Harness - Frame	QC-C1500		MK
1	ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1	Door Position Switch	by exit device manufacturer		
1	Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times.

Set: 910.1

2	Continuous Hinge	MCK-12HD	CL	MK
2	Surface Closer	4041 Series	AL	LC
1	Threshold	to architect detail		PE
2	Door Position Switch	by security system supplier		
2	Push/Pulls	as selected by architect		

Notes: Door operable at all times. Opening door activated door contact.

Set: 911.0

1	Continuous Hinge	MCK-12HD	CL	MK
1	Mortise Deadlock	MS1850S	628	AD
2	Cylinder	as required	US26D	SA
2	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Push Bar & Pull	11147	US32D	RO
1	Surface Closer	4041 SCUSH	AL	LC
1	Threshold	to architect detail		PE
1	Door Position Switch	by security system supplier		

Notes: Door closed & locked at all times. Opening door activated door contact.

Set: 912.0

1	Automatic Operator			
1	Bottom Pivot	370	626	RF
1	Concealed Closer	608EL	626	RF
2	Set Deadbolt Push/Pull	DB100D	US32D	CL
1	Stop Strike	ESK2		CL
2	Electric Strike	310-1		FO
1	Card Reader	by security system supplier		
2	Door Position Switch	by security system supplier		
1	Motion Sensor	XMS		SU
1	Emergency Exit Button	by security system supplier		
1	Power Supply	by security system supplier		
1	Wiring Diagram	Point to Point		

Notes: Mode of operation for door during the building's open (day) hours:

1. Door operable from either side at all times. (doors are never locked during business hours).
2. ADA push button device works any time to automatically open door.
3. Exit sign above door is illuminated.

Mode of operation for door H203.E during the building's closed (night) hours:

1. Electric Strikes are turned on by the building's security access control system and hold the doors shut
2. Outside Card reader would override Electric Strike and allow access into door.
3. Inside Motion Detector, emergency exit button or automatic operator paddle will release electric strike allowing egress.
4. Open exit to Stair 13 and Ramp 01 would be available 24 hours, which would provide ample exit width for any after-hours custodial staff in the space.
5. A "Courtyard Closed" sign will be posted at the top Stair 13 and Ramp 01.
6. No Assembly events will be held in this courtyard when the doors are closed.
7. Exit sign above door would not be illuminated

Set: 912.1

1	Automatic Operator			
1	Bottom Pivot	370	626	RF
1	Concealed Closer	608EL	626	RF
2	Push/Pulls	as selected by architect		
2	Door Position Switch	by security system supplier		
1	Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Opening door activated door contact.

Set: 913.0

1	Automatic Operator			
1	Bottom Pivot	370	626	RF
1	Concealed Closer	608EL	626	RF
1	Exit Device (CVR, nightlatch)	NB 16 43 55 56 70 AD8410 106	US32D	SA

1	Exit device (CVR, exit only)	NB 16 43 55 70 AD8410	US32D	SA
2	Door Pull	as selected by architect	US32D	RO
1	Card Reader	by security system supplier		
2	Door Position Switch	by security system supplier		
1	Power Supply	by exit device manufacturer		
1	Wiring Diagram	Point to Point		
2	Door Loop	TSB-CXL		SU
1	ElectroLynx Harness - Frame	QC-C1500		MK
1	ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK

Notes: Door closed & alarmed at all times. Presenting valid credential outside shunts door position switches, activates outside automatic operator switch & allows for authorized entrance. Operating inside automatic operator switchshunts door contacting and allows authorized egress at all times.

Set: 913.1

1	Bottom Pivot	370	626	RF
1	Paddle Operator	4591-01	US26D	AD
1	Deadlatch	4900 1-1/8" BS	628	AD
1	Cylinder	as required	US26D	SA
1	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1	Electric Strike	7100	628	AD
1	Push/Pulls	as selected by architect		
1	ElectroLynx Harness - Frame	QC-C1500		MK
1	Automatic Operator			
1	Card Reader	by security system supplier		
1	Door Position Switch	by security system supplier		
1	Wiring Diagram	Point to Point		
1	Motion Sensor	XMS		SU

Notes: Door closed & alarmed at all times. Presenting valid credential outside shunts door position switches & allows for authorized entrance. Use of inside paddle operator activates request to exit swiths shunting door contact allowing authorized egress. With loss of power door remains locked.

Set: 913.2

2	Continuous Hinge	MCK-12HD ACC-12	CL	MK
1	Multipoint Lock	55 70 NB7013 ETMI	US15	SA
1	Electromech. Multi-Point Lock	55 NB7074 ETMI	US15	SA
1	Cylinder	as required	US26D	SA
1	Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
2	Surface Closer	4041 Series	AL	LC
2	Door Stop	as requires	US26D	RO
2	ElectroLynx Harness - Frame	QC-C1500		MK

1 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1 Card Reader	by security system supplier		
1 Door Position Switch	by security system supplier		
1 Power Supply	by security system supplier		
1 Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches & allows for authorized entrance. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times. With loss of power door remains locked.

Set: 914.0

6 Hinge	as required	US15	MK
2 Hinge	as required x QC12	US15	MK
3 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Automatic Operator			
1 Surface Closer	4041 Series	AL	LC
1 Surface Vert Rod Exit	16 43 55 NB8710	US32D	SA
1 Surface Vert Rod Exit	16 43 55 56 70 NB8713 ETMI	US32D	SA
2 Door Stop	as requires	US26D	RO
2 ElectroLynx Harness - Frame	QC-C1500		MK
2 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1 Card Reader	by security system supplier		
2 Door Position Switch	by security system supplier		
1 Power Supply	by exit device manufacturer		
1 Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches, activates outside automatic operator switch, activates electric latch retraction & allows for authorized entrance. Operating inside trim or use of automatic operator switch activates request to exit switch shunting door contacting and allowing authorized egress at all times. Use of inside automatic operator switch activates electric latch retraction. With loss of power door remains locked.

Set: 915.0

3 Hinge	as required	US15	MK
1 Hinge	as required x QC12	US15	MK
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Automatic Operator			
1 Door Stop	as requires	US26D	RO
1 ElectroLynx Harness - Frame	QC-C1500		MK
1 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1 Rim Exit Device	16 43 55 56 70 AD8513 ETMI	US32D	SA
1 Card Reader	by security system supplier		
1 Door Position Switch	by security system supplier		

1 Power Supply	by exit device manufacturer
1 Wiring Diagram	Point to Point

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches, activates outside automatic operator switch, activates electric latch retraction & allows for authorized entrance. Operating inside trim or use of automatic operator switch activates request to exit switch shunting door contacting and allowing authorized egress at all times. Use of inside automatic operator switch activates electric latch retraction. With loss of power door remains locked.

Set: 916.0

3 Hinge	as required	US15	MK
1 Hinge	as required x QC12	US15	MK
1 Electric Exit Device	12 43 55 8876-24v ETMI	US32D	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO
1 ElectroLynx Harness - Frame	QC-C1500		MK
1 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1 Card Reader	by security system supplier		
1 Door Position Switch	by security system supplier		
1 Power Supply	by exit device manufacturer		
1 Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches & allows for authorized entrance. Operating inside trim activates request to exit switch shunting door contact and allowing authorized egress at all times. With loss of power door remains locked.

Set: 916.1

1 Continuous Hinge	MCK-25HD ACC-12	CL	MK
1 Electric Exit Device	12 43 70 8876-24v ETMI	US32D	SA
1 Permanent Core	Best 7 Pin - Keyed to facility system	626	BE
1 Surface Closer	4041 Series	AL	LC
1 Door Stop	as requires	US26D	RO
1 Threshold	to architect detail		PE
1 Gasketing	Head & Jamb		PE
1 ElectroLynx Harness - Frame	QC-C1500		MK
1 ElectroLynx Harness - Door	QC-CXXX (Size as required)		MK
1 Card Reader	by security system supplier		
1 Door Position Switch	by security system supplier		
1 Power Supply	by exit device manufacturer		
1 Wiring Diagram	Point to Point		

Notes: Door closed & locked at all times. Presenting valid credential outside shunts door position switches

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& allows for authorized entrance. With loss of power door remains locked.

State Project No. H27-6069-AC

END OF SECTION 08 71 00

SECTION 23 05 19 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solar-Powered Thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Pitot-tube flowmeters.
6. Turbine flowmeters.
7. Venturi flowmeters.
8. Impeller-turbine, thermal-energy meters.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Product certificates.
- D. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 SOLAR-POWERED THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 1. Omega.
- B. Series: SPT10:
 1. Case: Hi-impact ABS.
 2. Range: -40 to 150°C (-40 to 300°F).
 3. Display: 9.5 mm (3/8") High LCD digits.
 4. Accuracy: 1% of reading or 1° , whichever is greater.
 5. Autorange Resolution:
 - a. 1° : -40 to 27°C (-40 to 19°F).
 - b. 0.1° : -28.0 to 93.0°C (-19.9 to 199.9°F).

- c. 1°: 94 to 150°C (200 to 300°F).
6. Recalibration: Internal potentiometer.
7. Lux Rating: 10 Lux (1' candle).
8. Display Update: 10 seconds.
9. Ambient Operating: -35 to 60°C (-30 to 140°F).
10. Ambient Temp Error: Zero.
11. Humidity: 95% RH non-condensing.
12. Sensor: Glass passivated thermistor.
13. Stem Assemblies:
 - a. Industrial Glass:
 - 1) Full conformance with Fed Spec GG-T-321D; fully interchangeable with industrial glass thermometers.
 - b. Bimetallic:
 - 1) Full conformance with ASME B40.3 – 1990; fully interchangeable with bimetallic dial thermometers.

2.2 DUCT-THERMOMETER MOUNTING BRACKETS

- A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.3 THERMOWELLS

- A. Thermowells:
 1. Standard: ASME B40.200.
 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 3. Material for Use with Copper Tubing: CNR or CUNI.
 4. Material for Use with Steel Piping: CRES.
 5. Type: Stepped shank unless straight or tapered shank is indicated.
 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
 7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
 8. Bore: Diameter required to match thermometer bulb or stem.
 9. Insertion Length: Length required to match thermometer bulb or stem.
 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
- B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. AMETEK, Inc.; U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Ernst Flow Industries.
 - d. Flo Fab Inc.
 - e. Marsh Bellofram.
 - f. Miljoco Corporation.
 - g. Noshok.
 - h. Palmer Wahl Instrumentation Group.
 - i. REOTEMP Instrument Corporation.
 - j. Tel-Tru Manufacturing Company.
 - k. Terrice, H. O. Co.
 - l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - m. Weiss Instruments, Inc.
 - n. WIKA Instrument Corporation - USA.
 - o. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); stainless steel; 6-inch (152-mm nominal diameter).
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass pipe with NPS 1/2 (DN 15) pipe threads.
- C. Valves: Brass or stainless-steel needle, with NPS 1/2 (DN 15), ASME B1.20.1 pipe threads.

2.6 FLOWMETERS

- A. ONICON F-3500 Series ~~or equal~~:

1. Accuracy:
 - a. $\pm 1.0\%$ of reading from 2 to 20 ft/sec.
 - b. ± 0.02 ft/sec below 2 ft/sec.
2. Flow Range:
 - a. 0.1 ft/s to 20 ft/s (200:1 turndown).
3. Sensing Method:
 - a. Electromagnetic sensing (no moving parts).
4. Conductivity Range:
 - a. 20 to 60,000 μ Siemens/cm.
5. Pipe Size Range:
 - a. 3" through 72" nominal diameter.
6. Input Power:
 - a. 20 – 28 VDC, 250mA @ 24 VDC.
 - b. 20 – 28 VAC 60 Hz, 6 VA.
7. Liquid Temperature Range:
 - a. 15° to 250° F.
8. Ambient Temperature Range:
 - a. $\bar{20}^{\circ}$ to 150° F.
9. Operating Pressure:
 - a. 400 PSI maximum.
10. Pressure Drop:
 - a. Less than 0.1 psi at 12 ft/s velocity in 3" and larger pipes.
11. Output Signals Provided:
 - a. Analog Output (Isolated):
 - 1) Selectable: 4-20mA, 0-10V or 0-5V.
 - b. Frequency Output:
 - 1) 0-15 Volt peak pulse, 0-500Hz.

- c. Scale Pulse Output:
 - 1) Isolated solid state dry contact.
 - 2) Contact Rating: 50VDC, 100mA maximum.
 - 3) Pulse Duration: 0.5, 1, 2 or 60 seconds.

- 12. Material:
 - a. Wetted metal components: 316 stainless steel.
 - b. Sensor Head: Polypropylene.

- 13. Electronics Enclosure:
 - a. Weathertight NEMA 4 aluminum enclosure.

- 14. Electrical Connections:
 - a. 10' of PVC jacketed cable with 1/2" NPT conduit connection.

OPERATING RANGE FOR COMMON PIPE SIZES 0.1 TO 20 ft/sec	
Pipe Size (inches)	Flow Rate (GPM)
3	2.4 - 460
4	4 - 800
6	6 - 1,800
8	16 - 3,100
10	24 - 4,900
12	35 - 7,050
14	42 - 8,600
16	55 - 11,400
18	70 - 14,600
20	86 - 18,100
24	125 - 26,500
30	223 - 41,900
36	304 - 60,900

WIRE COLOR	DESCRIPTION	NOTES
RED	(+) Supply Voltage: 24 VDC, 250 mA or 24 VAC, 60 Hz, 6 VA	Connect to power supply (+): DC (+) or AC (line)

BLACK	(-) Isolated Supply Voltage Common	Connect to power supply (-): DC (-) or AC (neutral)
GREEN / YELLOW	Earth ground connection	Required to operate the meter
GREEN	(+) Isolated Frequency Output	Required when connecting to ONICON display or BTU meter
YELLOW	(-) Frequency Output Common	
BLUE	(+) Isolated Analog Output	Configurable as a 4-20 mA, 0-10 Volt or 0-5 Volt Output
BROWN	(-) Isolated Analog Output Common	
GRAY	Scaled Output Isolated Dry Contact	Scalable dry contact pulse output for totalization
VIOLET		
DIAGNOSTIC SIGNALS		
ORANGE	Master Alarm, Dry Contact	Dry contact closure signal indicating fault conditions
WHITE		

F-3500 Wiring Diagram

2.7 THERMAL-ENERGY METERS

A. ONICON System-10-N2 BTU Meter ~~or equal~~:

1. Calibration:
 - a. Flow meters and temperature sensors are individually calibrated followed by a complete system calibration.
 - b. Field commissioning is also available.
2. Accuracy:
 - a. Differential temperature accuracy $\pm 0.15^{\circ}\text{F}$ over calibrated range.
 - b. Computing nonlinearity within $\pm 0.05\%$.
3. Programming:
 - a. Factory programmed for specific application.
 - b. Field programmable via front panel interface.
4. Memory:
 - a. Non-volatile EEPROM memory retains all program parameters and totalized values in the event of power loss.
5. Display:
 - a. Alphanumeric LCD displays total energy, total flow, energy rate, flow rate, supply temperature.

b. Alpha: 16 character, 0.2" high; Numeric: 6 digits, 0.4" high.

6. Output Signals:

a. N2 Output Points:

NAME	POINT TYPE / CATEGORY	UNITS
Total Energy	ADF	Btu, kW-hrs or ton-hrs
Energy Rate	AI	Btu/hr, kW or tons
Total Flow	ADF	gallons, liters or meters ³
Flow Rate	AI	gpm, gph, mgd, l/s, l/m, l/hr or m ³ /hr
Supply Temperature	AI	°F or °C
Return Temperature	AI	°F or °C
Energy Total Reset	BO	Not applicable
Flow Total Reset	BO	Not applicable
Auxiliary Input 1	ADF	Pulse Accumulator
Auxiliary Input Re-set	BO	Not applicable

b. Isolated Solid State Dry Contact for Energy Total:

- 1) Contact Rating: 100mA, 50V.
- 2) Contact Duration: 0.5, 1, 2, or 6 seconds.

c. Optional Analog Output(s) (4-20mA, 0-10 V or 0-5):

- 1) One or four analog output (s) available for flow rate, energy rate, supply/returns temps or delta-T.

7. Liquid Flow Signal Input:

a. 0-15 V pulse output from any ONICON flow meter.

8. Temperature Sensors:

- a. Solid state sensors are custom calibrated using N.I.S.T. traceable temperature standards.
- b. Current based signal (mA) is unaffected by wire length.

9. Temperature Range:

- a. Liquid temperature range: 32° to 200°F.
- b. Optional liquid temperature range: 122° to 302°F.
- c. Ambient temperature range: 40° to 120°F.

10. Mechanical:

a. Electronics Enclosure:

- 1) Standard: Steel NEMA 13, wall mount, 8"x10"x4".
- 2) Optional: NEMA 4 (Not UL listed).
- 3) Approximate weight: 12lbs.

b. Temperature Thermowells:

- 1) Standard: ½" NPT brass thermowells (length varies with pipe size) with junction box. (Note: 6" pipes and larger require SS thermowell option)
- 2) Optional:
 - a) ½" NPT stainless steel thermowells.
 - b) Outdoor junction box with thermal insulation.
 - c) Hot tap thermowells with isolation valves are available in plated brass or stainless steel.

11. Electrical:

a. Input Power:

- 1) Standard: 24 VAC, 50/60 Hz, 500 mA.
- 2) Optional: 120 VAC, 50/60 Hz, 200 mA.
230 VAC, 50 Hz, 150 mA.
- 3) Based on Btu meters configured for network connection without the optional analog outputs.

b. Internal Supply:

- 1) Provides 24 VDC at 200 mA to electronics and flow meter.

c. Wiring:

- 1) Temperature Signals: Use 18-22 ga twisted shielded pair.
- 2) Flow Signals: Use 18-22 ga shielded – see flow meter specification sheet for number of conductors.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.

- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- I. Install remote-mounted pressure gages on panel.
- J. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- K. Install valve and syphon fitting in piping for each pressure gage for steam.
- L. Install flow indicators in piping systems in accessible positions for easy viewing.
- M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- N. Install flowmeter elements in accessible positions in piping systems.
- O. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- P. Install permanent indicators on walls or brackets in accessible and readable positions.
- Q. Install connection fittings in accessible locations for attachment to portable indicators.
- R. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
- S. Install thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic zone.
 - 2. Inlet and outlet of each hydronic boiler.
 - 3. Two inlets and two outlets of each chiller.
 - 4. Inlet and outlet of each hydronic coil in air-handling units.
 - 5. Two inlets and two outlets of each hydronic heat exchanger.
 - 6. Inlet and outlet of each thermal-storage tank.
 - 7. Outside-, return-, supply-, and mixed-air ducts.
- T. Install pressure gages in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
 - 3. Suction and discharge of each pump.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:
 - 1. Liquid-filled, bimetallic-actuated type.
 - 2. Industrial-style, liquid-in-glass type.
- B. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:
 - 1. Liquid-filled, bimetallic-actuated type.
 - 2. Industrial-style, liquid-in-glass type.
- C. Thermometers at inlets and outlets of each chiller shall be one of the following:
 - 1. Liquid-filled, bimetallic-actuated type.
 - 2. Industrial-style, liquid-in-glass type.
- D. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
 - 1. Liquid-filled, bimetallic-actuated type.
 - 2. Industrial-style, liquid-in-glass type.
- E. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one of the following:
 - 1. Liquid-filled, bimetallic-actuated type.
 - 2. Industrial-style, liquid-in-glass type.
- F. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be one of the following:
 - 1. Liquid-filled, bimetallic-actuated type.

2. Industrial-style, liquid-in-glass type.
- G. Thermometers at inlet and outlet of each thermal-storage tank shall be one of the following:
1. Liquid-filled, bimetallic-actuated type.
 2. Industrial-style, liquid-in-glass type.
- H. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:
1. Liquid-filled, bimetallic-actuated type.
 2. Industrial-style, liquid-in-glass type.
- I. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).
- B. Scale Range for Condenser-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).
- C. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F (0 to 150 deg C).
- D. Scale Range for Steam and Steam-Condensate Piping: 20 to 240 deg F (0 to 150 deg C).
- E. Scale Range for Air Ducts: 0 to 100 deg F (Minus 20 to plus 50 deg C).

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:
 1. Liquid-filled, direct-mounted, metal case.
 2. Sealed, direct-mounted, plastic case.
- B. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be one of the following:
 1. Liquid-filled, direct-mounted, metal case.
 2. Sealed, direct-mounted, plastic case.
- C. Pressure gages at suction and discharge of each pump shall be one of the following:
 1. Liquid-filled, direct-mounted, metal case.
 2. Sealed, direct-mounted, plastic case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 psi (0 to 600 kPa).
- B. Scale Range for Condenser-Water Piping: 0 to 100 psi (0 to 600 kPa).

- C. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi (0 to 600 kPa).
- D. Scale Range for Steam Piping: 0 to 100 psi (0 to 600 kPa).

3.8 FLOWMETER SCHEDULE

- A. Flowmeters for Chilled-Water Piping: Pitot-tube type.
- B. Flowmeters for Condenser-Water Piping: Pitot-tube type.
- C. Flowmeters for Heating, Hot-Water Piping: Pitot-tube type.
- D. Flowmeters for Steam and Steam-Condensate Piping: Turbine type.

3.9 THERMAL-ENERGY METER SCHEDULE

- A. Thermal-Energy Meters: Impeller-turbine type.

END OF SECTION 23 05 19

SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. High-performance butterfly valves.
5. Bronze swing check valves.
6. Iron swing check valves.
7. Iron swing check valves with closure control.
8. Bronze gate valves.
9. Iron gate valves.
10. Bronze globe valves.
11. Iron globe valves.
12. Chainwheels.

B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.2 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.3 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.

- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves.
 - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
 - 1. Gate Valves: With rising stem.
 - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Solder Joint: With sockets according to ASME B16.18.
 - 3. Threaded: With threads according to ASME B1.20.1.

2.2 BRASS BALL VALVES

- A. One-Piece, Reduced-Port, Brass Ball Valves with Brass Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Kitz Corporation.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig (2760 kPa).
 - c. Body Design: One piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded.
 - f. Seats: PTFE or TFE.
 - g. Stem: Brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Reduced.
- B. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. DynaQuip Controls.
 - d. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
 - e. Hammond Valve.
 - f. Jamesbury; a subsidiary of Metso Automation.
 - g. Jomar International, LTD.
 - h. Kitz Corporation.
 - i. Legend Valve.
 - j. Marwin Valve; a division of Richards Industries.
 - k. Milwaukee Valve Company.
 - l. NIBCO INC.
 - m. Red-White Valve Corporation.
 - n. RuB Inc.

2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Two piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Brass.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.

C. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
 - d. Hammond Valve.
 - e. Jamesbury; a subsidiary of Metso Automation.
 - f. Kitz Corporation.
 - g. Marwin Valve; a division of Richards Industries.
 - h. Milwaukee Valve Company.
 - i. RuB Inc.
2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).

- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Forged brass.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel, vented.
- j. Port: Full.

D. Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Hammond Valve.
 - b. Jamesbury; a subsidiary of Metso Automation.
 - c. Legend Valve.
 - d. Marwin Valve; a division of Richards Industries.
 - e. Milwaukee Valve Company.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Two piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Brass.
 - i. Ball: Chrome-plated brass.
 - j. Port: Regular.

E. Two-Piece, Regular-Port, Brass Ball Valves with Stainless-Steel Trim:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Jamesbury; a subsidiary of Metso Automation.
 - b. Marwin Valve; a division of Richards Industries.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Two piece.
 - e. Body Material: Brass or bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.

- i. Ball: Stainless steel, vented.
- j. Port: Regular.

2.3 BRONZE BALL VALVES

A. One-Piece, Reduced-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. American Valve, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig (2760 kPa).
 - c. Body Design: One piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE or TFE.
 - g. Stem: Bronze.
 - h. Ball: Chrome-plated brass.
 - i. Port: Reduced.

B. One-Piece, Reduced-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig (4140 kPa).
 - c. Body Design: One piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE or TFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Reduced.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

- a. American Valve, Inc.
- b. Conbraco Industries, Inc.; Apollo Valves.
- c. Crane Co.; Crane Valve Group; Crane Valves.
- d. Hammond Valve.
- e. Lance Valves; a division of Advanced Thermal Systems, Inc.
- f. Legend Valve.
- g. Milwaukee Valve Company.
- h. NIBCO INC.
- i. Red-White Valve Corporation.
- j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig (1035 kPa).
- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Bronze.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

D. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

- a. Conbraco Industries, Inc.; Apollo Valves.
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Hammond Valve.
- d. Lance Valves; a division of Advanced Thermal Systems, Inc.
- e. Milwaukee Valve Company.
- f. NIBCO INC.
- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig (1035 kPa).
- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel, vented.
- j. Port: Full.

- E. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. American Valve, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. DynaQuip Controls.
 - f. Hammond Valve.
 - g. Lance Valves; a division of Advanced Thermal Systems, Inc.
 - h. Milwaukee Valve Company.
 - i. NIBCO INC.
 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Regular.
- F. Two-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Regular.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with Metal Seat:

1. **Manufacturers: Subject to compliance with requirements, provide products by the following or equal:**
 - a. **Zwick.**
2. **Description:**
 - a. **Triple eccentric design.**
 - b. **Metal seating.**
 - c. **CWP Rating: 150 psig (1035 kpa).**
 - d. **Full bi-directional shutoff as per API 598 and/or DIN EN 12266-1.**
 - e. **Temperature range up to 815°C.**
 - f. **Size range 2" – 72" (DN 50-1800).**
 - g. **Friction free opening and closing.**
 - h. **Vacuum tight.**
 - i. **Laminated seal and seat made of stainless steel.**
 - j. **Anti blow-out shaft API 609.**
 - k. **Steel casting, stainless steel, special alloys.**
 - l. **Fire-safe acc. To BS 6755 and API 607 4th ed. for both flow directions.**
 - m. **SIL 3.**
 - n. **EPA 21.**

Addendum #3 deletes the original section 2.5 "High Performance Butterfly Valves" & the spec numbering has been appropriately shifted.

2.5 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. **Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:**
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Powell Valves.
 - j. Red-White Valve Corporation.
 - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - l. Zy-Tech Global Industries, Inc.
2. **Description:**

- a. Standard: MSS SP-80, Type 3.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Hammond Valve.
 - e. Kitz Corporation.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Red-White Valve Corporation.
 - i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: PTFE or TFE.

C. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Kitz Corporation.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Red-White Valve Corporation.
 - i. Zy-Tech Global Industries, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 300 psig (2070 kPa).
 - c. Body Design: Horizontal flow.

- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

D. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 300 psig (2070 kPa).
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: PTFE or TFE.

2.6 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Hammond Valve.
 - e. Kitz Corporation.
 - f. Legend Valve.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Powell Valves.
 - j. Red-White Valve Corporation.
 - k. Sure Flow Equipment Inc.
 - l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - m. Zy-Tech Global Industries, Inc.
2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).

- c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
- d. Body Design: Clear or full waterway.
- e. Body Material: ASTM A 126, gray iron with bolted bonnet.
- f. Ends: Flanged.
- g. Trim: Bronze.
- h. Gasket: Asbestos free.

B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
- 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Composition.
 - h. Seat Ring: Bronze.
 - i. Disc Holder: Bronze.
 - j. Disc: PTFE or TFE.
 - k. Gasket: Asbestos free.

C. Class 250, Iron Swing Check Valves with Metal Seats:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.

- h. Gasket: Asbestos free.

2.7 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.
 - h. Gasket: Asbestos free.
 - i. Closure Control: Factory-installed, exterior lever and spring.

B. Class 125, Iron Swing Check Valves with Lever and Weight-Closure Control:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.
 - h. Gasket: Asbestos free.
 - i. Closure Control: Factory-installed, exterior lever and weight.

2.8 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Powell Valves.
 - j. Red-White Valve Corporation.
 - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - l. Zy-Tech Global Industries, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Powell Valves.
 - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - k. Zy-Tech Global Industries, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 2.

- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded or solder joint.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

C. Class 150, NRS Bronze Gate Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Hammond Valve.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Powell Valves.
 - f. Red-White Valve Corporation.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 300 psig (2070 kPa).
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

D. Class 150, RS Bronze Gate Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Hammond Valve.
 - d. Kitz Corporation.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Powell Valves.
 - h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - i. Zy-Tech Global Industries, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig (2070 kPa).

- c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

2.9 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Flo Fab Inc.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Legend Valve.
 - h. Milwaukee Valve Company.
 - i. NIBCO INC.
 - j. Powell Valves.
 - k. Red-White Valve Corporation.
 - l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - m. Zy-Tech Global Industries, Inc.
2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.

B. Class 125, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Flo Fab Inc.
 - e. Hammond Valve.
 - f. Kitz Corporation.

- g. Legend Valve.
 - h. Milwaukee Valve Company.
 - i. NIBCO INC.
 - j. Powell Valves.
 - k. Red-White Valve Corporation.
 - l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - m. Zy-Tech Global Industries, Inc.
2. Description:
- a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.
- C. Class 250, NRS, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
- a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. NIBCO INC.
2. Description:
- a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.
- D. Class 250, OS&Y, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
- a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Powell Valves.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.

2.10 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Hammond Valve.
 - d. Kitz Corporation.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Powell Valves.
 - h. Red-White Valve Corporation.
 - i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - j. Zy-Tech Global Industries, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, Bronze Globe Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. NIBCO INC.
 - d. Red-White Valve Corporation.
2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded or solder joint.
- e. Stem: Bronze.
- f. Disc: PTFE or TFE.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

C. Class 150, Bronze Globe Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Hammond Valve.
 - c. Kitz Corporation.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Powell Valves.
 - g. Red-White Valve Corporation.
 - h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - i. Zy-Tech Global Industries, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig (2070 kPa).
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

2.11 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Hammond Valve.
 - e. Kitz Corporation.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Powell Valves.

- i. Red-White Valve Corporation.
 - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - k. Zy-Tech Global Industries, Inc.
2. Description:
- a. Standard: MSS SP-85, Type I.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Packing and Gasket: Asbestos free.
- B. Class 250, Iron Globe Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-85, Type I.
 - b. CWP Rating: 500 psig (3450 kPa).
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Packing and Gasket: Asbestos free.

2.12 CHAINWHEELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
1. Babbitt Steam Specialty Co.
 2. Roto Hammer Industries.
 3. Trumbull Industries.
- B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 2. Attachment: For connection to butterfly valve stems.
 3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.

4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for butterfly gate and globe valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.
- F. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly, or gate valves.
 2. Throttling Service, Except Steam: Globe or ball valves.
 3. Throttling Service, Steam: Globe or butterfly valves.
 4. Pump-Discharge Check Valves:
 - a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze disc.
 - b. NPS 2-1/2 (DN 65) and Larger: Iron swing check valves with lever and weight or with spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
 4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
 5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.

3.5 CHILLED-WATER VALVE SCHEDULE

- A. Pipe NPS 2 (DN 50) and Smaller:
1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 2. Bronze Angle Valves: Class 150, bronze disc.
 3. Ball Valves: Two piece, full port, brass or bronze with bronze trim.
 4. Bronze Swing Check Valves: Class 150, bronze disc.
 5. Bronze Gate Valves: Class 150, NRS, bronze.
 6. Bronze Globe Valves: Class 150, bronze disc.
- B. Pipe NPS 2-1/2 (DN 65) and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
 2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 CWP, EPDM seat, aluminum-bronze disc.
 3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24 (DN 350 to DN 600): 150 CWP, EPDM seat, aluminum-bronze disc.
 4. High-Performance Butterfly Valves: Class 150, single flange.
 5. Iron Swing Check Valves: Class 250, metal seats.
 6. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring weight.
 7. Iron Gate Valves: Class 250, OS&Y.
 8. Iron Globe Valves: Class 250.

3.6 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, brass or bronze with bronze trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.
4. Bronze Gate Valves: Class 150, NRS.
5. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 CWP, EPDM seat, aluminum-bronze disc.
3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24 (DN 350 to DN 600): 150 CWP, EPDM seat, aluminum-bronze disc.
4. High-Performance Butterfly Valves: Class 150, single flange.
5. Iron Swing Check Valves: Class 250, metal seats.
6. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring weight.
7. Iron Gate Valves: Class 250, OS&Y.
8. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 250.

3.7 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, brass or bronze with bronze trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.
4. Bronze Gate Valves: Class 150, NRS.
5. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 CWP, EPDM seat, aluminum-bronze disc.
3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24 (DN 350 to DN 600): 150 CWP, EPDM seat, aluminum-bronze disc.
4. High-Performance Butterfly Valves: Class 150, single flange.
5. Iron Swing Check Valves: Class 250, metal seats.
6. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring weight.
7. Iron Gate Valves: Class 250, OS&Y.

8. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 250.

3.8 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG (104 kPa) OR LESS)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball Valves: Two piece, full port, brass or bronze with bronze trim.
2. Bronze Swing Check Valves: Class 150, bronze disc.
3. Bronze Gate Valves: Class 150, NRS.
4. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. High-Performance Butterfly Valves: Class 150, single flange.
3. Iron Swing Check Valves: Class 250, metal seats.
4. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring weight.
5. Iron Gate Valves: Class 250, OS&Y.
6. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 250.

3.9 HIGH-PRESSURE STEAM VALVE SCHEDULE (MORE THAN 15 PSIG (104 kPa))

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball Valves: Two piece, full port, brass or bronze with bronze trim.
2. Bronze Swing Check Valves: Class 150, bronze disc.
3. Bronze Gate Valves: Class 150, NRS, bronze.
4. Globe Valves: Class 150, bronze, bronze disc.

B. Pipe Sizes NPS 2-1/2 (DN 65) and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. High-Performance Butterfly Valves: Class 150, single flange.
3. Iron Swing Check Valves: Class 250, metal seats.
4. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring weight.
5. Iron Gate Valves: Class 250, OS&Y.
6. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 250.

3.10 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball Valves: Two piece, full port, brass or bronze with bronze trim.
2. Bronze Swing Check Valves: Class 150, bronze disc.

3. Bronze Gate Valves: Class 150, NRS.
 4. Bronze Globe Valves: Class 150, bronze disc.
- B. Pipe NPS 2-1/2 (DN 65) and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
 2. High-Performance Butterfly Valves: Class 150, single flange.
 3. Iron Swing Check Valves: Class 250, metal seats.
 4. Iron Swing Check Valves with Closure Control: Class 125, lever and spring weight.
 5. Iron Gate Valves: Class 250, OS&Y.
 6. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 250.

END OF SECTION 23 05 23

SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All work of this Division shall be coordinated and provided by the single Central Control and Monitoring System (CCMS) Contractor.
- B. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 23 Sections for details.
- C. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.

1.2 SCOPE OF WORK

- A. This section includes the controls, instrumentation and associated piping and wiring required to make the mechanical systems provided under Division 23 perform as described in these specifications and as shown. Provide a complete system of automatic temperature control of the direct digital type. The system shall be complete in all respects including all labor, materials, equipment, and service necessary, and shall be installed by personnel in the direct employ of the manufacturer. Provide a distributed process network control system complete with all necessary hardware and software including all programming. The DDC systems for the new Darla Moore School of Business (DMSB) shall be compatible with the existing USC campus wide control system network in all respects. The existing control system network is Johnson Controls Metasys.
- B. The energy profile for the DMSB shall be added to the existing USC Energy Kiosk server software for campus wide monitoring of the following:
 - 1. Week to week energy consumption comparison for building:
 - a. Electricity.
 - b. Heating.
 - c. Cooling.
 - 2. Weekly CO2 production:
 - a. Format for DMSB energy profile shall be the same as the existing building currently being monitored.
- C. The energy profile for the DMSB shall be added to the existing USC Energy Dashboard server energy analysis software.
 - 1. Add DMSB building energy data to the total campus energy data for inclusion of the DMSB energy profile for graphical display of total campus:
 - a. Hourly power consumption.
 - b. Power consumption by square foot.
 - c. Weekly energy consumption.

- d. Weekly peak consumption.
2. Add the new DMSB building energy data to the following existing reports:
 - a. Energy Hog Report.
 - b. Total Meter Report.
 - c. Weekly Demand Report.
 - d. Chiller Plants Load Report.
 3. Format for DMSB energy profile shall be the same as the existing building currently being monitored.
- D. Add DMSB building energy to existing Energy Essentials software as specified under section 2.2.C.3.e for monitoring and analysis of DMSB energy costs.
 - E. Utilize the existing CMMS server for the purpose of providing a location for archiving system configuration data, graphics and historical data such as trend data and operator transactions.
 - F. Provide a complete and operational Central Control and Monitoring System (CCMS) including all devices and software necessary to perform the functions herein described or indicated on the drawings.
 - G. The CMMS shall be a Web based system communicating over the building owners Local Area Network (LAN). Contractor shall be responsible for coordination with the owner's IT staff to ensure that the CMMS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN. TCP/IP connections and addresses shall be provided by the owner for connection of supervisory panels to the USC network..
 - H. The primary desktop and laptop interface will be via a standard Web Browser such as Internet Explorer or Netscape. CMMS contractor shall provide software license(s) for CMMS WEB access for a minimum of twenty concurrent users.
 - I. The primary focus of the Central Control and Monitoring System (CCMS) will be to monitor and control the new HVAC system components, air handling units, fans, heat exchangers, coils, valves, pumps, variable speed drives, etc. The system shall be expandable to serve future equipment, systems, and auxiliary field devices.
 - J. CCMS contractor shall provide all DDC panels, power supplies, wiring, conduit, solenoid valves, relays, differential pressure transmitters, differential pressure switches, RTDS, pressure sensors, etc. necessary for a complete and operable automatic control system and DDC field panels and connecting LAN.
 - K. The systems engineering phase shall include the selection and integration of components into a complete system which will meet the performance and prescriptive requirements of the Contract, together with drawings, specifications, descriptions of operation, diagrams including system architecture and other materials listed under "Submittals" paragraph of this Section. The successful contractor shall be responsible for all systems engineering.
 - L. The demarcation of work and responsibilities between the BMS Contractor and other related trades shall be as outlined in the BMS RESPONSIBILITY MATRIX

BMS RESPONSIBILITY MATRIX				
WORK	FURNISH	INSTALL	Low Volt. WIRING/TUBE	LINE POWER
BMS low voltage and communication wiring	BMS	BMS	BMS	N/A
VAV box nodes	BMS	23	BMS	26
Chilled Beam nodes	BMS	23	BMS	26
BMS conduits and raceway	BMS	BMS	BMS	BMS
Automatic dampers	23	23	N/A	N/A
Manual valves	23	23	N/A	N/A
Automatic valves	BMS	23	BMS	N/A
VAV boxes	23	23	N/A	N/A
Pipe insertion devices and taps including thermowells, flow and pressure stations.	BMS	23	BMS	26
BMS Current Switches.	BMS	BMS	BMS	N/A
BMS Control Relays	BMS	BMS	BMS	N/A
Power distribution system monitoring interfaces	26	26	26	26
Concrete and/or inertia equipment pads and seismic bracing	23	23	N/A	N/A
BMS interface with Chiller controls	BMS	BMS	BMS	BMS
Chiller controls interface with BMS	23	23	BMS	26
BMS interface with <u>Underfloor</u> controls	BMS	BMS	BMS	BMS
Underfloor controls interface with BMS	23	23	BMS	26
All BMS Nodes, equipment, housings, enclosures and panels.	BMS	BMS	BMS	26
Smoke Detectors	26	26	26	26
Fire/Smoke Dampers	23	23	BMS	26
Fire Dampers	23	23	N/A	N/A
VFDs	23	26	BMS	26
Fire Alarm shutdown relay interlock wiring	26	26	26	26
Fire Alarm smoke control relay interlock wiring	26	26	BMS	26
Fan Coil Unit controls	BMS	BMS	BMS	26
Unit Heater controls	BMS	BMS	BMS	26
Starters, HOA switches	23	23	N/A	26
Control damper actuators	BMS	BMS	BMS	26

1.3 QUALITY ASSURANCE

- A. Quality assurance for automatic control systems includes a multi-step program consisting of a pre-qualification procedure for manufacturer and installation specialist; a system engineering, products and shop drawing phase; installation; testing and adjusting; reporting; commissioning testing and verifications; operating instruction and training; and the submission of maintenance and operating manuals.
- B. CMMS Contractor:
- The Central Control and Monitoring System (CMMS) herein specified shall be fully integrated and installed as a complete package by the Central Control and Monitoring System contractor. The System shall include all wiring, piping, installation supervision,

calibration, adjustments, and checkout necessary for a complete and fully operational system.

2. The CMMS Contractor shall be a factory owned branch office that is regularly engaged in the engineering, programming, installation and service of CMMSs of similar size and complexity. Bids by wholesalers, mechanical contractors, franchised dealers, applied partners or any other firm whose principal business is not that of manufacturing and installing automatic temperature control systems shall not be acceptable.
3. The CMMS Contractor shall have a minimum of ten years experience with the complete, turnkey installation of CMMSs of similar size and technical complexity.
4. The CMMS shall be complete in all respects and shall be provided, installed and commissioned by the CMMS equipment manufacturer. Equipment manufacturer shall be responsible for and warrant the proper installation and operation of the CMMS and control system equipment.
5. The following CMMS contractors are approved to provide and install the CMMS for this project subject to their ability to meet all requirements of this specification:

Johnson Controls, Inc
14 Woodcross Drive
Columbia, SC 29212

6. Bid approval does not imply nor suggest compliance of specification requirements.

C. CMMS Products Manufacturer:

1. The CMMS architecture shall consist of the products of a manufacturer regularly engaged in the production of CMMSs, and shall be the manufacturer's latest standard of design. Controllers and DDC (Direct Digital Control) system components shall be current production products.
2. All other equipment shall be the products of the CMMS manufacturers or of an approved manufacturer regularly engaged in production of specialized CMMS materials or equipment.
3. Following is a list of acceptable CMMS products manufacturers:

Johnson Controls, Inc
14 Woodcross Drive
Columbia, SC 29212

4. Bid approval does not imply nor suggest compliance of specification requirements.

1.4 WORK INCLUDED AND INTERFACE REQUIREMENTS

A. Installation of Central Control and Monitoring System (CMMS):

1. The CMMS contractor shall provide all necessary hardware and software to integrate the new control system with the existing USC campus CMMS. Integration means the ability to monitor, override, change setpoints, and provide real-time bi-directional dynamic data exchange between the new control system and the existing CMMS hardware and software.
2. The existing USC campus CMMS is a Johnson Controls Metasys system. The CMMS is comprised of multiple supervisory controllers, monitoring and communicating with various building control systems over the USC campus Ethernet LAN system. The new building control system will be connected to, and communicate with, the existing campus CMMS server via the USC campus Ethernet LAN.

3. All new control points, monitoring points and software points shall be added to the existing USC CMMS database and shall be available for monitoring and adjustment at any computer, with current copy of Microsoft Internet Explorer software (Release 6.0 or later), that is connected to the USC LAN.
4. All new building software and databases shall be archived on the hard drive at the USC CMMS server. In the event that any building controller should lose its program that controller's archived software program shall be downloaded across the CMMS network from the CMMS server to the respective building controller.
5. The CMMS contractor will provide all necessary hardware, software, and labor to allow communication with all any computer, with current copy of Microsoft Internet Explorer (Release 6.0 or later), that is connected to the USC LAN.
6. Integrity of the existing CMMS shall be maintained during installation.
7. The new building control system shall be compatible in every respect with existing Metasys CMMS hardware and software. All new controllers shall be compatible with Metasys database and Metasys software development tools.

1.5 SUBMITTALS

A. Shop Drawings, Product Data, and Samples:

1. Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.
2. Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
3. The CCMS Contractor shall correct any errors or omissions noted in the first review.
4. At a minimum, submit the following:
 - a. CCMS network architecture diagrams including all nodes and interconnections.
 - b. Systems schematics, sequences and flow diagrams.
 - c. Points schedule for each point in the CCMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
 - d. Samples of Graphic Display screen types and associated menus.
 - e. Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
 - f. Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
 - ~~g.~~ Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.
 - ~~h.~~ Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address
 - i. Details of all CCMS interfaces and connections to the work of other trades.
 - j. Product data sheets or marked catalog pages including part number, photo and description for all products including software.

1.6 RECORD DOCUMENTATION

A. Operation and Maintenance Manuals:

1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the CCMS provided:
 - a. Table of contents.
 - b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
 - c. Manufacturers product data sheets or catalog pages for all products including software.
 - d. System Operator's manuals.
 - e. Archive copy of all site-specific databases and sequences.
 - f. CCMS network diagrams.
 - g. Interfaces to all third-party products and work by other trades.
2. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

1.7 WARRANTY

A. Standard Material and Labor Warranty:

1. Provide a one-year labor and material warranty on the CCMS.
2. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the CCMS Contractor at the cost of the CCMS Contractor.
3. Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during CCMS Contractor's normal business hours.

PART 2 - PRODUCTS

2.1 GENERAL DESCRIPTION

- A. The Central Control and Monitoring System (CCMS) shall use an open architecture. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.
- B. The Central Control and Monitoring System shall consist of the following:
 1. Standalone Network Automation Engine(s).
 2. Field Equipment Controller(s).
 3. Input/Output Module(s).

4. Local Display Device(s).
 5. Distributed User Interface(s).
 6. Network processing, data storage and communications equipment.
 7. Other components required for a complete and working CCMS.
- C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

2.2 CCMS ARCHITECTURE

A. Automation Network:

1. The CCMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
2. The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
3. Network Automation Engines (NAE) shall reside on the automation network.
4. The automation network will be compatible with other campus-wide networks. Where indicated, the automation network shall be connected to the campus network and share resources with it by way of standard networking devices and practices.

B. Control Network:

1. Network Automation Engines shall provide supervisory control over the control network.
2. Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
3. DDC Controllers shall reside on the control network
4. Wireless communication between DDC controllers is acceptable. All sensors shall be wired.

C. Distributed Web Based User Interface:

1. All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.
2. Alarms:
 - a. Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
 - 1) Log date and time of alarm occurrence.
 - 2) Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.

- 3) Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
 - 4) Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
 - 5) Provide the capability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
 - 6) Any attribute of any object in the system may be designated to report an alarm.
- b. The FMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions
3. Reports and Summaries:
- a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
 - 1) All points in the CCMS
 - 2) All points in each CCMS application
 - 3) All points in a specific controller
 - 4) All points in a user-defined group of points
 - 5) All points currently in alarm
 - 6) All points locked out
 - 7) All CCMS schedules
 - 8) All user defined and adjustable variables, schedules, interlocks and the like.
 - b. Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
 - c. Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.
 - d. The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.
 - e. Energy Essentials Software: Provide a focused set of reports that includes essential information required for effective management of energy resources. Required includes but shall not be limited to:
 - 1) Energy Overview.
 - 2) Load Profile.
 - 3) Simple Energy Cost.
 - 4) Consumption.
 - 5) Equipment Runtime.
 - 6) Electrical Energy.
 - 7) Energy Production .
 - f. Reports shall be selectable by date, time, area and device. Each report shall include a graphical color visual summary of essential energy information.

4. Schedules:
 - a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
 - 1) Weekly schedules.
 - 2) Exception Schedules.
 - 3) Monthly calendars.
 - b. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
 - c. It shall be possible to define one or more exception schedules for each schedule including references to calendars
5. Password:
 - a. Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.
 - b. A minimum of five levels of access shall be supported individually or in any combination as follows:
 - 1) Level 1 = View Data.
 - 2) Level 2 = Command.
 - 3) Level 3 = Operator Overrides.
 - 4) Level 4 = Database Modification.
 - 5) Level 5 = Database Configuration.
 - 6) Level 6 = All privileges, including Password Add/Modify.
 - c. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
6. Dynamic Color Graphics:
 - a. The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.
 - b. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed. The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
7. Historical trending and data collection:
 - a. Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:
 - 1) Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:
 - a) Defined time interval.

- b) Upon a change of value.
- 2) Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.
- b. The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format.
- 8. Trend data viewing and analysis:
 - a. Provide a trend viewing utility that shall have access to all database points.
 - b. It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
 - c. The trend viewing utility shall have the capability to define trend study displays to include multiple trends
 - d. Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
 - e. Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.
 - f. Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.
 - g. Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

2.3 NETWORK AUTOMATION ENGINES (NAE)

A. Network Automation Engine (NAE):

1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
3. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
4. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
5. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
6. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

- a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
- b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

2.4 DDC SYSTEM CONTROLLERS

A. Field Equipment Controller (FEC):

1. The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
2. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
3. The FEC shall be assembled in a plenum-rated housing with flammability rated to UL94-5VB.
4. The FEC shall include a removable base to allow pre-wiring without the controller.
5. The FEC shall accommodate the direct wiring of analog and binary I/O field points.
6. The FEC shall support the following types of inputs and outputs:
 - a. Universal Inputs - shall be configured to monitor any of the following:
 - 1) Analog Input, Voltage Mode.
 - 2) Analog Input, Current Mode.
 - 3) Analog Input, Resistive Mode.
 - 4) Binary Input, Dry Contact Maintained Mode.
 - 5) Binary Input, Pulse Counter Mode.
 - b. Binary Inputs - shall be configured to monitor either of the following:
 - 1) Dry Contact Maintained Mode.
 - 2) Pulse Counter Mode.
 - c. Analog Outputs - shall be configured to output either of the following:
 - 1) Analog Output, Voltage Mode.
 - 2) Analog Output, current Mode.
 - d. Binary Outputs - shall output the following:
 - 1) 24 VAC Triac.
 - e. Configurable Outputs - shall be capable of the following:
 - 1) Analog Output, Voltage Mode.
 - 2) Binary Output Mode.
7. The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
 - a. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.

- b. The FC Bus shall support communications between the FECs and the NAE.
 - c. The FC Bus shall support a minimum of 100 IOMs and FEC in any combination.
 - d. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
8. The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
- a. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
 - b. The SA Bus shall support a minimum of 10 devices per trunk.
 - c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
9. The FEC shall support, but not be limited to, the following:
- a. Hot water, chilled water/central plant applications.
 - b. Built-up air handling units for special applications.
 - c. Terminal units.
 - d. Special programs as required for systems control.

2.5 FIELD DEVICES

A. Input/Output Module (IOM):

1. The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.
2. The IOM shall communicate with the FEC over either the FC Bus or the SA Bus using BACnet Standard protocol SSPC-135, Clause 9.

B. Networked Thermostat (TEC):

1. The Networked Thermostats shall be capable of controlling the following:
 - a. A four pipe fan coil system with multi-speed fan control.
 - b. A two pipe fan coil with a single speed fan.
 - c. The Networked Thermostat shall support remote read/write and parameter adjustment from the web based User Interfaceable through a Network Automation Engine.
2. The Networked Thermostat shall include an intuitive User Interface providing plain text messages.
 - a. Two line, 8 character backlit display.
 - b. LED indicators for Fan, Heat, and Cool status.
 - c. Five (5) User Interface Keys:
 - 1) Mode.
 - 2) Fan.
 - 3) Override.
 - 4) Degrees C/F.
 - 5) Up/Down.

3. The Networked Thermostats shall provide the flexibility to support the following inputs:
 - a. Integral Indoor Air Temperature Sensor.
 - b. Duct Mount Air Temperature Sensor.
 - c. Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator.
 - d. Two configurable binary inputs.
4. The Networked Thermostats shall provide the flexibility to support the following outputs:
 - a. Three Speed Fan Control.
 - b. On/Off Control.
 - c. Floating Control.
 - d. Proportional (0 to 10V) Control.

C. VAV Modular Assembly (VMA):

1. The VAV Modular Assembly shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units. It shall address both single and dual duct applications.
2. The VAV Modular Assembly shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.
3. The VAV Modular Assembly shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.
4. The VAV Modular Assembly shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.
5. The VAV Modular Assembly shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
6. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 30 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
7. The controller shall determine airflow by dynamic pressure measurement using an integral dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.
8. Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
9. The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
10. Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.
11. The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.
12. Control setpoint changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.
13. The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.

14. The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
15. The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.
16. Controller performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The VMA shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.
 - a. Absolute temperature loop error.
 - b. Signed temperature loop error.
 - c. Absolute airflow loop error.
 - d. Signed airflow loop error.
 - e. Average damper actuator duty cycle.
17. The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:
 - a. Unreliable space temperature sensor.
 - b. Unreliable differential pressure sensor.
 - c. Starved box.
 - d. Actuator stall
 - e. Insufficient cooling.
 - f. Insufficient heating.
18. The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.
 - a. The controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow Based on the percent of outdoor air in the primary air stream.
 - b. The controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.
 - c. Inputs:
 - 1) Analog inputs with user defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:
 - a) 0-10 VDC Sensors.
 - b) 1000ohm RTDs.
 - c) NTC Thermistors.
 - d. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."
 - e. For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.

f. Provide side loop application for humidity control.

19. Outputs:

a. Analog outputs shall provide the following control outputs:

1) 0-10 VDC.

b. Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.

c. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.

20. Application Configuration:

a. The VAV Modular Assembly shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.

21. Sensor Support:

a. The VAV Modular Assembly shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.

b. The VMA shall support an LCD display room sensor.

c. The VMA shall also support standard room sensors as defined by analog input requirements.

d. The VMA shall support humidity sensors defined by the AI side loop.

D. Network Sensors (NS):

1. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:

a. Zone Temperature.

b. Zone humidity.

c. Zone setpoint.

2. The NS shall transmit the zone information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.

3. The Network Sensors shall include the following items:

1) A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint.

2) An LED to indicate the status of the Override feature.

3) A button to toggle the temperature display between Fahrenheit and Celsius.

4) A button to initiate a timed override command.

4. The NS shall be available with either screw terminals or phone jack.

5. The NS shall be available in either surface mount or wall mount styles.

2.6 INPUT DEVICES

A. General Requirements:

1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.
- B. Temperature Sensors:
1. General Requirements:
 - a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
 - b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
 - c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:
 2. Room Temperature Sensors:
 - a. Room sensors shall be constructed for either surface or wall box mounting.
 - b. Room sensors shall have the following options when specified:
 - 1) Setpoint reset slide switch providing a ± 3 degree (adjustable) range.
 - 2) Individual heating/cooling setpoint slide switches.
 - 3) A momentary override request push button for activation of after-hours operation.
 3. Thermo wells:
 - a. When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
 - b. Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.
 - c. Thermo wells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
 - d. Thermo wells shall be constructed of 316 stainless steel.
 4. Outside Air Sensors:
 - a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
 - b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
 - c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
 5. Duct Mount Sensors:
 - a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
 - b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
 - c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
 6. Averaging Sensors:

- a. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
 - b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
 - c. Capillary supports at the sides of the duct shall be provided to support the sensing string.
7. Acceptable Manufacturers: Johnson Controls, Setra.
- C. Humidity Sensors:
1. The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
 2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
 3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.
 4. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealite fittings and stainless steel bushings.
 5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
 6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
 7. Acceptable Manufacturers: Johnson Controls, Veris Industries, and Mamac.
- D. Differential Pressure Transmitters:
1. General Air and Water Pressure Transmitter Requirements:
 - a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
 - c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
 - d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
 2. Low Differential Water Pressure Applications (0" - 20" w.c.)
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:

- 1) .01-20" w.c. input differential pressure range.
 - 2) 4-20 mA output.
 - 3) Maintain accuracy up to 20 to 1 ratio turndown.
 - 4) Reference Accuracy: +0.2% of full span.
- c. Acceptable Manufacturers: Setra and Mamac.
3. Medium to High Differential Water Pressure Applications (Over 21" w.c.)
- a. The differential pressure transmitter shall meet the low pressure transmitter specifications with the following exceptions:
 - 1) Differential pressure range 10" w.c. to 300 PSI.
 - 2) Reference Accuracy: $\pm 1\%$ of full span (includes non-linearity, hysteresis, and repeatability).
 - b. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
 - c. Acceptable Manufacturers: Setra and Mamac.
4. Building Differential Air Pressure Applications (-1" to +1" w.c.)
- a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - 1) -1.00 to +1.00 w.c. input differential pressure ranges. (Select range appropriate for system application)
 - 2) 4-20 mA output.
 - 3) Maintain accuracy up to 20 to 1 ratio turndown.
 - 4) Reference Accuracy: +0.2% of full span.
 - c. Acceptable Manufacturers: Johnson Controls and Setra.
5. Low Differential Air Pressure Applications (0" to 5" w.c.)
- a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - 1) (0.00 - 1.00" to 5.00") w.c. input differential pressure ranges. (Select range appropriate for system application.)
 - 2) 4-20 mA output.
 - 3) Maintain accuracy up to 20 to 1 ratio turndown.
 - 4) Reference Accuracy: +0.2% of full span.
 - a. Acceptable Manufacturers: Johnson Controls and Setra.

6. Medium Differential Air Pressure Applications (5" to 21" w.c.):

- a. The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements:
 - 1) Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.
 - 2) Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 PSIG).
 - 3) Thermal Effects: <+.033 F.S./Deg. F. over 40°F. to 100°F. (calibrated at 70°F.).
- b. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
- c. Acceptable manufacturers: Johnson Controls and Setra.

E. Flow Monitoring:

1. Air Flow Monitoring:

- a. Provide airflow temperature measurement devices where indicated on the plans. Airflow devices shown on HVAC equipment schedules shall be provided and factory installed by the equipment manufacturer. Airflow devices will be as specified in the central control and monitoring specification.
- b. Each measuring device shall consist of one or more multi-point measuring probes and a single microprocessor-based transmitter. Each transmitter shall operate on 24VAC.
- c. Each sensing point shall independently determine the airflow rate and temperature, which shall be equally weighted and averaged by the transmitter prior to output.
- d. Each independent airflow sensor shall have a laboratory accuracy of +/-2% of reading over the entire operating airflow range of 0-5000FPM and be wind tunnel calibrated or verified against standards that are traceable to NIST.

1) The number of sensor housings provided for each location shall be:

Duct or Plenum Area (sq. ft)	Total # Sensors/Location
<2	4
2 to <4	6
4 to <8	8
8 to <16	12
>=16	16

- e. The transmitter shall be capable of communicating with the host controls using the following interface options:
 - 1) Linear analog output signal: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA (4 wire).
 - 2) RS-485: Field selectable Johnson Controls N2 Bus.
- f. Acceptable Manufacturers: Johnson Controls, Ebtron.

2. Water Flow Monitoring:
 - a. Water flow meters shall be electromagnetic type with integral microprocessor-Based electronics. The meter shall have an accuracy of 0.25%.
 - b. Acceptable manufacturers: Onicon, Dynasonics.

- F. Power Monitoring Devices:
 1. All power monitoring devices will be provided by Division 26. Information from these devices will be conveyed by Bacnet protocol. Johnson Controls will receive this information and integrate into the CCMS. Johnson Controls shall provide programming necessary to isolate individual loads for DOE measurement and verification purposes. This information can then be monitored and will be displayed by the campus energy dashboard.

- G. Smoke Detectors:
 1. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Division 23. All wiring for air duct detectors shall be provided under Division 26, Fire Alarm System.

- H. Status and Safety Switches:
 1. General Requirements:
 - a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the CCMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
 2. Current Sensing Switches:
 - a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
 - b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
 - c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
 - d. Acceptable manufacturers: Veris Industries.
 3. Air Filter Status Switches:
 - a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
 - b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
 - c. Provide appropriate scale range and differential adjustment for intended service.
 - d. Acceptable manufacturers: Johnson Controls, Cleveland Controls.
 4. Air Flow Switches:

- a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
 - b. Acceptable manufacturers: Johnson Controls, Cleveland Controls.
5. Air Pressure Safety Switches:
- a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
 - b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
 - c. Acceptable manufacturers: Johnson Controls, Cleveland Controls.
6. Water Flow Switches:
- a. Water flow switches shall be equal to the Johnson Controls P74.
7. Low Temperature Limit Switches:
- a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
 - b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
 - c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
 - d. The low temperature limit switch shall be equal to Johnson Controls A70.

2.7 OUTPUT DEVICES

A. Actuators:

1. General Requirements:
 - a. Damper and valve actuators shall be electronic. Controls submittals shall indicate actuator fail position as normally open or closed.
2. Electronic Damper Actuators:
 - a. Electronic damper actuators shall be direct shaft mount.
 - b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.
 - c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The

feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

- d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
- e. Acceptable manufacturers: Johnson Controls, Mamac.

3. Electronic Valve Actuators:

- a. Electronic valve actuators shall be manufactured by the valve manufacturer.
- b. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
- c. Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized Based on valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.
- d. Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
- e. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.
- f. Acceptable manufacturers: Johnson Controls.

B. Control Relays:

1. Control Pilot Relays:

- a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
- b. Mounting Bases shall be snap-mount.
- c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
- d. Contacts shall be rated for 10 amps at 120VAC.
- e. Relays shall have an integral indicator light and check button.
- f. Acceptable manufacturers: Johnson Controls, Lectro.

C. Control Valves (Chilled Water):

1. All modulating control valves shall be of the "pressure independent" type configured with one integrated valve body that incorporates one chamber with an adjustable Cv and a separate pressure regulating chamber used to maintain a constant differential pressure across the control surface.
2. Each control valve shall be individually flow tested at the factory and verified to deviate no more than $\pm 5\%$ through the selected operating pressure range. A calibrated performance tag shall be provided with each valve that verifies the flow rate in 10° rotation increments up to full rated flow (option with $1/2"$). All testing shall be performed with instruments calibrated to the requirements of ANSI/ISA-S75.11-1985, with traceability to NIST and/or ISO standards.
3. Control valve rangeability shall be 100:1 minimum.
4. Each control valve shall be subjected to 70 psid and tested to exceed ANSI/FCI 70-2-1998 leakage ratings. Class IV leakage or better is required for control valves 2" nominal size and less. Class III leakage or better is required for control valves larger than 2".
5. In all control valves 8" and smaller, it shall be possible to modify the valve flow characteristics without removing the valve from the piping system.
6. Balancing valves and associated balancing shall not be required where pressure independent modulating control valves are installed.
7. The control valve actuator shall modulate all valves up to 8" in nominal size from 0 to 100% design flow while rotating the valve stem a maximum of 90° .
8. There shall be three ports installed at the factory integral to each valve and capable of being used to measure pressure or temperature. The first port shall be installed at the inlet to the valve. The second shall be installed between the Cv chamber and the pressure regulating chamber. The third shall be installed at the outlet of the valve. Should the ports not be provided as part of the valve body than they shall be installed in a spool piece and attached to the body.
9. The differential pressure between the first and the third port shall be used in commissioning to verify that the minimum differential pressure (typically 5 psid) required for pressure independent operation is available.
10. The differential pressure between the first and second ports shall be used to verify proper valve operation and flow regulation. It shall be possible to verify the flow rate through the control valve using the valve stem position and the differential pressure measurement between the first and second port in the valve. If these valve features are not available, a flow meter shall be installed to verify actual flow rate in operation through the valve.
11. CB valves to be standard modulating.
12. All valves shall be warranted by the manufacturer for no less than 5 years from the date of purchase.
13. Acceptable manufacturers: Johnson Controls, Danfoss, Delta Flow.

D. Control Valves (Hot Water & Steam Systems):

1. All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Specification.
2. Chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general, valves (2 or 3-way) serving variable flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI. Valves (3-way) serving constant flow air

handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.

3. Ball valves shall be used for hot and chilled water applications, water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units except those described hereinafter.
4. Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all special applications as indicated on the valve schedule. Valve discs shall be composition type. Valve stems shall be stainless steel.
5. Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless steel vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.
6. Acceptable manufacturers: Johnson Controls, Danfoss, Delta Flow.

2.8 MISCELLANEOUS DEVICES

A. Local Control Panels:

1. All control panels shall be factory constructed, incorporating the CCMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.
2. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
3. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
4. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
5. All wiring shall be neatly installed in plastic trays or tie-wrapped.
6. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

B. Thermostats:

1. Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

PART 3 - PERFORMANCE / EXECUTION

3.1 CCMS SPECIFIC REQUIREMENTS

A. Graphic Displays:

1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection.

B. Actuation / Control Type:

1. Primary Equipment:

- a. Controls shall be provided by equipment manufacturer as specified herein.
- b. All damper and valve actuation shall be electric.

2. Air Handling Equipment

- a. All air handlers shall be controlled with a HVAC-DDC Controller
- b. All damper and valve actuation shall be electric.

3. Terminal Equipment:

- a. Terminal Units (VAV, FPVAV, FCU etc.) shall have electric damper and valve actuation.
- b. All Terminal Units shall be controlled with HVAC-DDC Controller).

3.2 INSTALLATION PRACTICES

A. CCMS Wiring:

1. All conduit, wiring, accessories and wiring connections required for the installation of the Central Control and Monitoring System, as herein specified, shall be provided by the CCMS Contractor unless specifically shown on the Electrical Drawings under Division 26 Electrical. All wiring shall comply with the requirements of applicable portions of Division 26 and all local and national electric codes, unless specified otherwise in this section.
2. All CCMS wiring materials and installation methods shall comply with CCMS manufacturer recommendations.
3. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the CCMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the CCMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
4. Class 2 Wiring:
 - a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
 - b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.

5. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
 6. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.
- B. CCMS Raceway:
1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".
 2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
 3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
 4. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.
- C. Penetrations:
1. Provide fire stopping for all penetrations used by dedicated CCMS conduits and raceways.
 2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
 3. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
 4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.
- D. CCMS Identification Standards:
1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.
 2. Cable types specified in Item A shall be color coded for easy identification and troubleshooting.
- E. CCMS Panel Installation:
1. The CCMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
 2. The CCMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.
- F. Input Devices:
1. All Input devices shall be installed per the manufacturer recommendation
 2. Locate components of the CCMS in accessible local control panels wherever possible.
- G. HVAC Input Devices – General:
1. All Input devices shall be installed per the manufacturer recommendation
 2. Locate components of the CCMS in accessible local control panels wherever possible.

3. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
4. Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
5. Outside Air Sensors
 - a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
 - b. Sensors shall be installed with a rain proof, perforated cover.
6. Water Differential Pressure Sensors
 - a. Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.
 - b. Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
 - c. The transmitters shall be installed in an accessible location wherever possible.
7. Medium to High Differential Water Pressure Applications (Over 21" w.c.):
 - a. Air bleed units, bypass valves and compression fittings shall be provided.
8. Building Differential Air Pressure Applications (-1" to +1" w.c.):
 - a. Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
 - b. The interior tip shall be inconspicuous and located as shown on the drawings.
9. Duct Temperature Sensors:
 - a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
 - b. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
 - c. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
 - d. The sensor shall be mounted to suitable supports using factory approved element holders.
10. Space Sensors:
 - a. Shall be mounted per ADA requirements.
 - b. Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.
11. Low Temperature Limit Switches:
 - a. Install on the discharge side of the first water or steam coil in the air stream.
 - b. Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
 - c. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.

12. Air Differential Pressure Status Switches:
 - a. Install with static pressure tips, tubing, fittings, and air filter.
13. Water Differential Pressure Status Switches:
 - a. Install with shut off valves for isolation.

H. HVAC Output Devices:

1. All output devices shall be installed per the manufacturers recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.
3. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
4. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.
5. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Central Control and Monitoring System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems.

3.3 TRAINING

A. The CCMS contractor shall provide the following training services:

1. One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the CCMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

3.4 COMMISSIONING

A. Fully commission all aspects of the Central Control and Monitoring System work.

B. Acceptance Check Sheet:

1. Prepare a check sheet that includes all points for all functions of the CCMS as indicated on the point list included in this specification.
2. Submit the check sheet to the Engineer for approval
3. The Engineer will use the check sheet as the basis for acceptance with the CCMS Contractor.

C. VAV box performance verification and documentation:

1. The CCMS Contractor shall test each VAV box for operation and correct flow. At each step, after a settling time, box air flows and damper positions will be sampled. Following the tests, a pass/fail report indicating results shall be produced and submitted to the engineer for review. Possible results are Pass, No change in flow between full open and full close, Reverse operation or Maximum flow not achieved. The report shall be submitted as documentation of the installation.
 2. The CCMS Contractor shall issue a report based on a sampling of the VAV calculated loop performance metrics. The report shall indicate performance criteria, include the count of conforming and non-conforming boxes, list the non-conforming boxes along with their performance data.
- D. Promptly rectify all listed deficiencies and submit to the Engineer that this has been done.

END OF SECTION 23 09 00

SECTION 23 57 00 - PACKAGED HEATING HOT WATER SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Pre-Packaged Duplex Heat Transfer Package with variable speed pumps for 100% standby operation as specified on the Water Heater/Hot Water Packaged Pumping System Schedule on the mechanical drawings.
1. Pre-Engineered, Pre-Packaged Duplex Pumping Module consisting of two Pumps, two Suction Diffusers, two Triple Duty Valves, an Air Elimination System, Steam to Water Heat Exchanger, Float and Thermostatic Main Trap, Electric/Electric Low NPSH required Duplex Condensate Return Unit, Flash Tank, Domestic Water Heaters and a Control Panel and Adjustable Frequency Drives as specified in major electrical components below, Pre-Piped, Pre-Wired, and mounted on Solid Steel Flat Base, reinforced and raised with Welded Structural Steel Channels.
 2. Base shall be constructed with lifting lugs that will allow a package to be lifted to be positioned into place.
 3. Connections:
 - a. HWS, HWR, Steam and Pumped Condensate pipe connections shall be as noted in the schedule on the mechanical drawings. Package shall be built such that inlets and outlets match configuration shown on mechanical drawings.
 - b. Make-up water, 3/4" threaded and coupled.
 - c. Single point power wiring connection for voltage, phase, and hertz as noted in the schedule on the mechanical drawings.
 - d. Control wiring terminal strip.
 4. Maximum dimensions shall not exceed those noted in the schedule on the mechanical drawings.
- B. The Packaged Pumping Module Shall be Field Insulated by Others.

1.2 REFERENCED STANDARDS

- A. Hydraulic Institute.
- B. ANSI - American National Standards Institute.
- C. NEMA - National Electrical Manufacturers Association.
- D. UL – 508 Industrial Control Panels.
- E. UL - QCZJ Packaged Pumping Systems.

- F. ETL - Electric Testing Laboratories.
- G. NEC - National Electrical Code (NFPA 70,) current edition.
- H. IEC - International Electrotechnical Commission.
- I. ISO - International Standards Organization.
- J. ASME B31.9.
- K. ASHRAE 90.1-2001.

1.3 SUBMITTALS

- A. General: In addition to the following, comply with the requirements of Division 1 for submittals, warranty and project closeout procedures.
- B. Furnish catalog information of all major components scheduled on the contract bid documents. In addition furnish installation, operation and maintenance (IOM) manuals on all equipment components, scaled and dimensioned fabrication drawings, sequence of operation for controls furnished, complete power wiring, control wiring and piping diagrams all as required for a complete explanation and description of all items of equipment. Include a copy of the standard startup and service reports to be used on each packaged system furnished and tentative service schedule based on the contract completion date (CCD).
- C. Furnish pump curve for the pump. The pump curve shall show as a minimum; bhp, motor characteristics, flow, total dynamic head, impeller diameter and system curve. Furnish a system profile analysis including constant speed and variable speed pump curves and system curve. The analysis shall also include pump, motor and AFD (where applicable) efficiencies, job specific load profile, staging points, horsepower and kilowatt-hour consumption. Submittals must be specific to this project. Generic submittals will not be accepted.
- D. Furnish selection report for heat exchanger listing total heat exchanged, steam used, shell and tubeside pressure drops, heat transfer surface area fouling factor and other pertinent data.
- E. Manufacturer shall furnish to the engineer upon request, a detailed item by item pressure drop calculation for all equipment and fittings furnished on the pumping package. The analysis shall be based on data from Crane Company Technical Paper No. 410.
- F. All information submitted shall be individually "tagged" to easily identify it with the item of corresponding material or equipment that is being submitted. Failure to comply with the aforementioned requirements will result in that item, or, at the discretion of the Engineer, all items being rejected without being reviewed until such time as these conditions are satisfied.
- G. Submittals that are "rejected" as being "non-compliant" will be re-reviewed with all time for subsequent reviews back charged to the contractor in accordance with the engineer's current prevailing rate schedule. If a rate schedule for additional services is included, as part of the

contract with the owner, that rate schedule shall be used in lieu of the "current prevailing" rate schedule.

- H. Provide 10 copies of the submittals, as specified.
- I. Provide all submittal information inclusive of fabrication drawings for review by the Engineer in accordance with the requirements of Division 1.

1.4 FABRICATION DRAWINGS

- A. As part of the aforementioned submittal requirements, provide three dimensional AutoCAD 2009 or higher dimensioned fabrication shop drawings as specified; detailing major elements, components, and systems included as part of the packaged pumping module. Provide, as a minimum, two scaled and dimensioned elevations indicating outside dimensions of the frame, piping and electrical connections.
 - 1. Include the following:
 - a. Clearances for operating, servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
 - b. Equipment connections and support details.

1.5 QUALITY ASSURANCE

- A. The manufacturer shall assume "Unit Responsibility" for the complete package. Unit responsibility shall be defined as responsibility for the interface and successful operation of all components supplied by the manufacturer. The manufacturer shall assemble the package. The manufacturer must be actively engaged in the design and fabrication of the packaged system being assembled.
- B. The manufacturer must have dedicated and qualified service/startup division for all components provided as part of the packaged systems.
- C. The manufacturer of the packaged system must be an authorized manufacturer's representative or reseller for all major components of the packaged system.
- D. Underwriter's Laboratories shall list the manufacturer as a manufacturer of packaged pumping systems.
- E. The manufacturer shall have not less than 5 years demonstrated and documented experience in the design, fabrication, testing and startup/servicing of packaged systems.
- F. ASME Section IX certified welders shall perform all welding of the piping.

- G. The manufacturer shall run test the completed packaged assembly at the factory for not less than 2 hours prior to shipment.
- H. The manufacturer shall carry a minimum product liability insurance of \$5,000,000.00 per occurrence.
- I. Bidders shall comply with all sections of this specification relating to Packaged Pumping Module. Deviations from this specification shall not be permitted.
- J. The contractor and Packaged Pumping Module Manufacturer shall be bound by these specifications.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to the site so they arrive in the same condition as when they left the factory.
- B. Prior to shipping, all open pipe connections shall be provided with protective ends caps to ensure that dirt, debris and other foreign matter are not introduced into the piping systems.
- C. The entire packaged system shall be factory assembled, tested and shipped.

1.7 WARRANTY & SERVICE

- A. The entire packaged assembly, inclusive of all components shall be fully warranted (full parts and labor) by the manufacturer against defects in workmanship and operation for a period of eighteen months from the date of shipment.
- B. The manufacturer shall guarantee in writing a response time of one (1) business day or less to calls for warranty and or service related emergencies.
- C. An authorized local service vendor of the manufacturer may perform the initial service call for diagnostic purposes.
- D. The manufacturer shall provide a 24-hour toll free emergency service hot line.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - 1. Hy-Fab Division of the James M. Pleasants Company, Inc.
 - 2. HTS Pump'n Flo.

3. ITT Bell & Gossett.

2.2 MANUFACTURED UNITS

- A. Each unit shall be provided with a permanently engraved nameplate bearing the name of the manufacturer. Each nameplate shall contain package specific engraved information on the nameplate. This information shall include as a minimum the following information:
 1. Model Number.
 2. Serial Number.
 3. Electrical Characteristics.
 4. Design Flow and Head Capacity.
- B. Each packaged unit shall be factory assembled and provided with the components required to meet the requirements of this specification.
- C. The piping system and in-line appurtenances shall be subjected to a hydrostatic pressure test after final assembly. Test pressure shall be not less than 10% below the setting of the packaged system's relief valve. The duration of the test shall be two hours. No change in the test pressure over the two-hour test period is allowed. Loss of pressure requires the leak to be fixed and the packaged system to be retested.
- D. Each unit shall be provided with a single point power connection and control power wiring terminal strip.
- E. All power and control wiring shall meet the requirements of the current edition of the National Electric Code (NFPA 70.)

2.3 STRUCTURAL STEEL FRAME

1. The frame shall be heavy-duty steel channel and angle iron construction. The frame material shall be ASTM A36 structural steel.
2. All welding for the frame shall be performed by AWS D1.1 certified welders.

2.4 INTERCONNECTING HYDRONIC PIPING

- A. The interconnecting piping shall be steel: 2½" and larger; ASTM A 53, Grade B, Schedule 40 seamless or ERW, black steel pipe, bevel ends for welding; 2", ASTM A 53, Grade B, Schedule 40, seamless or ERW, black steel pipe, threaded and coupled furnished with coupling; 1½" and smaller, ASTM A 53, Grade B, schedule 40 seamless black steel pipe, threaded and coupled furnished with coupling.
- B. Fittings:

1. Cast Iron Threaded Fittings: ANSI B16.4, Class 125 and 250 as applicable, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
2. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150 and 250 as applicable, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
3. Malleable-Iron Unions: ASME B16.39, Classes 150, 250 and 300 as applicable, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends. Threads shall conform to ANSI B1.20.1.
4. Steel Fittings: ASTM A 234, wall thickness to match adjoining pipe for welded joints.

C. Steel Flanges and Flanged Fittings:

1. ANSI B16.5, including bolts, nuts, and gaskets of the following material group, end connection and facing:
 - a. Weld-Neck, Raised Face standard, Flat Face where necessary to match valves or equipment.
 - b. Gasket Material: thickness, material, and type suitable for fluid to be handled, and design temperatures and pressures.

- D. All major components and in-line appurtenances that require periodic removal for service shall be provided with a flange on both sides.

2.5 PAINTING

- A. Each factory assembled packaged system, including all major components, shall be thoroughly cleaned after fabrication is complete.
- B. Entire package shall be primed after cleaning.
- C. After cleaning and priming, the package shall be painted with at least one coat of high-quality machinery grade enamel paint.
- D. Nameplates of the components shall not be painted over.

2.6 PUMPS

- A. End Suction Pumps: Furnish ITT Bell & Gossett Series1531 or equal of size GPM and TDH as scheduled on the drawings.
 1. Motor shall be of size, type, electrical characteristics and efficiency scheduled on the drawings. Motors for use with AFDs shall be "inverter ready." Motors shall be non-overloading across entire curve.
 2. Pump shall be close-coupled, single stage, end suction design capable of being serviced without disturbing piping connections.

3. The impeller shall be bronze enclosed, single suction type, dynamically balanced, keyed to the shaft. The allowable residual unbalance in the impeller rotating assembly shall conform to ANSI Grade G6.3.
4. The liquid cavity shall be sealed off by internally flushed mechanical seal with ceramic seat of 99.5% pure alumina oxide and hardness of 68 Rockwell C, or a tensile strength of 300,000 PSI, and carbon seal ring, suitable for continuous operation at 225 degrees F. A replaceable bronze shaft sleeve shall completely cover the wetted area of the shaft under the seal.
5. The pump casing shall be of Class 30 cast iron suitable for 175 PSI working pressure. The pump volute shall be supplied with vent, drain, and gauge tapings.
6. Pumps shall be capable of withstanding a horizontal load of 0.5 G without adversely affecting pump operation.

2.7 U-TUBE SHELL AND TUBE HEAT EXCHANGER

- A. Furnish with the package, a Bell and Gossett Heat Exchanger or equal as scheduled on the mechanical plans.
 1. Heat exchanger selections shall be selected by computer by the manufacturer to provide minimum heat transfer surface area requirements under the specified conditions. The maximum tube velocity shall not exceed 7.5 feet/second.
 2. Heat exchangers shall be constructed with cast iron heads, steel shell, baffles and tube sheets in accordance with the ASME Code for Unfired Pressure Vessels and furnished with manufacturer's data report, ASME form #U-1. Each unit shall be registered as required with the National Board of Boiler and Pressure Vessel inspectors.
 3. Heating surface shall be 3/4" O.D. copper tubing securely expanded to the tube sheets at one (1) end and properly supported at the other end.
 4. Heat exchangers shall be complete with all necessary connections for steam supply, condensate drain, water inlet and outlet, and a tapping for a vacuum breaker.
 5. Fouling allowance for the tube side shall be a minimum of 0.0005.
 6. Heat exchangers shall be hydrostatically tested at the factory and shall bear an ASME stamp for 125 psig working pressure, with certificate issued.
 7. Steam-to-hot water heat exchangers shall have steam in the shell and water in the tubes.
 8. Heat exchangers 10" in diameter and larger shall have flanged cast iron heads for water connections.

2.8 STEAM SPECIALTIES

- A. Main Steam Trap:
 1. Furnish and install a main steam trap for each heat exchanger on the heat transfer package.
 2. The trap shall be a Float and Thermostatic type selected to handle at least 1.5 times the condensate load of the heat exchanger with 1/2 psi differential pressure. The trap seat pressure rating shall be greater than the steam pressure supplied to the temperature control valve(s.)

3. The trap shall be mounted at least 15 inches below the bottom of the heat exchanger shell so that condensate flows from the shell to the trap by gravity. The trap shall have an inlet strainer and service valves and unions installed such that the trap may be isolated and removed from service.
 4. The outlet of the trap shall drain by gravity to a condensate return unit on the package.
- B. Vacuum Breaker:
1. Install a Hoffman model 62 vacuum breaker or equal vertically. Use fittings as required to install in the tapping provided on the heat exchanger shell.
 2. The vacuum breaker shall be adjustable between $\frac{1}{4}$ " and 20" Hg vacuum.
 3. The vacuum breaker shall be suitable for service at steam pressures up to 150 psig (366° F.)
- C. Steam Control Valves:
1. Steam control valve(s) shall be furnished by the controls contractor and field installed by the mechanical contractor.
 2. Temperature controls shall be furnished and installed by the controls contractor.
- D. Duplex Low NPSHR Condensate Unit for Condensate Up to 209°F:
1. Furnish on the heat transfer module, as scheduled on the drawings, a Domestic series CC Duplex Condensate Pumping Unit as manufactured by ITT Bell & Gossett **or equal** consisting of:
 - a. One (1) Cast iron receiver:
 - 1) The condensate receiver shall be of close grained cast iron construction (warranted for 20 years from the date of shipment against failure due to corrosion).
 - 2) The receiver shall have an inlet, vent and an overflow opening to provide means of secondary venting.
 - 3) The receiver shall be furnished with two (2) externally adjustable double pole float switches.
 - b. Two (2) low (2') NPSHR condensate return pumps of capacities, motor horsepower and electrical characteristics listed on the condensate return unit schedule:
 - 1) The centrifugal water pumps shall be flange mounted on the receiver.
 - 2) Each pump shall have a bronze axial inducer impeller to minimize NPSH requirements.
 - 3) Pumps shall be close coupled vertical design, permanently aligned, bronze fitted and be equipped with stainless steel shaft, dynamically balanced enclosed bronze impeller, and renewable bronze case ring.
 - 4) Each pump shall be close-coupled to a 3500 rpm, vertical drip proof motor.
 - 5) The pumps shall use a carbon/ceramic mechanical shaft seal shall be rated for 250°F.

- 6) Each pump shall have a Pressure/Temperature test port installed in its discharge port tapping to be used for balancing the pumps.
 - 7) Each pump shall have a strainer, check valve, and flow limiting valve installed on its discharge piping.
- c. One (1) NEMA 2 Pump Control Panel (may be integrated with the hot water pump starter/power distribution panel):
- 1) The control panel assembly shall be listed by Underwriters' Laboratories, Inc. All control cabinet components shall be U.L. listed or recognized.
 - 2) The control panel with drip lip and piano hinged door shall be mounted on the receiver, and wired, and shall include:
 - a) (2) Combination starters with adjustable thermal overloads and fused disconnect.
 - b) (2) " Hand-Off-Auto " selector switches.
 - c) (2) Pump running pilot lights.
 - d) (1) Numbered terminal strip.
 - e) (1) Mechanical alternator. The mechanical alternator shall; change the operating sequence automatically after each cycle; provide simultaneous operation under peak load conditions: and operate the second pump automatically, should the active pump or its controls fail.
 - f) (1) Fused control circuit transformer. The control power will be supplied from the load side of pump number one's disconnect switch.
 - g) (1) Control power switching relay. The control power switching relay shall allow the switch over of control power from pump number one to pump number two in the event of a failure or a no power condition of pump number one.
 - h) Power for the condensate return unit shall be furnished from the Power Distribution Panel described in Major Electrical components below. The package manufacturer shall complete all required wiring.
 - i) All wiring shall be performed per manufacturer's instructions and applicable state, federal, and local codes.
 - j) All factory wiring shall be numbered for easy identification and the numbers shall coincide with those shown on the wiring diagram.
 - k) All interconnecting wiring between the pump controls and control panel shall be enclosed in liquid tight flexible conduit.

2.9 MAJOR HYDRONIC COMPONENTS

- A. Air Elimination System with System Pressurization, Relief, and Make-Up Assembly shall consist of:
1. Bell & Gossett Coalescing Air Separator **or equal** as scheduled on the drawings.

- a. The unit shall have flanged inlet and outlet connections in line with the centerline of the vessel shell. The unit shall have an internal stainless steel coalescing medium with 3/16" (4.8 mm) perforations and 51% open area designed to remove entrained air and direct it to the compression tank (air control system) or air vent (air elimination system) at the top of the unit and remove suspended sediment and direct it the blow down valve at the bottom of the unit.
 - b. Manufacturer shall furnish data sheet specifying air collection efficiency and pressure drop at rated flow.
 - c. The air separator must be designed, constructed, and stamped for 125 psig @ 450°F in accordance with Section VIII, Division I of the ASME Boiler and Pressure Vessel Code, and registered with the National Board of Boiler and Pressure Vessel Inspectors. A Manufacturer's Data Report for Pressure Vessels, Form U-1 as required by the provisions of the ASME Boiler and Pressure Vessel Code shall be furnished for each air separator upon request.
 - d. One (1) ITT Bell & Gossett 107A High Capacity Automatic Air Elimination Vent **or equal** shall be mounted on top air connection of the Air Separator.
 - e. One (1) Blow-Down Valve shall be mounted on the bottom drain connection of the tangential air separator.
2. One (1) ASME Bladder Tank sized as scheduled on drawings.
 - a. The Bladder Tank shall a pre-charged steel expansion tank with replaceable heavy duty Butyl rubber bladder. The tank shall have a 1 in. NPT system connection, 3/4 in. drain, and a .302-32 charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements.
 - b. The tank must be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 125 PSI working pressure. A Manufacturers' Data Report for Pressure Vessels, Form U-1 as required by the provisions of the ASME Boiler and Pressure Vessel Code shall be furnished for each air separator upon request.
 3. System Pressurization, Water Make-Up Valve and Relief Valve assembly consisting of:
 - a. One (1) ITT Bell & Gossett No. 7 pressure reducing valve **or equal** for system pressurization and water make-up.
 - b. One (1) line sized bypass, with bypass valve and two isolation valves and unions to permit service of the pressure reducing valve.
 - c. One (1) Bell and Gossett 1170-100 ASME Relief Valve **or equal**.
 - d. One (1) Bladder Tank Isolation Valve to be a Lockshield Valve to prevent inadvertent isolation of Bladder Tank.
 - e. One (1) connection to Bladder Tank with one ITT Bell & Gossett 87 Automatic Air Vent **or equal**.
- B. Triple Duty Valves:ITT Bell & Gossett, Taco, Armstrong or equal.
1. Triple Duty Valve shall be a center-guided, non-slam, lift check valve fitted with a bronze seat, replaceable bronze disc with EPDM seat insert, stainless steel stem and chatter preventing stainless steel spring.

2. Valve shall be designed to permit re-packing under full line pressure.
 3. Valve shall be rated to 175 PSIG and shall be flanged cast iron. Valve shall be rated for 250 degrees F.
 4. The valve shall be equipped with readout ports to facilitate differential pressure readings across the valve orifice. Pressure drop data for each valve shall be provided for each 10% of valve range.
 5. Provide B&G 3DS-5S or equal. One per pump.
- C. Suction Diffusers: ITT Bell & Gossett, Taco, Armstrong or equal.
1. Suction Diffuser shall consist of an angle type body with internal straightening vanes that run the full length of the diffuser and a combination diffuser/strainer/orifice cylinder with 3/16" diameter openings for pump protection.
 2. The orifice cylinder shall be equipped with a disposable bronze fine 16-mesh strainer, which shall be removed after system start-up. Orifice cylinder shall be designed to withstand pressure differential equal to pump shutoff head and shall have a free area equal to five times cross sectional area of pump suction opening.
 3. Vane length shall be no less than 2 1/2 times the pump connection diameter.
 4. Diffuser shall be mounted with a fabricated support foot, if required.
 5. B&G HG 3x/3z or equal. One per pump.
- D. Instrumentation: Two (2) Hydronic Indicators:
1. Provide Flow Conditioning Corp. Hydronic Indicator System. These systems shall consist of Hydronic Indicators and Manifold Valves to provide accurate pressure indications of the pump suction and discharge pressures.
 2. Hydronic Indicator shall meet ASA Grade A specifications for pressure gauges, accurate to 1%. Case shall be 4½" diameter, stem mounted, heavy steel with screwed ring and unbreakable crystal. Indicator shall have recalibrator, compound scale calibrated both in pounds and feet from full vacuum to selected pressure, twin tip pointer for accurate reading, and quick-set dial for pressure comparison. Maximum indicator pressure shall be sufficient to read the sum of pump shut off head plus the appropriate system pressure (PRV setting.)
 3. Manifold Valve shall be spring return pushbutton manifold of rugged brass construction with ports for connection to system at indicated points and with test port connection for gauge calibration. Manifold shall include ports to be connected to the pump suction and discharge flange pressure gauge tapings to indicate pump performance.
 4. Hydronic Indicator System shall be attached to the package on a rigid structural steel support at a convenient height to permit easy pushbutton operation and dial observation.
 5. Hydronic Indicator shall be connected to pumps with 0.25" nylon tubing. Tubing shall have a pressure rating of 400 psi. Tubing shall be routed from the pumps to the gauges in a neat and workmanlike manner. Tubing shall be free of joints and fittings, except at connection points.
- E. Suction Isolation Valve: W-K-M Series E Lug Body Butterfly Valves.
1. Butterfly Valve to be constructed with Cast Iron Body, Bronze Disc, SS stem and EPDM phenolic backed cartridge seat.

2. Disc shall be of streamlined design for low pressure drop.
3. Stems, seals and disc shall be constructed so valve primary seal is between disc and seat.
4. If Valve is between 2"-12", it shall be rated for 200 psi dead-end service. If Valve is between 14"-24", it shall be rated for 150 psi dead-end service.
5. Furnish valve with a ten position handle.

F. Unless otherwise specified.

1. The feeder shell shall be constructed of 10 gauge steel minimum. Tank head shall be 9 gauge. The bypass feeder shall be rated at 300 psi and 200°F.
2. The tank shall have a 3-1/2" wide-mouth opening so that chemical addition can be performed without the need of a funnel. The bypass feeder shall have a continuous threaded closure requiring 2-1/2 turns to close and seal. Closures using partial threads or lugs or rated less than 300 psi shall not be considered equal.
3. The cap shall be constructed of cast iron with an epoxy-coated underside to prevent corrosion and shall use a square ring gasket seal.

2.10 INSTANTANEOUS WATER HEATERS

- A. Instantaneous heater shall be Cemline Series "SEH"; factory assembled and packaged or equal. Water heater shall be constructed in accordance with ASME Code for a working pressure of 150 psig. The packaged water heater shall be constructed with a 316 stainless steel tank, with stainless threaded opening, 1/2" O.D. copper tubes, copper lined tube sheet, and steel coil head. Coil shall be double walled 3/4" O.D. tubing with vented leak paths.
- B. Heater shall be mounted on a steel support skid. Heater shall be insulated with foam in place insulation protected by an enameled metal jacket, 20 gauge minimum thickness. Heater shall be factory assembled and piped including incoming steam strainer, electronic operated temperature regulator, main and auxiliary float and thermostatic steam traps, and condensate strainer. Coil shall be baffled and shall have an integral bronze circulator to circulate the water across the coil.
- C. Electronic control system shall maintain +/-2 deg. F deg. 0% to 100% under constant load and +/-4 deg F under diversified load. The system shall consist of a electronic control valve, control panel enclosure housing a PID temperature controller with digital indication of shell outlet water temperature, digital over-temperature limit switch, flow meter for feed-forward sensing, and feedback sensor. The limit switch shall close the control valve and open a solenoid valve to function as a secondary water relief valve in an over-temperature condition.
- D. The control valve shall have the following features:
1. 50 to 1 Turndown.
 2. Electric actuator with fail closed Design particularly on loss of power.
- E. The PID controller shall incorporate remote communications via MODBUS protocol for interoperability with the building automation system. The following information shall be accessible locally at the controller or remotely via the communications port:

1. Set point can be changed remotely.
 2. Outlet temperature.
 3. Over temperature alarm.
 4. Control output signal to valve.
 5. Water flow through the heater.
- F. Heater shall be furnished with a meter pressure gauge and an A.S.M.E pressure-temperature relief valve of sufficient size to relieve total BTU input of the coil.
- G. Heater shall be provided with a vacuum breaker.
- H. The steam condensate from the water heaters shall be cooled to 150 degrees F. either internally or externally through the use of a double wall shell and tube heat exchanger. Manufacturer shall assume responsibility for correct sizing of components to assure performance designated in design criteria.
- I. Heaters shall be:
1. CEMLINE Corporation Model: H8SEH830-DW **or equal** for IHWH-01. Heater shall be mounted horizontally. Coil to heat 25 GPM from 40 °F to 140 °F with 50 psig steam to the control valve.
 2. CEMLINE Corporation Model: H10SEH1030-DW **or equal** for IHWH-02. Heater shall be mounted horizontally. Coil to heat 50 GPM from 40 °F to 140 °F with 50 psig steam to the control valve.
- J. Options:
1. U-tube style coils shall be double walled ¾" O.D. tubing with vented leak paths.
 2. Furnish water heater with additional safety system designed to relieve excessively heated water from the vessel. The safety system shall be field programmable for set point and differential and shall be of the electronic type.
- K. Warranty for the heat exchanger shall be 10 years non-prorated against failure due to thermal shock, mechanical failure, manufacturing or material defect or erosion.

2.11 SHELL & TUBE, DOUBLE WALL, U-TUBE HEAT EXCHANGER

- A. Manufacturer:
1. Furnish on the package, new double wall shell and tube heat exchanger for condensate cooling as indicated on the drawings. Heat exchanger shall be per the model scheduled as manufactured by **Bell & Gossett**, Taco, Armstrong or equal. Heat exchanger shall meet types, sizes, capacities, and characteristics as scheduled on the Equipment Schedule drawings.

B. Double-Wall, Shell-and-Tube, U-Tube Heat Exchanger:

1. A water to water (model DWU), double-wall, removable U-Tube type heat exchanger of the sizes and capacities noted on the schedule. The heat exchanger shall consist of 3/4" OD copper outer tube with a copper inner tube, cast iron head of either two or four pass configuration, steel shell, air gap tubesheet and supports. Unit's shell shall be designed for 150 PSIG working pressure at 375°F and tubes shall be designed for 125 PSIG working pressure at 375°F.
2. Tubes shall be of Diamondback design with a 3/4" O.D. 20 gauge outer tube copper and copper inner tube. Tubing shall provide a minimum total of 47 vented leak paths between the tube walls. Shall be secured to a steel tubesheet via rolled joints.
3. Heat exchanger shall be constructed of a cast iron or fabricated steel head, steel shell, and steel baffles, tie rods, and spacers. Unit shall have a compressed fiber gasket to seal the shell at the tubesheet.
4. Heat exchanger design shall allow for a maximum tubeside velocity no greater than 7.5 feet/ second and a shell side velocity no greater than 4.0 feet/second. Unit shall be constructed with a fouling factor equal too or greater than that scheduled. Unit diameter shall be no less than 12 inches and the bundle length shall be no greater than that scheduled.
5. Heat exchanger shall be provided with the scheduled square footage of heat transfer area.
6. Unit shall be constructed in accordance with ASME Code Rules and shall have a manufacturer's data report for pressure vessels, form No. U-1. Form U-1 shall be furnished to the engineer for the owner upon request. An authorized inspector, holding a National Board commission, certifying that construction conforms to the latest ASME Code for pressure vessels must sign this form. The ASME "U" symbol should also be stamped on the Heat Exchanger(s). In addition, each unit registered with the National Board of Boiler and Pressure Vessel Inspectors.
7. Heat exchanger manufacturer shall be ISO-9001 certified.
8. Where indicated heat exchanger shall be provided with alternate materials of construction as noted on schedule and installation drawings.
9. Steam heat exchanger shall be provided with the proper vacuum breaker and/or vent as required.

2.12 MAJOR ELECTRICAL COMPONENTS

A. Single Point Power:

1. Package manufacturer shall furnish a single power connection for all electrical equipment on package.
2. A single door operated disconnect shall be furnished which shall de-energize all AFDs on the package.
3. Circuit breakers shall be furnished for each AFD which is not furnished with an integral circuit breaker.

B. VARIABLE FREQUENCY MOTOR CONTROLLER W/BYPASS

1. Quality Assurance:
 - a. Manufacturer of the AC Drive shall be certified ISO 9001 facility.
 - b. The AC Drive and all associated optional equipment shall be UL Listed according to UL 508 C-Power Conversion Equipment. As verification, a UL designation shall be attached on the inside of the combination enclosure.
 - c. The AC Drive shall be designed, constructed, and tested in accordance with UL, cUL, NEMA, IEC, and NEC standards.
 - d. Every power converter shall be tested in the factory with an AC induction motor.
 - e. 18-month warranty, from date of shipment, shall be provided on materials and workmanship.
2. Manufacturers:
 - a. S-Flex by Schneider Electric **or equal**.
3. General Description:
 - a. The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage.
 - b. The input power section shall comply with the following requirements:
 - 1) It shall utilize a full wave bridge design.
 - 2) It shall convert AC line power of fixed voltage and frequency to fixed DC voltage.
 - 3) It shall be insensitive to phase rotation of the AC line.
 - c. The output power section shall change fixed DC voltage to adjustable frequency AC voltage.
 - d. The adjustable frequency drive UL Type 1 enclosure package shall consist of a circuit breaker disconnect, a 2-contactor bypass power circuit, a 120 V control transformer, and a control circuit terminal block for digital and analog field wiring. The drive shall have a selector switch mounted and wired for Adjustable Frequency controller-Off-Bypass, which shall be accessible on the front of the enclosure package.
 - e. The entire drive package, including the bypass starter circuit, shall be UL508C listed and coordinated with NEMA ICS 7.1.
4. Construction:
 - a. The AC Drive power converter shall be enclosed in a UL Type 1 enclosure with a circuit breaker disconnect, user terminal block connections, and bypass controls. The enclosure shall provide dedicated user terminations for power and control device connection.
 - b. Provisions shall be included for locking the disconnect in the Off position with a padlock.

- c. Provisions shall be included for using a padlock to limit enclosure access by unauthorized personnel.
 - d. The UL Type 1 enclosure shall have bottom conduit knock-outs for power and control wiring.
5. Application Data:
- a. The AC Drive shall be sized to operate a variable torque load.
 - b. The speed range shall be from a minimum speed of 1 Hz to a maximum speed of 200 Hz.
6. Environmental Ratings:
- a. The AC Drive shall meet IEC 60664-1 Annex A and NEMA ICS 1, UL, and cUL standards.
 - b. The AC Drive shall be designed to operate in an ambient temperature from -10 to 40 °C (+14 to 104 °F).
 - c. The maximum relative humidity shall be 95%, non-condensing or dripping water.
 - d. The AC Drive shall be rated to operate at altitudes less than or equal to 3300 ft (1000 m). For altitudes above 3300 ft (1000 m), the AC Drive current should be derated 1% for every 330 ft (100 m) up to 10,000 ft (3,000 m).
 - e. The AC Drive shall be Seismic qualified to 2003 IBC, NFPA 5000 and ASCE 7 Building Codes in compliance with ICC ES AC156 testing criteria with an Importance Factor $I_p=1.5$.
 - f. The AC Drive shall be UL Type 1 plenum rated, suitable for placement in a compartment circulating conditioned air to the building.
7. Ratings:
- a. The AC Drive shall be designed to operate at the voltage specified on the schedule.
 - b. The AC Drive shall operate from an input frequency range of 50 to 60 Hz \pm 5%.
 - c. The displacement power factor shall not be less than 0.96 lagging under any speed or load condition.
 - d. The efficiency of the AC Drive at 100% speed and load shall typically be 95% or greater.
 - e. The variable-torque rated AC Drive nominal full load current limit shall be not less than 110% for 60 seconds.
8. Protection:
- a. Upon power-up, the AC Drive power converter shall automatically test for valid operation of memory, valid operation of precharge circuit, loss of communication, DC-to-DC power supply, and control power.
 - b. The enclosure shall provide a fully coordinated 100,000 A short circuit current rating marked on the enclosure nameplate, with short circuit coordination to UL 508C Power Conversion Equipment and NEMA ICS 7.1.
 - c. The AC Drive power converter shall be protected against short circuits between output phases and also phase-to-ground.

- d. Upon loss of the analog process follower reference signal, the AC Drive power converter shall be programmable to display a detected fault condition signal.
 - e. The AC Drive power converter shall have a solid-state UL 508C listed overload protective device.
 - f. The output frequency shall be software enabled to fold back when the motor is in an overcurrent condition.
 - g. The output switching frequency of the AC Drive power converter shall be selectable from 6 to 16 kHz.
 - h. The AC Drive power converter shall provide an auto reset feature which can provide up to 10 programmable reset attempts after a detected fault has occurred.
9. Adjustments and Configurations:
- a. The AC Drive power converter will be factory programmed to operate all specified optional devices.
 - b. The acceleration and deceleration ramp times shall be adjustable from 0.1 to 3200 seconds.
 - c. The AC Drive power converter configuration shall have provisions for an Energy Savings motor type.
 - d. The AC Drive power converter shall have memory capability to retain and record drive operation and detected fault type for the past four faults.
10. Keypad Displace Interface:
- a. An operator interface shall offer the modification of AC Drive power converter adjustments through a keypad. All electrical values, configuration parameters, I/O assignments, application and activity function access, detected fault condition signals, local control, adjustment storage, and diagnostics shall be accessible.
 - b. The AC Drive power converter software revision, output current, motor frequency, and motor voltage shall be readable through the drive display.
11. Operator Controls:
- a. The control power for the digital inputs and outputs shall be 24 VDC.
 - b. The terminal block shall be used for all logic and analog signal connections to the power converter.
 - c. Three voltage-free relay output contacts shall be provided. One of the contacts shall indicate the detected fault status of the AC Drive and shall always be available. One of the contacts shall indicate bypass operation and shall always be available. One contact shall indicate a drive run status and shall only be available when communication cards are not used.
 - d. The combination enclosure shall have dedicated operator controls for Adjustable Frequency Controller-Off-Bypass selection.
 - e. The combination enclosure shall include a terminal point connection for fire/freezestat interlock, to prevent drive or bypass operation. The interlock must shut down the motor in drive and bypass modes.
 - f. The combination enclosure shall include a terminal point connection for smoke/purge controls.

12. Serial communication:
 - a. The AC Drive shall have serial communications capability for the following protocols:
 - 1) BACnet (Optional adapter required).
13. Drive Output and Bypass Contactors:
 - a. The AC Drive shall include electrically interlocked bypass contactors complete with a Class 10 thermal overload relay, circuit breaker disconnect, control circuit transformer, and Adjustable Frequency Controller-Off-Bypass selector switch.
 - b. The operator shall have full control of the bypass starter by operation of the Adjustable Frequency Controller-Off-Bypass selector switch.
14. Harmonic Mitigation:
 - a. Each drive shall include reduced harmonics technology to reduce power system harmonics.
15. The AFDs shall be started, stopped, staged and have their speed controlled by the building automation system.

PART 3 - EXECUTION

- A. The contractor shall set in place and anchor the Packaged Pumping Module in accordance with the written recommendations of the manufacturer of the Packaged Pumping Module. Packaged Pumping Module base with pre-aligned pumps shall be installed level without stress. Pump alignment shall be rechecked by the contractor.
- B. The contractor shall make all piping connections to the Packaged Pumping Module's connections provided, all in accordance with the written recommendations of the manufacturer of the Packaged Pumping Module. Piping connections shall not allow piping stress to be transferred to the Packaged Pumping Module during installation or operation.
- C. Power wiring, as required, shall be done in accordance with the division of responsibility as specified elsewhere. All power wiring shall be performed per the current edition of the NEC (NFPA 70.)
- D. Remote differential pressure transmitters and flowmeters furnished with the packaged pumping system shall be installed by the mechanical contractor per the manufacturer's instructions. A three valve bypass shall be installed for each differential pressure transmitter per the submittal drawings.
- E. Control wiring for remote mounted differential pressure switches, differential pressure transmitters, flow transmitters, start/stop commands, alarms etc. shall be the responsibility of

the control contractor. All control wiring shall be performed per the current edition of the NEC (NFPA 70.)

3.2 START-UP

- A. The system manufacturer or factory-trained representative shall provide start-up of the packaged pumping system. This start-up shall include verification of proper installation, system initiation, adjustment and fine tuning. This jobsite visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.
- B. Remove Suction Diffuser Start-Up Strainer after system has been running for 48 hours.

3.3 CLEANING

- A. Entire Package shall be thoroughly cleaned after installation.

3.4 TRAINING

- A. The system manufacturer or factory trained representative shall provide on-site training for owner's personnel. This training shall fully cover maintenance and operation of all system components. The system manufacturer must have a complete HVAC training program available for this purpose.

END OF SECTION 23 57 00

SECTION 23 57 00.01 - CHILLED WATER PUMP PACKAGE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Pre-Packaged Chilled Water Pump Package with variable pumps for 100% standby operation as specified on the Chilled Water Pump Package Schedule on the mechanical drawings.
1. Pre-Engineered, Pre-Packaged Pumping Module consisting of four Pumps, four Suction Diffusers, four Triple Duty Valves, Air Elimination Systems, Plate-and-Frame Heat Exchanger and a Control Panel and Adjustable Frequency Drives as specified in major electrical components below, Pre-Piped, Pre-Wired, and mounted on Solid Steel Flat Base, reinforced and raised with Welded Structural Steel Channels.
 2. Base shall be constructed with lifting lugs that will allow a package to be lifted to be positioned into place.
 3. Connections:
 - a. CHWS, CHWR, Steam and pipe connections shall be as noted in the schedule on the mechanical drawings. Package shall be built such that inlets and outlets match configuration shown on mechanical drawings.
 - b. Make-up water, ¾" threaded and coupled.
 - c. Single point power wiring connection for voltage, phase, and hertz as noted in the schedule on the mechanical drawings.
 - d. Control wiring terminal strip.
 4. Maximum dimensions shall not exceed those noted in the schedule on the mechanical drawings.
- B. The Packaged Pumping Module Shall be Field Insulated by Others

1.2 REFERENCED STANDARDS

- A. Hydraulic Institute.
- B. ANSI - American National Standards Institute.
- C. NEMA - National Electrical Manufacturers Association.
- D. UL – 508 Industrial Control Panels.
- E. UL - QCZJ Packaged Pumping Systems.
- F. ETL - Electric Testing Laboratories.
- G. NEC - National Electrical Code (NFPA 70,) current edition.

- H. IEC - International Electrotechnical Commission.
- I. ISO - International Standards Organization.
- J. ASME B31.9.
- K. ASHRAE 90.1-2001.

1.3 SUBMITTALS

- A. General: In addition to the following, comply with the requirements of Division 1 for submittals, warranty and project closeout procedures.
- B. Furnish catalog information of all major components scheduled on the contract bid documents. In addition furnish installation, operation and maintenance (IOM) manuals on all equipment components, scaled and dimensioned fabrication drawings, sequence of operation for controls furnished, complete power wiring, control wiring and piping diagrams all as required for a complete explanation and description of all items of equipment. Include a copy of the standard startup and service reports to be used on each packaged system furnished and tentative service schedule based on the contract completion date (CCD).
- C. Furnish pump curve for the pump. The pump curve shall show as a minimum; bhp, motor characteristics, flow, total dynamic head, impeller diameter and system curve. Furnish a system profile analysis including constant speed and variable speed pump curves and system curve. The analysis shall also include pump, motor and AFD (where applicable) efficiencies, job specific load profile, staging points, horsepower and kilowatt-hour consumption. Submittals must be specific to this project. Generic submittals will not be accepted.
- D. Furnish selection report for heat exchanger listing total heat exchanged, steam used, shell and tubeside pressure drops, heat transfer surface area fouling factor and other pertinent data.
- E. Manufacturer shall furnish to the engineer upon request, a detailed item by item pressure drop calculation for all equipment and fittings furnished on the pumping package. The analysis shall be based on data from Crane Company Technical Paper No. 410.
- F. All information submitted shall be individually "tagged" to easily identify it with the item of corresponding material or equipment that is being submitted. Failure to comply with the aforementioned requirements will result in that item, or, at the discretion of the Engineer, all items being rejected without being reviewed until such time as these conditions are satisfied.
- G. Submittals that are "rejected" as being "non-compliant" will be re-reviewed with all time for subsequent reviews back charged to the contractor in accordance with the engineer's current prevailing rate schedule. If a rate schedule for additional services is included, as part of the contract with the owner, that rate schedule shall be used in lieu of the "current prevailing" rate schedule.
- H. Provide 10 copies of the submittals, as specified.

- I. Provide all submittal information inclusive of fabrication drawings for review by the Engineer in accordance with the requirements of Division 1.

1.4 FABRICATION DRAWINGS

- A. As part of the aforementioned submittal requirements, provide three dimensional AutoCAD 2009 or higher dimensioned fabrication shop drawings as specified; detailing major elements, components, and systems included as part of the packaged pumping module. Provide, as a minimum, two scaled and dimensioned elevations indicating outside dimensions of the frame, piping and electrical connections.
 1. Include the following:
 - a. Clearances for operating, servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
 - b. Equipment connections and support details.

1.5 QUALITY ASSURANCE

- A. The manufacturer shall assume "Unit Responsibility" for the complete package. Unit responsibility shall be defined as responsibility for the interface and successful operation of all components supplied by the manufacturer. The manufacturer shall assemble the package. The manufacturer must be actively engaged in the design and fabrication of the packaged system being assembled.
- B. The manufacturer must have dedicated and qualified service/startup division for all components provided as part of the packaged systems.
- C. The manufacturer of the packaged system must be an authorized manufacturer's representative or reseller for all major components of the packaged system.
- D. Underwriter's Laboratories shall list the manufacturer as a manufacturer of packaged pumping systems.
- E. The manufacturer shall have not less than 5 years demonstrated and documented experience in the design, fabrication, testing and startup/servicing of packaged systems.
- F. ASME Section IX certified welders shall perform all welding of the piping.
- G. The manufacturer shall run test the completed packaged assembly at the factory for not less than 2 hours prior to shipment.
- H. The manufacturer shall carry a minimum product liability insurance of \$5,000,000.00 per occurrence.
- I. Bidders shall comply with all sections of this specification relating to Packaged Pumping Module. Deviations from this specification shall not be permitted.

- J. The contractor and Packaged Pumping Module Manufacturer shall be bound by these specifications.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to the site so they arrive in the same condition as when they left the factory.
- B. Prior to shipping, all open pipe connections shall be provided with protective ends caps to ensure that dirt, debris and other foreign matter are not introduced into the piping systems.
- C. The entire packaged system shall be factory assembled, tested and shipped.

1.7 WARRANTY & SERVICE

- A. The entire packaged assembly, inclusive of all components shall be fully warranted (full parts and labor) by the manufacturer against defects in workmanship and operation for a period of eighteen months from the date of shipment.
- B. The manufacturer shall guarantee in writing a response time of one (1) business day or less to calls for warranty and or service related emergencies.
- C. An authorized local service vendor of the manufacturer may perform the initial service call for diagnostic purposes.
- D. The manufacturer shall provide a 24-hour toll free emergency service hot line.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Hy-Fab Division of the James M. Pleasants Company, Inc.
 - b. HTS Pump'n Flo.
 - c. ITT Bell & Gossett.

2.2 MANUFACTURED UNITS

- A. Each unit shall be provided with a permanently engraved nameplate bearing the name of the manufacturer. Each nameplate shall contain package specific engraved information on the nameplate. This information shall include as a minimum the following information:
 - 1. Model Number.

2. Serial Number.
 3. Electrical Characteristics.
 4. Design Flow and Head Capacity.
- B. Each packaged unit shall be factory assembled and provided with the components required to meet the requirements of this specification.
- C. The piping system and in-line appurtenances shall be subjected to a hydrostatic pressure test after final assembly. Test pressure shall be not less than 10% below the setting of the packaged system's relief valve. The duration of the test shall be two hours. No change in the test pressure over the two-hour test period is allowed. Loss of pressure requires the leak to be fixed and the packaged system to be retested.
- D. Each unit shall be provided with a single point power connection and control power wiring terminal strip.
- E. All power and control wiring shall meet the requirements of the current edition of the National Electric Code (NFPA 70.)

2.3 STRUCTURAL STEEL FRAME

- A. The frame shall be heavy-duty steel channel and angle iron construction. The frame material shall be ASTM A36 structural steel.
- B. All welding for the frame shall be performed by AWS D1.1 certified welders.

2.4 INTERCONNECTING HYDRONIC PIPING

- A. The interconnecting piping shall be steel: 2½" and larger; ASTM A 53, Grade B, Schedule 40 seamless or ERW, black steel pipe, bevel ends for welding; 2", ASTM A 53, Grade B, Schedule 40, seamless or ERW, black steel pipe, threaded and coupled furnished with coupling; 1½" and smaller, ASTM A 53, Grade B, schedule 40 seamless black steel pipe, threaded and coupled furnished with coupling.
- B. Fittings:
1. Cast Iron Threaded Fittings: ANSI B16.4, Class 125 and 250 as applicable, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
 2. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150 and 250 as applicable, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
 3. Malleable-Iron Unions: ASME B16.39, Classes 150, 250 and 300 as applicable, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends. Threads shall conform to ANSI B1.20.1.
 4. Steel Fittings: ASTM A 234, wall thickness to match adjoining pipe for welded joints.
- C. Steel Flanges and Flanged Fittings:

1. ANSI B16.5, including bolts, nuts, and gaskets of the following material group, end connection and facing:
 - a. Weld-Neck, Raised Face standard, Flat Face where necessary to match valves or equipment.
 - b. Gasket Material: thickness, material, and type suitable for fluid to be handled, and design temperatures and pressures.
- D. All major components and in-line appurtenances that require periodic removal for service shall be provided with a flange on both sides.

2.5 PAINTING

- A. Each factory assembled packaged system, including all major components, shall be thoroughly cleaned after fabrication is complete.
- B. Entire package shall be primed after cleaning.
- C. After cleaning and priming, the package shall be painted with at least one coat of high-quality machinery grade enamel paint.
- D. Nameplates of the components shall not be painted over.

2.6 PUMPS

- A. End Suction Pumps: Furnish ITT Bell & Gossett Series1531 **or equal** of size GPM and TDH as scheduled on the drawings.
 1. Motor shall be of size, type, electrical characteristics and efficiency scheduled on the drawings. Motors for use with AFDs shall be "inverter ready." Motors shall be non-overloading across entire curve.
 2. Pump shall be close-coupled, single stage, end suction design capable of being serviced without disturbing piping connections.
 3. The impeller shall be bronze enclosed, single suction type, dynamically balanced, keyed to the shaft. The allowable residual unbalance in the impeller rotating assembly shall conform to ANSI Grade G6.3.
 4. The liquid cavity shall be sealed off by internally flushed mechanical seal with ceramic seat of 99.5% pure alumina oxide and hardness of 68 Rockwell C, or a tensile strength of 300,000 PSI, and carbon seal ring, suitable for continuous operation at 225 degrees F. A replaceable bronze shaft sleeve shall completely cover the wetted area of the shaft under the seal.
 5. The pump casing shall be of Class 30 cast iron suitable for 175 PSI working pressure. The pump volute shall be supplied with vent, drain, and gauge tappings.
 6. Pumps shall be capable of withstanding a horizontal load of 0.5 G without adversely affecting pump operation.

2.7 PLATE-AND-FRAME HEAT EXCHANGER

A. Manufacturer:

1. Contractor shall furnish and install new plate and frame heat exchanger for the system as indicated on the drawings. Heat exchanger shall be a model GPX as manufactured by **Bell & Gossett or equal**. Heat exchanger shall meet types, sizes, capacities, and characteristics as scheduled on the Equipment Schedule drawings.

B. Plate Heat Exchanger:

1. A plate and frame, water to water, type heat exchanger of the sizes and capacities noted on the schedule. The heat exchanger shall consist of stainless steel heat transfer plates, steel end plates, and a carbon steel carrying bar, of single pass configuration. Unit's shall be specifically designed for 150 PSIG working pressure at 230°F. Heat exchanger selection shall be optimized by the manufacturer to provide minimum heat transfer surface area requirements under specified capacity and pressure drops.
2. The plate heat exchanger shall be shipped to the site as completely assembled units. The heat exchanger shall be pressure tested and flushed clean at the factory prior to shipment. All nozzle connections shall be factory sealed prior to shipment to prevent the entrance of foreign matter into the heat exchanger during shipment, storage, and installation.
3. Corrugated channel steel plates shall be of type 304 or 316 SS. Channel plate ports shall be double gasketed to prevent cross contamination of hot and cold side fluids. Gaskets shall be of a one piece design formulated from Nitrile rubber. Plates shall be grooved to accept the gaskets and gasket clips to minimize movement.
4. Channel carrying bar shall be of carbon steel, aluminum or stainless steel with zinc yellow chromate finish.
5. Fixed frame plates and movable pressure plates shall be corrosion resistant epoxy painted carbon steel. Flow through the plates shall be of a counter flow design to maximize the heat transfer capability of the unit.
6. Connection 2" and smaller shall be carbon steel NPT tappings. Connections 4" and larger shall be studded port design to accept ANSI flange connection. Connection ports shall be integral to the frame or pressure plate.
7. Unit to be supplied with OSHA approved splash guard, enclosing exterior channel plate and gasketed surfaces. Heat exchanger shall be provided with the scheduled square footage of heat transfer area.
8. Unit shall be constructed in accordance with ASME Code Rules and shall have a manufacturer's data report for pressure vessels, form No. U-1. Form U-1 shall be furnished to the engineer for the owner upon request. An authorized inspector, holding a National Board commission, certifying that construction conforms to the latest ASME Code for pressure vessels must sign this form. The ASME "U" symbol should also be stamped on the Heat Exchanger(s). In addition, each unit registered with the National Board of Boiler and Pressure Vessel Inspectors.
9. Heat exchanger manufacturer shall be ISO-9001 certified.
10. Where indicated heat exchanger shall be provided with alternate materials of construction as noted on schedule and installation drawings

2.8 MAJOR HYDRONIC COMPONENTS

- A. Air Elimination System with System Pressurization, Relief, and Make-Up Assembly shall consist of:
1. Bell & Gossett Coalescing Air Separators **or equal** as scheduled on the drawings.
 - a. The unitS shall have flanged inlet and outlet connections in line with the centerline of the vessel shell. The unit shall have an internal stainless steel coalescing medium with 3/16" (4.8 mm) perforations and 51% open area designed to remove entrained air and direct it to the compression tank (air control system) or air vent (air elimination system) at the top of the unit and remove suspended sediment and direct it the blow down valve at the bottom of the unit.
 - 1) Manufacturer shall furnish data sheet specifying air collection efficiency and pressure drop at rated flow.
 - 2) The air separator must be designed, constructed, and stamped for 125 psig @ 450°F in accordance with Section VIII, Division I of the ASME Boiler and Pressure Vessel Code, and registered with the National Board of Boiler and Pressure Vessel Inspectors. A Manufacturer's Data Report for Pressure Vessels, Form U-1 as required by the provisions of the ASME Boiler and Pressure Vessel Code shall be furnished for each air separator upon request.
 - 3) One (1) ITT Bell & Gossett 107A High Capacity Automatic Air Elimination Vent **or equal** shall be mounted on top air connection of the Air Separator.
 - 4) One (1) Blow-Down Valve shall be mounted on the bottom drain connection of the tangential air separator.
 - b. One (1) ASME Bladder Tank sized as scheduled on drawings.
 - 1) The Bladder Tank shall a pre-charged steel expansion tank with replaceable heavy duty Butyl rubber bladder. The tank shall have a 1 in. NPT system connection, 3/4 in. drain, and a .302-32 charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements.
 - 2) The tank must be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 125 PSI working pressure. A Manufacturers' Data Report for Pressure Vessels, Form U-1 as required by the provisions of the ASME Boiler and Pressure Vessel Code shall be furnished for each air separator upon request.
 - c. System Pressurization, Water Make-Up Valve and Relief Valve assembly consisting of:
 - 1) One (1) ITT Bell & Gossett No. 7 pressure reducing valve **or equal** for system pressurization and water make-up.
 - 2) One (1) line sized bypass, with bypass valve and two isolation valves and unions to permit service of the pressure reducing valve.
 - 3) One (1) Bell and Gossett 1170-100 ASME Relief Valve **or equal**.
 - 4) One (1) Bladder Tank Isolation Valve to be a Lockshield Valve to prevent inadvertent isolation of Bladder Tank.

- 5) One (1) connection to Bladder Tank with one ITT Bell & Gossett 87 Automatic Air Vent **or equal**.
- B. Triple Duty Valves: ITT Bell & Gossett **or equal** sized as scheduled on the drawings.
1. Triple Duty Valve shall be a center-guided, non-slam, lift check valve fitted with a bronze seat, replaceable bronze disc with EPDM seat insert, stainless steel stem and chatter preventing stainless steel spring.
 2. Valve shall be designed to permit re-packing under full line pressure.
 3. Valve shall be rated to 175 PSIG and shall be flanged cast iron. Valve shall be rated for 250 degrees F.
 4. The valve shall be equipped with readout ports to facilitate differential pressure readings across the valve orifice. Pressure drop data for each valve shall be provided for each 10% of valve range.
- C. Suction Diffusers: ITT Bell & Gossett **or equal** sized as scheduled on the drawings.
1. Suction Diffuser shall consist of an angle type body with internal straightening vanes that run the full length of the diffuser and a combination diffuser/strainer/orifice cylinder with 3/16" diameter openings for pump protection.
 2. The orifice cylinder shall be equipped with a disposable bronze fine 16-mesh strainer, which shall be removed after system start-up. Orifice cylinder shall be designed to withstand pressure differential equal to pump shutoff head and shall have a free area equal to five times cross sectional area of pump suction opening.
 3. Vane length shall be no less than 2 1/2 times the pump connection diameter.
 4. Diffuser shall be mounted with a fabricated support foot, if required.
- D. Instrumentation: Two (2) Hydronic Indicators.
1. Provide Flow Conditioning Corp. Hydronic Indicator System. These systems shall consist of Hydronic Indicators and Manifold Valves to provide accurate pressure indications of the pump suction and discharge pressures.
 2. Hydronic Indicator shall meet ASA Grade A specifications for pressure gauges, accurate to 1%. Case shall be 4½" diameter, stem mounted, heavy steel with screwed ring and unbreakable crystal. Indicator shall have recalibrator, compound scale calibrated both in pounds and feet from full vacuum to selected pressure, twin tip pointer for accurate reading, and quick-set dial for pressure comparison. Maximum indicator pressure shall be sufficient to read the sum of pump shut off head plus the appropriate system pressure (PRV setting.)
 3. Manifold Valve shall be spring return pushbutton manifold of rugged brass construction with ports for connection to system at indicated points and with test port connection for gauge calibration. Manifold shall include ports to be connected to the pump suction and discharge flange pressure gauge tapings to indicate pump performance.
 4. Hydronic Indicator System shall be attached to the package on a rigid structural steel support at a convenient height to permit easy pushbutton operation and dial observation.
 5. Hydronic Indicator shall be connected to pumps with 0.25" nylon tubing. Tubing shall have a pressure rating of 400 psi. Tubing shall be routed from the pumps to the gauges in a neat and workmanlike manner. Tubing shall be free of joints and fittings, except at connection points.

- E. Suction Isolation Valve: W-K-M Series E Lug Body Butterfly Valves.
1. Butterfly Valve to be constructed with Cast Iron Body, Bronze Disc, SS stem and EPDM phenolic backed cartridge seat.
 2. Disc shall be of streamlined design for low pressure drop.
 3. Stems, seals and disc shall be constructed so valve primary seal is between disc and seat.
 4. If Valve is between 2"-12", it shall be rated for 200 psi dead-end service. If Valve is between 14"-24", it shall be rated for 150 psi dead-end service.
 5. Furnish valve with a ten position handle.
- F. Unless otherwise specified.
1. The feeder shell shall be constructed of 10 gauge steel minimum. Tank head shall be 9 gauge. The bypass feeder shall be rated at 300 psi and 200°F.
 2. The tank shall have a 3-1/2" wide-mouth opening so that chemical addition can be performed without the need of a funnel. The bypass feeder shall have a continuous threaded closure requiring 2-1/2 turns to close and seal. Closures using partial threads or lugs or rated less than 300 psi shall not be considered equal.
 3. The cap shall be constructed of cast iron with an epoxy-coated underside to prevent corrosion and shall use a square ring gasket seal.

2.9 MAJOR ELECTRICAL COMPONENTS

- A. Single Point Power:
1. Package manufacturer shall furnish a single power connection for all electrical equipment on package.
 2. A single door operated disconnect shall be furnished which shall de-energize all AFDs on the package.
 3. Circuit breakers shall be furnished for each AFD which is not furnished with an integral circuit breaker.
- B. Variable Frequency Motor Controller W/Bypass:
1. Quality Assurance:
 - a. Manufacturer of the AC Drive shall be certified ISO 9001 facility.
 - b. The AC Drive and all associated optional equipment shall be UL Listed according to UL 508 C-Power Conversion Equipment. As verification, a UL designation shall be attached on the inside of the combination enclosure.
 - c. The AC Drive shall be designed, constructed, and tested in accordance with UL, cUL, NEMA, IEC, and NEC standards.
 - d. Every power converter shall be tested in the factory with an AC induction motor.
 - e. 18-month warranty, from date of shipment, shall be provided on materials and workmanship.
 2. Manufacturers:

- a. S-Flex by Schneider Electric **or equal**.
3. General Description:
 - a. The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage.
 - b. The input power section shall comply with the following requirements:
 - 1) It shall utilize a full wave bridge design.
 - 2) It shall convert AC line power of fixed voltage and frequency to fixed DC voltage.
 - 3) It shall be insensitive to phase rotation of the AC line.
 - a) The output power section shall change fixed DC voltage to adjustable frequency AC voltage.
 - b) The adjustable frequency drive UL Type 1 enclosure package shall consist of a circuit breaker disconnect, a 2-contactor bypass power circuit, a 120 V control transformer, and a control circuit terminal block for digital and analog field wiring. The drive shall have a selector switch mounted and wired for Adjustable Frequency controller-Off-Bypass, which shall be accessible on the front of the enclosure package.
 - c) The entire drive package, including the bypass starter circuit, shall be UL508C listed and coordinated with NEMA ICS 7.1.
 4. Construction:
 - a. The AC Drive power converter shall be enclosed in a UL Type 1 enclosure with a circuit breaker disconnect, user terminal block connections, and bypass controls. The enclosure shall provide dedicated user terminations for power and control device connection.
 - b. Provisions shall be included for locking the disconnect in the Off position with a padlock.
 - c. Provisions shall be included for using a padlock to limit enclosure access by unauthorized personnel.
 - d. The UL Type 1 enclosure shall have bottom conduit knock-outs for power and control wiring.
 5. Application Data:
 - a. The AC Drive shall be sized to operate a variable torque load.
 - b. The speed range shall be from a minimum speed of 1 Hz to a maximum speed of 200 Hz.
 6. Environmental Ratings:
 - a. The AC Drive shall meet IEC 60664-1 Annex A and NEMA ICS 1, UL, and cUL standards.
 - b. The AC Drive shall be designed to operate in an ambient temperature from -10 to 40 °C (+14 to 104 °F).

- c. The maximum relative humidity shall be 95%, non-condensing or dripping water.
 - d. The AC Drive shall be rated to operate at altitudes less than or equal to 3300 ft (1000 m). For altitudes above 3300 ft (1000 m), the AC Drive current should be derated 1% for every 330 ft (100 m) up to 10,000 ft (3,000 m).
 - e. The AC Drive shall be Seismic qualified to 2003 IBC, NFPA 5000 and ASCE 7 Building Codes in compliance with ICC ES AC156 testing criteria with an Importance Factor $I_p=1.5$.
 - f. The AC Drive shall be UL Type 1 plenum rated, suitable for placement in a compartment circulating conditioned air to the building.
7. Ratings:
- a. The AC Drive shall be designed to operate at the voltage specified on the schedule.
 - b. The AC Drive shall operate from an input frequency range of 50 to 60 Hz \pm 5%.
 - c. The displacement power factor shall not be less than 0.96 lagging under any speed or load condition.
 - d. The efficiency of the AC Drive at 100% speed and load shall typically be 95% or greater.
 - e. The variable-torque rated AC Drive nominal full load current limit shall be not less than 110% for 60 seconds.
8. Protection:
- a. Upon power-up, the AC Drive power converter shall automatically test for valid operation of memory, valid operation of precharge circuit, loss of communication, DC-to-DC power supply, and control power.
 - b. The enclosure shall provide a fully coordinated 100,000 A short circuit current rating marked on the enclosure nameplate, with short circuit coordination to UL 508C Power Conversion Equipment and NEMA ICS 7.1.
 - c. The AC Drive power converter shall be protected against short circuits between output phases and also phase-to-ground.
 - d. Upon loss of the analog process follower reference signal, the AC Drive power converter shall be programmable to display a detected fault condition signal.
 - e. The AC Drive power converter shall have a solid-state UL 508C listed overload protective device.
 - f. The output frequency shall be software enabled to fold back when the motor is in an overcurrent condition.
 - g. The output switching frequency of the AC Drive power converter shall be selectable from 6 to 16 kHz.
 - h. The AC Drive power converter shall provide an auto reset feature which can provide up to 10 programmable reset attempts after a detected fault has occurred.
9. Adjustments and Configurations:
- a. The AC Drive power converter will be factory programmed to operate all specified optional devices.
 - b. The acceleration and deceleration ramp times shall be adjustable from 0.1 to 3200 seconds.

- c. The AC Drive power converter configuration shall have provisions for an Energy Savings motor type.
 - d. The AC Drive power converter shall have memory capability to retain and record drive operation and detected fault type for the past four faults.
10. Keypad Displace Interface:
- a. An operator interface shall offer the modification of AC Drive power converter adjustments through a keypad. All electrical values, configuration parameters, I/O assignments, application and activity function access, detected fault condition signals, local control, adjustment storage, and diagnostics shall be accessible.
 - b. The AC Drive power converter software revision, output current, motor frequency, and motor voltage shall be readable through the drive display.
11. Operator Controls:
- a. The control power for the digital inputs and outputs shall be 24 VDC.
 - b. The terminal block shall be used for all logic and analog signal connections to the power converter.
 - c. Three voltage-free relay output contacts shall be provided. One of the contacts shall indicate the detected fault status of the AC Drive and shall always be available. One of the contacts shall indicate bypass operation and shall always be available. One contact shall indicate a drive run status and shall only be available when communication cards are not used.
 - d. The combination enclosure shall have dedicated operator controls for Adjustable Frequency Controller-Off-Bypass selection.
 - e. The combination enclosure shall include a terminal point connection for fire/freezestat interlock, to prevent drive or bypass operation. The interlock must shut down the motor in drive and bypass modes.
 - f. The combination enclosure shall include a terminal point connection for smoke/purge controls.
12. Serial communication:
- a. The AC Drive shall have serial communications capability for the following protocols:
 - 1) BACnet (Optional adapter required).
13. Drive Output and Bypass Contactors:
- a. The AC Drive shall include electrically interlocked bypass contactors complete with a Class 10 thermal overload relay, circuit breaker disconnect, control circuit transformer, and Adjustable Frequency Controller-Off-Bypass selector switch.
 - b. The operator shall have full control of the bypass starter by operation of the Adjustable Frequency Controller-Off-Bypass selector switch.
14. Harmonic Mitigation:

- a. Each drive shall include reduced harmonics technology to reduce power system harmonics.
15. The AFDs shall be started, stopped, staged and have their speed controlled by the building automation system.

PART 3 - EXECUTION

- A. The contractor shall set in place and anchor the Packaged Pumping Module in accordance with the written recommendations of the manufacturer of the Packaged Pumping Module. Packaged Pumping Module base with pre-aligned pumps shall be installed level without stress. Pump alignment shall be rechecked by the contractor.
- B. The contractor shall make all piping connections to the Packaged Pumping Module's connections provided, all in accordance with the written recommendations of the manufacturer of the Packaged Pumping Module. Piping connections shall not allow piping stress to be transferred to the Packaged Pumping Module during installation or operation.
- C. Power wiring, as required, shall be done in accordance with the division of responsibility as specified elsewhere. All power wiring shall be performed per the current edition of the NEC (NFPA 70.)
- D. Remote differential pressure transmitters and flowmeters furnished with the packaged pumping system shall be installed by the mechanical contractor per the manufacturer's instructions. A three valve bypass shall be installed for each differential pressure transmitter per the submittal drawings.
- E. Control wiring for remote mounted differential pressure switches, differential pressure transmitters, flow transmitters, start/stop commands, alarms etc. shall be the responsibility of the control contractor. All control wiring shall be performed per the current edition of the NEC (NFPA 70.)

3.2 START-UP

- A. The system manufacturer or factory-trained representative shall provide start-up of the packaged pumping system. This start-up shall include verification of proper installation, system initiation, adjustment and fine tuning. This jobsite visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.
- B. Remove Suction Diffuser Start-Up Strainer after system has been running for 48 hours.

3.3 CLEANING

- A. Entire Package shall be thoroughly cleaned after installation.

3.4 TRAINING

- A. The system manufacturer or factory trained representative shall provide on-site training for owner's personnel. This training shall fully cover maintenance and operation of all system components. The system manufacturer must have a complete HVAC training program available for this purpose.

END OF SECTION 23 57 00.01

SECTION 33 10 05 – RAIN WATER HARVESTING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. This specification describes the technical orientation, equipment, factory testing and delivery of a general rain water collection system **with metering components**.
2. This is a customized and engineered system consisting of specific components integral to completing an operational packaged automatic system. Work shall be as herein specified and as denoted on the **approved shop drawings** but not limited to the following general terms.
3. Provide and install Rain Water Harvesting System in accordance with anticipated storage capacity, building usage, pressure and flow ratings necessary for non-potable make-up water for irrigation. All major components as outlined in the drawings will come as a packaged system. Components such as storage tanks will be buried underground.
4. Contractor to supply all necessary pipe, valves, meters, backflow prevention and other appurtenances not specifically noted on drawings as being provided by the manufacturer.
5. Contractor is responsible for power and control wiring from pumps **and metering assemblies** to control panel(s).
6. **Contractor is responsible for coordinating tie-ins with the landscape irrigation contractor and plumbing contractor.**

1.3 LEED BUILDING GENERAL REQUIREMENTS

- A. The University of South Carolina requires the Contractor to implement practices and procedures to meet the project's environmental performances goals, which include achieving LEED Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions shall not be allowed if such changes comprise the stated LEED BUILDING Performance Criteria.

1.4 SUBMITTALS

- A. See Division 1 Specification Sections for submittal procedures.

- B. Shop Drawings shall include Plan and Section views of the **tank, associated features, and flow metering manhole assemblies**. The section view shall clearly identify elevations/clearances of all equipment, including all critical dimensions and show locations of all fittings and accessories including man ways, vents, tank overflow lines, suction connection and piping, tank fill lines.
- C. The tank manufacturer's, **flow metering manhole assembly manufacturer's** and installing contractor's standard published warranty shall be included with the submittal information.
- D. Complete submittal package for the proposed design shall be supplied to the Professional prior to ordering. The package shall be complete and shall provide all information necessary to substantiate conformance with these plans and specifications in all details. Any and all deviations or exceptions shall be listed separately along with rationale for acceptance of same. Construction shall be governed by the drawings and specifications showing general dimensions and construction details. Any deviations from the plans or specifications shall be clearly indicated in the submittal package for approval by the Professional. When approved, the approval by the Professional of the tank supplier's drawings shall be an approval relating only to their general conformity with the bidding drawings and specifications and shall not guarantee detail dimensions and quantities, which remains the Contractor's responsibility.

1.5 QUALITY ASSURANCE

- A. Governing Standards, as applicable:
 - 1. Tank manufacturer shall be in the business of manufacturing tanks to Underwriters Laboratories (UL) Standard 58 and 1746, or UL 1316.
 - 2. Tank manufacturer shall be in the business of manufacturing tanks with materials conforming to the requirements of NSF Standard 61.
 - 3. American Society of Testing and Materials (ASTM)
 - 4. National/Regional Plumbing Codes

PART 2 - GENERAL DESCRIPTION

2.1 APPLICATION

- A. **The Rain Water Harvesting System is designed to collect and store rain water to provide water for irrigation and for building re-use.**
- B. **Rain water is intended only for non-potable use.**

PART 3 - PRODUCTS

3.1 RAIN WATER HARVESTING SYSTEM WITH STORAGE TANK

- A. Steel underground water storage tank or fiberglass reinforced plastic (FRP) underground water storage tank.
1. 15,000 gallon underground single wall protected steel storage tank with corrosion control system. Corrosion control system shall be solvent-free, tar-free polyurethane coating (75 mil) in accordance with UL 1746 specifications. Interior coating to be NSF61 compliant liner to include SP10 blast and internal seal-weld. Tank shall be approximately 10'-0" diameter by 25'-6" tank length. Tank shall be manufactured in accordance with Underwriters Laboratories UL 58 Construction and UL 1746 Part IV standards. Tank shall be constructed with mild carbon steel engineered to provide burial coverage up to 72" in accordance with latest UL 58 standard. The tank shall withstand surface H-20 and HS-20 axle loads.
 2. 15,000 gallon underground single wall FRP storage tank. Tank shall be manufactured with 100% premium resin and chopped glass, with no fillers or extenders used. No general, orthophthalic or odd lot resin will be used. The tank shall be manufactured with integral trapezoidal ribs for structural integrity and in accordance with Underwriters Laboratories UL 1316 standards. The tank shall be approximately 10'-0" diameter by 29'-6" tank length. The tank shall withstand surface H-20 and HS-20 axle loads and be capable of being buried in ground with 72" of overburden.
- B. The tank shall be provided with the following:
1. Two (2) 24" man ways with necessary extensions, heavy duty covers, nuts, bolts and gaskets. Extension(s) to come with four (4) 2" threaded full couplings for pipe and electrical connections.
 2. All interior piping shall be a minimum of SCH40.
 3. Tank shall include internal stainless steel or FRP ladders.
 4. Provide pump platform and/or pump fittings to sit or hang pumps from manway. Provide appropriate brackets and support to accept pumps, rails and/or pipe connections.
 5. All internal hardware shall be rust proof.
 6. Provide One (1) – 24" diameter inlet pipe connection (plainend) at top of tank center line (see Sheet CI500 for invert elevation). Tank inlet to have integral down corner pipes and diffusion plate to minimize turbulence. Provide striker plate.
 7. Provide One (1) – 18" diameter overflow pipe connection (plainend) at centerline of tank (see Sheet CI500 for invert elevation).
 8. Tank shall have lifting lug(s) that are capable of withstanding weight of tank with a safety factor of at least 2:1.
 9. Provide hold down straps and dead-man anchoring system per manufacturer. Supply buoyancy calculations assuming a fully flooded excavation with an installed empty tank.
- C. **Transfer Pumps:**
1. Furnish and install two (2) submersible non-clog water pumps. Pumps shall be duplex, 1 hp, 3/60/480, 2.7 FLA, multistage pump system. Pumps shall be designed for 8 gpm at 100' TDH. Each pump shall be designed to deliver the rated gpm and work on a lead lag system. Pumps shall also be furnished in

stainless steel flow inducer with integral low level sensor(s) with Adjustable Floating Suction Strainers. Strainers are designed to draw water from 6"-12" below the surface and will be field adjustable. Strainers hose size shall match pump section line. Provide quick connect fittings to attach pump to inside of many ways for easy removal.

D. Irrigation Booster Pump CP-12:

1. Furnish and install one (1) submersible non-clog water pump. Pump shall be simplex, 1.5 hp, 3/60/480, 3.65 FLA, SS, multistage pump system. Pump shall be designed for 1-35 gpm at 138' TDH. Pump shall also be furnished in stainless steel flow inducer with integral low level sensor with Adjustable Floating Suction Strainer. Strainer is designed to draw water from 6"-12" below the surface and will be field adjustable. Strainer hose size shall match pump section line. Provide quick connect fittings to attach pump to inside of man ways for easy removal.

E. Controls:

1. Provide NEMA 3R, (UL-508A Listed) CP-12-321 control unit constant pressure kit for CP-12 booster pump. System shall provide constant pressure, variable speed control of CP-12 submersible pump. Control unit shall come with 3-NC and 2-NO relay contacts. Controls shall be 3/60/480, 3HP max at 10 amps. **Provide with BACNet interface.**
2. Provide **float** to install in cistern tank. Float is provided to shut **booster** pump off when tank level reaches 6400 gallons. Float will be set at 43" above bottom of tank. At 43" booster pump will be disabled and municipal make-up water will provide water to irrigation until level in cistern tank is satisfied above 43". **Information from float shall be able to be relayed to inside control panel (BACNet) (covered by Section 22 48 00).**
3. **Provide float to install in cistern tank. Float is provided to shut transfer pumps off when minimum tank level is reached. Information from float shall be able to be relayed to inside control panel (BACNet) (covered by Section 22 48 00).**
4. Controls for irrigation system, **outside rainwater harvesting system and** inside building rainwater re-use system shall be coordinated prior to design submittal. **Controls for irrigation system, outside rainwater harvesting system and inside building rainwater re-use system shall be provided with BACNet interface.** See building electrical drawings for proposed location of controls.
5. **Provide meter to install on irrigation supply line from cistern tank. Information from meter shall be able to be relayed to control panel (BACNet).**

3.2 FLOW METERING MANHOLE SYSTEM

A. Fiberglass Manhole:

1. Provide appropriately sized fiberglass reinforced polyester composite metering manhole system that meets ASTM D3753-81 standards.
2. **The manhole will include top lid reduction to 24 inches (ID) for installation of H-20 rated cover. The manway reducer shall be concentric with respect to the larger**

portion of the manhole. The manhole shall provide an area for which a typical ring and cover plate can be supported without damage to the manhole.

3. The metering manhole system shall include a weir. The weir shall be integral to the manhole floor and body. The surface of the weir will be finished high grade polyester chemical resistant gel coat. The weir shall include a fiberglass ultrasonic transducer mounting bracket and pre drill flange for installation. The required hardware for installation shall be included.
4. The manhole shall be fitted with an 18 inch wide fiberglass ladder and the ladder shall extend from the manway reducer to the top of the weir. The ladder shall be attached to a fiberglass mounting bracket, integral to the manhole. The ladder shall meet all current OSHA requirements.
5. The manhole shall be fabricated with an integral fiberglass floor. The floor shall be minimum ½ inch thick laminate.
6. The manhole shall be fabricated with 2 inch diameter integral fiberglass NPT couplings to used as cable passes.
7. Fiberglass pipe stubs shall be fitted with neoprene rubber slip over couplers. Couplers shall be secured in place with stainless steel clamping rings.
8. Structural load rating of the manhole shall have a minimum dynamic-load rating of 16,000 lbf when tested according to ASTM 3753, Parts 8.4.1 and 8.4.1.1. The complete manhole shall not leak, crack or suffer other damage when loaded to 40,000 lbf. The unit shall not deflect downward more than 0.25 inches when point loaded at 24,000 lbf.
9. All metallic hardware shall be 18-8 grade stainless steel.
10. The fiberglass laminate used for fabrication shall have been tested and exhibit the following properties at 1/8 inch laminate thickness.
 - a. Specific Gravity: 1.2
 - b. Percent of Glass: 30%
 - c. Flexural Strength (ASTM D790): 11,300 psi
 - d. Flexural Modulus (ASTM D638): 0.88
 - e. Tensile Strength (ASTM D638): 9,700 psi
 - f. Barcol Hardness (ASTM D25832): 40
 - g. Heat Distortion Temp. (ASTM D648): 148 deg F

B. Open Channel Flow Monitor:

1. The flow transmitter shall be an ultrasonic microprocessor based echo-time measuring type providing an electrical output signal proportional to the flow rate, head, velocity or temperature as required. It shall consist of a non-contacting transducer and a transmitter connected by a coaxial cable.
2. Transducer
 - a. Primary Sensor: the acoustic sensor/transducer shall have polarized

- zirconium crystal with acoustic impedance matching face and transformer.**
- b. **Mounting: Fitting(s) per manufacturer's recommendations.**

3. Transmitter

- a. **Enclosure: Nema 4X Polycarbonate**
- b. **Power Supply: 115 VAC +/- 15%, 60 Hz**
- c. **Communications: Provide with BACNet interface**
- d. **Display: Alphanumeric LCD type with LED backlighting**
- e. **Function Details: Log data at customer selectable fixed or variable logging rates of 1 minute to a maximum of 24 hours for a minimum of 31 days up to 2.2 years. Log average flow rate at interval selected. In addition to flow rate, log flow total for 24 hour period, high and low flows and time of events, site identification number and date and time. The flowmeter shall be capable of programming a variable rate log to increase the log rate due to preset flowrate increases and return to original rate when flows return to normal. All data and operational parameters shall be protected to prevent loss should a power failure occur by a dual back-up system utilizing a super capacitor for up to 10 hour protection and a lithium battery for long term protection. Unit shall provide for automatic restart after power is restored without operator assistance.**

PART 4 - INSTALLATION AND FIELD QUALITY CONTROL

4.1 INSTALLATION

- A. Install underground tank **and flow metering manholes** in accordance with manufacturer's written instructions.
- B. If no significant rainfall has occurred during the course of construction, fill tank accordingly for test. Test pumps for operational start and stop to simulate online conditions. Adjust flow and pressure to match design criteria.

4.2 FIELD QUALITY CONTROL

- A. **System Integrator shall provide startup services to include:**
 - 1. **Installation oversight and technical support.**
 - 2. **Terminate and test control system wiring and operation of electrical components.**
 - 3. **Demonstrate proper pump, meter and controls operation.**
 - 4. **Make adjustments to meet user-defined system performance.**
 - 5. **Review operation and maintenance procedures with Owner's representative.**

PART 5 - EXECUTION

5.1 SEQUENCE OF OPERATION

- A. The purpose of system is to provide an alternative to the municipal water supply. The system is designed to collect, store and treat water from a storm event. The stored water will then be transferred under pressure to the building for re-use and through the irrigation system.

- B. Rain water passes through Storm Drainage Water Quality (**see section 33 41 00**) to filter and separate contaminants.
- C. **Filtered rainwater passes through flow metering manhole.**
- D. Water is then conveyed to an underground storage tank (cistern). Tank is designed with overflow protection during heavy rain events. Water is drawn from the tank via submersible pump and floating suction as called for by pressure regulated conditions. Water is drawn for building re-use and for landscape irrigation. **During dry periods: When the water level has been reduced to 6400 gallons, the irrigation booster pump shall be disabled and water for landscape irrigation use shall be drawn from City landscape irrigation service. When the water level has reached close to the bottom of the cistern, the transfer pumps for the building re-use shall be disabled and the water for building re-use shall be drawn from City service via domestic water piping inside the building.**
- E. **During heavy rain events, overflow water will exit the cistern and pass through a second flow metering manhole.**

END OF SECTION 33 10 05