Appendix A
Drawings (with Process Flow Diagrams)

GENERAL CIVIL LEGEND

- 2510 — CONTOURS
- DITCH CENTERLINE
- CULVERT/PIPE
- ROADWAY
- SURVEY CONTROL POINT
- TREES/VEGETATION
- PROPERTY LINE
- FENCE
- LINER
- SEDIMENT FENCE
- RIPRAP
- GRADING LIMITS
- TPN-3 TEST PIT
- MONITORING WELL
- CHECK DAM
- DEMOLISH
- ENERGY DISSIPATOR

GENERAL HVAC LEGEND

- CEILING DIFFUSER OR REGISTER (SUPPLY)
- CEILING REGISTER OR GRILLE (RETURN AND EXHAUST)
- MANUAL OPPOSED-BLAD BALANCING DAMPER
- OPPOSED BLADE DAMPER
- PARALLEL BLADE DAMPER
- M MOTORIZED CONTROL DAMPER
- HVAC FAN
- SUPPLY DUCT (SECTION
- INTAKE, RETURN, OR EXHAUST DUCT (SECTION)
- LOUVER
- FILTER
- DP DIFFERENTIAL PRESSURE SENSOR, VENDOR PROVIDED
- F FREEZE STAT
- H HUMIDISTAT
- PSX PRESSURE SENSOR
- S AIR DUCT SMOKE DETECTOR
- TS TEMPERATURE SENSOR, VENDOR PROVIDED
- X REFER TO SPECIFICATION

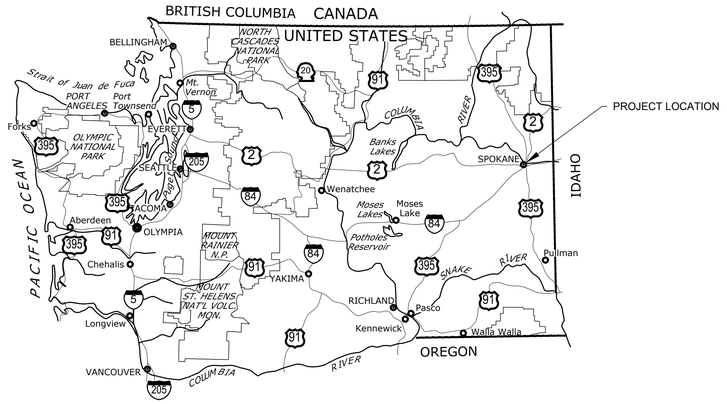
KAISER MEAD CUSTODIAL TRUST

GROUND WATER REMEDIATION INTERIM ACTION FOR EXTRACTION, TREATMENT AND DISCHARGE

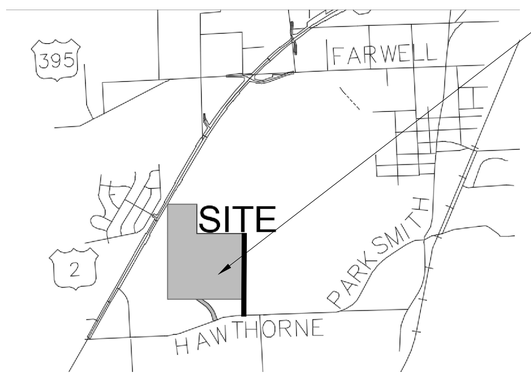
MAY 2020

FINAL DESIGN SUBMITTAL

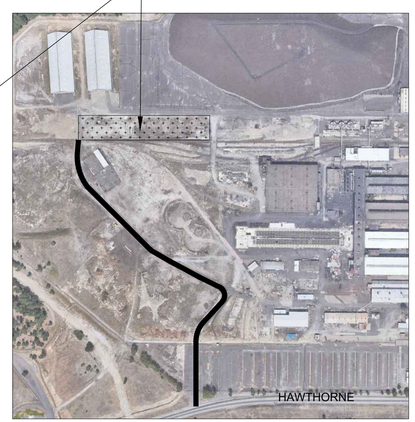
JACOBS



WASHINGTON KEY MAP



SITE AREA MAP



SITE ACCESS AND STAGING

FACILITY INDEX

FACILITY NUMBER	FACILITY DESCRIPTION
000-X-XXX	GENERAL SHEETS
001-X-XXX	EXTRACTION WELL SYSTEM
002-X-XXX	ENHANCED WETLANDS
003-X-XXX	EC BUILDING
004-X-XXX	EC UNIT
005-X-XXX	INFILTRATION BASIN

SHEET INDEX

5/8/2020

NO.	DATE	DSGN	REVISION	CHK	APVD
1	05/01/2020	Kelly I.	ADDENDUM - 1	DR	Dominic S.
0	04/03/2020		FINAL DESIGN - ISSUED FOR CONSTRUCTION	KI	Gary B.
				KI	APVD
				BY	APVD
				JD	Kelly I.
				JD	

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST

GENERAL
COVER SHEET

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	000-G-000
SHEET	1 of 44

FILENAME: 000-G-000.dwg PLOT DATE: PLOT TIME:

ABBREVIATIONS

A	AMMETER, AMPERES, AWNINGS
AB	ANCHOR BOLT, ABOVE
ABDN	ABANDON
AC	ACOUSTICAL, ACOUSTICAL CEILING
AC	ALTERNATING CURRENT
AC	ASPHALTIC CONCRETE
ACFL	ACCESS FLOORING
ACI	AMERICAN CONCRETE INSTITUTE
ACMU	ACOUSTICAL CONCRETE MASONRY UNIT, ACOUSTICAL CMU
ACP	ACOUSTICAL PANELS
ACST	ACOUSTICAL
ACT	ACOUSTICAL TILE
AD	AREA DRAIN
ADDL	ADDITIONAL
ADJ	ADJACENT
ADW	DRY WEATHER AVERAGE
AFD	ADJUSTABLE FREQUENCY DRIVE
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AG	ACOUSTICAL, ACOUSTICAL GLASS
AGGR	AGGREGATE
AHR	ANCHOR
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AJ	ADJUSTABLE
AL	ALUMINUM
ALKY	ALKALINITY
ALTN/ALT	ALTERNATE
AM	AUTO-MANUAL
AMRD	ACOUSTICAL METAL ROOF DECKING
ANDZ	ANODIZE
APPROX	APPROXIMATE
APVD	APPROVED
ARCH	ARCHITECTURAL
AR	ANALOG RELAY
AS	AS SELECTED
ATS	AUTOMATIC TRANSFER SWITCH
AUTO	AUTOMATIC
AUX	AUXILIARY
AVG	AVERAGE
AWW	WET WEATHER AVERAGE
@	AT
B	BELL
BAL	BALANCE
BETW	BETWEEN
BF	BLIND FLANGE, BOTTOM FACE
BFV	BUTTERFLY VALVE
BL	BASELINE
BFP	BACKFLOW PREVENTER
BLDG	BUILDING
BLK	BLOCK
BM	BEAM, BENCHMARK
BO	BOTTOM OF
B.O.B.	BOTTOM OF BEAM
BLL	BOTTOM LOWER LAYER
BOD	BOTTOM OF DUCT
BOP	BOTTOM OF PIPE
BOT	BOTTOM
BRG	BEARING
BRK	BRICK
BRKR	BREAKER
BSP	BLACK STEEL PIPE
BUL	BOTTOM UPPER LAYER
BV	BALL VALVE, BLOCK VENT
BVC	BEGINNING OF VERTICAL CURVE
C	CONDUIT, CASEMENT
°C	DEGREE CELSIUS
C TO C	CENTER TO CENTER
CAB	CABINET
CB	CATCH BASIN, CIRCUIT BREAKER
CC	CENTER OF CIRCLE
CC	CONTROL CABLE
CCP	CENTRAL CONTROL PANEL
CCS	CENTRAL CONTROL SYSTEM
CDF	CONTROLLED DENSITY FILL
CE	CONSTRUCTION ENTRANCE
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CHEM	CHEMICAL
CHKD	CHECKERED
CI	CAST IRON
CIP	CAST IRON PIPE, CAST IN PLACE
CIP	CULVERT INLET PROTECTION
CISP	CAST IRON SOIL PIPE
CJ	CONSTRUCTION JOINT
CKT	CIRCUIT
CL	CENTERLINE
CLDI	CEMENT LINED DUCTILE IRON
CLSF	CONTROLLED LOW STRENGTH FILL
CLG	CEILING
CLR	CLEAR, CLEARANCE
CLSM	CONTROLLED LOW STRENGTH MATERIAL
CMP	CENTRAL MONITORING PANEL
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CNTR	COUNTER
CO	CLEANOUT, CARBON MONOXIDE
COL	COLUMN, COLOR
CONC	CONCRETE
COND	CONDENSATE
CONDTN	CONDITIONED
CONN	CONNECTION
CONSTR	CONSTRUCTION
CONT	CONTINUED, CONTINUOUS, CONTINUATION
CONTR	CONTRACTOR
COORD	COORDINATE
COP	COPPER
CP	CENTER PIVOT
CP-X	CONTROL PANEL NO. X
CPLG	COUPLING
CPRSR	COMPRESSOR
CPT	CONTROL POWER TRANFORMER, CARPET
CPVC	CHLORINATED PVC
CR	CONTROL RELAY
CRS	COLD ROLLED STEEL
CRS	CONSTRUCTION ROAD STABILIZATION
CT	CERAMIC TILE
CT	CURRENT TRANSFORMER
CTC	COMPUTER TERMINAL CABINET
CTR	CENTER
CTRD	CENTERED
CTSK	COUNTERSUNK
CU	CUBIC
CU FT	CUBIC FOOT
CU IN	CUBIC INCH
CUH	COPPER TUBING, HARD DRAWN
CV	CHECK VALVE
CWR	CABINET DOOR MOUNTED WASTE RECEPTACLE
CY, CU YD	CUBIC YARD
CWS	CLEAN WATER SERVICES
D	DEEP, DRAIN
d	PENNY NAIL SIZE
DA	DUAL ACTION
DAS	DATA ACQUISTION SYSTEM
DBA	DEFORMED BAR ANCHOR
DBL	DOUBLE
DC	DIRECT CURRENT
DEG	DEGREE
DET	DETAIL
DF	DOUGLAS FIR, DRINKING FOUNTAIN
DI	DROP INLET
DH	DOUBLE HUNG
DI	DUCTILE IRON
DIA	DIAMETER
DIAG	DIAGONAL
DIP	DUCTILE IRON PIPE
DIR	DIRECTION
DISCH	DISCHARGE
DL	DEAD LOAD
DN	DOWN
DO	DISSOLVED OXYGEN
DOL	DIRECT-ON-LINE
DP, DPNL	DISTRIBUTION PANEL
DR	DOOR
DS	DOWNSPOUT
DWG	DRAWING
DWL	DOWEL
△	DELTA
E	EAST, EMPTY
EA	EACH, EXHAUST AIR
EB, EBCT	EMPTY BED CONTACT TIME
ECC	ECCENTRIC
EE	EMERGENCY EYEWASH
EDF	EGG-SHAPED DIGESTER FACILITY
EF	EACH FACE, EXHAUST FAN
EFF	EFFICIENCY, EFFICIENT
EFL	EFFLUENT
EIFS	EXTERIOR INSULATION AND FINISH SYSTEM
EL	ELEVATION
ELB	ELBOW
ELC	ELECTRICAL LOAD CENTER
ELEC	ELECTRIC, ELECTRICAL
ENGR	ENGINEER
EOP	EDGE OF PAVEMENT
ESC	EROSION AND SEDIMENT CONTROL
EP	EXPLOSION PROOF, EDGE OF PAVING
EQL	EQUAL
EQL SP	EQUALLY SPACED
EQPT	EQUIPMENT
ESC	EROSION AND SEDIMENT CONTROL
ETM	ELAPSED TIME METER
EVC	END OF VERTICAL CURVE
EW	EACH WAY
EWC	ELECTRIC WATER COOLER
EXH	EXHAUST
EXP	EXPANSION, EXPOSED
EXP AB	EXPANSION ANCHOR BOLT
EXP JT	EXPANSION JOINT
EXST, EXIST	EXISTING
EXT	EXTERIOR
° F	DEGREE FAHRENHEIT
FB	FLAT BAR
F, FU	FUSE
F, FX	FIXED
FAP	FIRE ALARM PANEL
FC	FLEXIBLE CONDUIT
FCA	FLANGED COUPLING ADAPTER
FCL2	FREE CHLORINE RESIDUAL
FCO	FLOOR CLEANOUT
FCTY	FACTORY
FD	FLOOR DRAIN
FDN	FOUNDATION
FDR	FEEDER
FEXT	FIRE EXTINGUISHER
FF	FINISHED FLOOR
FG	FINISH GRADE, FLOAT GLASS
FH	FLAT HEAD
FHY	FIRE HYDRANT
FIG	FIGURE
FL	FLOW LINE
FLG	FLANGE
FL	FLOOR
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FLUOR	FLUORESCENT
FNSH	FINISH
FOB	FLAT ON BOTTOM
FOT	FLAT ON TOP
FP	FIELD PANEL
FPM	FEET PER MINUTE
FR	FORWARD REVERSE
FRP	FIBERGLASS REINFORCED PLASTIC
FSHS	FOLDING SHOWER SEAT
FT	FOOT OR FEET
FTG	FOOTING
FU	FIXTURE UNIT
FVNR	FULL VOLTAGE NON-REVERSING
FVR	FULL VOLTAGE REVERSING
FWD	FORWARD
G, GND	GROUND
GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GB	GYPSUM BOARD
GC	GROOVED COUPLING
GCMU	GLAZED CONCRETE MASONRY UNITS
GFA	GROOVED FLANGE ADAPTER
GFI	GROUND FAULT INTERRUPTER
GFR	GROUND FAULT RELAY
GH	GREENHOUSE
GL	GLASS
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GPS	GLOBAL POSITION SYSTEM
GRTG	GRATING
GSB	GYPSUM SOFFIT BOARD
GSP	GALVANIZED STEEL PIPE
GV	GATE VALVE
GVL	GRAVEL
GWB	GYPSUM WALLBOARD
GYP	GYPSUM
H	HIGH, HORN OR HOWLER
H2S	HYDROGEN SULFIDE
H.A.S.	HEADED ANCHOR STUD
HC	HOLLOW CORE WOOD
HCL	HYDROCHLORIC ACID
HDNR	HARDENER
HDNS	HARDNESS
HDR	HEADER
HDW	HARDWARE
HGL	HYDRAULIC GRADE LINE
HK	HOOK
HGT	HEIGHT
HH	HANDHOLE
HID	HIGH INTENSITY DISCHARGE
HK	HOOK
HM	HOLLOW METAL
HOA	HAND-OFF-AUTO
HOR	HAND-OFF-REMOTE
HORIZ	HORIZONTAL
HP	HORSEPOWER
HPT	HIGH POINT
HPU	HYDRAULIC POWER UNIT
HR	HOSE RACK, HANDRAIL
HV	HOSE VALVE
HVAC	HEATING, VENTILATING AND AIR CONDITIONING
HWL	HIGH WATER LEVEL
IC	INTERRUPTING CAPACITY
ID	INDUCED DRAFT, INSIDE DIAMETER
IE	INVERT ELEVATION
I.F.	INSIDE FACE
IG	INSULATING, INSULATING GLASS
IN	INCH
INCAND	INCANDESCENT
INFL	INFLUENT
INJS	INJECTIONS
INST	INSTANTANEOUS
INSTM	INSTRUMENT, INSTRUMENTATION
INSUL	INSULATION
INVT	INVERT
IP	INLET PROTECTION, INSTRUMENTATION PANEL
IRRIG	IRRIGATION
ITG	INSULATED TEMPERED GLASS
ITX	ISOLATION TRANSFORMER
IU	INTAKE UNIT
IW	IRRIGATION WELL
J	JALOUSIE
JA	JAL-AWNING
JB	JUNCTION BOX
JAN	JANITOR
JCT	JUNCTION
JT	JOINT
K	KEY GROUP, KEY INTERLOCK
KIP	THOUSAND POUNDS
KIT	KITCHEN
K-PL	KICKPLATE
kPa	KILOPASCAL
KSK	KITCHEN SINK
KV	KILOVOLTS
KVA	KILOVOLT AMPERES
KVAR	KILOVOLT AMPERES REACTIVE
KW	KILOWATT
L	ANGLE, LENGTH
LA	LIGHTNING ARRESTER
LAB	LABORATORY
LAM	LAMINATE
LAT	LATITUDE
LB	POUND
LC	LIGHTING CONTACTOR
LD	COMBINATION LOUVER/DAMPER
LDG	LOADING DOCK
LEL	LOWER EXPLOSIVE LIMIT
LF	LINEAR FEET
LG	LONG
LH	LEFT HAND
LL	LIVE LOAD
LHR	LEFT HAND REVERSE
LLH	LONG LEG HORIZONTAL
LLV	LONG LEG VERTICAL
LNTL	LINTEL
LONG	LONGITUDINAL
LOS	LOCK-OUT STOP PUSHBUTTON
LP	LIGHT POLE, LIGHTING PANEL, LOCAL PANEL
LPT	LOW POINT
LR	LATCHING RELAY
LR	LOCAL-REMOTE
LR	LONG RADIUS
LS	LABORATORY SINK
LT	LEFT
LTG, LTS	LIGHTS OR LIGHTING
LTX	LIGHTING TRANSFORMER
LWL	LOW WATER LEVEL
MA	MANUAL-AUTO
MAS	MASONRY
MATL	MATERIAL
MAX	MAXIMUM
MB	MACHINE BOLT
MC	MASONRY CLEARANCE
MC	MODULATE-CLOSE
MCC	MOTOR CONTROL CENTER
MCJ	MASONRY CONTROL JOINT
MDO	MEDIUM DENSITY OVERLAY
MECH	MECHANICAL
MFD	MANUFACTURED
MFR	MANUFACTURER
MGD	MILLION GALLONS PER DAY
MH	MANHOLE, MOUNTING HEIGHT
MIN	MINIMUM
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MLO	MAIN LUGS ONLY
MMDW	DRY WEATHER MAXIMUM MONTH
MMP	MECHANICAL MOUNTING PANEL
MMWW	WET WEATHER MAXIMUM MONTH
MO	MANUAL OPERABLE, MASONRY OPENING
MP	METAL PANEL
MPa	MEGAPASCAL
MPU	MULTIPURPOSE UNIT
MS	MANUFACTURER'S STANDARD
MSC	MANUFACTURER SUPPLIED CABLE
MSR	GROUPED MOTOR CONTROL
MT	MOUNT
MTD	MOUNTED
MTG	MOUNTING
MTS	MANUAL TRANSFER SWITCH
MTS	MILL TYPE STEEL PIPE
MU	MULCHING
MV	MERCURY VAPOR
MWS	MAXIMUM WATER SURFACE
N	NORTH, NEUTRAL
NA	NOT APPLICABLE
NA	NON-AUTOMATIC
NC	NORMALLY CLOSED
NEUT	NEUTRAL
NG	NATURAL GAS
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NIC	NOT IN CONTRACT
N.O.	NORMALLY OPEN
NO., #	NUMBER
NOM	NOMINAL
NP	NON-PROTECTED
NPT	NATIONAL PIPE THREADS
NS	NON-SHRINK
NTS	NOT TO SCALE
O2	OXYGEN
O TO O	OUT TO OUT
OA	OVERALL, ODOROUS AIR
OC	ON CENTER
OC	OPEN-CLOSE (O)
OCA	OPEN-CLOSE-AUTO
OCR	OPEN-CLOSE-REMOTE
OD	OUTSIDE DIAMETER, OVERFLOW DRAIN
O.F.	OUTSIDE FACE
OFCI	OWNER FURNISHED, CONTRACTOR INSTALLED
OFOI	OWNER FURNISHED, OWNER INSTALLED
OL	OVERLOAD RELAY
OO	ON-OFF
OOA	ON-OFF-AUTO
OOR	ON-OFF-REMOTE
OP	OPAQUE PANEL, OUTLET PROTECTION
OPER	OPERATOR
OPNG	OPENING
OPP	OPPOSITE
OSA	OUTSIDE AIR
OSC	OPEN-STOP-CLOSE
OSD	OPEN SITE DRAIN
OWSJ	OPEN WEB STEEL JOIST
OZ	OUNCE
P	PROJECTED
P	PILASTER, PIPE
PAVT	PAVER TILE
PB	PUSHBUTTON SWITCH
PC	POINT OF CURVE, PHOTOCELL
PC	PRECAST CONCRETE PANEL
PCCP	PRESTRESSED CONCRETE CYLINDER PIPE
PCV	PRESSURE CONTROL VALVE
PE	PLAIN END
PED	PEDESTAL, PEDESTRIAN
PEP	POLYETHYLENE PIPE
PEN.	PENETRATION
PFC	POUNDS PER CUBIC FOOT
PH	PENTHOUSE
pH	HYDROGEN ION CONCENTRATION
PH	PHASE
PI	POINT OF INTERSECTION
PIT	PILOT TUBE TEST STATION
PJF	PREMOULDED JOINT FILLER
PL	PLATE (STEEL)
PL	PROPERTY LINE
PLAM	PLASTIC LAMINATE
PLAS	PLASTER, PLASTIC
PLC	PROGRAMMABLE LOGIC CONTROLLER
PLYWD	PLYWOOD
PNL	PANEL
PP	POWER POLE
P-P	PUSH-PULL
PPL	POLYPROPYLENE LINED
PR	PAIR
PRC	POINT OF REVERSE CURVE
PRCST	PRECAST
PREFAB	PREFABRICATION
PRES	PRESSURE
PRI	PRIMARY
PRM	PERMANENT REFERENCED MARKER
PROJ	PROJECTION
PROP	PROPERTY
PS	PLASTIC SHEET, POLYCARBONATE SHEET
PS	PAINT SYSTEM
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH, GAUGE
PT	POINT OF TANGENCY
PT	POTENTIAL TRANSFORMER
PT	PRESSURE TREATED
PTD	PAPER TOWEL DISPENSER
PTN	PARTITION
PV	PLUG VALVE
PVC	POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
PVMT	PAVEMENT
PVT	POINT OF VERTICAL TANGENCY
QAA	AVERAGE FLOW
QMM	MAXIMUM 30 DAY FLOW
QPI	PEAK INSTANTANEOUS FLOW
QPP	PEAK PUMPING FLOW
QT	QUARRY TILE
R	RISER
R OR RAD	RADIUS
RA	RETURN AIR
RC	REINFORCED CONCRETE
RCP	REINFORCED CONCRETE PIPE
RCPT	RECEPTACLE
RD	ROAD, ROOF DRAIN
RDCR	REDUCER
RDW	REDWOOD
RECIR	RECIRCULATION
REF	REFER OR REFERENCE
REFR	REFRIGERATE, REFRIGERANT
REINF	REINFORCED, REINFORCING, REINFORCE
REQD	REQUIRED
RESIL	RESILIENT
RFS	ROLL-UP FIRE SHUTTER
RH	RIGHT HAND
RH	RODHOLE
RHR	RIGHT HAND REVERSE
RL	RAIN LEADER
RLD	RAIN LOAD
RLS	RUBBER LINED STEEL
RM	ROOM
RO	ROUGH OPENING
ROL	RAISE-OFF-LOWER
RPM	REVOLUTIONS PER MINUTE
RR	RIPRAP

NOTES:

1. CONTACT ENGINEER FOR ABBREVIATIONS USED BUT NOT SHOWN ON THIS DRAWING.

GENERAL NOTE:

1. THIS IS A STANDARD LEGEND SHEET. THEREFORE, NOT ALL OF THE INFORMATION SHOWN MAY BE USED ON THIS PROJECT.

4-3-2020

KELLY B. IRVIN
STATE OF WASHINGTON
37117
REGISTERED
PROFESSIONAL ENGINEER

NO.	DATE	DSGN	
0	04/03/2020	DR	FINAL DESIGN - ISSUED FOR CONSTRUCTION
		CHK	REVISION
		JD	Kelly I.
		APVD	Gary B.
KI		BY	Dominic S.
			Kelly I.

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust

JACOBS

KAISER MEAD CUSTODIAL TRUST

STANDARD SYMBOLS AND ABREVIATIONS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	000-G-001
SHEET	2 of 44

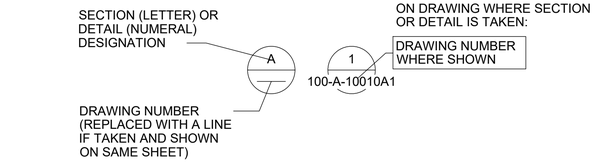
ABBREVIATIONS

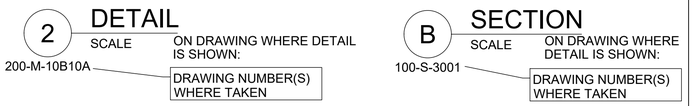
RRUB	RADIAL RUBBER
RS	RIGID STEEL
RST	REINFORCING STEEL
RT	RIGHT
RTN	RETURN
RTO	REGENERATIVE THERMAL OXIDIZER
RUB	RUBBER
RUBC	RUBBER CUSHIONED FLOORING
RUBS	RUBBER ESD CONTROL FLOORING
R/W	RIGHT OF WAY
S	I-BEAM
S	SLOPE, SOUTH, SWITCH
SA	SUPPLY AIR
SATC	SUSPENDED ACCUSTICAL TILE CEILING
SB	SEDIMENT BASIN
SC	SHOWER CURTAIN, SOLID CORE WOOD
SCADA	SUPERVISORY CONTROL AND DATA ACQUISITION
SCC	SOLID CORE
SCFM	STANDARD CUBIC FEED PER MINUTE
SCHED	SCHEDULE
SCU	SPEED CONTROL UNIT
SDP	SUB-DISTRIBUTION PANEL
SDWK	SIDEWALK
SEC	SECONDARY
SECT	SECTION
SED	SEDIMENTATION
SEW	SEWAGE
SG	LAMINATED SAFETY GLASS, SAFETY
SGWB	SUSPENDED GYPSUM WALL BOARD
SH	SHEET
SHA	SURFACE HARDENING AGENT
SHS	SOLIDS HANDLING SYSTEM
SIM	SIMILAR
SK	SINK
SL	SNOW LOAD
SLR	SEALER
SMLS	SEAMLESS EPOXY
SOI	SPRAY- ON INSULATION
SOLN	SOLUTION
SP	SPACE OR SPACES, SPANDREL PANEL, STORMPROOF
SPEC, SPECS	SPECIFICATIONS
SPD	SUMP PUMP DISCHARGE
SPG	SPACING
SPLY	SUPPLY
SQ	SQUARE
SQ FT	SQUARE FOOT, FEET
SQ IN	SQUARE INCH
SR	SHORT RADIUS
SS	START-STOP
SST	STAINLESS STEEL
SSC	SUPERVISORY SET POINT CONTROL
ST	STORM DRAIN
ST	STRAIGHT
STA	STATUS, STATION
STD	STANDARD
STIF	STIFFENER
STIRR	STIRRUP
STL	STEEL
STRL	STRUCTUAL
STRUCT	STRUCTURE
SUBFL	SUBFLOOR
SUSP	SUSPENDED
SV	SOLENOID VALVE
SVIN	SHEET VINYL
SWBD	SWITCHBOARD
SWGR	SWITCHGEAR
SYMM	SYMMETRICAL
T	THERMOSTAT, TREAD
T&B	TOP AND BOTTOM
T&G	TONGUE AND GROOVE
TA	TRANSFER AIR
TAN	TANGENT
TB	TERMINAL BOARD
TBG	TUBING
TC	TIME TO CLOSE
TC	TURBIDITY CURTAIN
TCAD	TIME CLOSE AFTER DE-ENERGIZATION
TCAE	TIME CLOSE AFTER ENERGIZATION
TDH	TOTAL DYNAMIC HEAD
TDR	TIME DELAY RELAY
TECH	TECHNICAL
TEL	TELEPHONE
TEMP	TEMPORARY, TEMPERATURE
TF	TOP FACE
TFG	TEMPERED FLOAT GLASS
TG	TEMPERED
TH	TOP-HINGED
THD	THREAD
THK	THICKNESS
THRU	THROUGH
TJB	TERMINAL JUNCTION BOX
TL	TEFLON LINED PIPE
T.O.	TIME TO OPEN, TOP OF
TOAE	TIME OPEN AFTER ENERGIZATION
TOC	TOP OF CONCRETE
TOC	TOP OF CURB
TOD	TIME ON DELAY, TOP OF DUCT
	TOTAL OXYGEN DEMAND
TOF	TOP OF FOOTING
TOG	TOP OF GROUT, TOP OF GRATE
T.O.P.	TOP OF PARAPET
TOS	TOP OF SLAB
TOW	TOP OF WALL
TP	TURNING POINT
TR	TRANSOM, TRUSS
TRANS	TRANSFORMER, TRANSITION
TRANSV	TRANSVERSE
TRD	TREAD
TS	TEMPORARY SEEDING, TUBE STEEL
TSHT	THRESHOLD
TSS	TOTAL SUSPENSION SOLIDS
TST	TOP OF STEEL
TTC	TELEPHONE TERMINAL CABINET
TTD	TOILET TISSUE DISPENSER
TU-X	TREATMENT UNIT NO. X
TURB	TURBIDITY
TWP	TRANSLUCENT WALL PANEL
TX	TRANSFORMER
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
UNO	UNLESS NOTED OTHERWISE
UPS	UNINTERRUPTIBLE POWER SUPPLY
USB	UNIT SUBSTATION
UVR	UNDER VOLTAGE RELAY
V	VENT, VALVE
V	VOLTMETER, VOLTS
VB	VAPOR BARRIER (RETARDER)
VC	VERTICAL CURVE
VCP	VITRIFIED CLAY PIPE
VCT	VINYL COMPOSITION TILE
VEL	VELOCITY
VERT	VERTICAL
VHC	VOLATILE HYDROCARBONS
VIB	VIBRATION
VIF	VERIFY IN FIELD
VIN	VINYL
VINT, VT	VINYL TILE
VP	VERTICAL PIVOTED
VPS	VENEER PLASTER SYSTEM
VPC	POINT OF VERTICAL CURVATURE
VPI	POINT OF VERTICAL INTERSECTION
VPT	POINT OF VERTICAL TANGENT
VS	VERTICAL SLIDE
VTR	VENT THRU ROOF
VWC	VINYL WALL COVERING
W	WEST
W/	WITH
WC	WATER COLUMN
WEASTRIP	WEATHERSTRIP
WG	WIRE, WIRE GLASS
WH	WATTHOUR METER
WHD	WATTHOUR DEMAND METER
WP	WATERPROOF, WEATHERPROOF, WORKPOINT
WR	WASTE RECEPTACLE
WRB	WATER RESISTANT GWB
WS	WATER SURFACE, WATERSTOP, WELDED STEEL
WWF	WELDED WIRE FABRIC
WWPH	WET WEATHER PEAK HOUR

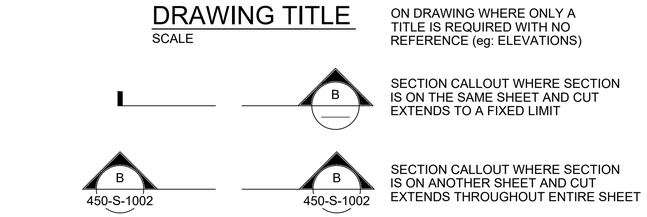
NOTES:

1. CONTACT ENGINEER FOR ABBREVIATIONS USED BUT NOT SHOWN ON THIS DRAWING.

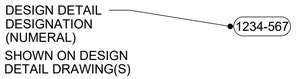
SECTION / DETAIL DESIGNATIONS







DESIGN DETAIL DESIGNATION



NOTES:

1. ALL DESIGN DETAILS ARE TYPICAL AND MUST BE USED IF DESIGN DETAIL DESIGNATION IS NOT SHOWN
2. THE TERM STANDARD DETAIL, OR A FORM OF IT, IS SYNOMONOUS WITH DESIGN DETAIL. THE DESIGN DETAILS REPRESENT THE CHARACTER AND NATURE OF THE WORK REQUIRED THROUGHOUT THE PROJECT. ALL ASSOCIATED WORK SHALL BE IN ACCORDANCE WITH THE DESIGN DETAILS SHOWN WHETHER THE DETAILS ARE SPECIFICALLY REFERENCED OR NOT.

CIVIL/MECHANICAL NOTES

PIPE & FITTINGS:

PVC: SCH 80, TYPE 1, GRADE 1 OR CLASS 12454-B PER ASTM D1784 AND D1785; FITTINGS PER ASTM D2466 AND ASTM D2467; FLANGES ASME B16.1, CLASS125; BOLTING ASTM A193/A193M, TYPE 316 SST, GRADE B8M HEX HEAD, ASTM A194/194M GRADE 8M NUTS, ASTM F436 TYPE 3 ALLOY WASHERS AT NUTS AND BOLT HEADS; FULL-FACED GASKETS, 1/8" THICK EPR. INSTALL PER SPEC SECTION 40 27 00; HYDROTEST ALL PIPING IN ACCORDANCE WITH SPECIFICATION REQUIREMENTS.

HDPE: HIGH DENSITY POLYETHYLENE PER ASTM D3350 FOR PE4710 MATERIAL WITH CELL CLASSIFICATION 445474C OR BETTER; MINIMUM PRESSURE RATING OF 150 PSI FOR PRESSURE PIPES; IPS OUTSIDE DIAMETER; JOINED BY BUTT FUSION; MOLDED FITTINGS PER ASTM D3261; 316 SST BACKING RINGS FOR MOLDED FLANGE ADAPTERS; 316 SST BOLTS, NUTS, AND WASHERS. INSTALL PER SPEC SECTION 33 05 01.10; HYDROTEST ALL PIPING IN ACCORDANCE WITH SPECIFICATION REQUIREMENTS.

VALVES:

PVC BALL VALVES: NIBCO/CHEMTROL TRU-BLOC, ASAHI/AMERICA TYPE 21, OR EQUAL; RATED 150 PSI, ASTM D1784 TYPE 1, GRADE 1 PVC, FULL PORT; DUAL UNION SOLVENT-WELD SOCKET ENDS OR SINGLE UNION WITH FLANGED ENDS.

CHECK VALVES: ASAHI/AMERICA SWING CHECK, OR EQUAL; PVC SWING CHECK, FLANGED ENDS, EPDM SEALS; FOR HORIZONTAL OR VERTICAL INSTALLATION.

AIR RELEASE (AUTOMATIC DEGASSING) VALVES: PLAST-O-MATIC/SERIES DGV, PRIMARY FLUID SYSTEMS/ACCU-VENT, OR EQUAL; PVC; RATED 100 PSI.

SPECIALTIES:

MODULAR MECHANICAL SEAL: THUNDERLINE/LINK-SEAL OR EQUAL; SYNTHETIC RUBBER LINKS, ASTM A276 316 SST HARDWARE, REINFORCED NYLON POLYMER PRESSURE PLATES; SIZE FOR PIPE AND WALL SLEEVE DIAMETERS AS SHOWN FOR WATERTIGHT SEAL OF ANNULAR SPACE.

GENERAL HVAC ABBREVIATIONS

ACCU	AIR-COOLED CONDENSING UNIT
ACU	AIR CONDITIONING UNIT
AFD	ADJUSTABLE FREQUENCY DRIVE
ASU	AIR SUPPLY UNIT
CP	CONTROL PANEL
DDC	DIRECT DIGITAL CONTROL PANEL
DH	DUCT HEATER
EG-X	EXHAUST GRILLE
EF	EXHAUST FAN
FD	FIRE DAMPER
FRP	FIBERGLASS REINFORCED PLASTIC
FUR	DUCT FURNACE
HCP	HVAC CONTROL PANEL
HPW	WATER SOURCE HEAT PUMP
HTP	INDOOR HEAT PUMP UNIT
LV	LOUVER
MAU	MAKE-UP AIR UNIT
MD	MOTORIZED DAMPER
MS	MOTOR STARTER
RG-X	RETURN GRILLE
S	SMOKE DETECTOR
SF	SUPPLY FAN
SG-X	SUPPLY GRILLE
SS	STAINLESS STEEL
TG-X	TRANSFER GRILLE
UH	UNIT HEATER
VFD	VARIABLE FREQUENCY DRIVE

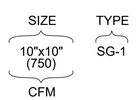
HVAC FLOW IDEN.

EA	EXHAUST AIR
OA	OUTSIDE AIR
SA	SUPPLY AIR

GENERAL BUILDING SERVICE NOTES

1. THIS IS A STANDARD LEGEND SHEET, THERFORE NOT ALL OF THE INFORMATION SHOWN MAY BE USED ON THIS PROJECT.
2. ALL DIMENSIONS ARE INCHES UNLESS OTHERWISE NOTED.
3. ALL DUCT DIMENSIONS ARE INSIDE CLEAR.
4. VERIFY AND COORDINATE EQUIPMENT LAYOUT, SIZE, AND CONNECTION SERVICES WITH EQUIPMENT ACTUALLY SELECTED FOR INSTALLATION.
5. DO NOT SCALE DUCTWORK AND EQUIPMENT FOR SIZE.
6. COORDINATE ENTIRE INSTALLATION OF THE HVAC SYSTEMS WITH THE WORK OF ALL OTHER TRADES PRIOR TO ANY FABRICATION OR INSTALLATION.
7. COORDINATE EXACT LOCATION AND SIZES OF REQUIRED OPENINGS AND SUPPORTS FOR FURNISHED EQUIPMENT WITH THE GENERAL CONTRACTOR.
8. ALL EQUIPMENT SHALL BE INSTALLED IN STRICT ACCORDANCE WITH THE EQUIPMENT MANUFACTURER'S REQUIREMENTS, AND THE 2015 INTERNATIONAL MECHANICAL CODE.
9. PROVIDE ALL FITTINGS, TRANSITIONS, DAMPERS, VALVES, AND OTHER DEVICES REQUIRED FOR COMPLETE WORKABLE INSTALLATION.
10. ALL EQUIPMENT, DUCTS, PIPING, AND OTHER DEVICES OR MATERIAL EXPOSED TO THE WEATHER SHALL BE COMPLETELY WEATHERPROOF.
11. ALL VALVES, CONTROLS, DAMPERS, FANS, ETC. SHALL BE INSTALLED IN ACCESSIBLE LOCATION. PROVIDE ADEQUATELY SIZED ACCESS DOORS OR PANELS WHERE REQUIRED.
12. THE LOCATION OF CEILING AIR INLETS AND OUTLETS SHALL BE IN ACCORDANCE WITH ARCHITECTURAL REFLECTED CEILING PLAN.
13. SOME OF THE STANDARD DETAILS MAY NOT APPLY TO THIS PARTICULAR BUILDING OR PROJECT.
14. PROVIDE ALL MATERIALS AND EQUIPMENT AND PERFORM ALL TESTS REQUIRED TO INSTALL COMPLETE AND OPERABLE BUILDING MECHANICAL SYSTEMS AS INDICATED ON THE DRAWINGS, AS SPECIFIED AND AS REQUIRED BY CODE.
15. POWER TO MOTORIZED DAMPERS SHALL BE BY DIV. 23 CONTRACTOR, UNLESS NOTED OTHERWISE.
16. LOCATE ALL TEMPERATURE, PRESSURE, AND FLOW MEASURING DEVICES IN ACCESSIBLE LOCATIONS WITH STRAIGHT SECTION OF PIPE OR DUCT UP OR DOWN STREAM AS RECOMMENDED BY MANUFACTURER.
17. ALL CONTROL WIRING SHALL COMPLY WITH THE NATIONAL ELECTRIC CODE AND SPECIFICATIONS.
18. CONCRETE HOUSEKEEPING PADS TO SUIT BUILDING MECHANICAL EQUIPMENT SHALL BE SIZED BY MECHANICAL CONTRACTOR.
19. PROVIDE SUFFICIENT CLEARANCE AT AHU'S, MAU'S AND OTHER BUILDING MECHANICAL EQUIPMENT FOR ACCESS DOORS, ACCESS PANELS, FILTER, AND COILS.
20. FOR ADDITIONAL ABBREVIATIONS AND SYMBOLS OF OTHER DIVISIONS, SEE OTHER LEGENDS.
21. DASHED SYMBOL INDICATES COMPONENT PROVIDED BY OTHER DISCIPLINE.

AIR DISTRIBUTION LEGEND



4-3-2020

KELLY B. ERING
STATE OF WASHINGTON
37117
REGISTERED
PROFESSIONAL ENGINEER

NO.	DATE	DSGN
0	04/03/2020	Kelly I.

FINAL DESIGN - ISSUED FOR CONSTRUCTION

REVISION	CHK	DR
	Dominic S.	Kelly I.
	Gary B.	APVD
KI	BY	APVD
JD	APVD	Kelly I.

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST

STANDARD SYMBOLS AND ABREVIATIONS CONT.

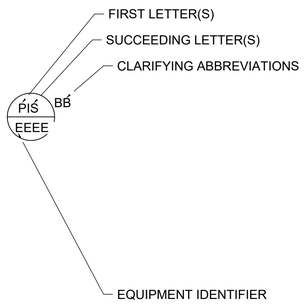
VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	000-G-002
SHEET	3 of 44

INSTRUMENT IDENTIFICATION

EXAMPLE SYMBOLS



DIGITAL SYSTEM INTERFACES

- ▲ ANALOG INPUT
- ▼ ANALOG OUTPUT
- △ DISCRETE INPUT
- ▽ DISCRETE OUTPUT

INSTRUMENT IDENTIFICATION LETTERS TABLE

LETTER	FIRST-LETTER		SUCCEEDING-LETTERS		
	PROCESS OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS (+)		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE (*)	USER'S CHOICE (*)	USER'S CHOICE (*)
C	USER'S CHOICE (*)			CONTROL	
D	DENSITY (S.G)	DIFFERENTIAL			
E	VOLTAGE		PRIMARY ELEMENT, SENSOR		
F	FLOW RATE	RATIO (FRACTION)			
G	USER'S CHOICE (*)		GLASS, GAUGE VIEWING DEVICE	GATE	
H	HAND (MANUAL)				HIGH
!	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOTION	MOMENTARY			MIDDLE, INTERMEDIATE
N	TORQUE		USER'S CHOICE (*)	USER'S CHOICE (*)	USER'S CHOICE (*)
O	USER'S CHOICE (*)		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD OR PRINT		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED (+)	X AXIS	UNCLASSIFIED (+)	UNCLASSIFIED (+)	UNCLASSIFIED (+)
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION	Z AXIS		DRIVE, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

TABLE BASED ON THE INSTRUMENTATION, SYSTEMS, AND AUTOMATION SOCIETY (ISA) STANDARD.

(+) WHEN USED, EXPLANATION IS SHOWN ADJACENT TO INSTRUMENT SYMBOL. SEE ABBREVIATIONS AND LETTER SYMBOLS.

(*) WHEN USED, DEFINE THE MEANING HERE FOR THE PROJECT

GENERAL INSTRUMENT OR FUNCTIONAL SYMBOLS

- FIELD MOUNTED INSTRUMENT
- REAR-OF-PANEL MOUNTED INSTRUMENT (OPERATOR INACCESSIBLE)
- PANEL MOUNTED INSTRUMENT
- MOTOR CONTROL CENTER MOUNTED INSTRUMENT
- COMPUTER FUNCTION
- PLC FUNCTION

SPECIAL CASES

- YL OO — ON AND OFF EVENT LIGHTS
- HS OO — ON-OFF HAND SWITCH. MAINTAINED CONTACT SWITCH (CONTROLLED DEVICE WILL RESTART ON RETURN OF POWER AFTER POWER FAILURE).
- HS SS — STOP-START HAND SWITCH MOMENTARY CONTACT SWITCHES (CONTROLLED DEVICE WILL NOT RESTART ON RETURN OF POWER AFTER POWER FAILURE).

TRANSDUCERS

A	ANALOG	I	CURRENT
D	DIGITAL	P	PNEUMATIC
E	VOLTAGE	PF	PULSE FREQUENCY
F	FREQUENCY	PD	PULSE DURATION
H	HYDRAULIC	R	RESISTANCE

EXAMPLE:

FY I/P — CURRENT TO PNEUMATIC TRANSDUCER (BACK OF PANEL, IN A FLOW LOOP)

LINE LEGEND

- PROCESS (CLOSED CONDUIT, DASHED LINE INDICATES ALTERNATE FLOW STREAM)
- PROCESS (OPEN CHANNEL)
- ANALOG SIGNAL (4 TO 20 mAdc, ETC.)
- DISCRETE SIGNAL (ON/OFF, ETC.)
- PNEUMATIC SIGNAL
- FILLED SYSTEM SIGNAL
- HYDRAULIC SYSTEM SIGNAL
- DATA LINK
- BUILDING OR FACILITY BOUNDARY
- PACKAGE SYSTEM EQUIPMENT

PARALLELING LINES

(2) 3(2)

(A) (B)

(A) TOTAL OF 2 SIGNALS

(B) 3 TYPICAL SETS OF 2 SIGNALS EACH. TOTAL OF 6 SIGNALS.

- CONNECTING LINES
- NON-CONNECTING LINES

INTERFACE SYMBOLS

S WA — WA D

= PROCESS INTERFACE

= SIGNAL INTERFACE

W = SOURCE UNIT PROCESS NO. (1 OR 2 DIGITS)

A = INTERFACE NO. (2 DIGITS)

D = DESTINATION DRAWING NO.

S = SOURCE DRAWING NO.

N — PROCESS OR SIGNAL LINE CONTINUATION N=1,2,3,ETC — N

INTERFACE TO OR FROM PROCESS EXTERNAL TO PROJECT

SELF CONTAINED VALVE & EQUIPMENT TAG NUMBERS

W-D-X-Y

W = UNIT PROCESS NUMBER

D:
- ARV = AIR RELEASE VALVE
- AVRV = AIR AND VACUUM RELEASE VALVE
- E = EJECTOR
- G = GATE
- M = MECHANICAL EQUIPMENT
- P = PUMP
- T = TANK

X = LOOP NUMBER

Y = UNIT NUMBER

ABBREVIATIONS & LETTER SYMBOLS

AC	ALTERNATING CURRENT
ALKY	ALKALINITY
AM	AUTO-MANUAL
CAM	COMPUTER-AUTO-MANUAL
CCS	CENTRAL CONTROL SYSTEM
CL_2 etc.	CHLORINE (TYPICAL: USE STANDARD CHEMICAL ELEMENT ABBREVIATION)
CM	COMPUTER-MANUAL
COD	CHEMICAL OXYGEN DEMAND
CP-X	CONTROL PANEL NO. X
DC	DIRECT CURRENT
DO	DISSOLVED OXYGEN
FCL_2	FREE CHLORINE RESIDUAL
FOS	FAST-OFF-SLOW
FOSA	FAST-OFF-SLOW-AUTO
FOSR	FAST-OFF-SLOW-REMOTE
FP-W-X	FIELD PANEL NO. WX (W = UNIT PROCESS NUMBER X = PANEL NUMBER)
FR	FORWARD-REVERSE
HDNS	HARDNESS
HOA	HAND-OFF-AUTO
HOR	HAND-OFF-REMOTE
LEL	LOWER EXPLOSIVE LIMIT
LOS	LOCKOUT STOP
LR	LOCAL-REMOTE
MA	MANUAL-AUTO
MBAS	METHYLENE BLUE ACTIVE SUBSTANCES
MC	MODULATE-CLOSE
MCC-X	MOTOR CONTROL CENTER NO. X
MSC	MANUFACTURER SUPPLIED CABLE
OC	OPEN-CLOSE (D)
OCR	OPEN-CLOSE-REMOTE
OCA	OPEN-CLOSE-AUTO
OO	ON-OFF
OOA	ON-OFF-AUTO
OOR	ON-OFF-REMOTE
OP	ORTHO PHOSPHORUS
ORP	OXIDATION REDUCTION POTENTIAL
OSC	OPEN-STOP-CLOSE
pH	HYDROGEN ION CONCENTRATION
RM-X	REMOTE MULTIPLEXING MODULE NO. X
RTU-X	REMOTE TELEMETRY UNIT NO. X
SF	SLOWER-FASTER
SS	START-STOP
SSC	SUPERVISORY SET POINT CONTROL
TCL_2	TOTAL CHLORINE RESIDUAL
TOC	TOTAL ORGANIC CARBON
TOD	TOTAL OXYGEN DEMAND
TURB	TURBIDITY
VHC	VOLATILE HYDROCARBONS
VIB	VIBRATION
Δ	DIFFERENCE
Σ	SUM
X	MULTIPLY
$\div$	DIVIDE
f(x)	CHARACTERIZED
X^n	RAISE TO THE Nth POWER
$\sqrt{\ }$	SQUARE ROOT
AVG	AVERAGE
1:1	REPEAT OR BOOST
>	SELECT HIGHEST SIGNAL
<	SELECT LOWEST SIGNAL
+/-	BIAS
%	GAIN OR ATTENUATE

GENERAL NOTES

1. COMPONENTS AND PANELS SHOWN WITH A SINGLE ASTERISK (✳) ARE TO BE PROVIDED AS PART OF A PACKAGE SYSTEM.
2. COMPONENTS AND PANELS SHOWN WITH A DOUBLE ASTERISK (✳✳) ARE TO BE PROVIDED UNDER DIVISION 16, ELECTRICAL.
3. THIS IS A STANDARD LEGEND. THEREFORE, NOT ALL OF THIS INFORMATION MAY BE USED ON THIS PROJECT.

JOSHUA CLEMENT THOMPSON — STATE OF WASHINGTON — 52468 — REGISTERED PROFESSIONAL ENGINEER

04/02/2020

NO.	DATE	DSGN
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION

DR: Josh T. — CHK: Steve B. — APVD: Steve B.

		KI	JD
		BY	APVD

REVISION

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST

I&C LEGEND

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

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VALVE SYMBOLS

- GATE
- KNIFE GATE
- BUTTERFLY
- GLOBE
- BALL
- V — VEE-BALL
- PLUG
- SEAT PORT ECCENTRIC PLUG
- DIAPHRAGM
- PINCH
- NEEDLE
- SWING CHECK
- BALL CHECK
- BACKFLOW PREVENTER
- ROTARY
- TELESCOPE
- S — SAMPLE
- MUD
- PRESSURE RELIEF
- AIR AND/OR VACUUM RELEASE
- REGULATED SIDE PRESSURE CONTROL
- PRESSURE REGULATION (CLAY-TYPE)
- MULTI-PORT VALVE (GATE VALVE SHOWN. FOR OTHER VALVE TYPES, APPROPRIATE VALVE SYMBOL SHOWN.) SEAT PORTS ARE IMPLIED BY INDICATED FLOW PATTERN.
- ANGLE GATE

GATE SYMBOLS

- SLUICE
- FABRICATED SLIDE
- STOP LOG
- BUTTERFLY
- FLAP
- SHEAR

ACTUATOR SYMBOLS

- PNEUMATIC DIAPHRAGM SPRING-OPPOSED, SINGLE OR DOUBLE ACTING
- VALVE POSITIONER
- MANUAL
- PNEUMATIC CYLINDER SINGLE OR DOUBLE ACTING ACTUATED BY ONE INPUT
- H — HYDRAULIC
- M — ELECTRIC MOTOR
- DIAPHRAGM, DIFFERENTIAL PRESSURE
- S — SOLENOID
- E/H — ELECTROHYDRAULIC

NOTE:
ON LOSS OF PRIMARY POWER (PNEUMATIC, ELECTRICAL, OR HYDRAULIC)

XX:
- FO FAIL OPEN
- FC FAIL CLOSED
- FLP FAIL TO LAST POSITION

PRIMARY ELEMENT SYMBOLS

- PARSHALL FLUME
- PROPELLER OR TURBINE METER
- LS — LEVEL (FLOAT)
- WEIR
- THERMAL FLOWMETER
- FI — ROTAMETER
- ORFICE PLATE
- LEVEL (BUBBLER TUBE)
- DE — DENSITY METER
- FLOW TUBE
- XX — GENERIC
- PITOT-STATIC
- LE — LEVEL
- VORTEX METER
- ULTRASONIC FLOWMETER
- M — ELECTROMAGNETIC FLOWMETER

MISCELLANEOUS SYMBOLS

- V — VENT TO ATMOSPHERE
- AIR GAP
- T — DRIP TRAP
- PIG INSERT POINT
- PIG CATCH POINT
- A — SELF CONTAINED AIR SUPPLY
- AP — AIR PURGE SET
- F — FLUSHING CONNECTION
- S — SAMPLE PORT WITH BALL VALVE
- WP — WATER PURGE SET
- FLEXIBLE CONNECTION
- AERATOR
- DIAPHRAGM SEAL
- ANNULAR DIAPHRAGM SEAL
- SS — COMPOSITE SAMPLER
- FLAME TRAP
- CALIBRATION COLUMN
- S — INLINE SILENCER
- BLIND FLANGE
- PIPE CAP
- STRAINER
- BASKET STRAINER
- FILTER
- PULSATION DAMPENER
- EXPANSION CHAMBER
- FFLCPLLLX — PANEL CONTINUED ON SAME OR OTHER DRAWING
- PANEL OUTLINE
- PANEL NAME
- 120V — 120 VOLT, 60 HZ POWER
- 480V — 480 VOLT, 60 HZ POWER
- XX — AIR SET XX = SUPPLY PRESSURE IN PSIG.
- PLUG
- RECEPTACLE
- RUPTURE DISK (VACUUM)
- RUPTURE DISK (PRESSURE)
- TV — TV MONITOR
- TV — TV CAMERA
- A, B → AND → C — LOGIC ELEMENT: IF A AND NOT B THEN C
- A, B → OR → C — LOGIC ELEMENT: IF A OR B THEN C
- RADIO ANTENNA
- I / OR / I — INTERLOCK, SEE CONTROL DIAGRAMS
- VOICE COMMUNICATION POINT
- SKIMMING MECHANISM
- SCREW CONVEYOR
- MIXER
- ELECTRIC MOTOR

PUMP AND COMPRESSOR SYMBOLS

- CENTRIFUGAL PUMP (DRY PIT) — XX
- CENTRIFUGAL WET PIT PUMP OR TURBINE PUMP — XX
- RECIPROCATING OR METERING PUMP (POSITIVE DISPLACEMENT) — XX
- DIAPHRAGM PUMP — XX
- GEAR PUMP OR BLOWER (POSITIVE DISPLACEMENT) — XX
- PROGESSING CAVITY PUMP — XX
- COMPRESSOR (CENTRIFUGAL) — XX
- COMPRESSOR (PISTON) — XX
- BLOWER OR FAN (CENTRIFUGAL) — XX
- EJECTOR
- PISTON PUMP — XX
- SUBMERSIBLE SUMP PUMP — XX
- ROTARY PUMP
- VACUUM PUMP
- SCREW PUMP

XX:
- AS ADJUSTABLE SPEED
- CS-1 CONSTANT SPEED (SINGLE SPEED)
- CS-2 CONSTANT SPEED (TWO SPEED)

LINE SIZE AND MATERIAL IDENTIFICATION

(FOR REFERENCE ONLY. SEE SITE AND MECHANICAL DRAWINGS)

CISP	CAST IRON SOIL PIPE
CLDI	CEMENT LINED DUCTILE IRON
CU	COPPER
FRP	FIBERGLASS REINFORCED PLASTIC
HDPE	HIGH-DENSITY POLYETHYLENE
PVC	POLYVINYL CHLORIDE
SST	STAINLESS STEEL
STL	STEEL

FLOW STREAM IDENTIFICATION

AI	AIR, INSTRUMENT
GW	GROUNDWATER
OF	OVERFLOW
SA	SAMPLE
TE	TREATED EFFLUENT
V	VENT
W1	NO. 1 (POTABLE) WATER
W2	NO. 2 (NON-POTABLE) WATER
WE	WETLAND EFFLUENT
WR	WETLAND RECIRCULATION

JOSHUA CLEMENT THOMPSON — STATE OF WASHINGTON — 32464 — REGISTERED PROFESSIONAL ENGINEER
04/02/2020

NO.	DATE	DSGN	DR	CHK	APVD
0	04/03/2020	Josh T.	Josh T.	Steve B.	Steve B.

FINAL DESIGN - ISSUED FOR CONSTRUCTION

REVISION	BY	APVD
KI	JD	

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST

I&C LEGEND

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 — 1"

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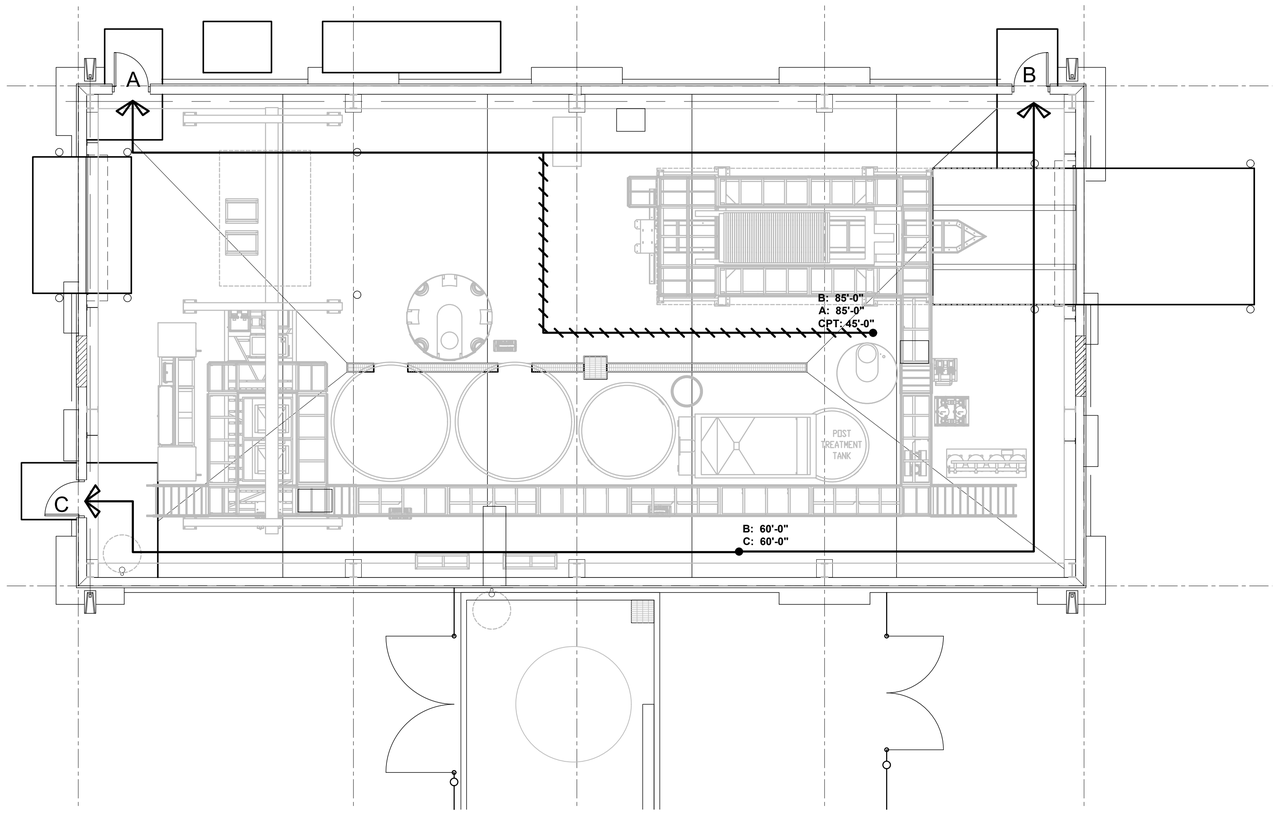
SHEET	5 of 44



EC BUILDING PLAN

NTS

LIFE SAFETY LEGEND

X:Y — TRAVEL DISTANCE "X" IN FEET TO EXIT "Y"

COMMON PATH OF TRAVEL (CPT)

32" MINIMUM EGRESS WIDTH PROVIDED

EC BUILDING - WASHINGTON STATE BUILDING CODE SUMMARY

Building Name	EC Building Code
Occupancy:	F-1
Actual Floor Area:	3,870 ft^2
Actual Height:	1 Story (> 25 feet)
Type of Construction:	Type II-B
Allowable Area:	15,500 ft^2/floor (per IBC Table 503) + 9,065 ft^2 (Frontage) + 0 ft^2 for sprinklers (Sprinklers not provided)
Allowable Height:	3 Stories (55 feet)
Fire Separation:	None Required (Buildings are more than 40 feet apart)
Design Occupant Load:	39 People
Actual Occupant Load:	2 People
Fire Sprinklers:	No Fire Sprinklers provided
Americans with Disabilities Act:	Not required (IBC 1103.2.9 Equipment Space exception)
Travel Distance Allowed (Max):	200 feet in F1 (IBC Table 1016.2)
Occupancy Separation (Rating):	Not Required
Hazardous Materials:	None at quantities that exceed limit in Table 414.2.5 or Table 307.1
Fire Resistance Rating:	None required
Structural Frame:	0 hours
Stairway Enclosures	N/A
Fire Suppression System	None Required
This Building is for Public Access	No

EC BUILDING PRESCRIPTIVE PATH FOR CONDITIONED SPACE WASHINGTON STATE ENERGY CODE

Prescriptive Path for Conditioned Space	Washington State Energy Code	
Climate Zone		5B
	Required Value	**Provided Value**
Walls - Exposed Metal Building Batt insulation with white vinyl vapor barrier	U-0.052	U-0.052
Perimeter Insulation	R-10	R-10
Roof - Exposed Metal Building Batt insulation with white vinyl vapor barrier	U-0.031	U-0.031
Coiling Doors – Insulated metal coiling doors	R-4.7	R-8
Swing Doors – Insulated Hollow Metal doors	U - 0.37	U = 0.25
Windows	SHGC = 0.53 N and 0.4 E, W, S	N/A
Skylights	U – 0.50	N/A

N/A - Not applicable

5416 REGISTERED ARCHITECT
Edward A Pieterick
EDWARD A PIETERICK
STATE OF WASHINGTON
04/03/2020

NO.	DATE	DSGN	DR	CHK	APVD
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION	KI	BY	APVD
		REVISION	JD		Ed P.
		Ed P.	Matt C.	Gary B.	

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST
ARCHITECTURAL
CODE REVIEW DATA SHEET

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	000-G-005
SHEET	6 of 44

SYMBOL	DESCRIPTION

ONE-LINE DIAGRAM

	DRAWOUT AIR CIRCUIT BREAKER, LOW VOLTAGE
400	CIRCUIT BREAKER, THERMAL MAGNETIC TRIP SHOWN, 3 POLE, UNO
AS/AF or AT/AF	CIRCUIT BREAKER, STATIC TRIP UNIT, SENSOR AMP TRIP AND FRAME RATINGS SHOWN, 3 POLE, UNO
100/M	CIRCUIT BREAKER, MAGNETIC TRIP ONLY, TRIP RATING SHOWN, 3 POLE, UNO
400 400	CIRCUIT BREAKER WITH CURRENT LIMITING FUSES, TRIP AND FUSE RATING INDICATED, 3 POLE, UNO
400 225	FUSED SWITCH, SWITCH AND FUSE CURRENT RATING INDICATED, 3 POLE, UNO
100	SWITCH, CURRENT RATING INDICATED, 3 POLE, UNO
60 (3)	FUSE, CURRENT RATING AND QUANTITY INDICATED
1	MAGNETIC STARTER WITH OVERLOAD, NEMA SIZE INDICATED, FVNR UNO
XX	ELECTRONIC STARTER/SPEED CONTROL RVSS = REDUCED VOLTAGE SOFT STARTER AFD = AC ADJUSTABLE FREQUENCY DRIVE DC = DC ADJUSTABLE SPEED DRIVE RVAT = REDUCED VOLTAGE AUTO TRANSFORMER TYPE RVRT = REDUCED VOLTAGE REACTOR TYPE
	CABLE OR BUS CONNECTION POINT
K	KEY INTERLOCK
	SURGE ARRESTER (GAP TYPE)
10	CAPACITOR - KVAR INDICATED, 3 PHASE
3	AC MOTOR, SQUIRREL CAGE INDUCTION - HORSEPOWER INDICATED
G 500/625	GENERATOR, KW/KVA RATING SHOWN
VS V 0-600V	ANALOG METER WITH SWITCH - SCALE RANGE SHOWN V = VOLTAGE KW = KILOWATTS A = AMPERAGE KVAR = KILOVARS PF = POWER FACTOR
DPM	DIGITAL POWER METER (MULTIFUNCTION)
	UTILITY REVENUE METER
	GROUND
15 KVA 480-120/240V 1 PH	TRANSFORMER, SIZE, VOLTAGE RATINGS, AND PHASE INDICATED
	SHIELDED ISOLATION TRANSFORMER
480-120V (3)	POTENTIAL TRANSFORMER, VOLTAGE RATING AND QUANTITY INDICATED
100:5 (3)	CURRENT TRANSFORMER, RATIO(100:5) AND QUANTITY INDICATED (3)
	CONNECTION POINT TO EQUIPMENT SPECIFIED IN OTHER DIVISIONS. RACEWAY, CONDUCTOR AND CONNECTION IN THIS DIVISION
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR

CONTROL DIAGRAM

	PUSH-BUTTON SWITCH, MOMENTARY CONTACT, NORMALLY OPEN
	PUSH-BUTTON SWITCH, MOMENTARY CONTACT, NORMALLY CLOSED
	PUSH-BUTTON SWITCH, MAINTAINED CONTACT WITH MECHANICAL INTERLOCK
	3 POSITION SELECTOR SWITCH MAINTAINED CONTACT

SYMBOL	DESCRIPTION

CONTROL DIAGRAM

OFF HAND REMOTE	SELECTOR SWITCH - MAINTAINED CONTACT - CHART IDENTIFIES OPERATION WHEN NEEDED FOR CLARITY:

POSITION			
CKT	HAND	OFF	REMOTE
1	X	O	O
2	O	O	X

	TOGGLE SWITCH, ON-OFF TYPE
ON OFF	SELECTOR SWITCH, ON-OFF TYPE
	MUSHROOM HEAD PUSHBUTTON SWITCH
A	INDICATING LIGHT, PUSH-TO-TEST, LETTER INDICATES COLOR
A	INDICATING LIGHT - LETTER INDICATES COLOR A - AMBER G - GREEN S - STROBE B - BLUE R - RED C - CLEAR W - WHITE
ETM	ELAPSED TIME METER
M	MOTOR STARTER CONTACTOR COIL
CRX	CONTROL RELAY, X INDICATES NUMERICAL ORDER IN CIRCUIT
TDR X	TIME DELAY RELAY, X INDICATES NUMERICAL ORDER IN CIRCUIT
SV X	SOLENOID VALVE, X INDICATES NUMERICAL ORDER IN CIRCUIT
	CONTACT - NORMALLY OPEN
	CONTACT - NORMALLY CLOSED
	REMOTE DEVICE
	TERMINAL BLOCK, REMOTE
	TERMINAL BLOCK, INTERNAL
	FUSED TERMINAL BLOCK
	CONCEALED CONDUIT AND CONDUCTORS*
CPT 120V	TRANSFORMER, CONTROL POWER
	PRESSURE SWITCH, NORMALLY CLOSED, OPEN ON RISING PRESSURE
	PRESSURE SWITCH, NORMALLY OPEN, CLOSES ON RISING PRESSURE
	FLOW SWITCH, CLOSES ON INCREASED FLOW
	FLOW SWITCH, OPENS ON INCREASED FLOW
	COAXIAL CABLE
	MULTICONDUCTOR SHIELDED CABLE

SYMBOL	DESCRIPTION

POWER SYSTEM PLAN

	CONNECTION POINT TO EQUIPMENT SPECIFIED. RACEWAY, CONDUCTOR,TERMINATION AND CONNECTION IN THIS DIVISION.
MCC-A	MAJOR ELECTRICAL COMPONENT OR DEVICE - NAME OR IDENTIFYING SYMBOL AS SHOWN.
	PANELBOARD - SURFACE MOUNTED
	PANELBOARD - FLUSH MOUNTED
	TERMINAL JUNCTION BOX
M	MOTOR, SQUIRREL CAGE INDUCTION
G	GENERATOR, VOLTAGE AND SIZE AS INDICATED.
LPXXA	HOME RUN - DESTINATION SHOWN
or G	EXPOSED CONDUIT AND CONDUCTORS*
or G	CONCEALED CONDUIT AND CONDUCTORS*

NOTE:
ALL UNMARKED CONDUIT RUNS CONSIST OF TWO NO. 12, ONE NO. 12 GROUND CONDUCTORS IN 3/4" CONDUIT. RUNS MARKED WITH CROSSHATCHES INDICATE NUMBER OF NO. 12 CONDUCTORS. CROSSHATCH WITH SUBSCRIPT "G" INDICATES GREEN GROUND WIRE.

G	CROSSHATCHES WITH BAR INDICATE NO.10 CONDUCTOR. SIZE CONDUIT ACCORDING TO SPECIFICATIONS AND APPLICABLE CODE.
[A1]	CONDUIT AND CONDUCTOR CALLOUT, SEE LEGEND.
	CONDUIT DOWN
	CONDUIT UP
	CONDUIT, STUBBED AND CAPPED
	CONDUIT TERMINATION AT CABLE TRAY
EX	EXISTING CONDUIT/ DUCT BANK
BD	BUS DUCT - SEE SPECIFICATIONS
CE	CONCRETE ENCASED CONDUIT
DB	DIRECT BURIED CONDUIT
FO	FIBER OPTIC CONDUIT
XXXX	CONCRETE ENCASED DUCT BANK WHERE XXXX IS THE DUCT BANK NAME. SEE CIRCUIT AND RACEWAY CODING DEFINITION
	CONCEALED CONDUIT ROUTING AREA
	CONDUIT ROUTING AREA
	CABLE TRAY
T	TRANSFORMER
J or JB	GENERAL CONTROL OR WIRING DEVICE. LETTER SYMBOLS OR ABBREVIATIONS INDICATE TYPE OF DEVICE
CS	CONTROL STATION, SEE CONTROL DIAGRAMS FOR CONTROL DEVICE(S) REQUIRED.
30	NONFUSED DISCONNECT SWITCH, CURRENT RATING INDICATED, 3 POLE
60/40	FUSED DISCONNECT SWITCH, CURRENT RATING INDICATED (60/40, 60=SWITCH RATING / 40=FUSE RATING) 3 POLE
2	COMBINATION CIRCUIT BREAKER AND MAGNETIC STARTER, NEMA SIZE INDICATED
XX 2	CONVENIENCE RECEPTACLE - DUPLEX (UNLESS NOTED OTHERWISE) WP - WEATHERPROOF C - CLOCK HANGER TL - TWIST LOCK CRE - CORROSION RESISTANT GFCI - GROUND FAULT CIRCUIT INTERRUPTER SUBSCRIPT NUMBER AT RECEPTACLE INDICATES CIRCUIT

LIGHTING SYSTEM PLAN

or	LUMINAIRE, SEE SCHEDULE
	LUMINAIRE, SEE SCHEDULE
or	LUMINAIRE WITH INTERNAL BATTERY BACKUP, SEE SCHEDULE
or	WALL MOUNTED LUMINAIRE, SEE SCHEDULE
XX or	EXIT LIGHTS - FILLED SECTION INDICATES LIGHTED FACE, ARROW INDICATES EGRESS DIRECTIONAL INDICATIORS, XX = FIXTURE NUMBER, SEE SCHEDULE
$3	WALL SWITCH: 2 - DOUBLE POLE P - PILOT LIGHT 3 - THREE WAY K - KEY OPERATED 4 - FOUR WAY D - DIMMER WP - WEATHERPROOF CRE - CORROSION RESISTANT EX - EXPLOSIONPROOF L - MOMENTARY 3-WAY M - MOTOR RATED MS - MANUAL STARTER WITH OVERLOADS
PC	PHOTO CELL

GROUND SYSTEM PLAN

	GROUND ROD
	GROUND ROD IN TEST WELL
G	GROUNDING CONDUCTOR, SIZE AS INDICATED
TA	CABLE TO TEE
XA	CABLE TO CROSS
	PLATE ADAPTER
XJ	CABLE TO REINFORCING STEEL
GT	GROUND ROD TO CABLE
	FLEXIBLE GROUND STRAP
GP	CABLE TO PIPE (BOLTED CONNECTION)
GF	CABLE TO FLAT
WA	CABLE TO STEEL SURFACE
GR	CABLE TO TOP OF GROUND ROD
SS	PARALLEL SPLICE
	PIGTAIL FOR CONNECTION TO EQUIPMENT CABINET OR FRAME
G	EQUIPMENT GROUND BUS
N	EQUIPMENT NEUTRAL BUS
LA	CABLE TO LUG

ABBREVIATIONS

A	AMPERE, AUTOMATIC
ATS	AUTOMATIC TRANSFER SWITCH
BKR	BREAKER
C	CONDUIT, CONTACTOR, CONDUCTOR, CLOSE
CR	CONTROL RELAY
DC	DIRECT CURRENT
F, FU	FUSE
G	GROUND
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
HH	HANDHOLE
HP	HORSEPOWER
HS	HAND SWITCH
J, JB	JUNCTION BOX
KA	KILOAMPERES
KV	KILOVOLT
KVA	KILOVOLT AMPERES
KW	KILOWATTS
M	MAGNETIC CONTACTOR COIL, MOTOR, MANUAL
MCC	MOTOR CONTROL CENTER
MH	MANHOLE, METAL HALIDE, MOUNTING HEIGHT
OL	OVERLOAD RELAY
PB	PULL BOX
RGS	RIGID GALVANIZED STEEL CONDUIT
TYP	TYP
V	VOLTAGE, VOLTS
W	WATTS
WP	WEATHERPROOF
XFMR	TRANSFORMER

BRIAN MACLEAN PILMER
STATE OF WASHINGTON
20111121
REGISTERED
PROFESSIONAL ENGINEER

04/03/2020

DSGN	NO.	DATE	REVISION	CHK	DR
Mariah A.	0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION	Tiffiny K.	Brian P.
				KI	BY
				JD	APVD

Brian P.
APVD

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

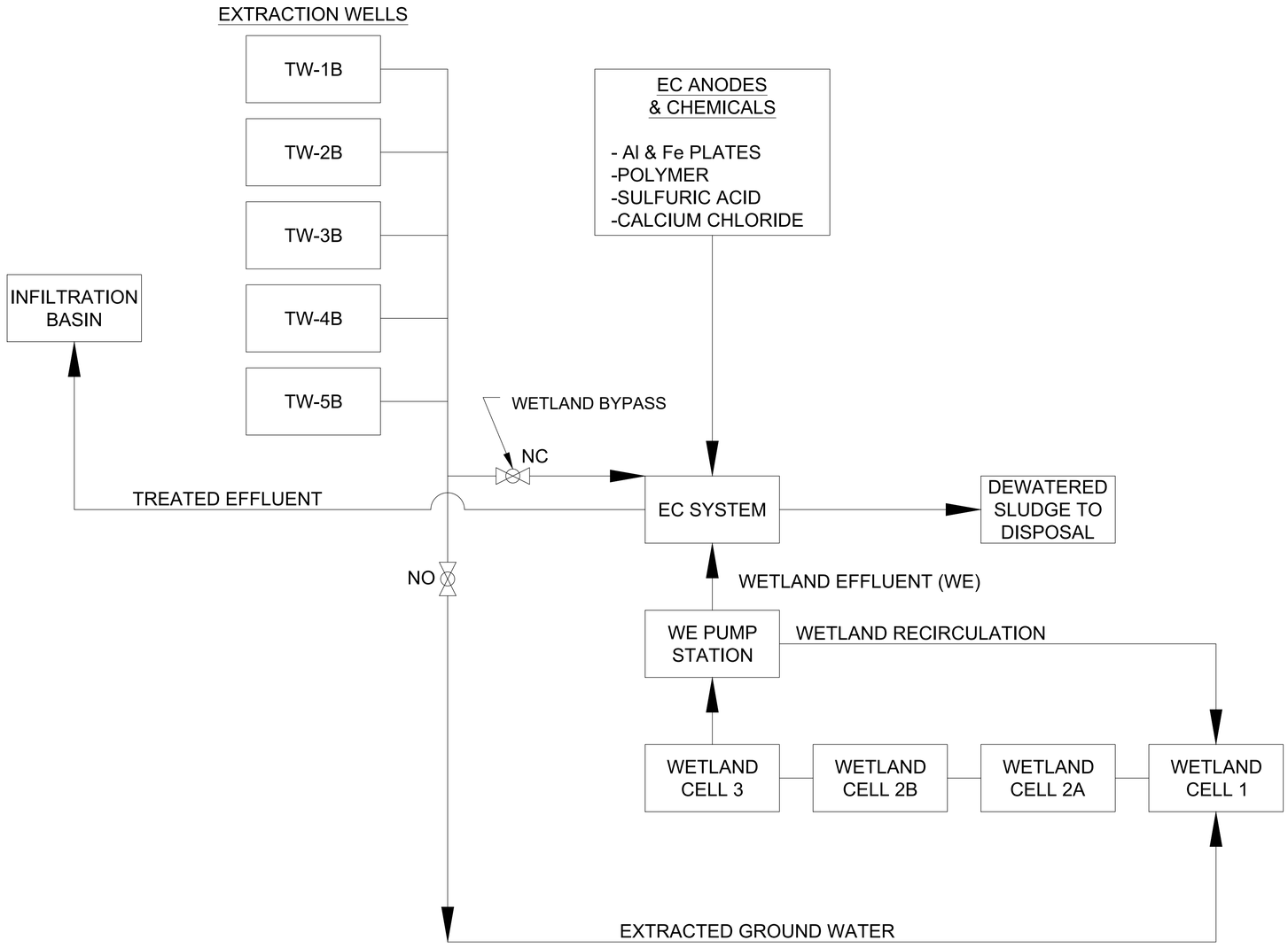
JACOBS

KAISER MEAD CUSTODIAL TRUST

ELECTRICAL LEGEND SHEET

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	000-G-006
SHEET	7 of 44



WILLIAM S. FAIRBOURNE
STATE OF WASHINGTON
25570
REGISTERED
PROFESSIONAL ENGINEER
4-3-20

NO.	DATE	DSGN	DR	CHK	APVD
0	04/03/2020	Bill F.	Dominic S.	Jim S.	Bill F.

FINAL DESIGN - ISSUED FOR CONSTRUCTION

REVISION	BY	APVD
	KI	JD

JACOBS

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

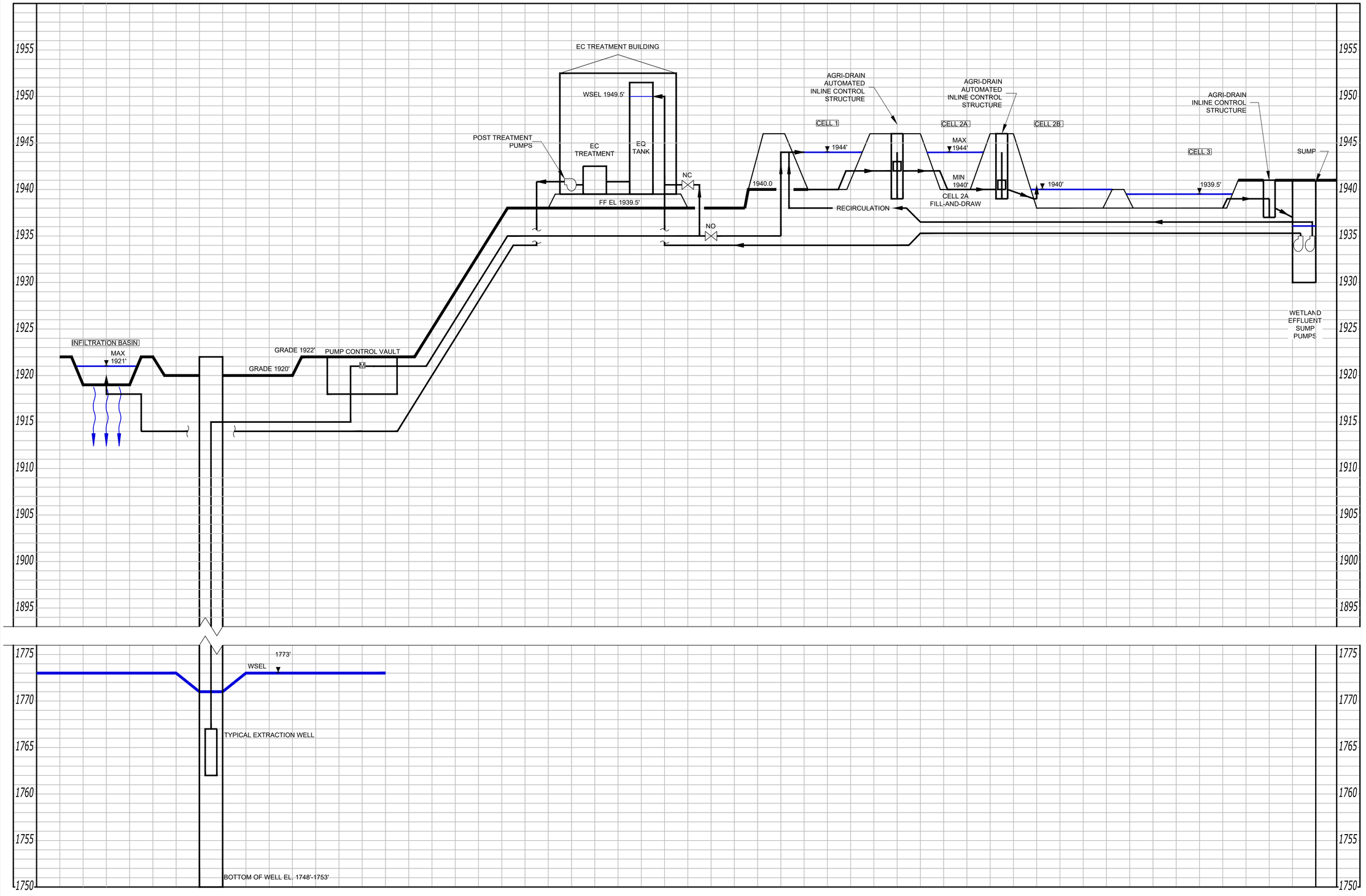
KAISER MEAD CUSTODIAL TRUST

SYSTEM PROCESS FLOW DIAGRAM

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	000-G-007
SHEET	8 of 44



HYDRAULIC PROFILE

NTS

WILLIAM S. FARRIS — STATE OF WASHINGTON — 23570 — REGISTERED PROFESSIONAL ENGINEER
5-5-20

NO.	DATE	DSGN	DR	CHK	APVD
0	04/03/2020	Bill F.	Dominic S.	Mark M.	APVD

FINAL DESIGN - ISSUED FOR CONSTRUCTION

REVISION	BY	APVD
	KI	JD

Bill F.

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST

HYDRAULIC PROFILE

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	000-G-008
SHEET	9 of 44

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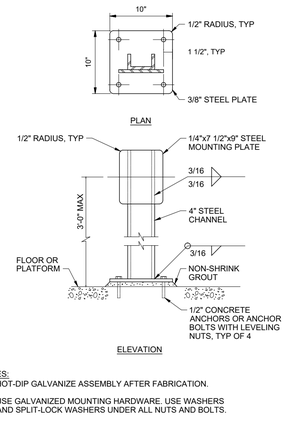
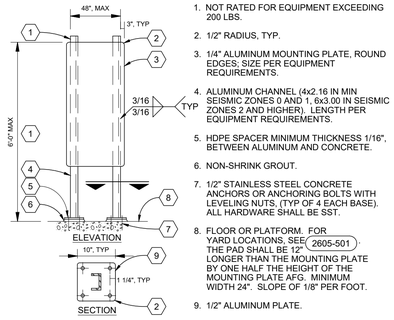


NOTES:
1. HOT-DIP GALVANIZE ASSEMBLY AFTER FABRICATION.
2. USE GALVANIZED MOUNTING HARDWARE. USE WASHERS AND SPLIT-LOCK WASHERS UNDER ALL NUTS AND BOLTS.

CONTROL STATION PEDESTAL

NTS

2605-005a

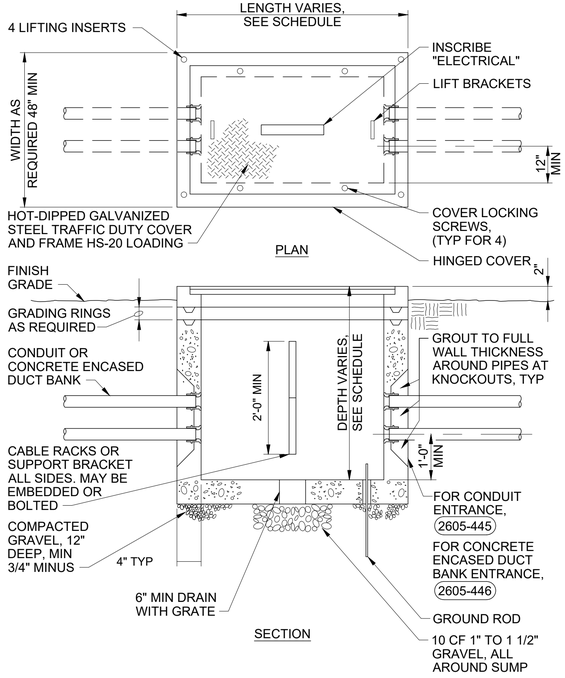


1. NOT RATED FOR EQUIPMENT EXCEEDING 200 LBS.
2. 1/2" RADIUS, TYP.
3. 1/4" ALUMINUM MOUNTING PLATE, ROUND EDGES; SIZE PER EQUIPMENT REQUIREMENTS.
4. ALUMINUM CHANNEL (4x2.16 IN MIN SEISMIC ZONES 0 AND 1, 6x3.00 IN SEISMIC ZONES 2 AND HIGHER). LENGTH PER EQUIPMENT REQUIREMENTS.
5. HDPE SPACER MINIMUM THICKNESS 1/16", BETWEEN ALUMINUM AND CONCRETE.
6. NON-SHRINK GROUT.
7. 1/2" STAINLESS STEEL CONCRETE ANCHORS OR ANCHORING BOLTS WITH LEVELING NUTS, (TYP OF 4 EACH BASE). ALL HARDWARE SHALL BE SST.
8. FLOOR OR PLATFORM. FOR YARD LOCATIONS, SEE 2605-501. THE PAD SHALL BE 12" LONGER THAN THE MOUNTING PLATE BY ONE HALF THE HEIGHT OF THE MOUNTING PLATE AFG. MINIMUM WIDTH 24". SLOPE OF 1/8" PER FOOT.
9. 1/2" ALUMINUM PLATE.

ELECTRICAL EQUIPMENT SUPPORT

NTS

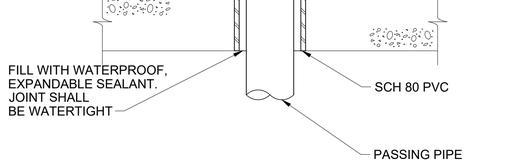
2605-008b



HANDHOLE

FOR WATER HOLDING STRUCTURES

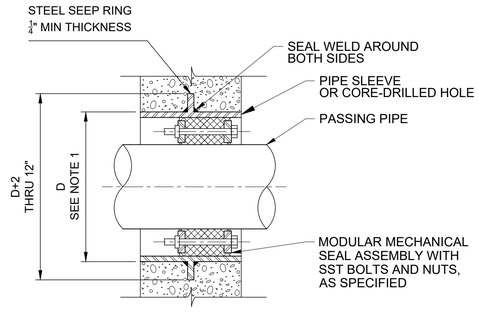
2605-444



FLOOR SLEEVE

NTS

4027-670



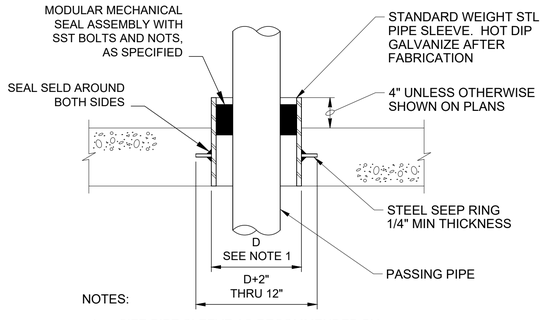
NOTES:

1. SIZE PIPE SLEEVE AS RECOMMENDED BY BODULAR MECHANICAL SEAL SUPPLIER FOR PASSING PIPE DIAMETER AND SEAL DIMENSIONS

WALL PIPE PENETRATION SEAL

FOR WATER HOLDING STRUCTURES

4027-607



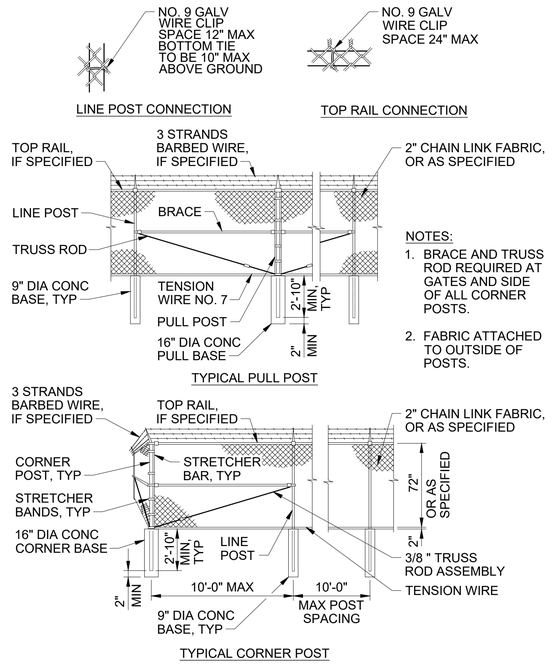
NOTES:

1. SIZE PIPE SLEEVE AS RECOMMENDED BY BODULAR MECHANICAL SEAL SUPPLIER FOR PASSING PIPE DIAMETER AND SEAL DIMENSIONS

FLOOR SLEEVE

FOR SEEP-PROOF PENETRATIONS

4027-621



CHAIN LINK FENCE

NTS

3231-410

WILLIAM S. FARMER — STATE OF WASHINGTON — 28512 — REGISTERED PROFESSIONAL ENGINEER — 4-3-20

BRIAN MACLEAN PILMER — STATE OF WASHINGTON — 20111121 — REGISTERED PROFESSIONAL ENGINEER — 04/03/2020

NO.	DATE	DSGN
0	04/03/2020	M. Alexander

FINAL DESIGN - ISSUED FOR CONSTRUCTION

REVISION	CHK	DR
KI	T. Kendall	JD
BY	B. Pilmer	APVD
APVD	B. Pilmer	

JACOBS

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

KAISER MEAD CUSTODIAL TRUST
STANDARD DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	
PROJ	KMCT2019
DWG	000-G-009
SHEET	10 of 44

DESIGN CRITERIA

1. APPLICABLE CODE: 2015 INTERNATIONAL BUILDING CODE (IBC), WITH THE STATE OF WASHINGTON AND SPOKANE COUNTY AMENDMENTS.
   A. HYDRAULIC STRUCTURES: ACI 350-06

2. REFER TO THE DRAWINGS FOR ADDITIONAL AND SPECIFIC STRUCTURE LOADINGS AND REQUIREMENTS.

3. ROOF LOADS:

DEAD LOAD	= AS CALCULATED PLUS 10 PSF COLLATERAL LOAD
LIVE LOAD	= 20 PSF (NON-REDUCIBLE)
GROUND SNOW LOAD, Pg	= 39 PSF
TERRAIN CATEGORY	= C
Ce	= 1.0
Ct	= 1.0
I	= 1.1
FLAT ROOF SNOW LOAD, Pf	= 30 PSF

4. FLOOR LIVE LOADS:

PROCESS AREAS	200 PSF
ELECTRICAL EQUIPMENT AREAS	300 PSF
MISC UNCLASSIFIED AREAS	150 PSF
WALKWAYS, PLATFORMS AND STAIRS	100 PSF
ACCESS CATWALKS	60 PSF

5. WIND LOAD:
   ASCE 7 METHOD

BASIC WIND SPEED (3-SECOND GUST)	= 115 MPH
EXPOSURE	= C
OCCUPANCY CATEGORY	= II

6. SEISMIC LOAD:

MAPPED SPECTRAL RESPONSE ACCELERATIONS	
S_S	= 0.337 g
S_1	= 0.116 g
DESIGN SPECTRAL RESPONSE ACCELERATIONS	
S_{DS}	= 0.344 g
S_{D1}	= 0.18 g
SITE CLASS	= D
OCCUPANCY CATEGORY	= II
SEISMIC DESIGN CATEGORY	= C
I_e	= 1.00

7. SOIL DESIGN PARAMETERS:
   A. NET ALLOWABLE SOIL BEARING PRESSURES:
      2500 PSF (1/3 INCREASE ALLOWED IN COMBINATION WITH WIND OR SEISMIC LOADS)

B. NATIVE SOIL UNIT WEIGHT:	120 PCF
C. DESIGN GROUND WATER ELEVATION:	N/A
D. FROST DEPTH:	24 IN
E. FRICTION ANGLE:	34 DEGREE

GENERAL INFORMATION

1. FOR ABBREVIATIONS NOT LISTED, SEE ASME Y14.38 “ABBREVIATIONS AND ACRONYMS: PUBLICATION AS DISTRIBUTED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME).
2. DESIGN DETAILS ARE INTENDED TO BE TYPICAL AND SHALL APPLY TO SIMILAR SITUATIONS OCCURRING THROUGHOUT THE PROJECT, WHETHER OR NOT THEY ARE INDIVIDUALLY CALLED OUT.
3. VERIFY FINAL OPENING DIMENSIONS IN WALLS, SLABS, AND DECKS WITH OTHER DISCIPLINE DRAWINGS PRIOR TO CONSTRUCTION OF THESE ELEMENTS.
4. FOR NUMBER, TYPE, SIZE, ARRANGEMENT, AND/OR LOCATION OF EQUIPMENT PADS SEE OTHER DISCIPLINE DRAWINGS. COORDINATE WITH EQUIPMENT SUPPLIER PRIOR TO PLACING SLABS, WALLS AND FOUNDATIONS. COORDINATE PIPING OPENINGS WITH OTHER DISCIPLINE DRAWINGS.
5. STRUCTURAL MEMBERS SHALL NOT BE CUT OR MODIFIED FOR PIPES, DUCTS, ETC, UNLESS SPECIFICALLY DETAILED OR APPROVED IN WRITING BY THE ENGINEER OF RECORD.
6. VISITS TO THE JOB SITE BY THE ENGINEER OF RECORD TO OBSERVE THE CONSTRUCTION DO NOT IN ANY WAY MEAN THAT ENGINEER IS GUARANTOR OF CONSTRUCTION WORK, NOR RESPONSIBLE FOR THE COMPREHENSIVE OR SPECIAL INSPECTIONS, COORDINATION, SUPERVISION, OR SAFETY AT THE JOB SITE.
7. INCLUDE PROPER ALLOWANCE FOR 6-INCH STRUCTURAL FILL BENEATH SLABS AND FOOTINGS PER EARTHWORK SPECIFICATION.

SPECIAL INSPECTION, OBSERVATIONS AND TESTING

1. FOR PROJECT SPECIAL INSPECTION, OBSERVATIONS AND TESTING, SEE THE STATEMENT OF SPECIAL INSPECTIONS PLAN ON DRAWINGS 000-S-002 THROUGH 000-S-003.

FOUNDATIONS

1. EXCAVATIONS SHALL BE SHORED TO PREVENT SUBSIDENCE OR DAMAGE TO ADJACENT EXISTING STRUCTURES, STREETS, UTILITIES, ETC.
2. ALL FOUNDATION BEARING SURFACES SHALL BE OBSERVED BY A GEOTECHNICAL ENGINEER OR HIS DESIGNEE PRIOR TO PLACEMENT OF FORMING OR REINFORCING STEEL THE OBSERVATION SHALL VERIFY THAT THE ACTUAL EXPOSED SUBGRADE IS AS ANTICIPATED BY THE SITE SPECIFIC BORINGS, TEST PITS, TESTING AND DATA REPORTS.

METAL BUILDING

1. REFER TO SPECIFICATION 13 34 19 FOR METAL BUILDING SYSTEM.
2. DESIGN LOADS FOR METAL BUILDING SHALL BE LOADS LISTED IN DESIGN CRITERIA, AND THE LOADS LISTED IN HVAC DRAWING 003-ME-003 AND ELECTRICAL DRAWING 004-E-001.

CONCRETE REINFORCING

1. MINIMUM REINFORCING FOR ALL CONCRETE WALLS AND SLABS SHALL BE AS FOLLOWS:

WALL THICKNESS	REINF EACH WAY	LOCATION
6"	#4@12"	CENTERED
8"	#5@12"	CENTERED
10"	#4@12"	EACH FACE
12"	#5@12"	EACH FACE

   PROVIDE LARGER SIZES AND MORE REINFORCING IN SECTIONS OF CONCRETE WHERE REQUIRED BY THE DETAILS ON THE DRAWINGS OR BY THE SPECIFICATIONS.

2. CLEARANCE FOR REINFORCEMENT BARS, UNLESS SHOWN OTHERWISE, SHALL BE:

WHEN PLACED ON GROUND:	3”
ALL OTHER CONCRETE SURFACES	2”

3. DO NOT WELD REINFORCING UNLESS SPECIFICALLY DETAILED OR WITHOUT PRIOR APPROVAL FROM ENGINEER OF RECORD.
4. REINFORCEMENT BENDS AND LAPS, UNLESS OTHERWISE NOTED, SHALL SATISFY THE FOLLOWING MINIMUM REQUIREMENTS:

CONCRETE DESIGN STRENGTH = 4,000 PSI OR 4,500 PSI ✶✶		GRADE 60 REINFORCING STEEL								
BAR SIZE		#3	#4	#5	#6	#7	#8	#9	#10	#11
LAP SPLICE LENGTH										
SPACING<6"	TOP BAR ✶	1'-4"	2'-0"	3'-0"	4'-0"	5'-10"	6'-8"	7'-7"	8'-6"	9'-5"
	OTHER BAR	1'-4"	1'-7"	2'-4"	3'-1"	4'-6"	5'-2"	5'-10"	6'-7"	7'-3"
SPACING≥6"	TOP BAR ✶	1'-4"	1'-6"	2'-0"	2'-5"	3'-6"	4'-0"	5'-0"	6'-2"	7'-5"
	OTHER BAR	1'-4"	1'-4"	1'-7"	1'-10"	2'-9"	3'-1"	3'-10"	4'-9"	5'-8"
EMBEDMENT LENGTH										
SPACING<6"	TOP BAR ✶	1'-0"	1'-7"	2'-4"	3'-1"	4'-6"	5'-2"	5'-10"	6'-7"	7'-3"
	OTHER BAR	1'-0"	1'-3"	1'-9"	2'-5"	3'-6"	4'-0"	4'-6"	5'-1"	5'-7"
SPACING≥6"	TOP BAR ✶	1'-0"	1'-3"	1'-7"	1'-10"	2'-9"	3'-1"	3'-10"	4'-9"	5'-8"
	OTHER BAR	1'-0"	1'-0"	1'-3"	1'-5"	2'-1"	2'-5"	3'-0"	3'-8"	4'-5"

   ✶ TOP BARS SHALL BE DEFINED AS ANY HORIZONTAL BARS PLACED SUCH THAT MORE THAN 12 INCHES OF CONCRETE IS CAST IN THE MEMBER BELOW THE BAR IN ANY SINGLE POUR. HORIZONTAL WALL BARS ARE CONSIDERED TOP BARS.

   ✶✶ WHERE 2500 OR 3000 PSI CONCRETE IS USED, INCREASE ABOVE LENGTHS BY 16 PERCENT

CONCRETE

1. 28-DAY CAST-IN-PLACE CONCRETE STRENGTHS:
   TYPICAL (UNLESS NOTED OTHERWISE): 4000 PSI
2. REINFORCING STEEL:

TYPICAL:	ASTM A615, GRADE 60
WELDED:	ASTM A706, GRADE 60

3. FABRICATION AND PLACEMENT OF REINFORCING STEEL SHALL BE IN ACCORDANCE WITH CRSI MSP-1 “MANUAL OF STANDARD PRACTICE” AND ACI 301 “SPECIFICATIONS FOR STRUCTURAL CONCRETE”.
4. ROUGHEN AND CLEAN CONSTRUCTION JOINTS IN WALLS AND SLABS AS SPECIFIED PRIOR TO PLACING ADJACENT CONCRETE.
5. COORDINATE PLACEMENT OF OPENINGS, CURBS, DOWELS, SLEEVES, CONDUITS, BOLTS AND INSERTS PRIOR TO PLACEMENT OF CONCRETE.
6. NO ALUMINUM CONDUIT OR PRODUCTS CONTAINING ALUMINUM OR ANY OTHER MATERIAL INJURIOUS TO THE CONCRETE SHALL BE EMBEDDED IN THE CONCRETE.

WELDING

1. WELDS SHALL CONFORM TO AMERICAN WELDING SOCIETY (AWS), LATEST EDITION:
   D1.1, STRUCTURAL WELDING CODE – STEEL
   D1.2, STRUCTURAL WELDING CODE – ALUMINUM
   D1.3, STRUCTURAL WELDING CODE – SHEET STEEL
   D1.4, STRUCTURAL WELDING CODE – REINFORCING STEEL
   D1.6, STRUCTURAL WELDING CODE – STAINLESS STEEL
2. REPAIR WELDS FOUND DEFECTIVE IN ACCORDANCE WITH AWS D1.1 SECTION 5.26.
3. USE INTERMITTENT WELDS AT FIELD WELDS OF EMBED PLATES AND ANGLES TO AVOID SPALLING OR CRACKING OF THE EXISTING CONCRETE.
4. BUTT JOINT WELDS SHALL BE COMPLETE JOINT PENETRATION (CJP) UNLESS INDICATED OTHERWISE.
5. WHEREVER FIELD WELDS ARE INDICATED THE SUBCONTRACTOR MAY SUBSTITUTE SHOP WELDS AT THEIR DISCRETION.

STRUCTURAL STEEL AND METAL FABRICATIONS

1. STRUCTURAL STEEL SHALL CONFORM TO THE FOLLOWING:

W-SHAPES	A992
MISCELLANEOUS SHAPES INCLUDING ANGLES, CHANNELS, PLATES, ETC.	A36 A500, GRADE B
SQUARE OR RECTANGULAR STEEL TUBING	A53, GRADE B
STEEL PIPE	

2. STRUCTURAL STEEL SHALL BE FABRICATED AND ERECTED IN CONFORMANCE WITH THE AISC STEEL CONSTRUCTION MANUAL, CURRENT EDITION, AND CURRENT OSHA STANDARDS.
3. BOLTS SHALL BE HIGH STRENGTH BOLTS CONFORMING TO THE FOLLOWING EXCEPT WHERE SPECIFICALLY INDICATED OTHERWISE:

UNLESS SHOWN OTHERWISE	A325-N
SLIP CRITICAL	A325-SC
ANCHOR BOLTS (AB)	
STAINLESS STEEL	F593, AISI TYPE 316, CONDITION CW
STEEL	F1554, GR 36
GALVANIZED STEEL	F1554, GR 36 / A153
MACHINE BOLTS (MB)	A307

4. ITEMS TO BE EMBEDDED IN CONCRETE SHALL BE CLEAN AND FREE OF OIL, DIRT AND PAINT.

DEFERRED SUBMITTALS

1. DEFERRED SUBMITTALS ARE THOSE PORTIONS OF THE DESIGN WHICH ARE NOT SUBMITTED AT THE TIME OF PERMIT APPLICATION AND WHICH ARE TO BE SUBMITTED TO THE PERMITTING AGENCY FOR ACCEPTANCE PRIOR TO INSTALLATION OF THAT PORTION OF THE WORK.
2. THE FOLLOWING IS A LIST OF DEFERRED SUBMITTALS PER IBC SECTION 106.3.4.2 THAT ARE EXPECTED TO CONTAIN STRUCTURAL CALCULATIONS OR SAFETY RELATED SYSTEM INFORMATION FOR REVIEW TO MEET BUILDING PERMITTING REQUIREMENTS FOR DESIGNED SYSTEMS. PRIOR TO INSTALLATION OF THE INDICATED STRUCTURAL ELEMENT, EQUIPMENT, DISTRIBUTION SYSTEM, OR COMPONENT OR ITS ANCHORAGE, THE EQUIPMENT MANUFACTURERS, TANK MANUFACTURERS, PLATFORM MANUFACTURER, MECHANICAL AND ELECTRICAL SUB CONTRACTOR SHALL SUBMIT THE REQUIRED CALCULATIONS AND SUPPORTING DATA AND DRAWINGS FOR REVIEW AND ACCEPTANCE BY THE ENGINEER. ADDITIONALLY, ACCEPTANCE INDICATED ON THE ENGINEER’S COMMENT FORM, ALONG WITH THE COMPLETED, FINAL SUBMITTAL SHALL THEN BE FILED BY THE CONTRACTOR AND ACKNOWLEDGED AS ACCEPTED BY THE PERMITTING AGENCY PRIOR TO INSTALLATION OF THESE ITEMS.

SPECIFICATION SECTION	ITEM
01 88 15	ANCHORAGE AND BRACING
OTHER	ANY EQUIPMENT OR COMPONENT IN WHICH A TECHNICAL SPECIFICATION REQUIRES SUBMITTAL OF EQUIPMENT OR ANCHORAGE SYSTEM CALCULATIONS
	ALL TANKS AND TANK ANCHORAGES
	ALL PLATFORMS AND PLATFORM COLUMN BASE ANCHORAGES
13 34 19	METAL BUILDING SYSTEM

POST-INSTALLED CONCRETE ANCHORS

1. GENERAL:
   A. AISI TYPE 316 STAINLESS IN CONTAINMENT SLAB AREA, OR HOT-DIP GALVANIZED IN DRY AREA.
   B. POST-INSTALLED ANCHOR SYSTEMS USED IN CONCRETE SHALL BE APPROVED BY ICC EVALUATION SERVICES REPORT OR EQUIVALENT FOR USE IN CRACKED CONCRETE AND FOR SHORT-TERM AND LONG-TERM LOADS INCLUDING WIND AND EARTHQUAKE.
   C. MECHANICAL ANCHORS: COMPLY WITH THE REQUIREMENTS OF ICC_ES AC193 OR ACI 355.2.
   D. ADHESIVE ANCHORS: COMPLY WITH THE REQUIREMENTS OF ICC_ES AC308 OR ACI 355.4.
2. TORQUE-CONTROLLED EXPANSION ANCHORS (WEDGE ANCHORS):
   A. MANUFACTURERS AND PRODUCTS:
      a. HILTI, INC., TULSA, OK; KWIK-BOLT -TZ (KB-TZ) ANCHORS (ESR_1917).
      b. POWERS FASTENERS, BREWSTER, NY; POWER-STUD +SD1, +SD2, +SD4, OR +SD6 ANCHORS (ESR-2502 AND ESR-2818).
      c. SIMPSON STRONG-TIE CO., INC., PLEASANTON, CA; STRONG_BOLT 2 ANCHORS (ESR-1771 AND ESR-3037).
      d. OR APPROVED EQUAL.
3. UNDERCUT ANCHORS:
   A. MANUFACTURERS AND PRODUCTS:
      a. USP STRUCTURAL CONNECTORS, BURNSVILLE, MN; DUC UNDERCUT ANCHOR (ESR-1970).
      b. HILTI, INC., TULSA, OK; HDA UNDERCUT ANCHOR (ESR-1546).
      c. SIMPSON STRONG-TIE CO., INC., PLEASANTON, CA; TORQ-CUT SELF_UNDERCUTTING ANCHOR (ESR-2705).
      d. POWERS FASTENERS, BREWSTER, NY; ATOMIC+ UNDERCUT ANCHOR (ESR-3067).
      e. OR APPROVED EQUAL.
4. ADHESIVE ANCHORS:
   A. THREADED ROD:
      a. DIAMETER AS SHOWN ON DRAWINGS.
      b. LENGTH AS REQUIRED TO PROVIDE MINIMUM DEPTH OF EMBEDMENT INDICATED AND THREAD PROJECTION REQUIRED.
      c. CLEAN AND FREE OF GREASE, OIL, OR OTHER DELETERIOUS MATERIAL.
   B. MANUFACTURERS AND PRODUCTS:
      a. HILTI, INC., TULSA, OK; HIT DOWELING ANCHOR SYSTEM, HIT RE 500 SD (ESR_2322), OR HIT-HY 200 (ESR_3187).
      b. SIMPSON STRONG-TIE CO., INC., PLEASANTON, CA; SET-XP EPOXY ADHESIVE ANCHORS (ESR-2508), OR AT-XP ADHESIVE ANCHORS (IAPMO UES-263).
      c. POWERS FASTENERS, BREWSTER, NY; PURE 110+ EPOXY ADHESIVE ANCHOR SYSTEM (ESR_3298).

STATE OF WASHINGTON LIAO YANG 25264 REGISTERED PROFESSIONAL ENGINEER 04-03-2020

NO.	DATE	DSGN
0	04/03/2020	DR

FINAL DESIGN - ISSUED FOR CONSTRUCTION

REVISION	CHK	APVD
KI	Matt C.	Gary B.
BY	APVD	Liao Y.
JD	DR	Liao Y.

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST
STRUCTURAL GENERAL NOTES

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	
PROJ	KMCT2019
DWG	000-S-001
SHEET	11 of 44

STATEMENT OF SPECIAL INSPECTIONS

GENERAL NOTES:

1. THE STATEMENT OF SPECIAL INSPECTIONS DRAWINGS PROVIDE PROJECT COMPLIANCE WITH THE PROVISIONS OF THE INTERNATIONAL BUILDING CODE (IBC) CHAPTER 17 FOR SPECIAL INSPECTION, STRUCTURAL OBSERVATION, AND TESTING FOR WIND AND SEISMIC RESISTANCE AS APPLICABLE. EXCEPT WHERE OTHERWISE NOTED, THIS INSPECTION IS OWNER FURNISHED.
2. STANDARD SPECIAL INSPECTION REQUIREMENTS FOR NONSTRUCTURAL COMPONENTS ARE CONTAINED IN TABLE 1 ON THIS DRAWING.
3. STANDARD SPECIAL INSPECTION REQUIREMENTS FOR STRUCTURAL COMPONENTS, REGARDLESS OF WIND OR SEISMIC DESIGN CATEGORIES, ARE CONTAINED IN TABLE 2 ON THIS DRAWING AND DRAWING 000-S-003.STANDARD TESTING REQUIREMENTS FOR STRUCTURAL COMPONENTS ARE CONTAINED IN TABLE 3 ON DRAWING 000-S-003.
4. PROJECT SPECIFIC REQUIREMENTS FOR STRUCTURES ASSIGNED TO SEISMIC DESIGN CATEGORIES B, C, D, E, OR F ARE CONTAINED IN TABLE 4 ON DRAWING 000-S-003. ADDITIONAL TESTING REQUIREMENTS FOR STRUCTURAL RESISTANCE ARE CONTAINED IN TABLE 6 ON DRAWING 000-S-003.
5. PROJECT SPECIFIC REQUIREMENTS FOR STRUCTURES SUBJECT TO NOMINAL DESIGN WIND SPEEDS IN EXCESS OF 110 MPH ARE CONTAINED IN TABLE 5 ON DRAWING 000-S-003.

SPECIAL INSPECTION

1. SPECIAL INSPECTION WILL BE IN ACCORDANCE WITH IBC SECTIONS 1704 AND 1705 TOGETHER WITH LOCAL AND STATE AMENDMENTS. REFER TO THE TABLES CONTAINED ON THESE GENERAL SHEETS FOR PROJECT SPECIFIC INSPECTION TYPES AND FREQUENCIES.
2. SPECIAL INSPECTIONS WILL BE PROVIDED BY A CERTIFIED OR QUALIFIED INSPECTOR AND ASSOCIATED TESTING WILL BE PERFORMED BY AN APPROVED ACCREDITED INDEPENDENT AGENCY. THE OWNER WILL SECURE AND PAY FOR THE SERVICES OF THE AGENCY TO PERFORM ALL SPECIAL INSPECTION AND ASSOCIATED TESTS. INSPECTORS FOR EACH SYSTEM AND MATERIAL WILL BE INTERNATIONAL CODE COUNCIL (ICC) CERTIFIED OR OTHERWISE APPROVED BY THE BUILDING OFFICIAL.
3. THE SPECIAL INSPECTOR WILL OBSERVE THE INDICATED WORK FOR COMPLIANCE WITH THE APPROVED CONTRACT DOCUMENTS AND SUBMIT RECORDS OF INSPECTION. ALL DISCREPANCIES WILL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE CONTRACTOR FOR CORRECTION.
4. SPECIAL INSPECTION AND ASSOCIATED TESTING REPORTS WILL BE SUBMITTED TO THE DESIGN ENGINEER, CONTRACTOR, BUILDING OFFICIAL, AND OWNER WITHIN ONE WEEK OF INSPECTION OR WITHIN ONE WEEK OF TEST COMPLETION. INSPECTIONS FOR WHICH REPORTING WILL BE REQUIRED ARE NOTED IN THE TABLES CONTAINED ON THIS STATEMENT OF SPECIAL INSPECTIONS.
5. AT THE CONCLUSION OF CONSTRUCTION, A FINAL REPORT DOCUMENTING REQUIRED SPECIAL INSPECTIONS AND CORRECTION OF PREVIOUSLY NOTED DISCREPANCIES WILL BE SUBMITTED.

GEOTECHNICAL OBSERVATION

1. ALL FOUNDATION BEARING SURFACES SHALL BE INSPECTED BY GEOTECHNICAL ENGINEER LICENSED IN THE STATE OF WASHINGTON PRIOR TO PLACEMENT OF REINFORCING STEEL. ADDITIONAL SPECIAL INSPECTION REQUIREMENTS ARE LISTED IN TABLE 1 ON THIS DRAWING.
2. GEOTECHNICAL TESTING REQUIREMENTS ARE LISTED IN TABLE 3.

STRUCTURAL OBSERVATION

1. STRUCTURAL OBSERVATION WILL BE IN ACCORDANCE WITH IBC SECTION 1704.5 TOGETHER WITH LOCAL AND STATE AMENDMENTS. REFER TO PROJECT SPECIFIC NOTES ON THIS SHEET.
2. ON-SITE STRUCTURAL OBSERVATION WILL BE PERFORMED FOR EACH IDENTIFIED SEISMIC FORCE- OR WIND FORCE-RESISTING SYSTEM, INCLUDING FOUNDATIONS AND CONNECTIONS. REFER TO THE GENERAL STRUCTURAL NOTES DRAWING FOR THE BASIC SEISMIC AND WIND FORCE-RESISTING SYSTEMS FOR THE STRUCTURES INCLUDED IN THE WORK.
3. STRUCTURAL OBSERVATION WILL BE PERFORMED BY A REGISTERED PROJECT DESIGN PROFESSIONAL FOR GENERAL CONFORMANCE TO THE APPROVED CONSTRUCTION DOCUMENTS. STRUCTURAL OBSERVATION DOES NOT INCLUDE OR WAIVE THE RESPONSIBILITY FOR ANY REQUIRED SPECIAL INSPECTIONS OR INSPECTIONS BY THE BUILDING OFFICIAL.
4. STRUCTURAL OBSERVATION WILL INCLUDE VISUAL OBSERVATION OF THE STRUCTURAL SYSTEM AT SIGNIFICANT CONSTRUCTION STAGES AND AT COMPLETION OF THE STRUCTURAL SYSTEM FOR EACH STRUCTURE CONTAINED IN THE WORK.

SPECIAL INSPECTIONS FOR WIND RESISTANCE

1. SPECIAL INSPECTIONS REQUIREMENTS FOR WIND RESISTANCE IN ACCORDANCE WITH IBC SECTION 1705.10 ARE NOT APPLICABLE TO THIS PROJECT.

SPECIAL INSPECTIONS FOR SEISMIC RESISTANCE

1. SPECIAL INSPECTIONS REQUIREMENTS FOR SEISMIC RESISTANCE WILL BE IN ACCORDANCE WITH IBC SECTION 1705.12 TOGETHER WITH LOCAL AND STATE AMENDMENTS.
2. SPECIAL INSPECTIONS REQUIREMENTS FOR SEISMIC RESISTANCE SHALL APPLY TO THE SYSTEMS AND COMPONENTS LISTED IN TABLE 4 ON DRAWING 000-S-003.
3. MAIN SYSTEMS REQUIRED TO BE COVERED UNDER PROJECT SPECIAL INSPECTION REQUIREMENTS INCLUDE THE FOLLOWING TOGETHER WITH THEIR CONNECTIONS. REFER TO SPECIFICATION 01 45 33, SPECIAL INSPECTION, OBSERVATION AND TESTING.

A. METAL BUILDING SYSTEM.

- AMERICAN BUILDINGS COMPANY, A NUCOR COMPANY, IS EXPECTED TO BE THE STEEL MANUFACTURER FOR STRUCTURAL STEEL OF THE EC BUILDING.

STRUCTURAL OBSERVATION TABLE

	SYSTEM FOR EACH FACILITY AS APPLICABLE	STAGE	ITEMS	COMMENTS
1.	FOUNDATION OF STRUCTURE AND SLAB ON GRADE	PRIOR TO FIRST CONCRETE PLACEMENT OF FIRST SECTION WHEN ITEMS CAN STILL BE REVISED	REINFORCING STEEL, CONCRETE WALL DOWELS, WATERSTOPS, EMBEDS, AND SIMILAR ITEMS	NOTE 1
2.	AT ADDITIONAL TIMES DURING CONSTRUCTION AT WHICH THE ENGINEER OF RECORD OR OWNER DEEM THE NEED FOR ADDITIONAL STRUCTURAL OBSERVATION			NOTE 1
3.	AT SUBSTANTIAL COMPLETION OF PRIMARY STRUCTURAL SYSTEM FOR DETERMINATION OF FINAL CONDITION OF STRUCTURE			NOTE 1

NOTES:
1. STRUCTURAL OBSERVER TO DISCUSS ITEMS AND SITE SPECIFIC CONDITIONS WITH SPECIAL INSPECTOR AND FIELD INSPECTION STAFF DURING OBSERVATION.

TABLE 1
REQUIRED NON-STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM OR MATERIAL	2015 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
GEOTECHNICAL						
1. SOILS:						
A. VERIFY MATERIALS BELOW SHALLOW FOUNDATIONS ARE ADEQUATE TO ACHIEVE THE DESIGN BEARING CAPACITY	1705.6, 1803.5.8, 1803.5.9, 1804.6		X		PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER	
B. VERIFY EXCAVATIONS ARE EXTENDED TO PROPER DEPTH AND HAVE REACHED PROPER MATERIAL	1705.6		X		PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER	
C. PERFORM CLASSIFICATION AND TESTING OF COMPACTED FILL MATERIALS	1705.6		X			SEE TABLE 3 FOR GRADATION TEST REQUIREMENTS
D.VERIFY USE OF PROPER MATERIALS, DENSITIES, AND LIFT THICKNESSES DURING PLACEMENT AND COMPACTION OF COMPACTED FILL	1705.6, 1803.5.8			X		SEE TABLE 3 FOR DENSITY TEST REQUIREMENTS
E. PRIOR TO PLACEMENT OF COMPACTED FILL, INSPECT SUBGRADE AND VERIFY THAT SITE HAS BEEN PREPARED PROPERLY	1705.6		X		PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER	SEE TABLE 3 FOR DENSITY TEST REQUIREMENTS
GENERAL						
1. CONSTRUCTION MATERIALS AND SYSTEMS THAT ARE ALTERNATIVES TO MATERIALS AND SYSTEMS PRESCRIBED BY CODE	1705.1.1 ITEM 1		X			
2. UNUSUAL DESIGN APPLICATION OF CODE MATERIALS	1705.1.1 ITEM 2			X		
3. INSTALLATION OF MATERIALS THAT REQUIRE ADDITIONAL MANUFACTURER'S INSTRUCTIONS BEYOND CODE REQUIREMENTS	1703.4.2, 1705.1.1 ITEM 3	ICC-ES EVALUATION REPORTS		X		
STRUCTURAL						
SEE TABLE 2.						

NOTES:
1. PERIODIC INSPECTION IS DEFINED AS INSPECTION BY THE SPECIAL INSPECTOR OF ALL MATERIALS AND SYSTEMS, IN SOME CASES PERFORMED DURING THEIR PLACEMENT AND IN ALL CASES PERFORMED UPON COMPLETION OF THEIR PLACEMENT. THE COMPLETION INSPECTION SHALL BE PERFORMED SO THAT WORK CAN BE CORRECTED PRIOR TO OTHER RELATED WORK PROCEEDING AND COVERING INSPECTED WORK.

TABLE 2
REQUIRED STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM	2015 IBC CODE REFERENCECE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
CONCRETE						
1. INSPECT REINFORCING STEEL AND VERIFY PLACEMENT	1705.3, 1908.4	ACI 318: Ch. 20, 25.2, 25.3, 26.6.1-26.6.3	X			SEE TABLE 6 FOR REINFORCING STEEL TESTING
2. INSPECTION OF ANCHORS CAST IN CONCRETE	1705.3	ACI 318: 17.8.2	X			
3. INSPECT ANCHORS POST-INSTALLED IN HARDENED CONCRETE MEMBERS		ACI 318: 26.7				
A. ADHESIVE ANCHORS INSTALLED IN HORIZONTALLY OR UPWARDLY INCLINED OREIENTATIONS TO RESIST SUSTAINED TENSION LOADS	1705.3	ACI 318: 17.8.2.4, ICC-ES EVALUATION REPORTS		X		
B. MECHANICAL ANCHORS AND ADHESIVE ANCHORS NOT DEFINED IN 4A.	1705.3	ACI 318: 17.8.2, ICC-ES EVALUATION REPORTS	X			
4. VERIFY USE OF REQUIRED DESIGN MIX	1705.3, 1904.1, 1904.2, 1908.2, 1908.3	ACI 318: Ch. 19, 26.4.3, 26.4.4	X			
5. PRIOR TO CONCRETE PLACEMENT, FABRICATE SPECIMENS FOR STRENGTH TESTS, PERFORM SLUMP AND AIR CONTENT TESTS, AND DETERMINE THE TEMPERATURE OF THE CONCRETE	1705.3, 1908.10	ASTM C 172, ASTM C 31, ACI 318: 26.12		X		SEE TABLE 3 FOR CONCRETE TEST REQUIREMENTS
6. INSPECT CONCRETE PLACEMENT FOR PROPER APPLICATION TECHNIQUES	1705.3, 1908.6, 1908.7, 1908.8	ACI 318: 26.5.1.1, 26.5.2.1		X		
7. VERIFY MAINTENANCE OF SPECIFIED CURING TEMPERATURE AND TECHNIQUES	1705.3, 1908.9	ACI 318: 26.5.3.2, 26.5.4.2, 26.5.5.2	X			
8. INSPECTION OF WATERSTOPS FOR PROPER SHAPE, LOCATION, JOINT QUALITY, AND SURROUNDING CONCRETE PLACEMENT		ACI: 26.5.6.2	X			
STRUCTURAL STEEL						
1. MATERIAL VERIFICATION OF STRUCTURAL STEEL:						
A. IDENTIFICATION MARKINGS TO CONFORM TO AISC 360	1705.2.1, 2203.1	Applicable ASTM Material Standards	X			
B. MANUFACTURER'S CERTIFIED TEST REPORTS	1705.2.1	AISC 360: Sec. N3.2, N5.2	X			
2. PRIOR TO BOLTING, VERIFY THAT THE FOLLOWING ARE IN COMPLIANCE:						
A. MANUFACTURER'S CERTIFICATIONS AVAILABLE FOR FASTENER MATERIALS	1705.2.1	AISC 360: Sec. N3.2, N5.2, N5.6 RCSC: Sec. 2.1, 9.1		X		
B. FASTENERS MARKED IN ACCORDANCE WITH ASTM REQUIREMENTS	1705.2.1	AISC 360: Sec. N3.2, N5.2, N5.6 Applicable ASTM Material Standards	X			
C. PROPER BOLTING PROCEDURE SELECTED FOR JOINT DETAIL	1705.2.1	AISC 360: Sec. N5.6 RCSC: Sec. 4	X			
D. CONNECTING ELEMENTS, INCLUDING THE APPROPRIATE FAYING SURFACE CONDITION AND HOLE PREPARATION, IF SPECIFIED, MEET APPLICABLE REQUIREMENTS	1705.2.1	AISC 360: Sec. N5.6 RCSC: Sec. 3.2, 4	X			

LIAO YANG
STATE OF WASHINGTON
25262
REGISTERED
PROFESSIONAL ENGINEER
04-03-2020

NO.	DATE	DSGN	DR	CHK	APVD
0	04/03/2020	Liao Y.	Liao Y.	Matt C.	Gary B.

FINAL DESIGN - ISSUED FOR CONSTRUCTION

JD	APVD	Liao Y.
KI	BY	

REVISION

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST

STRUCTURAL
STATEMENT OF
SPECIAL INSTRUCTIONS - 1

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	000-S-002
SHEET	12 of 44

TABLE 2 (CONTINUED)
REQUIRED STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM	2015 IBC CODE REFERENCECE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
E. PRE-INSTALLATION VERIFICATION TESTING BY INSTALLATION PERSONNEL OBSERVED AND DOCUMENTED FOR FASTENER ASSEMBLIES AND METHODS USED	1705.2.1	AISC 360: Sec. N5.6 RCSC: Sec. 7		X		
F. PROPER STORAGE PROVIDED FOR BOLTS, NUTS, WASHERS AND OTHER FASTENER COMPONENTS	1705.2.1	AISC 360: Sec. N5.6 RCSC: Sec. 2.2	X			
3. VERIFY DURING BOLTING:						
A. FASTENER ASSEMBLIES, OF SUITABLE CONDITION, PLACED IN ALL HOLES AND WASHERS (IF REQUIRED) ARE POSITIONED AS REQUIRED	1705.2.1	AISC 360: Sec. N5.6	X			
B. JOINT BROUGHT TO SNUG-TIGHT CONDITION PRIOR TO THE PRETENSIONING OPERATION	1705.2.1	AISC 360: Sec. N5.6	X			
C. FASTENER COMPONENT NOT TURNED BY THE WRENCH PREVENTED FROM ROTATING	1705.2.1	AISC 360: Sec. N5.6	X			
D. FASTENERS ARE PRETENSIONED IN ACCORDANCE WITH THE RCSC SPECIFICATION, PROGRESSING SYSTEMATICALLY FROM THE MOST RIGID POINT TOWARD THE FREE EDGES	1705.2.1	AISC 360: Sec. N5.6	X			SEE TABLE 3 FOR TESTING OF HIGH-STRENGTH BOLTING
4. PRIOR TO WELDING, VERIFY THAT THE FOLLOWING ARE IN COMPLIANCE:						
A. APPROVED WELDING PROCEDURE SPECIFICATIONS (WPS) AVAILABLE TO WELDERS AND WELDING INSPECTOR(S)	1705.2.1	AWS D1.1	X			
B. WELDER QUALIFICATIONS AND JOINT FIT-UP	1705.2	AWS D1.1	X		NOTE 2	ALSO SEE REQUIREMENTS OF SPEC. SECTION 05 05 23
5. VERIFY DURING WELDING:						
A. CONTROL AND HANDLING OF WELDING CONSUMABLES	1705.2.1	AWS D1.1	X			
B. ENVIRONMENTAL CONDITIONS	1705.2.1	AWS D1.1	X			
C. COMPLIANCE WITH WPS REQUIREMENTS	1705.2.1	AWS D1.1	X		NOTE 2	ALSO SEE REQUIREMENTS OF SPEC. SECTION 05 05 23 AND TABLE 3 FOR STRUCTURAL STEEL TEST REQUIREMENT
6. AFTER WELDING, VERIFY THE FOLLOWING:						
A. SIZE, LENGTH AND LOCATION OF WELDS	1705.2.1	AWS D1.1	X		NOTE 2	
B. WELDS MEET VISUAL ACCEPTANCE CRITERIA	1705.2.1	AWS D1.1	X		NOTE 2	ALSO SEE REQUIREMENTS OF SPEC. SECTION 05 05 23
C. BACKING REMOVED AND WELD TABS REMOVED (IF REQUIRED)	1705.2.1	AWS D1.1	X			
D. NONDESTRUCTIVE WELDING INSPECTION	1705.2	AWS D1.1	X		NOTE 2	ALSO SEE REQUIREMENTS OF SPEC. SECTION 05 05 23
7. INSPECTION OF STEEL FRAME JOINT DETAILS FOR COMPLIANCE:						
A. DETAILS SUCH AS BRACING AND STIFFENING	1705.2.1		X			
B. MEMBER LOCATIONS	1705.2.1		X			
C. APPLICATION OF JOINT DETAILS AT EACH CONNECTION	1705.2.1		X			

TABLE 2 (CONTINUED)
REQUIRED STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM	2015 IBC CODE REFERENCECE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
ALUMINUM						
1. MATERIAL VERIFICATION OF ALUMINUM:						
A. IDENTIFICATION MARKINGS TO CONFORM TO ASTM STANDARDS SPECIFIED IN THE APPROVED CONSTRUCTION DOCUMENTS	1705.1.1 ITEM 2		X			
B. MANUFACTURERS' CERTIFIED MILL TEST REPORTS	1705.1.1 ITEM 2		X			
2. INSPECTION OF WELDING:						
A. NONDESTRUCTIVE INSPECTION	1705.1.1 ITEM 2	AWS D1.2	X		NOTE 2	ALSO SEE REQUIREMENTS OF SPEC. SECTION 05 05 23

NOTES:
1. PERIODIC INSPECTION IS DEFINED AS INSPECTION BY THE SPECIAL INSPECTOR OF ALL MATERIALS AND SYSTEMS, IN SOME CASES PERFORMED DURING THEIR PLACEMENT AND IN ALL CASES PERFORMED UPON COMPLETION OF THEIR PLACEMENT. THE COMPLETION INSPECTION SHALL BE PERFORMED SO THAT WORK CAN BE CORRECTED PRIOR TO OTHER RELATED WORK PROCEEDING AND COVERING INSPECTED WORK.

2. VISUAL INSPECTION IS THE RESPONSIBILITY OF THE CONTRACTOR'S WELDING INSPECTOR(S) AND IS NOT CONSIDERED SPECIAL INSPECTION. CONTRACTOR MUST PROVIDE A QUALIFIED WELDING INSPECTOR TO OVERSEE CONTRACTOR'S WELDING OPERATIONS, AS REQUIRED BY AWS D1.1, SECTIONS 6.1.2 & 6.6, SPEC. SECTION 05 05 23 AND REFERENCED WELDING CODES.

TABLE 3
TESTING FOR REQUIRED SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

MATERIAL	TYPE OR SCOPE	STANDARD	2016 CBC CODE REFERENCE	FREQUENCY	BY WHOM	COMMENTS
GEOTECHNICAL						
COMPACTED FILL	GRADATION	ASTM C117, C136	1705.6		OWNER'S TESTING AGENCY	
COMPACTED FILL	COMPACTION	ASTM D1557	1705.6		OWNER'S TESTING AGENCY	
COMPACTED FILL	DENSITY	ASTM D6938	1705.6		OWNER'S TESTING AGENCY	
PREPARED SUBGRADE	DENSITY	ASTM D6938	1705.6		OWNER'S TESTING AGENCY	
CONCRETE						
CONCRETE	STRENGTH	ASTM C39	1705.3	ONCE EACH DAY, BUT NOT LESS THAN ONE SAMPLE FOR EACH 150 CUBIC YARDS OR 5,000 SFT OF WALLS OR SLABS PLACED	OWNER'S TESTING AGENCY	
CONCRETE	SLUMP	ASTM C143, C94	1705.3	ONE SAMPLE PER STRENGTH TEST	OWNER'S TESTING AGENCY	
CONCRETE	AIR CONTENT	ASTM C231, C94	1705.3	ONE SAMPLE PER STRENGTH TEST	OWNER'S TESTING AGENCY	
CONCRETE	TEMPERATURE	ASTM C1064	1705.3	ONE SAMPLE PER STRENGTH TEST	OWNER'S TESTING AGENCY	
STEEL						
HIGH-STRENGTH BOLTING	PRE-INSTALLATION VERIFICATION TESTING OF PRETENSIONED BOLTS	RCSC SPECIFICATION FOR STRUCTURAL JOINTS USING ASTM A325 OR A490 BOLTS, Sec. 7	1705.2	3 FASTENER ASSEMBLIES OF EACH COMBINATION OF DIAMETER, LENGTH, GRADE AND LOT	OWNER'S TESTING AGENCY	
STRUCTURAL STEEL	ULTRASONIC OR RADIOGRAPHIC NONDESTRUCTIVE TESTING	AWS D1.1	1705.2	SECTION 05 05 23, WELDING	OWNER'S TESTING AGENCY	PERFORM RT OR UT ON GROOVE WELDS
REINFORCING STEEL	MAGNETIC PARTICLE NONDESTRUCTIVE TESTING	AWS D1.4	1705.3	SECTION 05 05 23, WELDING	OWNER'S TESTING AGENCY	PERFORM ON FILLET WELDS AND PARTIAL JOINT PENETRATION WELDS

TABLE 4
REQUIRED SPECIAL INSPECTION FOR SEISMIC RESISTANCE FOR STRUCTURAL SYSTEMS
REFER TO TABLE 2 FOR STANDARD STRUCTURAL SPECIAL INSPECTION REQUIREMENTS
REFER TO SPECIFICATION SECTION 01 45 33

The Seismic Design Category (SDC) for this Project is C.

SYSTEM	INSPECTION REQUIRED FOR FOLLOWING SEISMIC DESIGN CATEGORIES	2015 IBC CODE REFERENCE	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
PROCESS MECHANICAL						
INSTALLATION OF PIPING SYSTEMS MEANT TO CARRY HAZARDOUS MATERIALS AND ITS ASSOCIATED MECHANICAL UNITS	"C" AND ABOVE	1705.12.6 ITEM 3	X			
STRUCTURAL						
STRUCTURAL STEEL INSPECTION OF SEISMIC-FORCE-RESISTING SYSTEMS	"B" AND ABOVE	1705.12.1.1, AISC 341		X		SEE TABLE 6 FOR STRUCTURAL STEEL TESTING
INSPECTION OF STRUCTURAL STEEL ELEMENTS INCLUDING STRUTS, COLLECTORS, CHORDS AND FOUNDATION ELEMENTS	"B" AND ABOVE	1705.12.1.2, AISC 341		X		SEE TABLE 6 FOR STRUCTURAL STEEL TESTING
INSPECT AND VERIFY THAT ANCHORAGE OR MOUNTING CONFORMS TO THE CERTIFICATE OF COMPLIANCE	"C" AND ABOVE	1705.12.4	X			

NOTES:
1. PERIODIC INSPECTION IS DEFINED AS INSPECTION BY THE SPECIAL INSPECTOR OF ALL MATERIALS AND SYSTEMS, IN SOME CASES PERFORMED DURING THEIR PLACEMENT AND IN ALL CASES PERFORMED UPON COMPLETION OF THEIR PLACEMENT. THE COMPLETION INSPECTION SHALL BE PERFORMED SO THAT WORK CAN BE CORRECTED PRIOR TO OTHER RELATED WORK PROCEEDING AND COVERING THE INSPECTED WORK.
2. TESTING OF SYSTEMS AND THEIR ANCHORAGE SHALL BE IN CONFORMANCE WITH 2015 IBC SECTION 1705.13.2.
3. CERTIFICATION OF SYSTEMS AND THEIR ANCHORAGE SHALL BE IN CONFORMANCE WITH 2015 IBC SECTION 1705.13.3.

TABLE 5
REQUIRED SPECIAL INSPECTION FOR WIND RESISTANCE FOR STRUCTURAL SYSTEMS
REFER TO SPECIFICATION SECTION 01 45 33

No Special Inspection for Wind Resistance for Structural Systems is required.

TABLE 6
TESTING FOR SEISMIC RESISTANCE
REFER TO SPECIFICATION SECTION 01 45 33

MATERIAL	TYPE OR SCOPE	STANDARD	2015 IBC CODE REFERENCE	FREQUENCY	BY WHOM	COMMENTS
NOT USED						
NO SPECIAL INSPECTION REQUIREMENT						

LIAO YANG STATE OF WASHINGTON 49264 REGISTERED PROFESSIONAL ENGINEER
04-03-2020

NO.	DATE	DSGN	REVISION	CHK	APVD
0	04/03/2020	DR	FINAL DESIGN - ISSUED FOR CONSTRUCTION	Matt C.	Gary B.
				KI	BY
				JD	APVD

Liao Y.
Liao Y.

JACOBS

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

KAISER MEAD CUSTODIAL TRUST
STRUCTURAL
STATEMENT OF
SPECIAL INSTRUCTIONS - 2

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	000-S-003
SHEET	13 of 44

OVERALL SITE PLAN

1" = 150'-0"

GENERAL NOTES

1. PROPOSED CONDUIT PIPING LOCATIONS SHOWN.
2. PROVIDE 2'-0" SPACE MINIMUM FROM AVISTA UNDERGROUND AND PADMOUNT EQUIPMENT. SEE AVISTA 2019 ELECTRIC SERVICE REQUIREMENTS (BLUE BOOK) AND COORDINATE WITH UTILITY PRIOR TO START OF WORK.
3. SEE DWG 004-E-002 FOR CONTRACTOR SCOPE OF WORK.

SHEET KEYNOTES

1. INSTALL DUCT BANK IN ACCORDANCE WITH AVISTA BLUE BOOK REQUIREMENTS. COORDINATE WITH UTILITY COMPANY PRIOR TO START OF WORK.
2. EXISTING JUNCTION CABINET BY UTILITY. PROVIDE DUCT BANK ROUTING FROM EXISTING UTILITY JUNCTION CABINET TO NEW JUNCTION CABINET FOR SERVICE.
3. JUNCTION CABINET PROVIDED BY UTILITY. PROVIDE DUCT BANK ROUTING TO AND FROM NEW UTILITY JUNCTION CABINET FOR SERVICE.
4. VERIFY DEPTH OF YARD PIPING. ENSURE ROUTE FOR DUCT BANK AND YARD PIPING ROUTE IS 5'-0" IN BETWEEN, AS REQUIRED BY UTILITY.
5. UTILITY TO PROVIDE MANHOLE, LEAVE OPEN TRENCH MANHOLE TO BE INSTALLED BY UTILITY.

CIRCUIT CALLOUTS

a = 3-[2"C PVC, PULLSTRING]
CONDUCTORS BY UTILITY

STUART W.J. BARTON
STATE OF WASHINGTON
54861
REGISTERED
PROFESSIONAL ENGINEER
2020-05-08

NO.	DATE	DSGN	DR	CHK	APVD	BY
1	05/01/2020	M. Alexander	T. Kendall	B. Martin	S. Barton	KI JD
0	04/03/2020	EXTRACTION SYSTEM ADDENDUM FINAL DESIGN - ISSUED FOR CONSTRUCTION REVISION				KI JD BY APVD

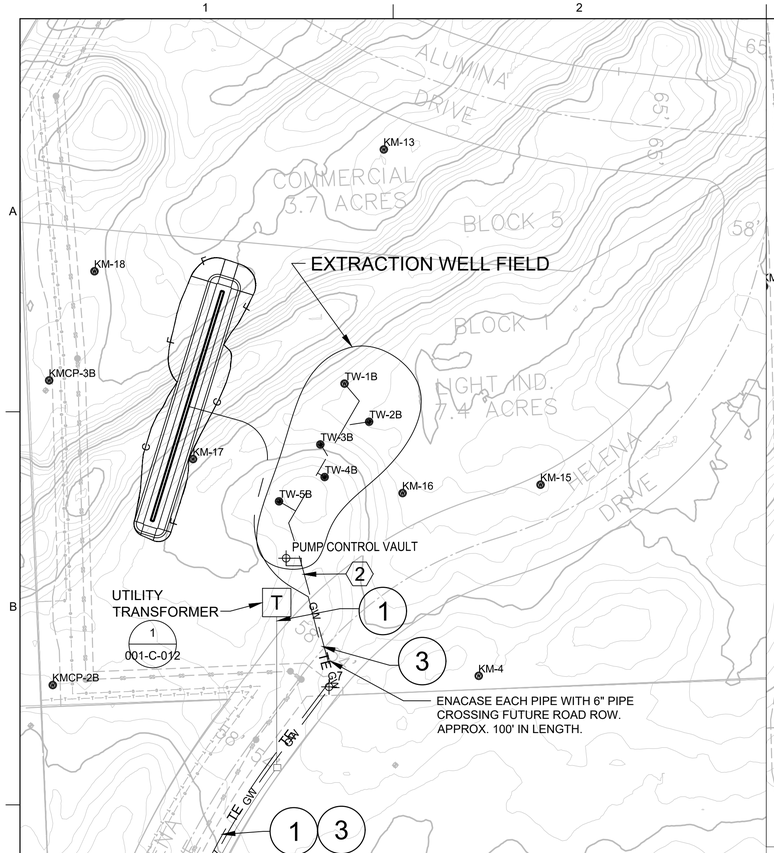
Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST
OVERALL
SITE PLAN

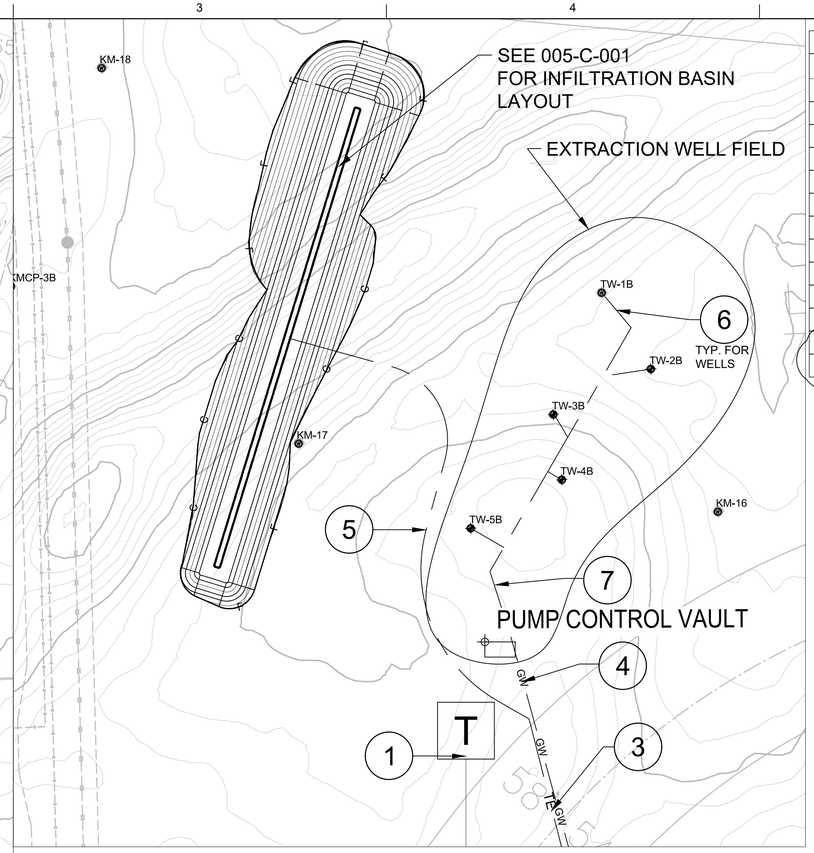
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	000-C-001
SHEET	14 of 44



WELLFIELD LAYOUT

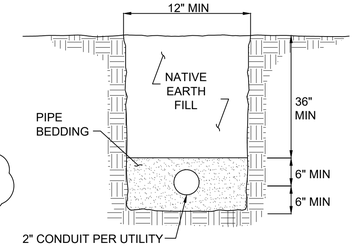
1" = 50'-0"



Point Table			
Point #	Raw Description	Northing	Easting
1	PUMP CONTROL HOUSE	296240.01	2487428.22
2	TW-5B	296315.02	2487418.87
3	TW-4B	296347.05	2487479.00
4	TW-3B	296390.09	2487473.39
5	TW-2B	296420.10	2487537.76
6	TW-1B	296470.42	2487505.32
7	WATER ALGN	296070.25	2487484.83
8	WATER ALGN	295276.09	2487234.05
9	WATER ALGN	295295.81	2487670.99
10	WATER ALGN	295426.15	2487811.38
11	WATER ALGN	295443.25	2488398.08
12	EC BUILDING NW CORNER	295427.46	2488294.22
13	EC BUILDING NE CORNER	295427.47	2488382.72

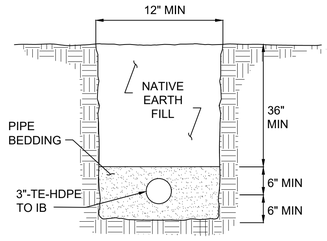
SHEET KEYNOTES

1. INSTALL AIR/VACUUM RELEASE VALVES (SEE DETAIL 5/002-M-003) AT HIGH POINTS IN BOTH FORCE MAINS (3-GW-HDPE AND 3-TE-HDPE).
2. INSTALL BLOWOFF STATION (SEE DETAIL6/002-M-003) AT LOW POINT OF 3" GW FORCE MAIN. SLOPE 3-GW-HDPE CONSTANTLY UPHILL FROM PUMP CONTROL HOUSE TO HIGH POINT BEFORE EC BUILDING.



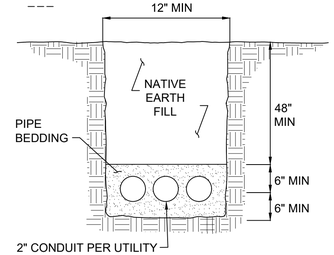
1 EXTRACTION POWER TRENCH

NTS



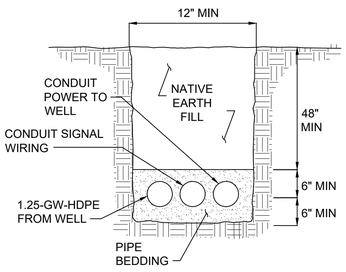
5 IB WATER TRENCH

NTS



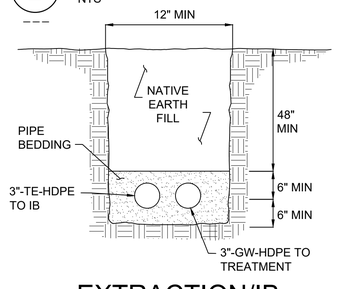
2 TREATMENT POWER TRENCH

NTS



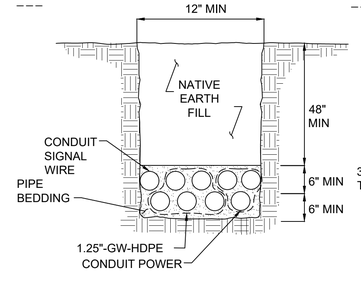
6 WELL TRENCH

NTS



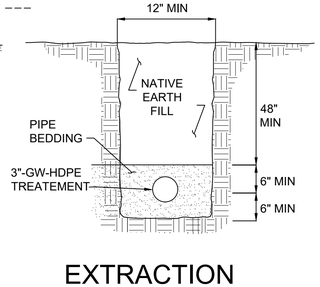
3 EXTRACTION/IB WATER TRENCH

NTS



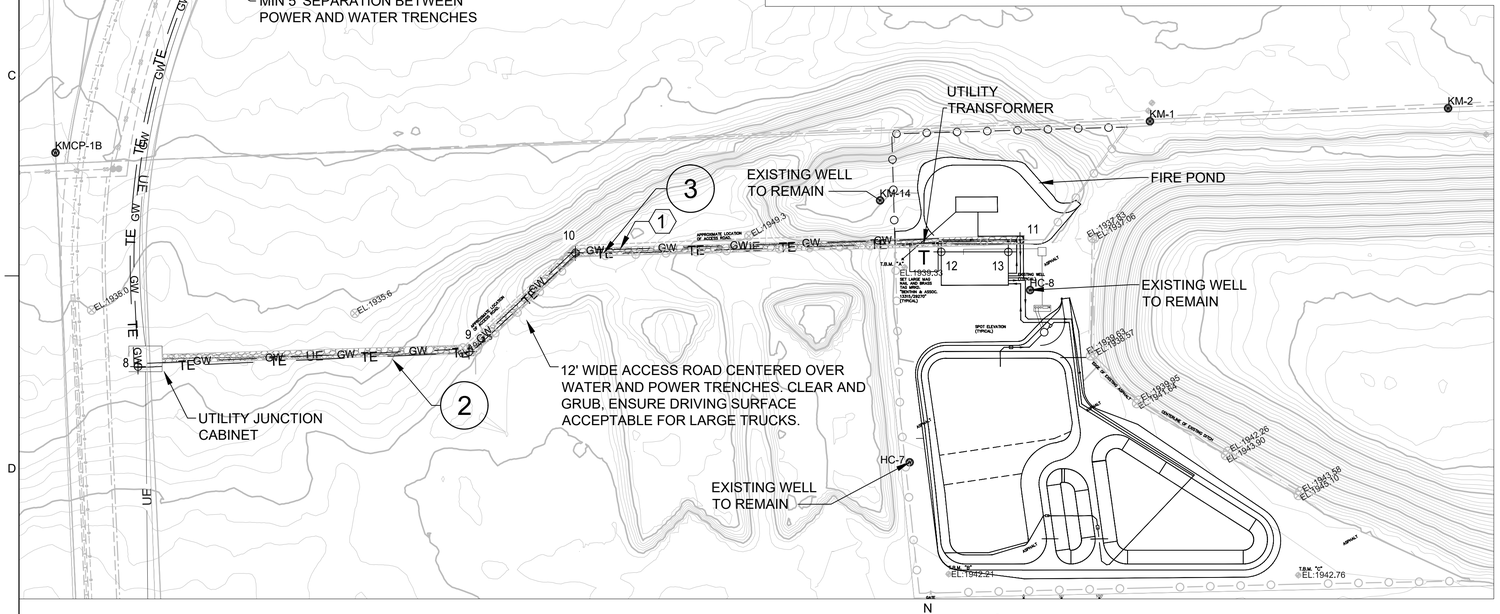
7 WELL TRENCH

NTS



4 EXTRACTION WATER TRENCH

NTS



SITE CIVIL PLAN

1" = 100'-0"

N

0 100 200 300

1"=100'-0"

STUART W.T. BARTON
STATE OF WASHINGTON
54861
REGISTERED PROFESSIONAL ENGINEER
2020-05-08

NO.	DATE	DR	CHK	APVD
1	05/01/2020	KI	JD	S. Barton
0	04/03/2020	KI	JD	S. Barton
DSGN	B. Martin	D. Spado		

1 EXTRACTION SYSTEM ADDENDUM
0 FINAL DESIGN - ISSUED FOR CONSTRUCTION

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST
SITE CIVIL PLAN

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	000-C-002
SHEET	15 of 44

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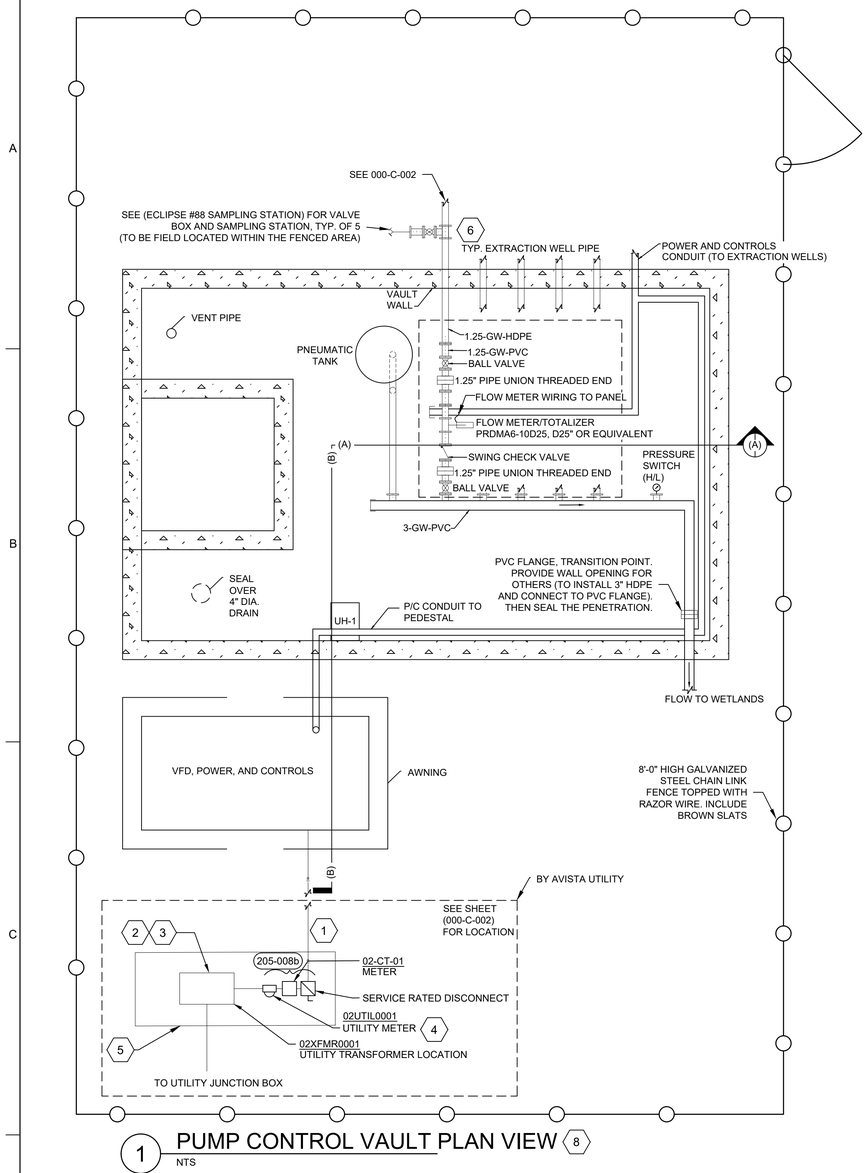
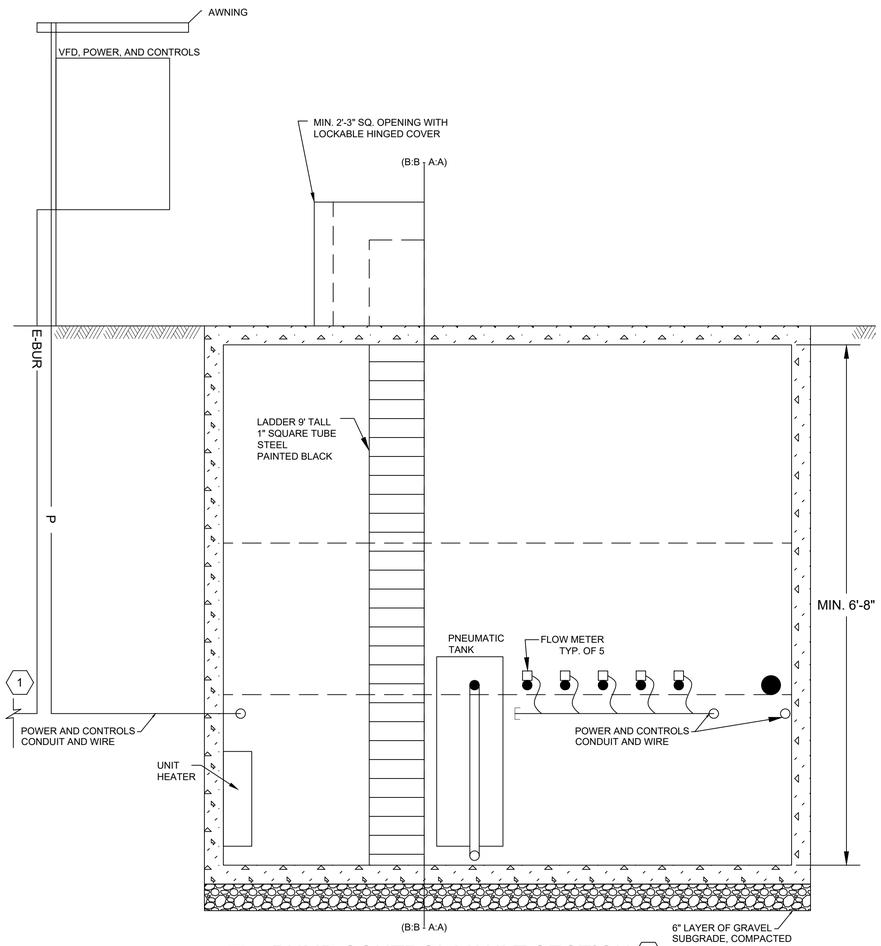
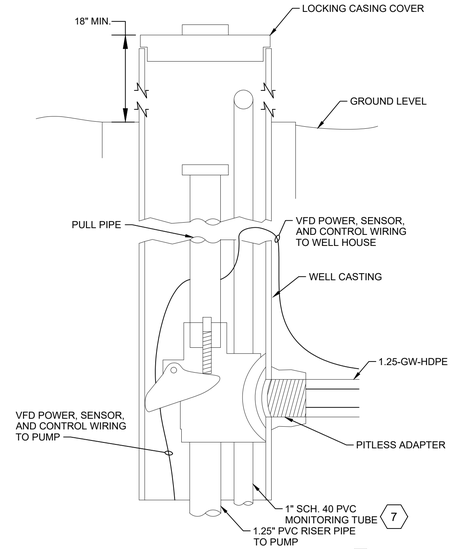


1 PUMP CONTROL VAULT PLAN VIEW 8
NTS



2 PUMP CONTROL VAULT SECTION 8
NTS



3 WELL HEAD COMPLETION 8
NTS

KEY NOTES

X

1. FIELD FIT LINES FROM SERVICE RATED DISCONNECT TO CONTROL PANEL AND WITHIN VAULT.
2. COORDINATE WITH UTILITY FOR SECURITY REQUIREMENTS ON SERVICE EQUIPMENT.
3. SIZED BY UTILITY. PROVIDE 2' MINIMUM DISTANCE FROM EDGE OF TRANSFORMER TO EDGE OF CONCRETE PAD PER AVISTA REQUIREMENTS, SEE 2019 AVISTA ELECTRIC SERVICE REQUIREMENTS (BLUEBOOK) FOR PAD DIMENSIONS.
4. PROVIDE 3/4" CONDUIT FROM CT CABINET TO UTILITY METER.
5. PROVIDE #4 BC 20"-0" MINIMUM CONCRETE-ENCASED ELECTRODE.
6. SAME CONFIGURATION PER WELL PIPE LINE, VAULT PENETRATIONS SEALED (TOTAL 5).
7. SUBMERSIBLE WELL PUMP PER PUMP SCHEDULE; SEE DWG 001-I-013 FOR PUMP SCHEDULE. CONDUCT PUMP TESTING IN ACCORDANCE WITH REQUIREMENTS ON DWG 002-M-003.
8. THIS DRAWING IS FOR SCHEMATIC AND GUIDANCE PURPOSES ONLY, AND MAY NOT REFLECT FINAL INSTALLED SYSTEM. SYSTEM IS TO FOLLOW REQUIREMENTS OUTLINE IN THE "VENDOR PACKAGE PERFORMANCE SCOPE FOR THE EXTRACTION PUMPS AND CONTROLS" DOCUMENT, ATTACHMENT D. ALL DESIGN WILL BE REVIEWED BY ALL APPROPRIATE DISCIPLINES, LIKE CIVIL, STRUCTURAL, ARCHITECTURAL, ELECTRICAL AND I&C, PRIOR TO MANUFACTURE AND INSTALLATION.

5/8/2020

DSGN	NO.	DATE	REVISION	CHK	APVD
E. Pietrick	0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION	KI	JD
D. Spado	1	05/01/2020	EXTRACTION SYSTEM ADDENDUM	KI	JD
DR				BY	APVD
B. Martin					K. Irving

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

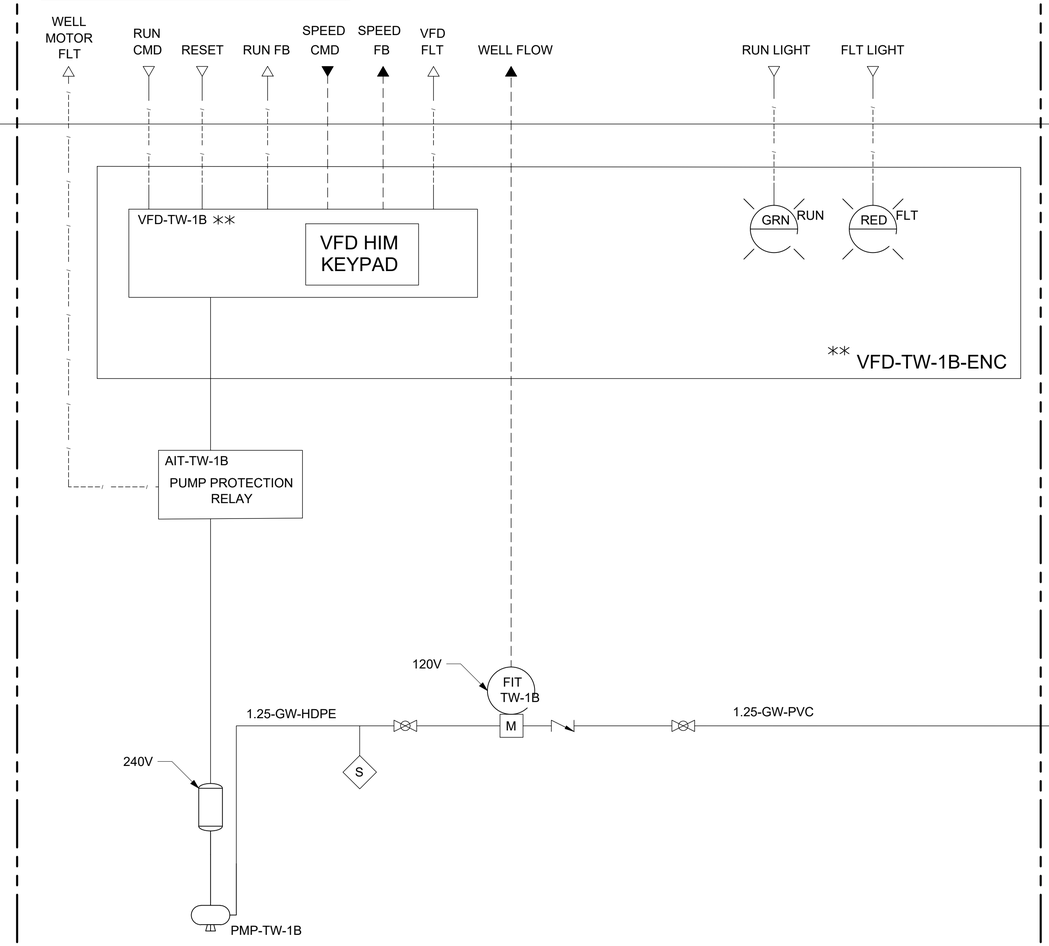
KAISER MEAD CUSTODIAL TRUST
EXTRACTION SYSTEM
PUMPS AND CONTROL DETAIL

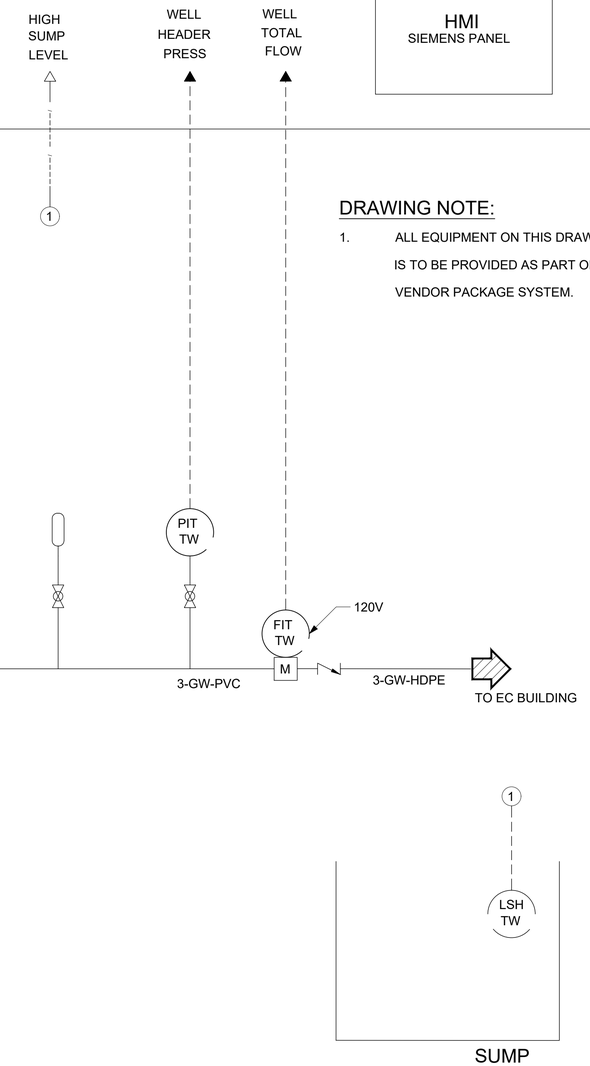
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	001-C-012
SHEET	16 of 44

WELL FIELD PLC
PLC CONTROL PANEL

EXTRACTION WELL #1 (TYP OF 5)





DRAWING NOTE:

1. ALL EQUIPMENT ON THIS DRAWING IS TO BE PROVIDED AS PART OF A VENDOR PACKAGE SYSTEM.

EXTRACTION WELL #2 (TYP OF 5)

EXTRACTION WELL #3 (TYP OF 5)

EXTRACTION WELL #4 (TYP OF 5)

EXTRACTION WELL #5 (TYP OF 5)

PUMP SCHEDULE

1. TW-1B - 10 GPM AT 246 FT TDH, GOULDS MODEL 10GS10, 1.0HP, 230V/3PH MOTOR WITH 230V/1PH POWER SUPPLY TO VFD
2. TW-2B - 15 GPM AT 253 FT TDH, GOULDS MODEL 10GS15, 1.5HP, 230V/3PH MOTOR WITH 230V/1PH POWER SUPPLY TO VFD
3. TW-3B - 20 GPM AT 260 FT TDH, GOULDS MODEL 18GS20, 2.0HP, 230V/3PH MOTOR WITH 230V/1PH POWER SUPPLY TO VFD
4. TW-4B - 20 GPM AT 260 FT TDH, GOULDS MODEL 18GS20, 2.0HP, 230V/3PH MOTOR WITH 230V/1PH POWER SUPPLY TO VFD
5. TW-5B - 10 GPM AT 242 FT TDH, GOULDS MODEL 10GS10, 1.0HP, 230V/3PH MOTOR WITH 230V/1PH POWER SUPPLY TO VFD

GENERAL NOTES

1. THIS DRAWING IS FOR SCHEMATIC AND GUIDANCE PURPOSES ONLY, AND MAY NOT REFLECT FINAL INSTALLED SYSTEM. SYSTEM IS TO FOLLOW REQUIREMENTS OUTLINED IN THE "VENDOR PACKAGE PERFORMANCE SCOPE FOR THE EXTRACTION PUMPS AND CONTROLS" DOCUMENT, ATTACHMENT D.
2. FOR ABBREVIATIONS AND SYMBOLS REFER TO I&C LEGENDS IN GENERAL DWGS SECTION
3. AUTO/MANUAL CONTROL AND SPEED SET POINTS FOR PUMPS WILL BE DONE VIA HMI. LOCAL MANUAL CONTROL OF PUMPS SHALL BE AVAILABLE THROUGH THE VFD HIM KEYPAD

JOSHUA CLEMENT THOMAS — STATE OF WASHINGTON — 52864 — REGISTERED PROFESSIONAL ENGINEER
05/07/2020

NO.	DATE	DSGN	DR	CHK	APVD
1	05/01/2020	EXTRACTION SYSTEM ADDENDUM	KI	JD	STEVE B.
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION	KI	JD	STEVE B.
		REVISION	BY	APVD	

JOSH T. / JOSH T.

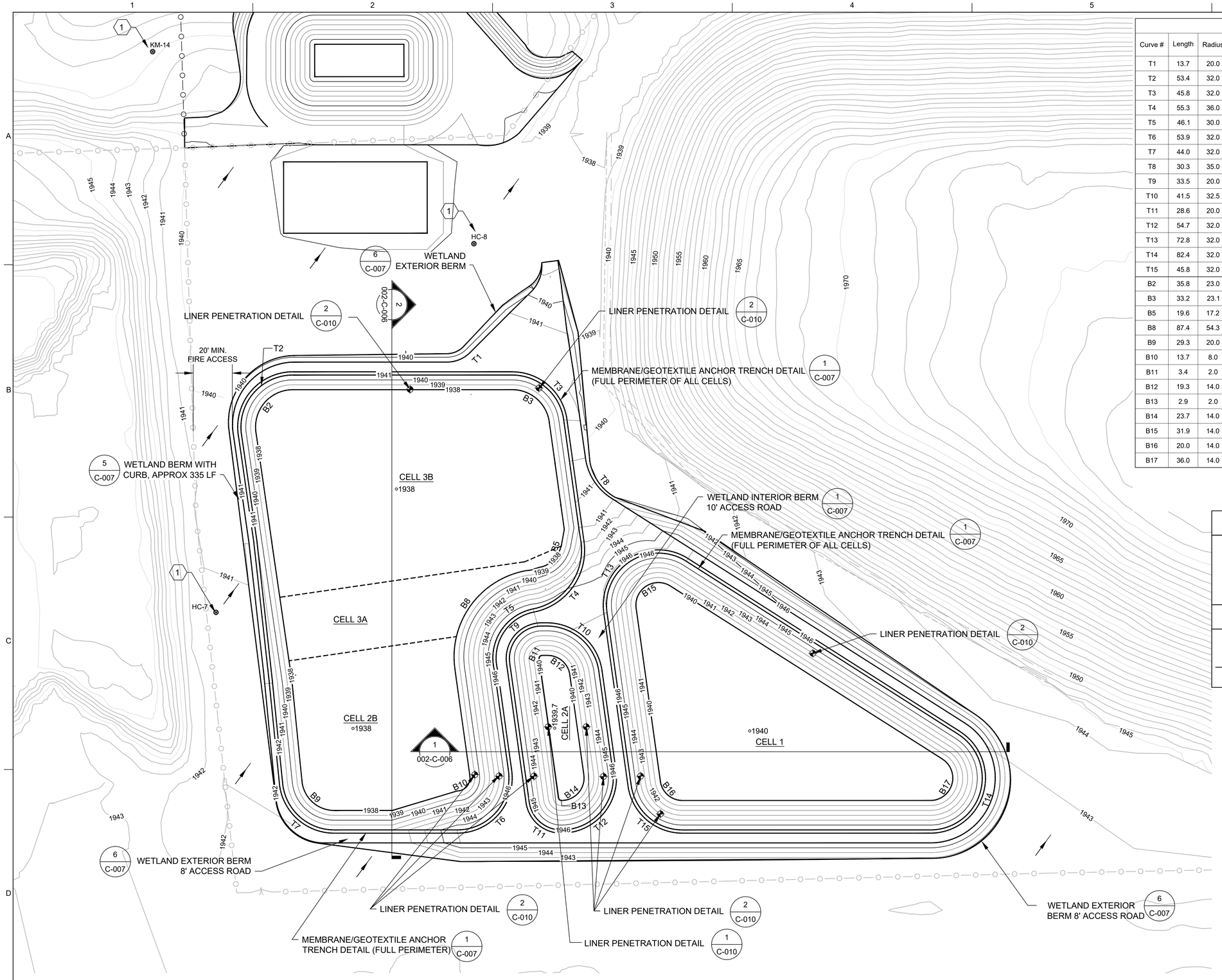
Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST
EXTRACTION SYSTEM P&ID

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	001-I-013
SHEET	17 of 44



Curve Table							
Curve #	Length	Radius	Delta	NORTHING START	EASTING START	NORTHING END	EASTING END
T1	13.7	20.0	039.38°	295304.17	2488396.89	295309.90	2488409.09
T2	53.4	32.0	095.63°	295296.05	2488299.91	295260.86	2488268.07
T3	45.8	32.0	082.07°	295268.49	2488466.98	295296.07	2488435.29
T4	55.3	36.0	087.97°	295151.89	2488448.06	295192.32	2488477.47
T5	46.1	30.0	087.97°	295151.89	2488448.06	295118.19	2488423.55
T6	53.9	32.0	096.57°	295015.63	2488401.89	295052.03	2488432.79
T7	44.0	32.0	078.83°	295042.84	2488293.79	295015.65	2488323.96
T8	30.3	35.0	049.57°	295244.91	2488480.22	295220.22	2488496.09
T9	33.5	20.0	096.10°	295141.32	2488452.73	295118.57	2488433.59
T10	41.5	32.5	073.07°	295115.56	2488488.13	295141.24	2488459.15
T11	28.6	20.0	082.05°	295032.84	2488445.56	295015.61	2488465.37
T12	54.7	32.0	097.96°	295015.61	2488465.37	295052.03	2488497.06
T13	72.8	32.0	130.43°	295181.28	2488542.38	295149.85	2488493.50
T14	82.4	32.0	147.52°	295015.61	2488692.77	295074.60	2488709.95
T15	45.8	32.0	082.05°	295043.18	2488508.40	295015.61	2488540.09
B2	35.8	23.0	089.37°	295286.92	2488297.50	295261.94	2488277.01
B3	33.2	23.1	082.62°	295267.35	2488457.90	295287.05	2488434.69
B5	19.6	17.2	065.20°	295177.58	2488452.20	295190.63	2488465.34
B8	87.4	54.3	092.24°	295175.52	2488443.89	295110.44	2488400.40
B9	29.3	20.0	083.75°	295045.62	2488305.53	295027.61	2488325.28
B10	13.7	8.0	097.86°	295039.61	2488401.09	295048.72	2488409.02
B11	3.4	2.0	097.21°	295123.34	2488453.37	295121.06	2488451.42
B12	19.3	14.0	079.13°	295112.00	2488470.48	295123.34	2488456.76
B13	2.9	2.0	082.02°	295035.33	2488463.39	295033.61	2488465.39
B14	23.7	14.0	096.94°	295033.61	2488465.39	295049.43	2488479.14
B15	31.9	14.0	130.43°	295166.09	2488532.71	295152.34	2488511.33
B16	20.0	14.0	081.98°	295045.67	2488526.22	295033.61	2488540.08
B17	36.0	14.0	147.52°	295033.61	2488692.77	295059.42	2488700.28

GENERAL NOTES

1. ON WETLAND AREA PERIMETER THE TOP OF BERM IS 8' WIDE WITH THE ROAD ON THE OUTER EDGE. INTERIOR BERMS ARE 10' WIDE WITH THE ROAD CENTERED.
2. ASPHALT DEMOLITION TO OCCUR UNDER ALL WETLAND BERMS AND EC BUILDING. ASPHALT TO BE REUSED IN BASE OF BERMS.

SHEET KEYNOTES

1. EXISTING WELL, PRESERVE AND PROTECT.

EXISTING SITE DRAINAGE FLOW DIRECTION.

WETLANDS CIVIL AND LINER PLAN

1" = 30'-0"

N

0 30 60 90

1" = 30'-0"

STUART W.J. BARTON
STATE OF WASHINGTON
54861
REGISTERED
PROFESSIONAL ENGINEER
2020-05-08

NO.	DATE	DSGN	DR	CHK	APVD
1	05/01/2020	M. MADISON	D. SPADO	D. PAIKO	D. PAIKO
0	04/03/2020				

1 05/01/2020 WETLANDS ADDENDUM — KI JD
0 04/03/2020 FINAL DESIGN - ISSUED FOR CONSTRUCTION — KI JD

REVISION BY APVD

JACOBS

KAISER MEAD CUSTODIAL TRUST

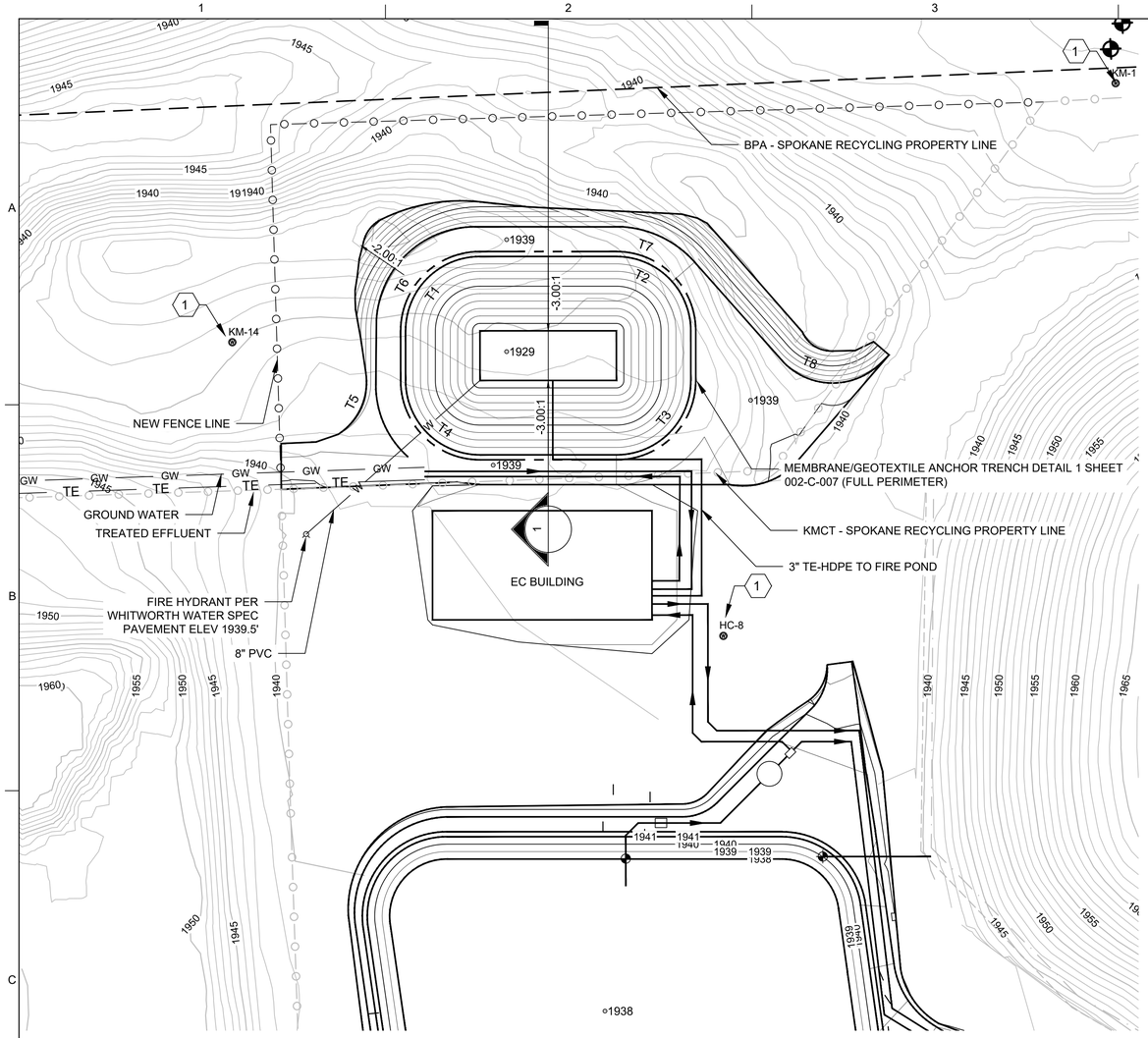
ENHANCED WETLANDS CIVIL AND LINER PLAN

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

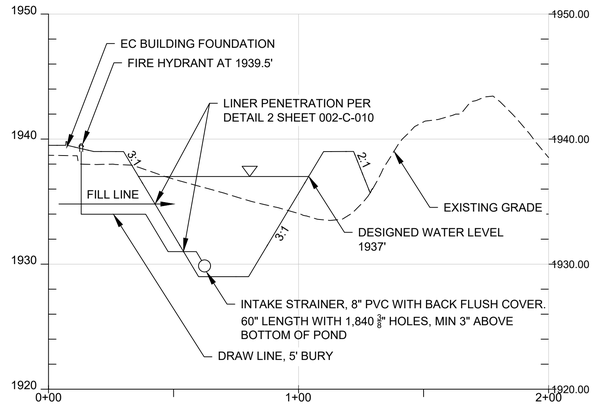
VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	
PROJ	KMCT2019
DWG	002-C-001
SHEET	18 of 44



Curve Table							
Curve #	Length	Radius	Delta	NORTHING START	EASTING START	NORTHING END	EASTING END
T1	47.1	30.0	090.00°	295529.99	2488313.36	295499.99	2488283.36
T2	47.1	30.0	090.00°	295499.99	2488398.36	295529.99	2488368.36
T3	47.1	30.0	090.00°	295449.99	2488368.36	295479.99	2488398.36
T4	47.1	30.0	090.00°	295479.99	2488283.36	295449.99	2488313.36
T5	26.8	23.5	065.28°	295458.32	2488256.26	295480.03	2488269.34
T6	66.2	42.0	090.27°	295542.01	2488313.36	295499.79	2488271.34
T7	36.3	42.0	049.43°	295527.72	2488399.92	295542.01	2488367.81
T8	46.5	30.0	088.76°	295490.06	2488433.00	295486.90	2488474.85



FIRE POND PLAN VIEW AND CROSS SECTION

1" = 30'-0"

STORAGE TABLE					
ELEV	AREA (sq. ft.)	AVG END INC. VOL. (cu. ft.)	AVG END TOTAL VOL. (cu. ft.)	AVG END TOTAL VOL (gallons)	
1,929.00	1,100.0	N/A	N/A	N/A	
1,930.00	1,578.3	1339.13	1339.13	10,015	RESERVED FOR UNUSABLE VOLUME TO COVER SUCTION PIPING
1,931.00	2,113.0	1845.65	3184.79	23,820	DESIGN DRAW-DOWN LEVEL
1,932.00	2,704.4	2408.70	5593.49	41,835	
1,933.00	3,352.2	3028.27	8621.76	64,485	
1,934.00	4,056.5	3704.37	12326.13	91,200	
1,935.00	4,817.4	4436.99	16763.12	125,390	
1,936.00	5,634.8	5226.13	21989.25	164,480	
1,937.00	6,508.8	6071.80	28061.05	209,900	DESIGN WATER LEVEL RESERVED FOR FREEZING LAYER
1,938.00	7,439.2	6973.99	35035.04	262,060	
1,939.00	8,426.2	7932.70	42967.74	321,400	RESERVED FOR FREEBOARD

GENERAL NOTES

1. 1,010 CY CUT
   850 CY FILL
   160 CY NET CUT
2. FIRE POND CROSS SECTION SHOWS SUPERIMPOSED FIRE HYDRANT AND PIPES AT THEIR RESPECTIVE ELEVATIONS, SECTION CUT IS OFFSET FROM THEIR LOCATIONS IN PLAN VIEW.

SHEET KEYNOTES

1. EXISTING WELL, PRESERVE AND PROTECT.

0 30 60 90
1" = 30'-0"

N

STUART W. BARTON
STATE OF WASHINGTON
54861
REGISTERED
PROFESSIONAL ENGINEER
2020-05-08

NO.	DATE	REVISION	BY	APVD
1	05/01/2020	WETLANDS ADDENDUM	KI	JD

DSGN S. BARTON DR S. BARTON CHK J. DEHNER APVD S. BARTON

JACOBS

KAISER MEAD CUSTODIAL TRUST

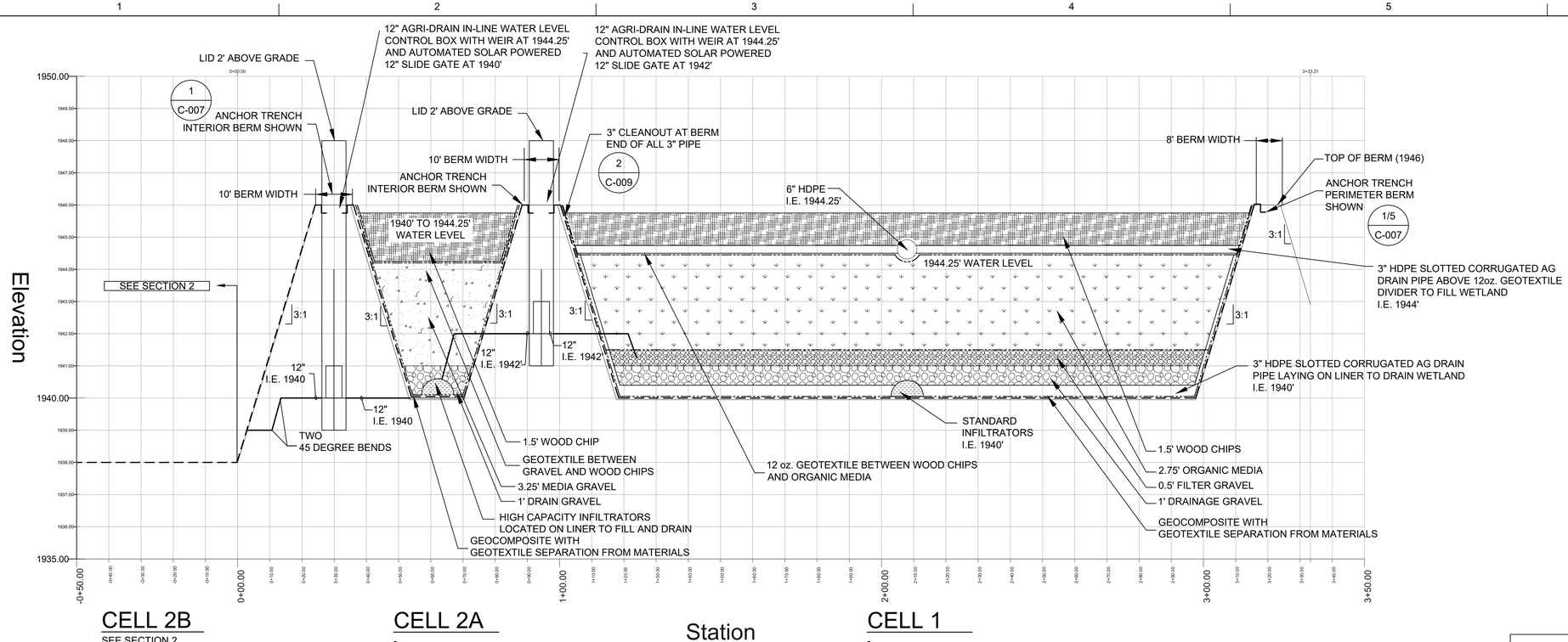
FIRE POND
PLAN VIEW

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

VERIFY SCALE

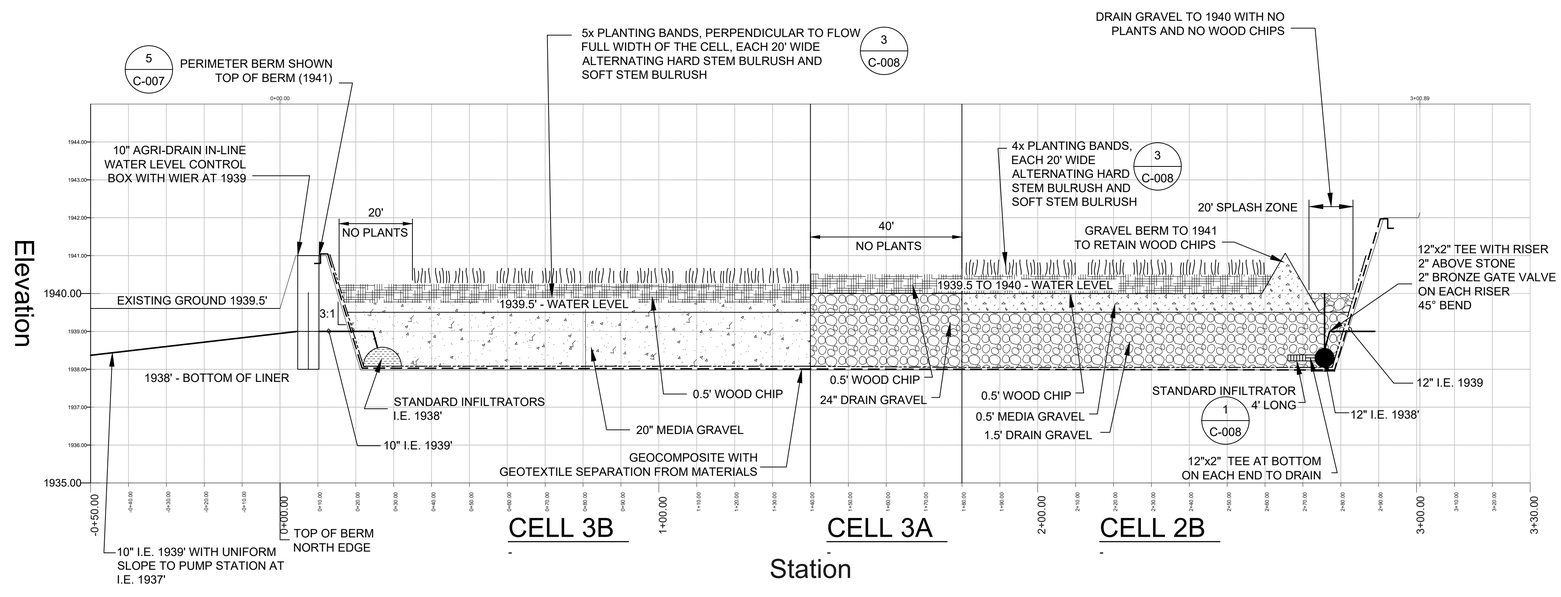
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	002-C-002
SHEET	19 of 44



1 CELL 1-2A CROSS SECTION DETAIL

BIO-CHEMICAL REACTOR (BCR) - NTS



2 CELL 3-2B CROSS SECTION DETAIL

HORIZONTAL SUBSURFACE FLOW WETLAND (SSF) - NTS

LEGEND

- WOOD CHIPS (100%)
- ORGANIC MEDIA (65% WOOD CHIPS, 25% SAWDUST, 9% GRASS HAY, AND 1% COMPOSTED HORSE MANURE BY VOLUME)
- FILTER GRAVEL (1" ROUNDED RIVER ROCK)
- MEDIA GRAVEL (3/4" ANGULAR BASALT)
- DRAIN GRAVEL (1 1/2" ROUNDED RIVER ROCK)
- 12 oz. NON-WOVEN GEOTEXTILE
- COMPOSITE GEOMEMBRANE - (GCL)

ROCK SPECS

1 1/2" DRAINAGE GRAVEL ROUNDED RIVER ROCK

SIZE	PASSING
2"	100%
3/4"	MAX 10%
FINES	<2%

1" FILTER GRAVEL ROUNDED RIVER ROCK

SIZE	PASSING
1 1/2"	100%
1/2"	MAX 10%
FINES	<2%

3/4" GRAVEL MEDIA CRUSHED ANGULAR BASALT

SIZE	PASSING
1"	100%
1/2"	MAX 10%
FINES	<2%

Madison, Mark INC500030001
Digitally signed by Madison, Mark INC500030001
Date: 2020.05.04 15:31:57 -07'00'
CIVIL - MECHANICAL

JAY G. DEHNERT, STATE OF WASHINGTON, 0023455, REGISTERED PROFESSIONAL ENGINEER
05/08/2020
LINER

NO.	DATE	DSGN	DR	CHK	APVD
1	05/01/2020	WETLANDS ADDENDUM	KI	JD	D. PAIKO
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION	KI	JD	D. PAIKO
		REVISION	BY	APVD	
		M. MADISON	D. SPADO	D. PAIKO	

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

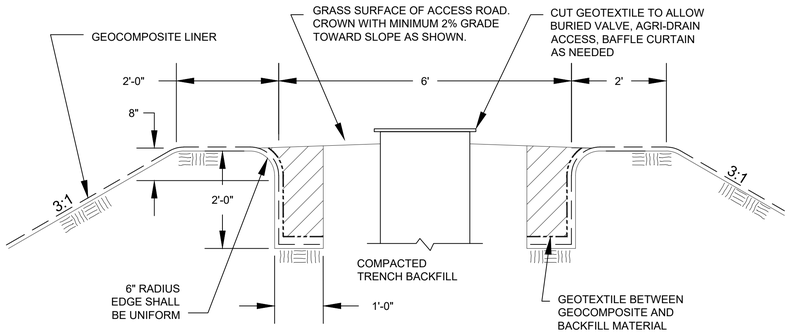
JACOBS

KAISER MEAD CUSTODIAL TRUST
ENHANCED WETLANDS
CIVIL SECTIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

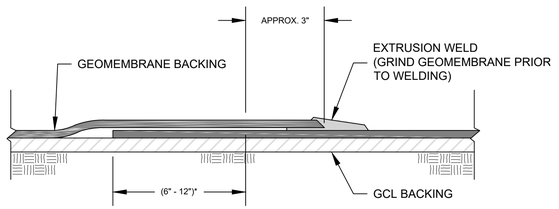
DATE	
PROJ	KMCT2019
DWG	002-C-006
SHEET	20 of 44

$PWURL $PWPATH FILENAME: 002-C-006.dwg PLOT DATE: PLOT TIME:



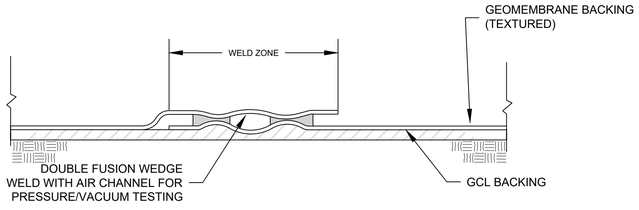
NOTES:
1. BETWEEN CELLS ON WETLAND AREA INTERIOR THE TOTAL WIDTH OF BERM TOP IS 10'.
2. PROVIDE MINIMUM 2% GRADE ON CREST ROAD TOWARD INTERIOR OF CELL.

1 LINING ANCHOR TRENCH
NTS



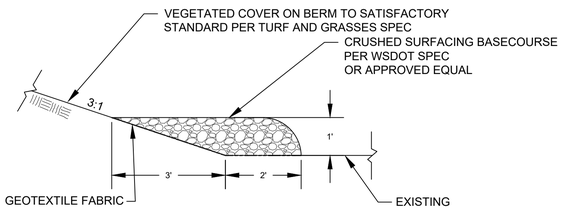
NOTES:
1. ALL WELDS SHALL BE CONTINUOUS AND WATERTIGHT.

2 EXTRUSION WELD SEAMS
NTS



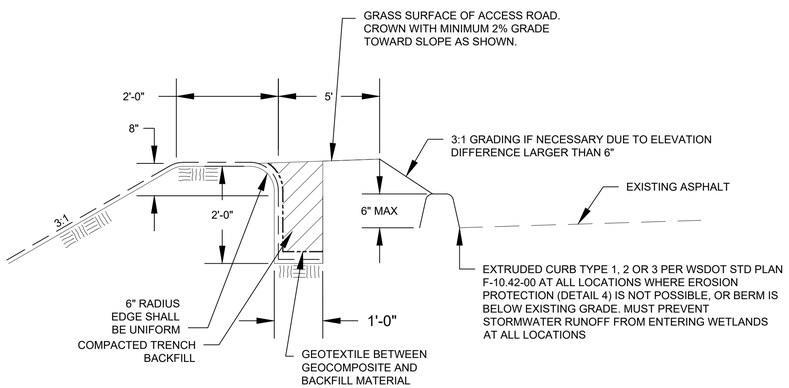
NOTES:
1. ALL WELDS SHALL BE CONTINUOUS AND WATERTIGHT.
2. REMOVE UNBOUNDED TOP EDGE IF AIR CHANNEL TEST FAILS AND VACUUM BOX TEST IS USED.

3 DOUBLE WEDGE FUSION WELD SEAMS
NTS



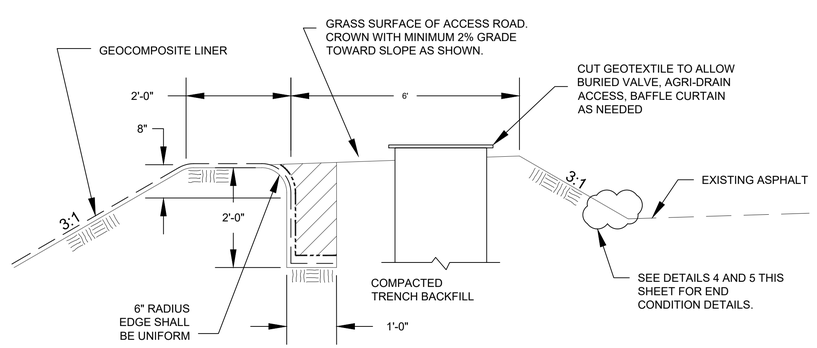
NOTES:
1. EROSION PROTECTION DETAIL APPLIES WHERE VERTICAL SEPARATION BETWEEN BERM TOP AND EXISTING ASPHALT IS GREATER THAN 1'. WHERE NO SEPARATION EXISTS FOR EROSION PROTECTION, CURBING IN DETAIL 5 IS REQUIRED.

4 EROSION PROTECTION
NTS



NOTES:
1. TOTAL WIDTH OF BERM TOP IS 5' WHERE CURB IS NECESSARY.
2. PROVIDE MINIMUM 2% GRADE ON ROAD TOWARD INTERIOR OF CELL.

5 WETLANDS BERM CURB DETAIL
NTS



NOTES:
1. WETLAND AREA PERIMETER TOTAL BERM WIDTH IS 8' WIDE.
2. PROVIDE MINIMUM 2% GRADE ON ROAD TOWARD INTERIOR OF CELL.

6 WETLANDS EXTERIOR BERM DETAIL
NTS

STUART W.J. BARTON — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER — 2020-05-08
Details: 4, 5, 6

JAY G. DEHNER — STATE OF WASHINGTON — 0023455 REGISTERED PROFESSIONAL ENGINEER — 05/08/2020
Details: 1, 2, 3

NO.	DATE	DSGN	DR	CHK	APVD
1	05/01/2020	D. PAIKO	D. PAIKO	D. SPADO	M. MADISON
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION			
		REVISION			

NO.	BY	APVD
1	KI	JD
0	KI	JD
	BY	APVD

D. PAIKO

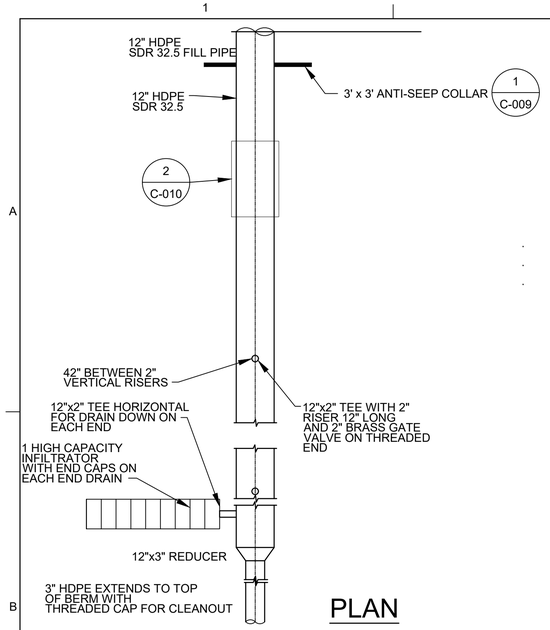
Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust

JACOBS

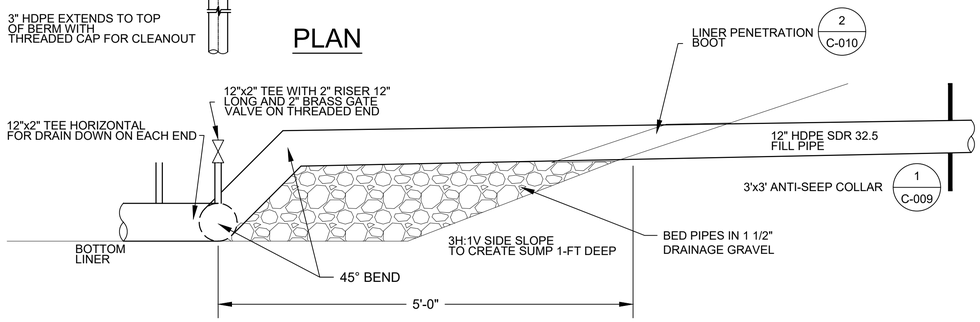
KAISER MEAD CUSTODIAL TRUST
ENHANCED WETLANDS CIVIL DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	
PROJ	KMCT2019
DWG	002-C-007
SHEET	21 of 44



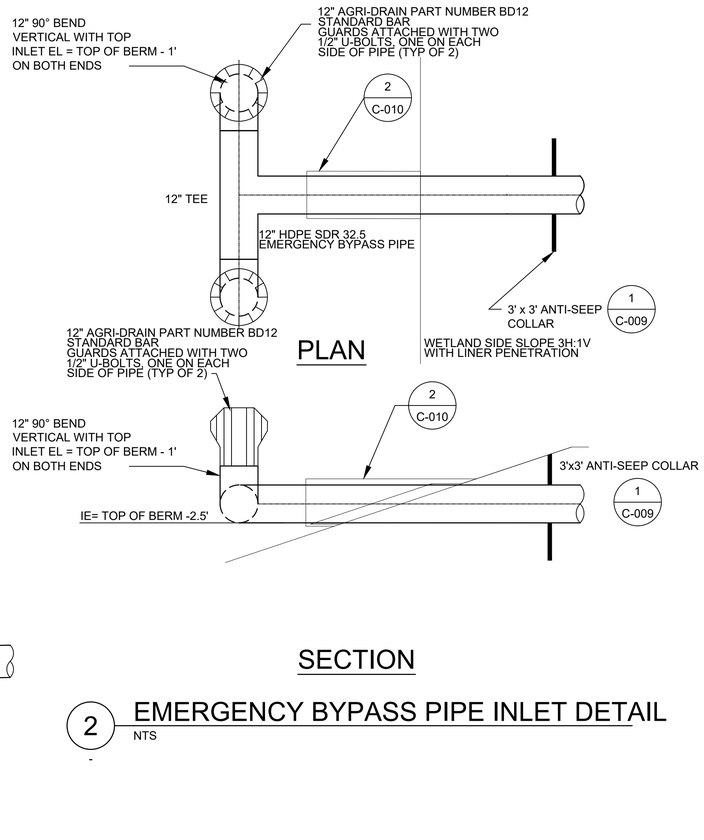
PLAN



SECTION

1 CELL 2B FILL PIPE TO RISER PIPE

NTS

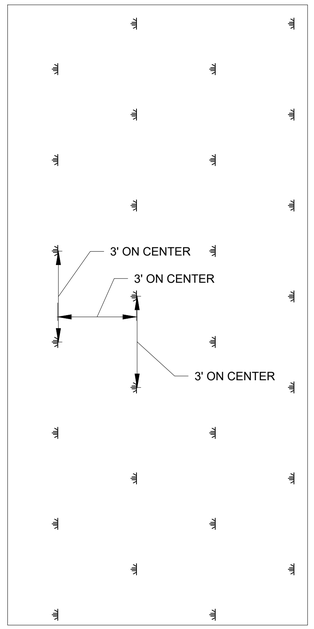


PLAN

SECTION

2 EMERGENCY BYPASS PIPE INLET DETAIL

NTS

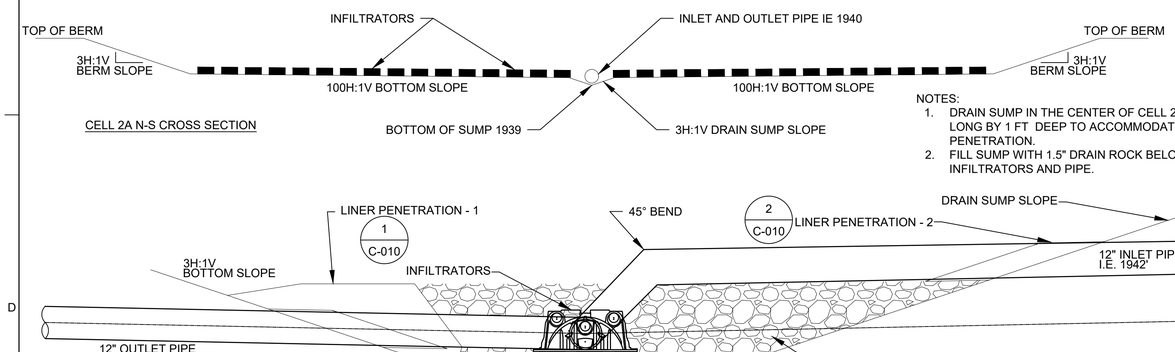


NOTES:

1. PLANT 1 GALLON POT ROOTED BULRUSH 3' ON CENTER IN OFFSET ROWS WITH MINIMUM 6 HEALTHY STEMS PER POT 2' TALL. LEAVE POTTING SOIL ON ROOT BALL. PLACE WITH TOP OF ROOT BALL AT NORMAL WATER SURFACE ELEVATION.
2. PLANT ROWS PERPENDICULAR TO WATER FLOW FULL WIDTH OF THE CELL WITHIN 2' OF THE NORMAL WATER SURFACE SHORELINE TO CREATE A BAND 20' WIDE PER SPECIES.
3. ALTERNATE SPECIES IN 20FT BANDS IN CELL 2B STARTING AT THE INFLOW END WITH SOFT STEM BULRUSH. LEAVE AN UNPLANTED BAND 20FT WIDE CENTERED ON THE ROW OR RISERS. ALTERNATE SPECIES IN 20FT BANDS IN CELL 3 STARTING AT THE INFLOW END WITH HARD STEM BULRUSH.

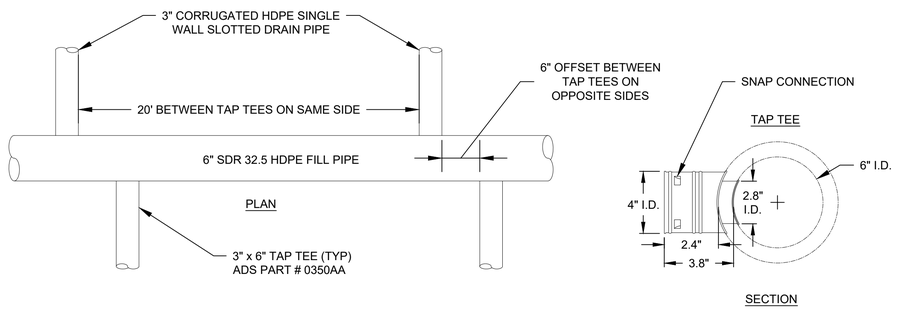
3 PLANT BAND DETAIL

NTS



4 CELL 2A BOTTOM SLOPE AND DRAIN SUMP DETAIL

NTS



5 CELL 1 INLET PIPE 6" HDPE TO 3" SLOTTED DRAIN PIPE TAP TEE

NTS

Madisen Mark
INC000003001
Digitally signed by Madisen Mark INC000003001
Date: 2020.05.01 15:20:03 -07'00'

NO.	DATE	DSGN
1	05/01/2020	D. PAIKO
0	04/03/2020	D. SPADO

REVISION: 1 WETLANDS ADDENDUM; 0 FINAL DESIGN - ISSUED FOR CONSTRUCTION

CHK	APVD	BY
M. MADISON	M. MADISON	KI
M. MADISON	M. MADISON	KI
JD	JD	KI
JD	JD	KI

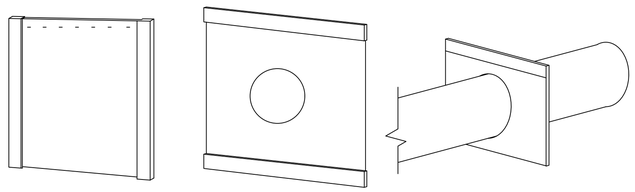
Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST
ENHANCED WETLANDS
CIVIL DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

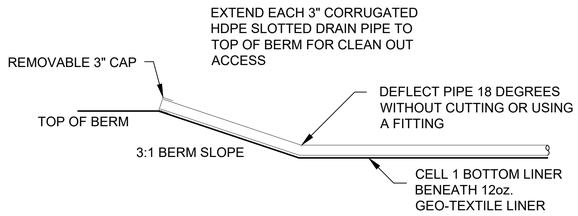
DATE	
PROJ	KMCT2019
DWG	002-C-008
SHEET	22 of 44



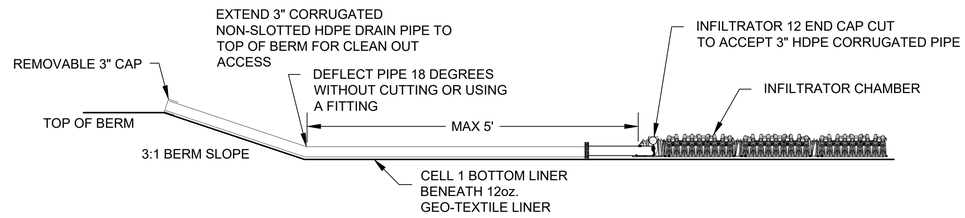
NOTES:

1. USE AGRI-DRAIN PART NUMBER ASC03 WITH 6", 10" AND 12" PIPE SIZES.
2. CUT OPENING IN CENTER OF COLLAR 1" SMALLER DIAMETER THAN PIPE OD AND STRETCH ONTO PIPE.
3. CONSTRUCTED OF 1/16" GUM RUBBER WITH A WOODEN FRAME.
4. USE ONE ANTI-SEEP COLLAR ON EACH PIPE WHERE IT CROSSES BELOW A BERM.
5. THOROUGHLY TAMP ALL MATERIAL AROUND THE MEMBRANE TO PREVENT ANY LOOSE ZONES AND VOIDS IMMEDIATELY ADJACENT TO THE PIPE AND/OR COLLAR

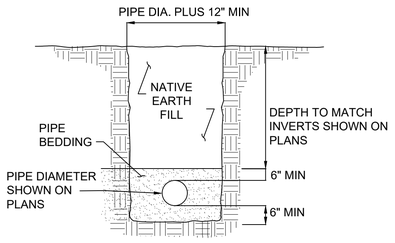
1 ANTI-SEEP COLLAR
NTS



2 SLOTTED DRAIN PIPE CLEANOUT (CELL 1)
NTS



3 INFILTRATOR CLEANOUT
NTS



6 WETLANDS PIPE TRENCH
NTS

Madison.Mark.INC0000300
Digitally signed by Madison.Mark.INC0000300
Date: 2020.05.01 15:20:03 -07'00'

NO.	DATE	DSGN	DR	CHK	APVD
1	05/01/2020	D. PAIKO	D. SPADO	M. MADISON	M. MADISON
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION			

REVISION

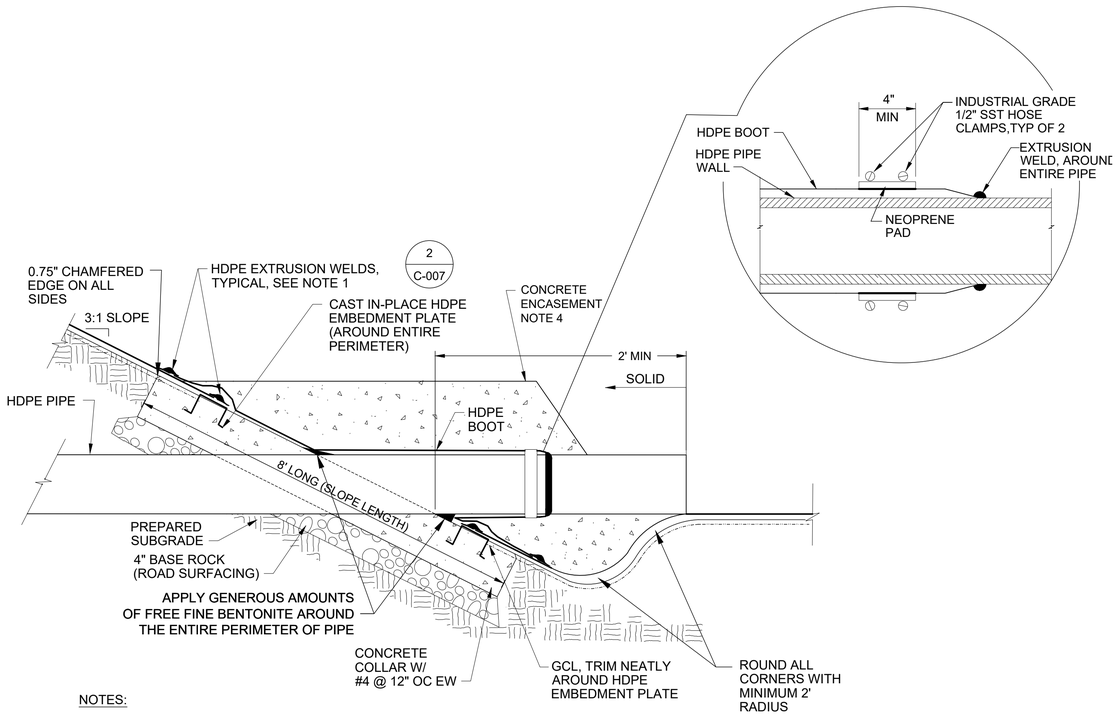
JACOBS

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

KAISER MEAD CUSTODIAL TRUST
ENHANCED WETLANDS
CIVIL DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	002-C-009
SHEET	23 of 44

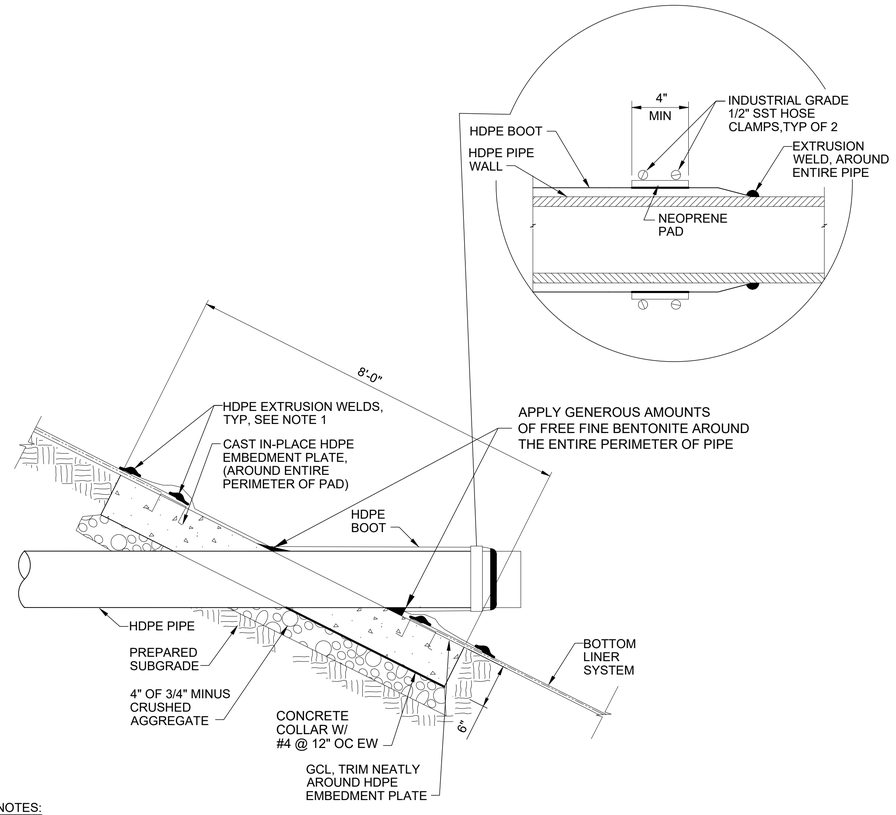


NOTES:

1. EXTRUSION WELD HDPE BOOT TO HDPE EMBEDMENT PLATE AROUND ENTIRE PENETRATION.
2. FORM BOOT WITH SUFFICIENT MATERIAL TO PREVENT OVER-STRESSING/TEARING OF HDPE LINING, BUT WITHOUT FOLDS OR WRINKLES OF HDPE GEOMEMBRANE.
3. PROVIDE 5' WIDE BY 8' LONG BY 6" THICK REINFORCED CONCRETE PAD (COLLAR), CONCRETE SHALL BE MINIMUM 3000 PSI. CENTER REINFORCEMENT MAT IN CENTER OF PAD. ALSO CENTER PIPE PENETRATION IN CENTER OF PAD (ALL DIRECTIONS). PROVIDE SMOOTH SURFACE FINISH ON PAD.
4. CAST-IN-PLACE HDPE EMBED A MINIMUM 3" FROM EDGE OF CONCRETE. COVER ENTIRE PAD WITH CUSHION GEOTEXTILE BEFORE PLACING CONCRETE ENCASEMENT.
5. PLACE MINIMUM 12" THICK CONCRETE ENCASEMENT AROUND ENTIRETY OF PIPE AND BOOT.

1 LINER PENETRATION DETAIL - 1

NTS



NOTES:

1. EXTRUSION WELD HDPE BOOT TO HDPE EMBEDMENT PLATE CONTINUOUSLY AROUND ENTIRE PENETRATION.
2. FORM BOOT WITH SUFFICIENT MATERIAL TO PREVENT OVER-STRESSING/TEARING OF HDPE LINING, BUT WITHOUT FOLDS OR WRINKLES OF HDPE GEOMEMBRANE.
3. PROVIDE 5' WIDE BY 8' LONG BY 6" THICK REINFORCED CONCRETE PAD (COLLAR). CENTER REINFORCEMENT MAT IN CENTER OF PAD. ALSO CENTER PIPE PENETRATION IN CENTER OF PAD (ALL DIRECTIONS). PROVIDE SMOOTH SURFACE FINISH ON PAD.
4. CONCRETE COLLAR NOT REQUIRED FOR EMERGENCY BYPASS PIPE PENETRATION, FIVE LOCATIONS, AND FOR CELL 1 INLET PIPE, ONE LOCATION. FOR THESE PENETRATIONS, TRIM GCL AND HDPE GEOMEMBRANE NEATLY AROUND PIPE PENETRATION AND EXTRUSION WELD HDPE BOOT TO LINER.

2 LINER PENETRATION DETAIL - 2

NTS

JAY G. DEHNER
STATE OF WASHINGTON
0023455
REGISTERED
PROFESSIONAL ENGINEER

06/04/2020

NO.	DATE	DSGN	DR	CHK	APVD
1	05/01/2020	D. PAIKO	D. SPADO	M. MADISON	M. MADISON
0	04/03/2020	KI	KI	BY	APVD
		JD	JD		

WETLANDS ADDENDUM
FINAL DESIGN - ISSUED FOR CONSTRUCTION
REVISION

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST
ENHANCED WETLANDS CIVIL DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	002-C-010
SHEET	24 of 44

NEW FENCE

KM-14 (3)

FROM WELL FIELD 3"GW-HDPE

FOR CONTINUATION SEE 000-C-002

3 (000-C-002) TO INFILTRATION BASIN 3"TE-HDPE

3" TE-HDPE TO FIRE POND

2"C FOR POWER (W/PULLSTRING)
1"C FOR CONTROLS (W/PULLSTRING)

TO 03-PB-01

EC BUILDING

SEE UNITED RENTAL DRAWINGS FOR FLOOR PENETRATIONS AND CONTINUATIONS OF PIPING INSIDE OF EC BUILDING

MANHOLE (2605-444)

3"GW-HDPE

3"TE-HDPE

2"C FOR POWER
1"C FOR CONTROLS

FIRE HYDRANT PER WHITWORTH WATER SPEC

FOR ENLARGED BUILDING PLAN SEE DRAWING 003-ME-003

3"GW-HDPE (5)

HC-8 (3)

VFD-201-ENC

WETLANDS PLC LOCAL CONTROL PANEL (2605-0085b)

3"WE-HDPE

WP/GFCI (5) (2)

VFD-202-ENC

02-PC-01 WETLANDS MINI POWER CENTER (1)

10"D-HDPE

1 (ME-002) AGRI-DRAIN WATER LEVEL CONTROL STRUCTURE INSTALLATION

WETLAND EFFLUENT PUMP STATION SEE 002-M-003

4

2 (C-010)

CELL 3B
HORIZONTAL
SUBSURFACE FLOW
(SEE SHEET 002-ME-001-B)

6 (002-C-009)

3"WR-HDPE

3"GW-HDPE

3 HC-7

CELL 3A
EXPANSION AREA
(SEE SHEET 002-ME-001-B)

CELL 2A
FILL/DRAIN
AERATION
(SEE SHEET
002-ME-001-B)

2 (C-010)

CELL 2B
AEROBIC POLISHING
(SEE SHEET 002-ME-001-B)

1 (C-010)

2 (C-010)

2 (C-010)

2 (C-010)

CELL 1
BIO-CHEMICAL REACTOR
(SEE SHEET 002-ME-001-A)

ANCHOR TRENCH, TYP. 1 (C-007)

6 (C-007) AGRI-DRAIN WATER LEVEL CONTROL STRUCTURE INSTALLATION

SITE PIPING AND ELECTRICAL PLAN

1" = 30'-0"

N

0 30 60 90

1"=30'-0"

ELECTRICAL PANELBOARD SCHEDULE

PANEL: 02-PC-01
VOLTAGE: 120/240 VAC, 1 PHASE, 3 WIRE
BUS SIZE: 100A
MAIN SIZE: 100A
SCCR:

LOCATION: WETLANDS
MOUNTING: STANCHION
FED FROM: 03-PB-01
MAIN TYPE: MAIN LUG
NOTES: NEMA 3R

CIRCUIT TITLE	BREAKER CKT NO.	BREAKER AMP	BREAKER POLE	LOAD, VA PHASE A	LOAD, VA PHASE B	LOAD, VA PHASE A	LOAD, VA PHASE B	BREAKER POLE	BREAKER AMP	BREAKER CKT NO.	CIRCUIT TITLE
PMP-201 (THROUGH VFD-201)	1	30	2	550		550		2	30	2	PMP-202 (THROUGH VFD-202)
---	3	---	---		550		550	---	---	4	---
RECEPTACLE	5	15	1	180				1	15	6	FUTURE LIGHT
FIT-210	7	15	1		50		50	1	15	8	LIT-210
SPARE	9	15	1					1	15	10	SPARE
SPARE	11	15	1					---	---	12	SPACE
SPACE	13	---	---					---	---	14	SPACE
SPACE	15	---	---					---	---	16	SPACE
SPACE	17	---	---					---	---	18	SPACE
SPACE	19	---	---					---	---	20	SPACE
SPACE	21	---	---					---	---	22	SPACE
SPACE	23	---	---					---	---	24	SPACE
	TOTAL LOAD			730	600	550	600				

PHASE A LOAD (VA) = 1280
PHASE B LOAD (VA) = 1200
TOTAL LOAD (VA)= 2480

GENERAL NOTES

1. ALL HDPE PIPE WITHIN WETLANDS FOOTPRINTS IS DR 32.5 EXCEPT 3" CORRUGATED AG DRAIN PIPE.
2. ALL PIPES IN THE WETLANDS AND ROWS OF INFILTRATORS HAVE ONE OR BOTH ENDS (AS INDICATED IN DRAWINGS) EXTENDED TO THE TOP OF BERM WITH CAPS FOR CLEANOUT.
3. ALL AGRI-DRAIN STRUCTURES ARE LOCATED IN THE BERM ACCESS ROAD BETWEEN VEHICLE WHEEL TRACKS.
4. ONLY MAINLINE PIPING OF THE WETLANDS IS SHOWN ON THIS SHEET.
5. ALL PIPE TRENCH WITHIN WETLANDS AND BERMS TO MATCH DETAIL (6/002-C-008).

SHEET KEYNOTES

1. PROVIDE SHEET METAL STANCHION FOR MOUNTING OF ELECTRICAL EQUIPMENT.
2. STUB UP CONDUIT TO STRUT MOUNTED RECEPTACLE. MOUNT RECEPTACLE AT 2'-6" AFG.
3. EXISTING WELL TO REMAIN, PRESERVE AND PROTECT.
4. AT PIPE OUTLET TO ROAD DITCH PROVIDE 1' THICK LAYER OF 6" RIP RAP TO ARMOR DITCH BOTTOM AND 2' UP BOTH SIDE SLOPES FOR 50' OF DITCH LENGTH.
5. BRANCH THE DISCHARGE FROM FINAL EFFLUENT PUMPS TO (2) 3"-TE-HDPE PIPES WITH ISOLATION BALL VALVES INSIDE THE EC BUILDING FOR DIRECTING THE T.E. FLOW EITHER TO INFILTRATION BASIN OR FIRE POND.

LEGEND

INFILTRATORS

NON-PERFORATED SDR 32.5 HDPE FILL PIPES

PIPE-LINER PENETRATION

BRIAN MACLEAN PALMER — STATE OF WASHINGTON — 20111216 — REGISTERED PROFESSIONAL ENGINEER

05/08/2020
ELECTRICAL

Madison.Mark.INC00003001
Digitally signed by Madison.Mark.INC00003001
Date: 2020.05.05 13:09:09 -07'00'
PIPING

NO.	DATE	DSGN	DR	CHK	APVD	BY	APVD
1	05/01/2020	M.ALEXANDER	T.KENDALL	B.PILMER	B.PILMER	KI	JD
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION				KI	JD
		REVISION				BY	APVD

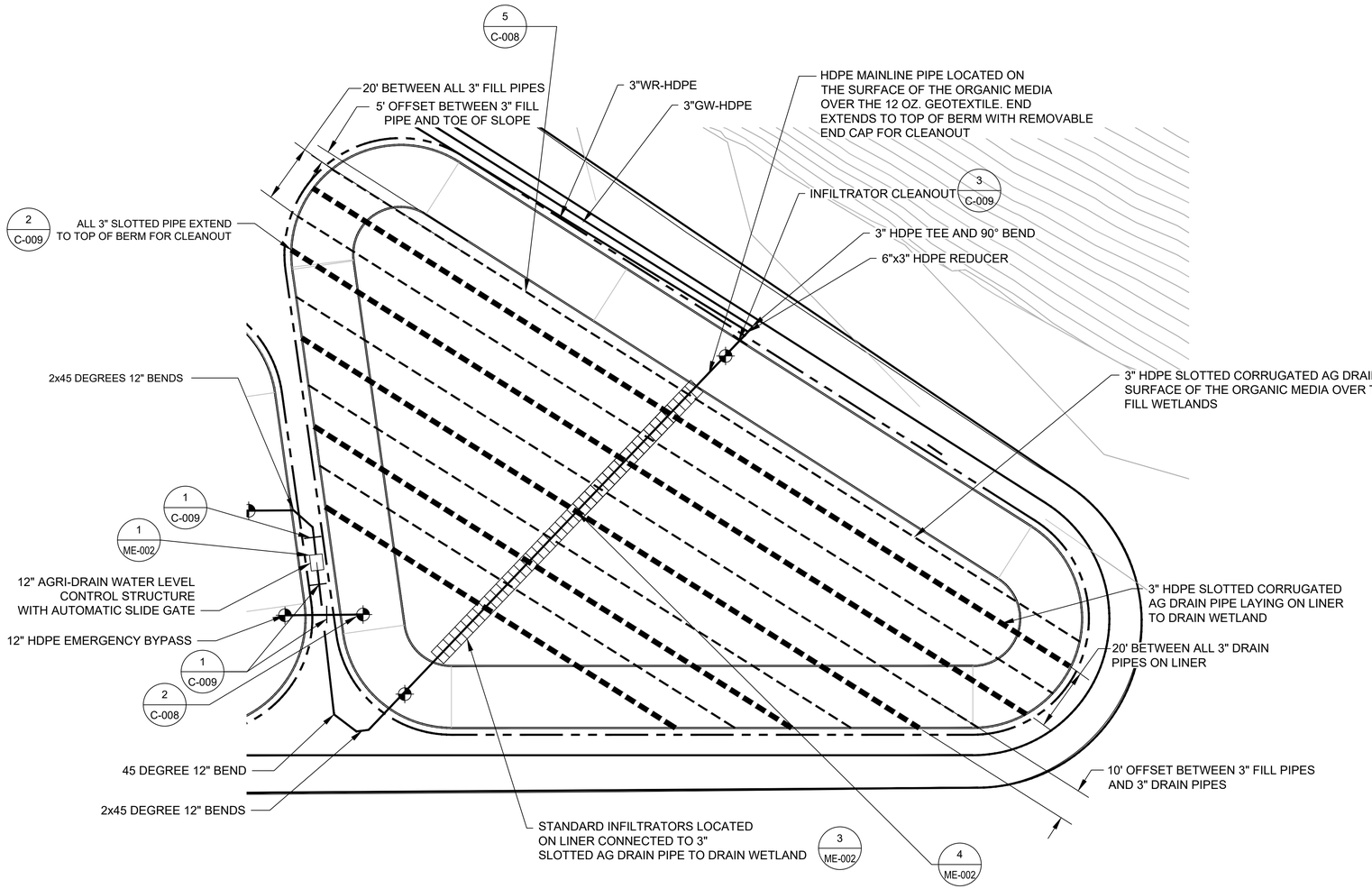
JACOBS

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

KAISER MEAD CUSTODIAL TRUST
ENHANCED WETLANDS
SITE PIPING AND ELECTRICAL PLAN

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	002-ME-001
SHEET	25 of 44



CELL 1 PIPING PLAN

1" = 20'-0"

N

0 20 40 60

1"=20'-0"

GENERAL NOTES

1. ALL HDPE PIPE IS DR 32.5 EXCEPT 3" CORRUGATED AG DRAIN PIPE.
2. ALL PIPES IN THE WETLANDS AND ROWS OF INFILTRATORS HAVE ONE OR BOTH ENDS (AS INDICATED IN DRAWINGS) EXTENDED TO THE TOP OF BERM WITH CAPS FOR CLEANOUT.
3. ALL AGRI-DRAIN STRUCTURES ARE LOCATED IN THE BERM ACCESS ROAD BETWEEN VEHICLE WHEEL TRACKS.
4. INFILTRATORS "ON LINER" TO BE PLACED ABOVE THE 12oz. GEO-TEXTILE LINER SEPARATION.

SHEET KEYNOTES

1. 3" NON-PERFORATED CORRUGATED HDPE DRAIN PIPE EXTENSION FROM END OF INFILTRATORS TO TOP OF BERM, NORTH END WITH THREADED END CAP FOR CLEAN OUT.

LEGEND

- INFILTRATORS
- PERFORATED CORRUGATED HDPE DRAIN PIPING
- PERFORATED CORRUGATED HDPE FILL PIPING
- PIPE-LINER PENETRATION

Madison, Mark INC000003001

Digitally signed by Madison, Mark INC000003001
Date: 2020.05.04 15:27:48 -07'00'

NO.	DATE	DSGN	DR	CHK	APVD
1	05/01/2020	D. PAIKO	D. SPADO	M. MADISON	M. MADISON
0	04/03/2020				

1 05/01/2020 WETLANDS ADDENDUM — KI JD BY APVD
0 04/03/2020 FINAL DESIGN - ISSUED FOR CONSTRUCTION — KI JD

REVISION

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

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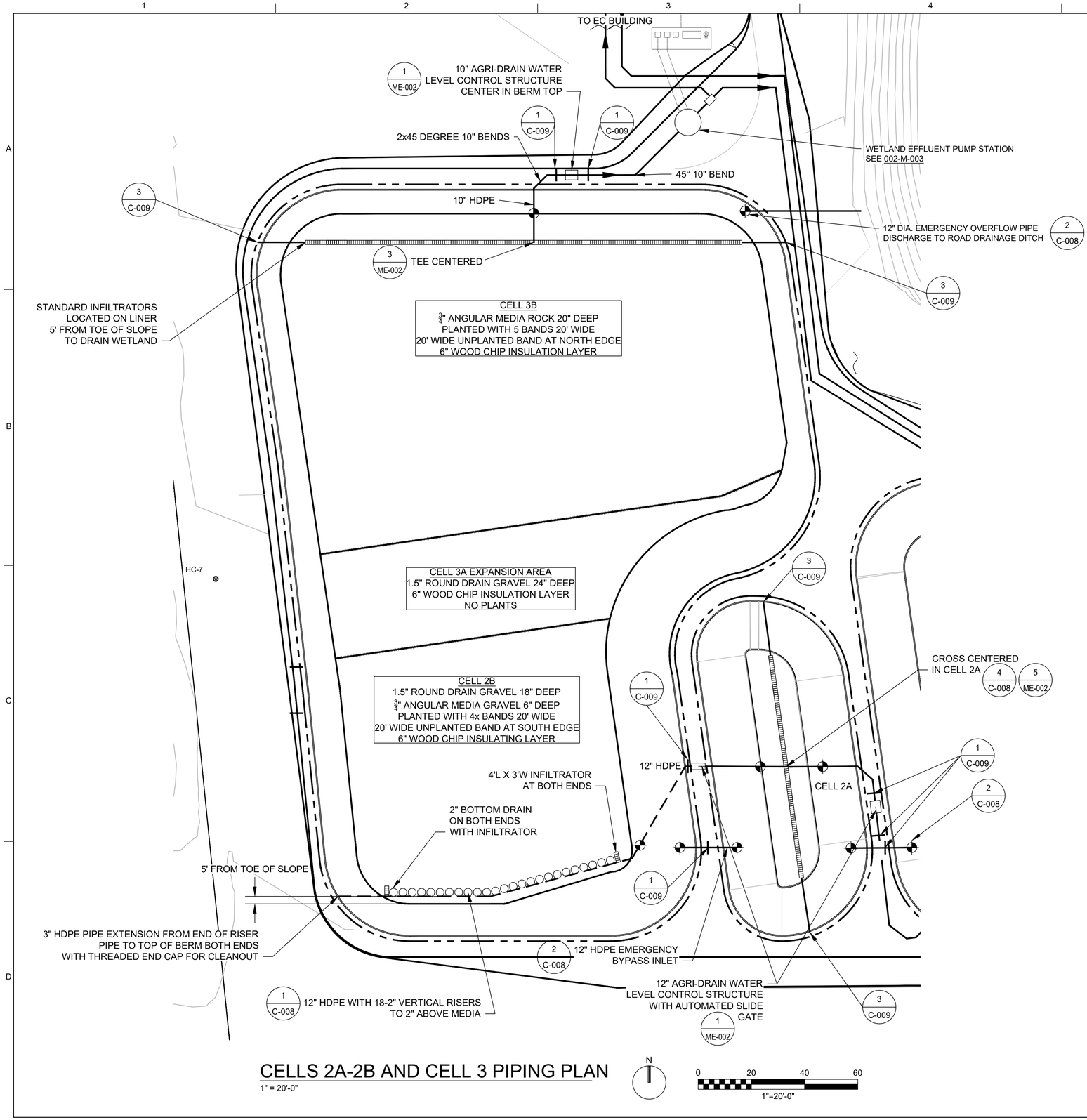
ENHANCED WETLANDS WETLANDS PIPING PLAN CELL 1

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	
PROJ	KMCT2019
DWG	002-ME-001_A
SHEET	26 of 44



CELLS 2A-2B AND CELL 3 PIPING PLAN

1" = 20'-0"

N

0 20 40 60

1"=20'-0"

GENERAL NOTES

1. ALL HDPE PIPE IS DR 32.5 EXCEPT 3" SLOTTED CORRUGATED AG DRAIN PIPE.
2. ALL PIPES IN THE WETLANDS ROWS OF INFILTRATORS HAVE ONE OR BOTH ENDS (AS INDICATED IN DRAWINGS) EXTENDED TO THE TOP OF BERM WITH CAPS FOR CLEANOUT.
3. ALL AGRI-DRAIN STRUCTURES ARE LOCATED IN THE BERM ACCESS ROAD BETWEEN VEHICLE WHEEL TRACKS.
4. INFILTRATORS "ON LINER" TO BE PLACED ABOVE THE 12oz. GEO-TEXTILE LINER SEPARATION.
5. PLANT SURFACE AREA OF CELL 2B AND 3 PER DETAIL (3/C-008). 20' WIDE ZONE WITH NO PLANTS ALONG SOUTH EDGE OF CELL 2B AND NORTH EDGE OF CELL 3. 40' WIDE ZONE WITH NO PLANTS BETWEEN CELL 2B AND CELL 3.

SHEET KEYNOTES

1. 3" NON-PERFORATED CORRUGATED HDPE DRAIN PIPE EXTENSION FROM END OF INFILTRATORS TO TOP OF BERM, BOTH ENDS WITH THREADED END CAP FOR CLEAN OUT.
2. ONE ANTI-SEEP COLLAR ON EVERY PIPE THAT CROSSES A BERM, CENTERED IN BERM.

LEGEND

INFILTRATORS

PIPE-LINER PENETRATION

Madison, Mark INC0000300

Digitally signed by Madison, Mark INC0000300

Date: 2020.05.04 15:27:48 -07'00'

NO.	DATE	DSGN	DR	CHK	APVD	BY	APVD
1	05/01/2020	D. PAIKO	D. SPADO	M. MADISON	M. MADISON	KI	JD
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION				KI	JD
		REVISION					

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
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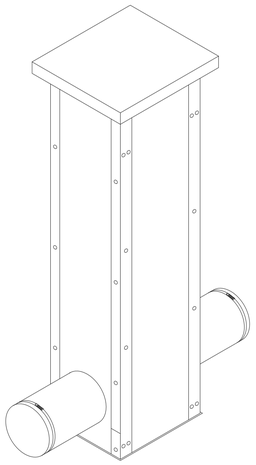
ENHANCED WETLANDS
WETLANDS PIPING PLAN
CELLS 2&3 PIPING PLAN

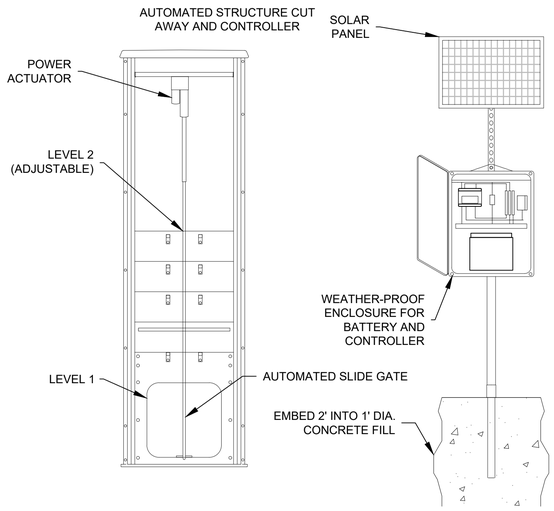
VERIFY SCALE

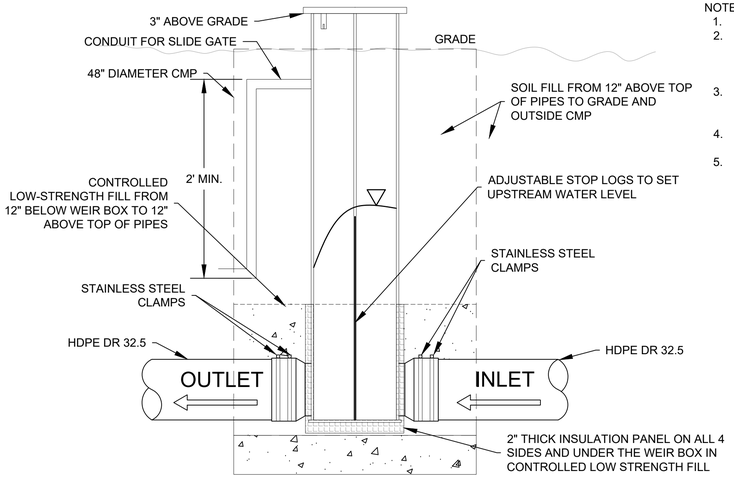
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	
PROJ	KMCT2019
DWG	002-ME-001_B
SHEET	27 of 44

MANUAL AND AUTOMATED STRUCTURE ISOMETRIC



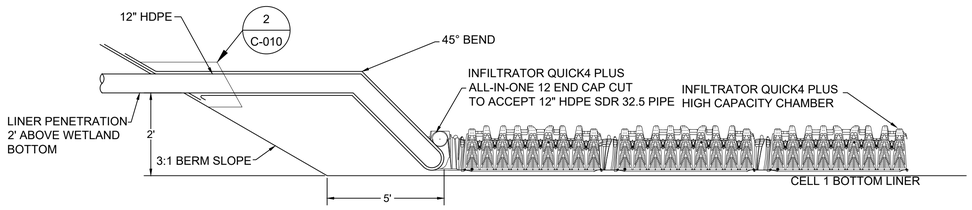




NOTES:
1. 10" MANUAL STRUCTURES IS 3 FT TALL.
2. 12" AUTOMATED STRUCTURE AT CELL 1 OUTLET IS 6' TALL WITH SLIDE GATE LOCATED AT BOTTOM, 12" AUTOMATED STRUCTURE AT CELL 2A OUTLET IS 8' TALL WITH SLIDE GATE LOCATED AT BOTTOM OF STRUCTURE.
3. 12" AUTOMATED STRUCTURES SHALL BE CAPABLE OF UP TO A MAXIMUM OF 8 OPEN PLUS 8 CLOSE CYCLES PER DAY AND A MINIMUM OF 4 CYCLES PER DAY
4. 48" DIA. CMP FROM 12" BELOW PIPE INVERT TO GRADE WITH TWO SLOTS TO ALLOW PLACING OVER PIPES WITHOUT RESTING ON PIPES.
5. MOUNT SOLAR PANEL AND CONTROLER AT EDGE OF BERM TOP AND RUN POWER WIRE IN CONDUIT TO GATE OPERATOR. BURY CONDUIT 2' MIN.

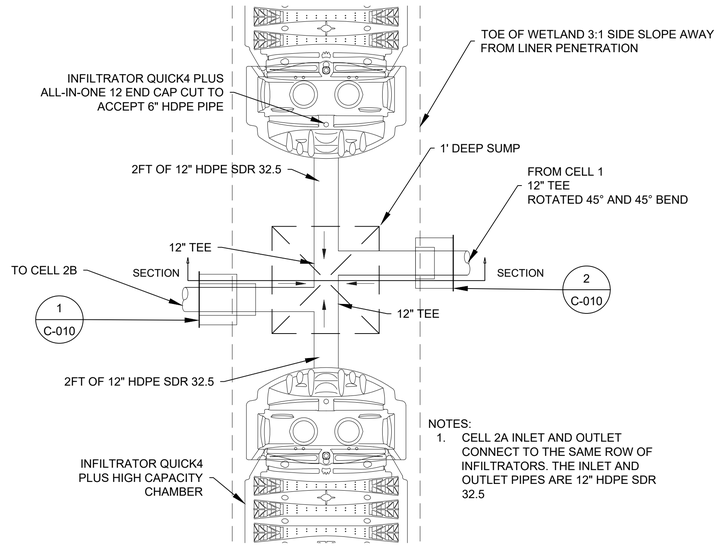
1 AGRI-DRAIN INLINE WATER LEVEL CONTROL STRUCTURE AND INSTALLATION DETAILS

NTS



3 INFILTRATOR TO HDPE PIPE TRANSITION - CELL 1

NTS

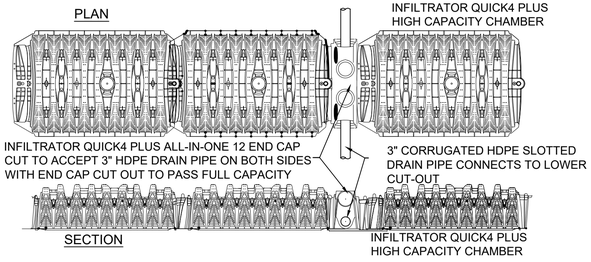


NOTES:
1. CELL 2A INLET AND OUTLET CONNECT TO THE SAME ROW OF INFILTRATORS. THE INLET AND OUTLET PIPES ARE 12" HDPE SDR 32.5

5 FILL AND DRAIN PIPE TO INFILTRATOR PLAN - CELL 2A

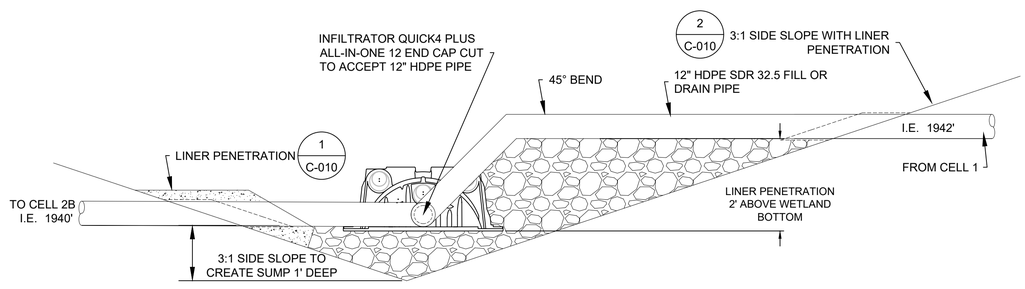
NTS

PLAN



4 HDPE SLOTTED DRAIN TO INFILTRATOR DETAIL - CELL 1

NTS



6 FILL AND DRAIN PIPE TO INFILTRATOR PROFILE - CELL 2A

NTS

Madison.Mark INC000003001
Digitally signed by Madison.Mark INC000003001
Date: 2020.05.04 15:27:48 -07'00'

NO.	DATE	DSGN	DR	CHK	APVD
1	05/01/2020	WETLANDS ADDENDUM	KI	JD	APVD
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION	KI	JD	M. MADISON
		REVISION	BY	APVD	M. MADISON
		D. PAIKO	D. SPADO		

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST

ENHANCED WETLANDS
MECHANICAL AND ELECTRICAL DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	002-ME-002
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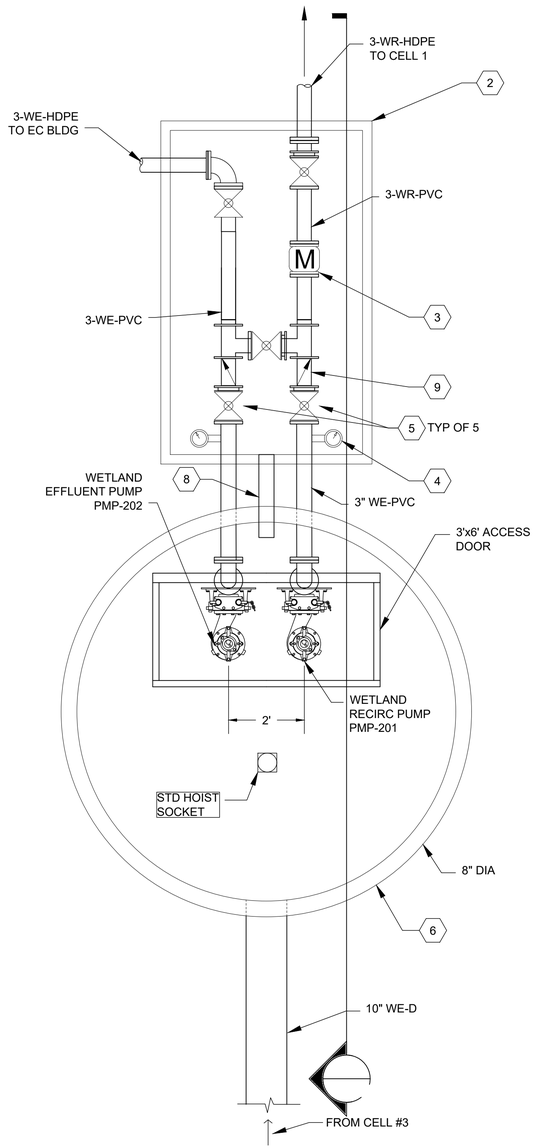
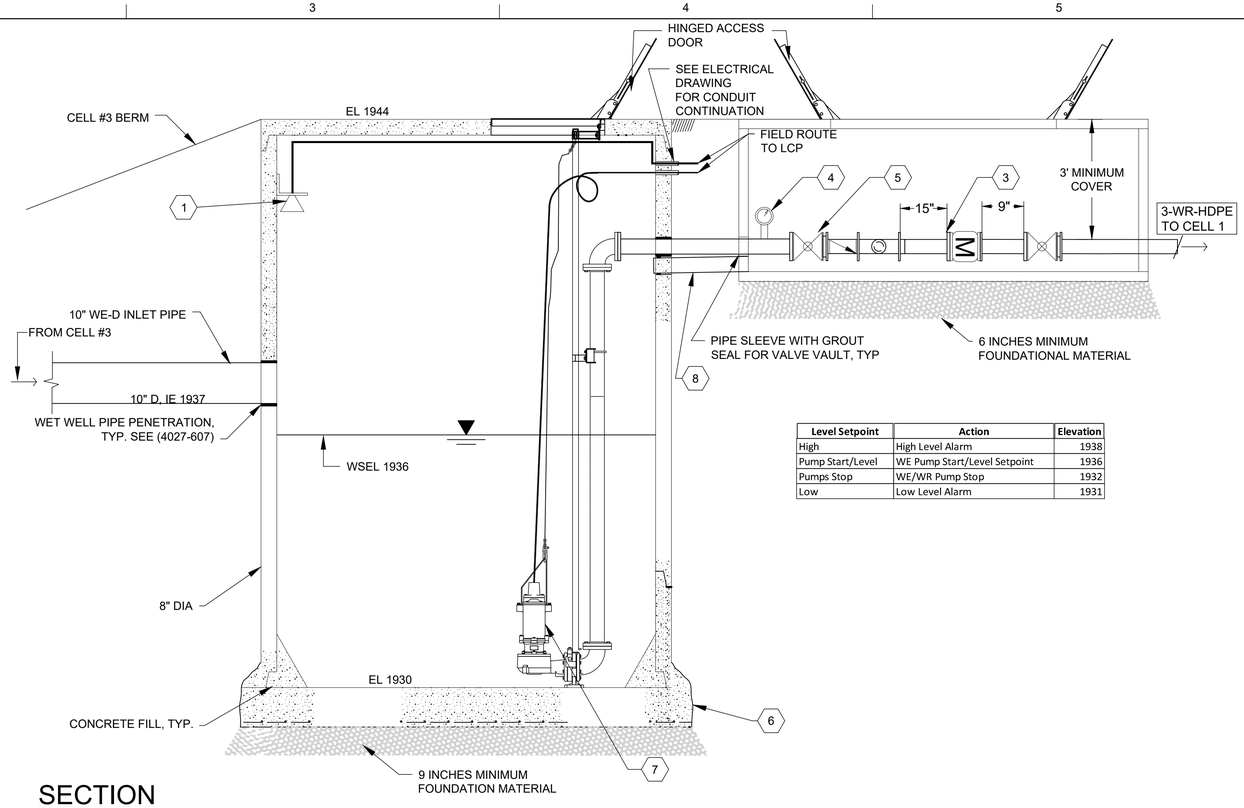


PUMP STATION PLAN

NTS



Level Setpoint	Action	Elevation
High	High Level Alarm	1938
Pump Start/Level	WE Pump Start/Level Setpoint	1936
Pumps Stop	WE/WR Pump Stop	1932
Low	Low Level Alarm	1931

SECTION

NTS

WETLAND EFFLUENT SUMP PUMP SCHEDULE

PMP-201	WR SUMP PUMP	75 GPM AT 19 FT TDH MAX (50 GPM AT 10 FT TDH TYP)	GOULDS 3WD51E3AA, 1HP, 230V/3PH MOTORS WITH VFD POWER SUPPLY
PMP-202	WE SUMP PUMP	75 GPM AT 19 FT TDH MAX (50 GPM AT 17 FT TDH TYP)	GOULDS 3WD51E3AA, 1HP, 230V/3PH MOTORS WITH VFD POWER SUPPLY

SUBMERSIBLE PUMP TESTING REQUIREMENTS:

3.01 FIELD QUALITY CONTROL

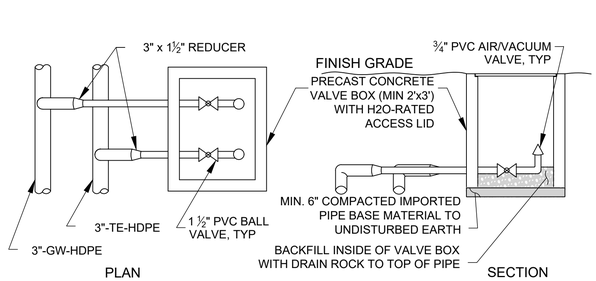
A. FUNCTIONAL TEST: CONDUCT ON EACH PUMP.

1. ALIGNMENT: TEST COMPLETE ASSEMBLIES FOR CORRECT ROTATION, PROPER ALIGNMENT AND CONNECTION, AND QUIET OPERATION.
2. FLOW OUTPUT: MEASURED BY PLANT INSTRUMENTATION AND/OR WET WELL VOLUME.
3. TEST FOR CONTINUOUS 30-MINUTE PERIOD, MINIMUM.

B. PUMP TEST:

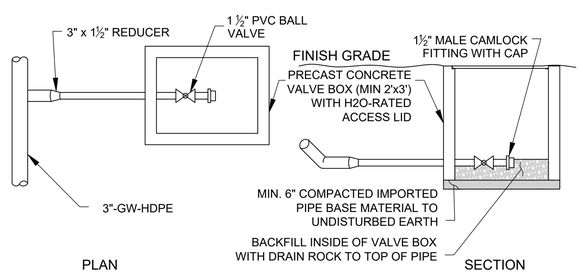
1. GENERAL:
   a. CONDUCT ON EACH PUMP PROVIDED.

2. ROUTINE PRODUCTION TESTS:
   a. CHECK IMPELLER, MOTOR RATING AND ELECTRICAL CONNECTIONS FOR COMPLIANCE TO SPECIFICATION OR INDUSTRY STANDARD.
   b. TEST MOTOR AND CABLE INSULATION FOR MOISTURE CONTENT AND INSULATION DEFECTS.
   c. PRIOR TO SUBMERGENCE, RUN PUMP DRY TO ESTABLISH CORRECT ROTATION AND MECHANICAL INTEGRITY.
   d. CONDUCT ABBREVIATED THREE-POINT OPERATIONAL PERFORMANCE TEST.



5 AIR/VACUUM RELEASE VALVE ASSEMBLY

NTS



6 BLOWOFF STATION

NTS

GENERAL NOTES

1. SEE 002-ME-001 FOR PUMP STATION LOCATION AND ORIENTATION.

SHEET KEYNOTES

1. LEVEL ELEMENT SEE TABLE FOR PUMP CONTROL SITE POINTS. SEE I&C DWGS FOR DETAILS.
2. PROVIDE PRECAST CONCRETE VAULT, MINIMUM 4'x8', IN ACCORDANCE WITH SECTION 33 05 13, MANHOLES.
3. MAGNETIC FLOWMETER, INSTALL WITH RECOMMENDED UPSTREAM AND DOWNSTREAM STRAIGHT FUNS AS RECOMMEND BY MFR. SEE I&C DWGS FOR DETAILS.
4. PRESSURE SWITCH WITH PRESSURE GAUGE, TYP OF 2, SEE I&C DWGS FOR DETAILS.
5. PVC (SCH 80) BALL VALVE, TYP.
6. PROVIDE 8-FOOT DIAMETER, PRECAST CONCRETE MANHOLE IN ACCORDANCE WITH SECTION 33 05 13, MANHOLES.
7. SUBMERSIBLE CENTRIFUGAL WASTEWATER SUMP PUMPS; SEE SCHEDULE FOR DETAILED INFO. INSTALL PUMPS IN ACCORDANCE WITH MFRS RECOMMENDATIONS AND COORDINATE ACCESS HATCH LOCATION FOR PUMP ACCESS.
8. 3-D-PVC: INSTALL VAULT GRAVITY DRAIN PIPE WITH 1 PERCENT SLOPE TO WET WELL. GROUT SEAL VAULT PENETRATION; SEAL WET WELL PENETRATION PER DETAIL 4027-607.
9. PVC (SCH80), SWING CHECK VALVE; SEE 000-G-002.

WILLIAM S. FARMER
STATE OF WASHINGTON
28512
REGISTERED
PROFESSIONAL ENGINEER
4-3-20

NO.	DATE	DSGN	DR	CHK	APVD
0	04/03/2020	B. FARMER	D. SPADO	B. FARMER	B. FARMER

FINAL DESIGN - ISSUED FOR CONSTRUCTION

REVISION	BY	APVD
	KI	JD

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST

ENHANCED WETLANDS: PROCESS MECHANICAL

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	002-M-003
SHEET	29 of 44

EC SYSTEM PLC *

WETLANDS PLC CONTROL PANEL

EQUIPMENT READY * (DO)

GENERAL ALARM * (DI)

WETLANDS PLC

GEN. ALM (1) | EC SYS. RDY (2) | PRESS HI (3) | PRESS HI (4) | MOIST ALM (5) | TEMP ALM (6) | MOIST ALM (7) | TEMP ALM (8) | FLOW (9)

VFD-201 **

FAULT (10) | RUNNING (11) | FAULT | SPEED CMD | SPEED FB | RUN CMD | RUN FB | RESET

VFD HIM DISPLAY

5

7 8 RED FLT GRN RUN

** VFD-201-ENC

VFD-202 **

FAULT (12) | RUNNING (13) | FAULT | SPEED CMD | SPEED FB | RUN CMD | RUN FB | RESET | LEVEL (14)

VFD HIM DISPLAY

6

9 10 RED FLT GRN RUN

** VFD-202-ENC

HMI

SIEMENS PANEL

WE SUMP VALVE VAULT

FIT 210

FE 210

120V

M

3" WR

N.C.

3" WE

TO EC TREATMENT

PSH 210 (1)

PSH 220 (2)

WETLAND CELL 1

12V SOLAR AUTOMATIC SLIDE GATE

WETLAND CELL 2A/2B

WETLAND CELL 3

FROM WELLFIELD VIA EC BUILDING

12V SOLAR AUTOMATIC SLIDE GATE

11

LIT 210

LE 210

120V

240V 3ph

3 5 AS PMP-201

240V 3ph

4 6 AS PMP-202

WETLAND EFFLUENT SUMP

GENERAL NOTES

1. FOR ABBREVIATIONS AND SYMBOLS REFER TO I&C LEGENDS IN GENERAL DRAWINGS SECTION
2. AUTO/MANUAL CONTROL AND SPEED SET POINTS FOR PUMPS WILL BE DONE VIA HMI. LOCAL MANUAL CONTROL OF PUMPS SHALL BE AVAILABLE THROUGH THE VFD HIM KEYPAD

PMP-201 = WR PUMP

PUMPS RECIRC FLOW BACK TO CELL 1 AND IS CONTROLLED ON A FLOW CONTROL LOOP

PMP-202 = WE PUMP

PUMPS FLOW TO EC SYSTEM AND IS ON LEVEL CONTROL LOOP

JOSHUA CLEMENT THOMPSON — STATE OF WASHINGTON — 52696 — REGISTERED PROFESSIONAL ENGINEER — 05/07/2020

NO.	DATE	DESCRIPTION	DR	CHK	APVD
1	05/01/2020	EXTRACTION SYSTEM ADDENDUM	JD	KI	APVD
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION	JD	KI	APVD

DSGN: JD DR: JD CHK: KI APVD: BY

DESIGNED — DRAWN BY — CHECKED BY — APPROVED BY — SERVICE DATE

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST

ENHANCED WETLANDS:
P&ID
WETLANDS PUMP AND LIFT STATION

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	
PROJ	KMCT2019
DWG	002-I-001
SHEET	30 of 44

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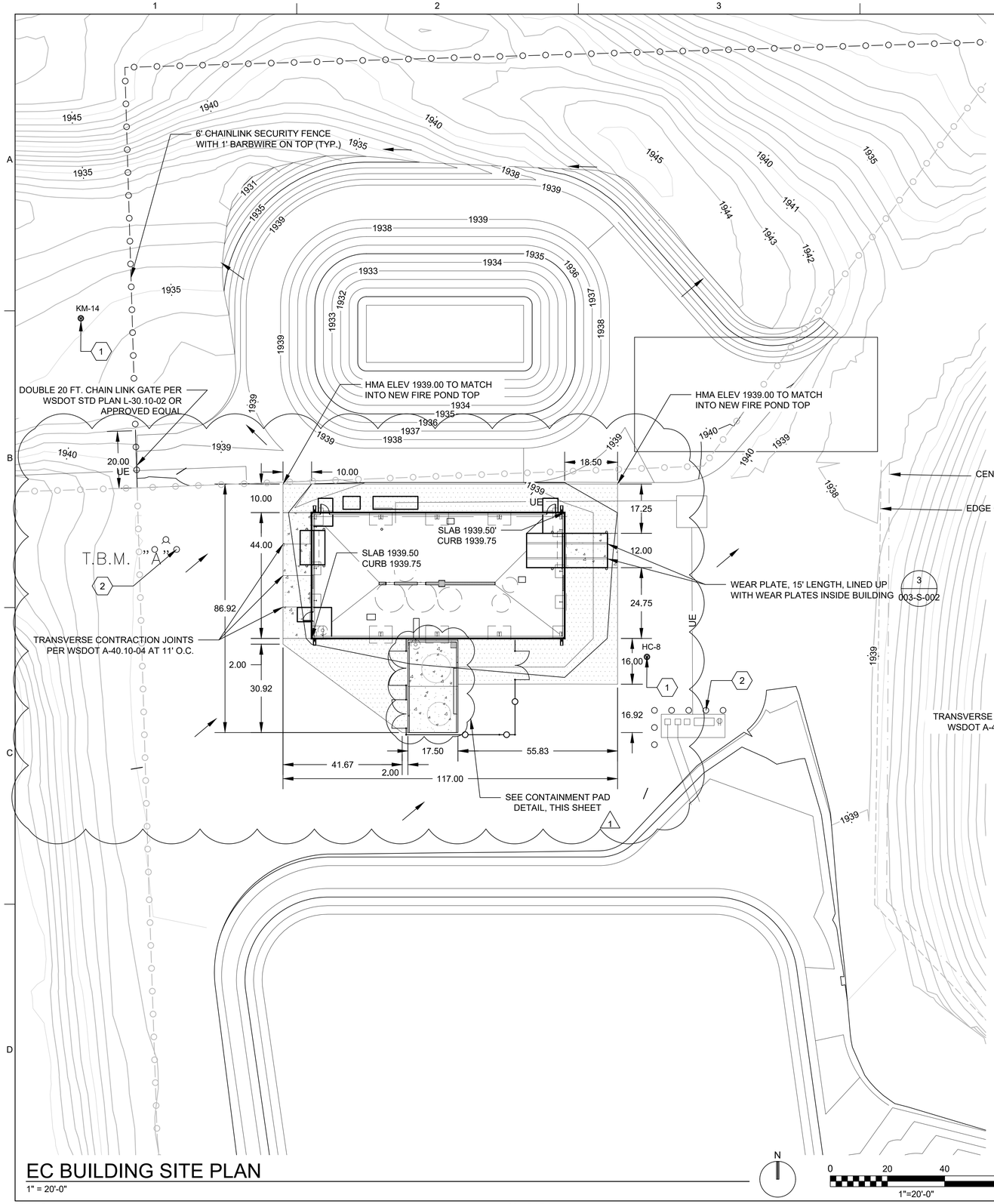
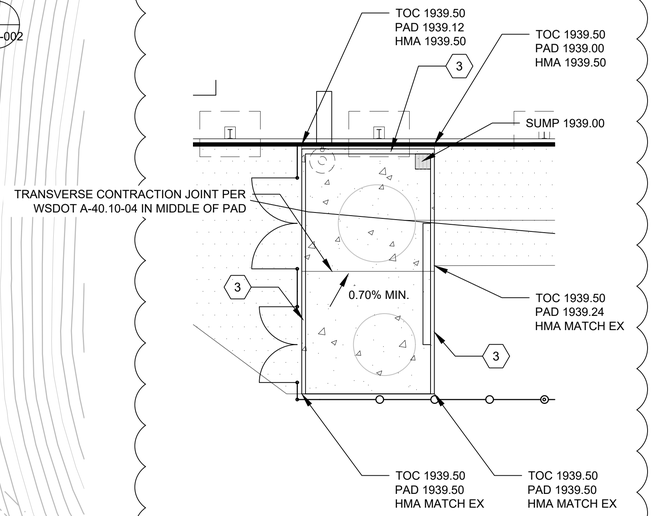


EC BUILDING SITE PLAN

1" = 20'-0"



CONTAINMENT PAD DETAIL

1" = 10'-0"

GENERAL NOTES

1. HMA AND CONCRETE EDGES TO BE SAWCUT TO EXISTING ASPHALT PAVEMENT.
2. TRENCHES FOR UTILITIES THAT ARE NOT UNDER THE WETLANDS BERMS (SHOWN ON SHEET 002-ME-001) BUT ARE UNDER ASPHALT ARE TO BE REPAIRED FOLLOWING THE INLAND NORTHWEST REGIONAL PAVEMENT CUT POLICY UTILIZING THE ASPHALT SECTION DETAILED IN THE LEGEND BELOW.
3. ALL SURFACES TO DRAIN AWAY FROM BUILDING.
4. BUILDING SLAB ELEVATION OF 1939.50 IS DETERMINED FROM LIDAR SURVEY AND MAY NEED TO BE FIELD ADJUSTED. BUILDING CURB TO BE A MINIMUM OF 1" ABOVE EXISTING ELEVATION TO FACILITATE DRAINAGE.
5. ALL HMA AND CONC. CONNECTIONS TO BUILDING ARE AT 1939.50 AND SLOPE DOWN AND AWAY FROM BUILDING TO MATCH INTO EXISTING ELEVATIONS UNLESS OTHERWISE NOTED.

1

SHEET KEYNOTES

1. EXISTING WELL TO REMAIN, PRESERVE AND PROTECT.
2. EXTERIOR BOLLARDS PER DETAIL 3471-810 ON SHEET 003-S-004. MAXIMUM 6' SPACING ON-CENTER. ENSURE FULL COVERAGE AROUND FIRE HYDRANT AND WETLAND POWER CENTER. SEE SHEET 003-S-001 FOR LOCATION OF BOLLARDS AROUND AND INSIDE BUILDING (NOT SUBJECT TO 6' SPACING).
3. CEMENT CONC. PEDESTRIAN CURB PER WSDOT STD PLAN F-10.12-03 WITH VARIABLE EXPOSED HEIGHT.

1

LEGEND

HMA PERFORMANCE GRADE 70-34 MIN 3" THICK OVER MIN 4" CRUSHED SURFACING BASE COURSE PER WSDOT OR APPROVED EQUAL.

CONCRETE PAD MIN 6" THICK OVER MIN 6" CRUSHED SURFACING BASE COURSE PER WSDOT OR APPROVED EQUAL. ½" JOINT FILLER TO BE INSTALLED BETWEEN CONCRETE AND BUILDING FOUNDATION.

SITE DRAINAGE FLOW DIRECTION.

STUART W.L. BARTON
STATE OF WASHINGTON
PROFESSIONAL ENGINEER
22851
2020-05-08

NO.	DATE	DSGN	DR	CHK	APVD
1	05/01/2020	WETLANDS ADDENDUM	KI	JD	S. BARTON
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION	KI	JD	S. BARTON
		REVISION	BY	APVD	

E. PIETRICK D. SPADO

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST
EC BUILDING
SITE PLAN AND DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

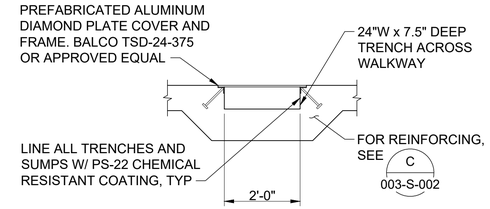
DATE	
PROJ	KMCT2019
DWG	003-C-001
SHEET	31 of 44

GENERAL NOTES

1. SEE SPECIFICATION 13 34 19 FOR PRE-ENGINEERED STEEL BUILDING DESCRIPTION AND THE DESCRIPTION OF DOORS AND LOUVERS.
2. SEE DRAWING KM-011 FOR PROCESS EQUIPMENT PLAN.
3. FOR DESCRIPTION OF PAINTS AND PAINT APPLICATIONS, SEE 09 90 00 PAINTING AND COATING.
4. ALL INTERIOR STRUCTURAL STEEL AND DECKING SHALL BE PAINTED WITH PAINT SYSTEM NO. 5 COLOR: WHITE.
5. INTERIOR AND EXTERIOR BOLLARDS SHALL BE PAINTED WITH PAINT SYSTEM NO. 5 COLOR: SAFETY YELLOW.
6. THE WALLS AND FLOORS OF ALL TRENCHES AND SUMP SHALL BE PAINTED WITH PAINT SYSTEM NO. 22.
7. INCLUDE PROPER ALLOWANCE FOR 6-INCH STRUCTURAL FILL BENEATH SLAB AND FOOTINGS PER EARTHWORK SPECIFICATION.
8. CENTER OPENING ON TRENCH BELOW. SEAL BETWEEN PIPE AND METAL LINER USING POLYURETHANE SEALANT WITH BACKER ROD EACH FACE. COORDINATE HEIGHT OF OPENINGS WITH EXTERIOR TANK INSTALLATION.

FEXT 10lb CLASS ABC FIRE EXTINGUISHER.

1 CONDUIT PENETRATION
NTS



2 PIPE TRENCH
NTS

FOUNDATION PLAN
3/16" = 1'- 0"

.5% SLOPE

1	05/01/2020	STRUCTURAL ADDENDUM	JD
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION	JD
NO.	DATE	REVISION	BY
DSGN	Liao Y.	DR	Matt C.
		CHK	Gary B.
		APVD	Liao Y.

LIAO YANG — STATE OF WASHINGTON — 49264 — REGISTERED PROFESSIONAL ENGINEER — 05-18-2020

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST

EC BUILDING:
FOUNDATION PLANS
SECTIONS AND DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	
PROJ	KMCT2019
DWG	003-S-001
SHEET	32 of 44

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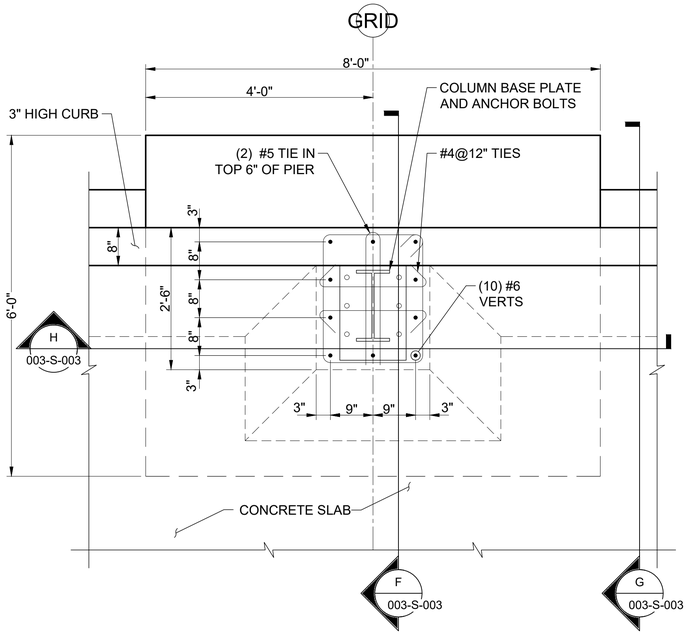
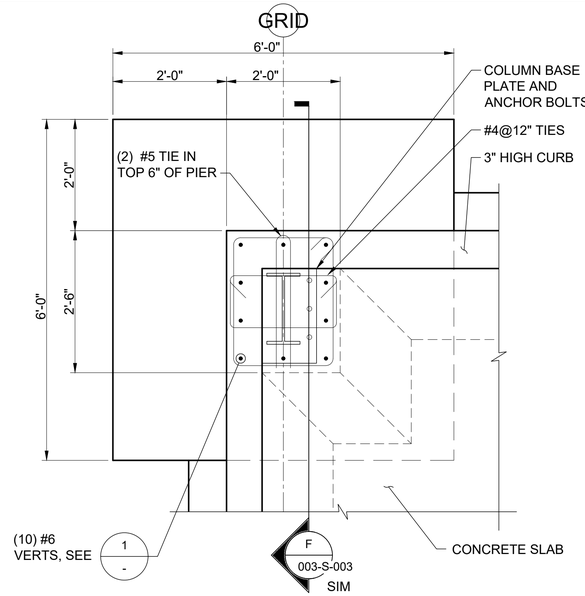


1 COLUMN FOOTING PLAN

3/4" = 1'-0"

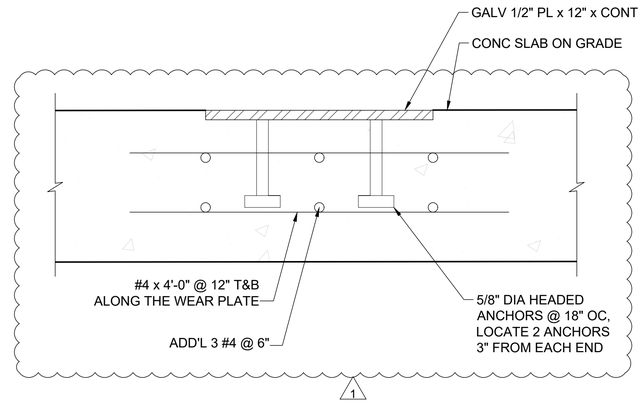
003-S-001



2 COLUMN FOOTING PLAN

3/4" = 1'-0"

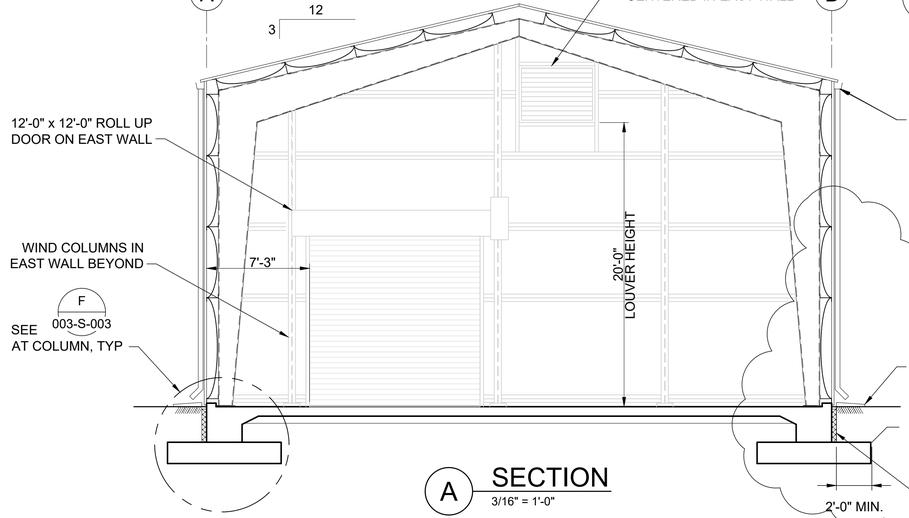
003-S-001



3 WEAR PLATE DETAIL

3" = 1'-0"

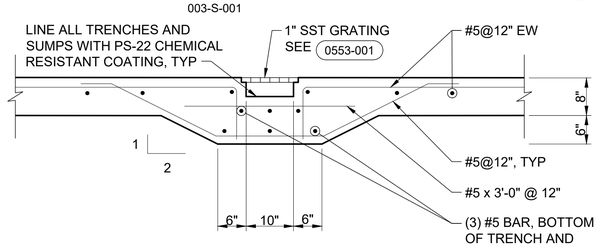
003-S-001



A SECTION

3/16" = 1'-0"

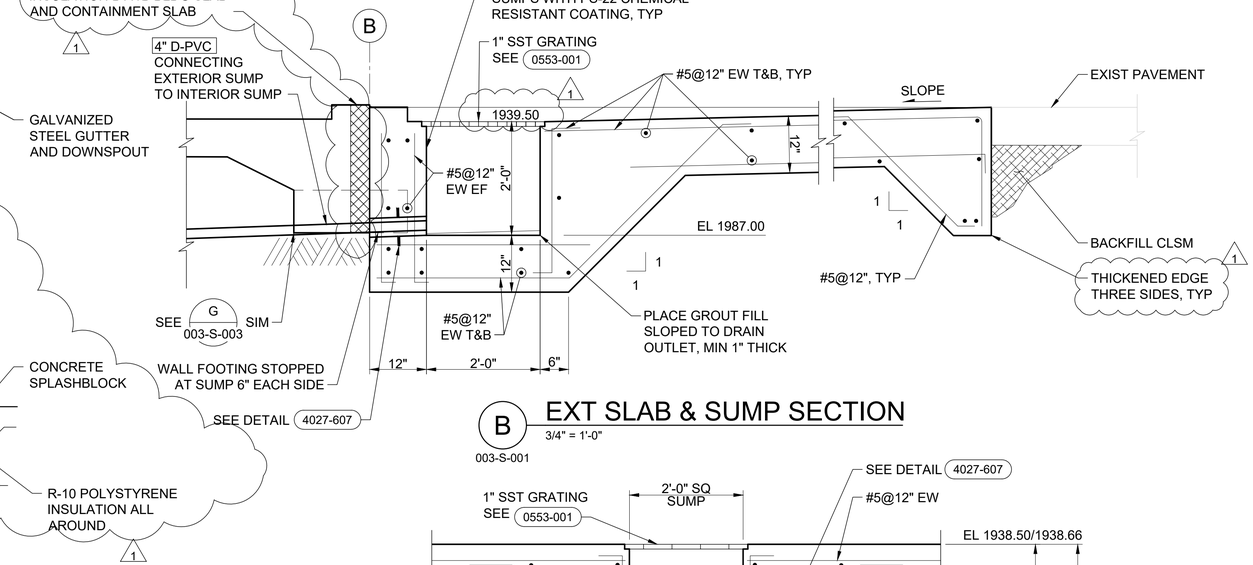
003-S-001



C TRENCH REINF DETAIL

3/4" = 1'-0"

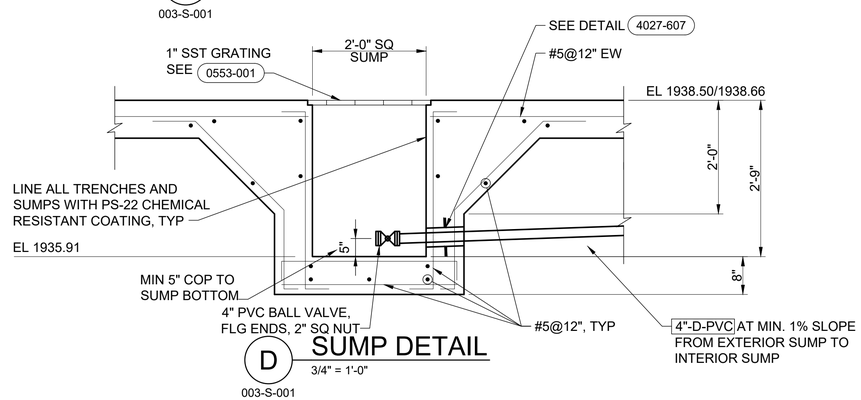
003-S-001



B EXT SLAB & SUMP SECTION

3/4" = 1'-0"

003-S-001



D SUMP DETAIL

3/4" = 1'-0"

003-S-001

05-18-2020

NO.	DATE	DSGN
1	05/01/2020	STRUCTURAL ADDENDUM
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION

		JD	APVD	Liao Y.
		KI	BY	Gary B.
		JD	CHK	Matt C.
		KI	DR	Liao Y.

REVISION

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST

EC BUILDING:
SECTIONS AND DETAILS

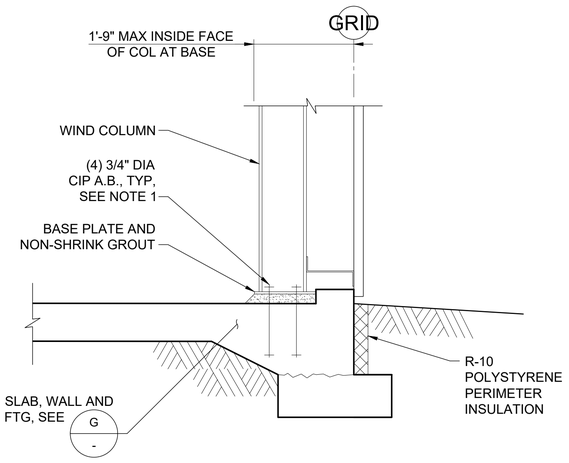
VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

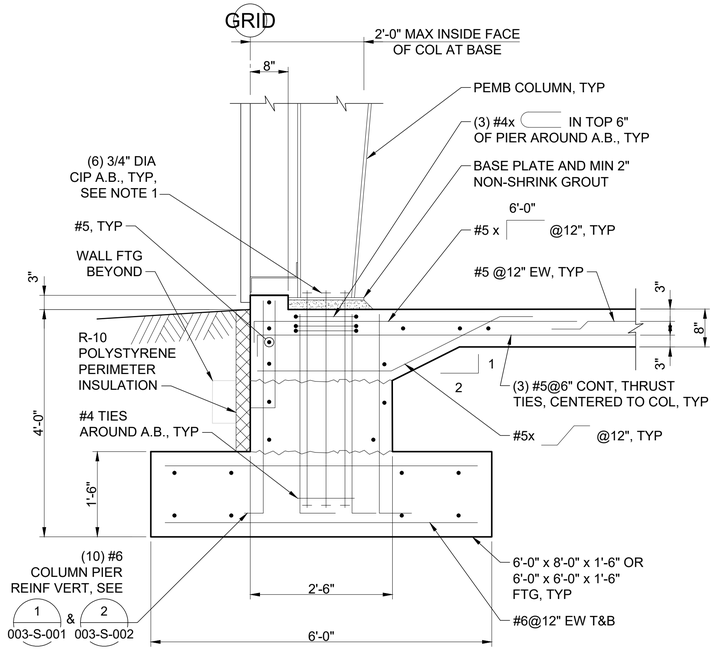
DATE	
PROJ	KMCT2019
DWG	003-S-002
SHEET	33 of 44

GENERAL SHEET NOTES

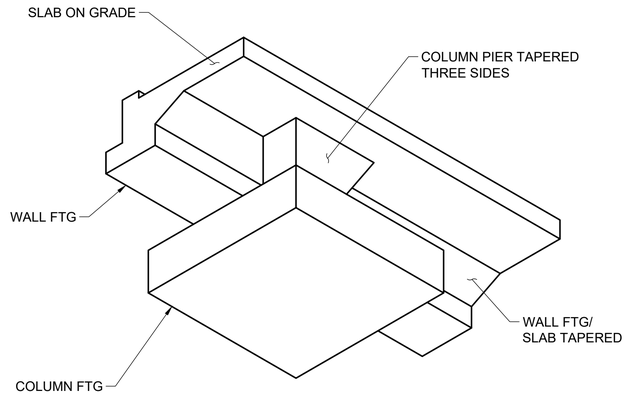
1. COLUMN ANCHOR BOLTS ARE SIZED APPROXIMATELY. THE ACTUAL NUMBERS AND DIAMETERS OF ANCHOR BOLTS, EMBEDMENT AND SUPPLEMENTARY REINFORCEMENT FOR THE ANCHORAGE MAY BE CHANGED BASED ON COLUMN REACTIONS PROVIDED BY PEMB MANUFACTURER.



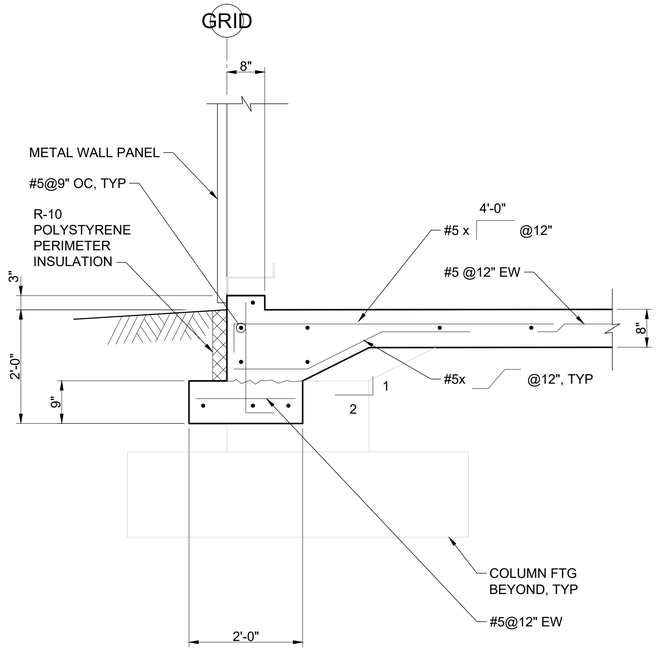
E WIND COLUMN FTG
3/4" = 1'-0"
003-S-001



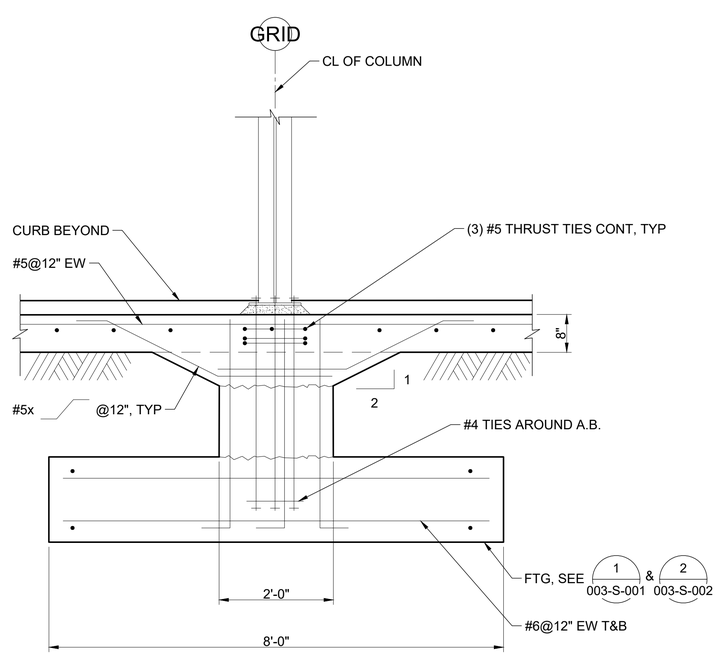
F SECTION
3/4" = 1'-0"
003-S-002



FOUNDATION FTG ISOMETRIC VIEW
NTS



G SECTION
3/4" = 1'-0"
003-S-002



H SECTION
3/4" = 1'-0"
003-S-002

LIAO YANG — STATE OF WASHINGTON — 49264 — REGISTERED PROFESSIONAL ENGINEER
04-03-2020

NO.	DATE	DSGN	DR	CHK	APVD
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION	Liao Y.	Matt C.	Gary B.
		REVISION	KI	BY	APVD
			JD	APVD	Liao Y.

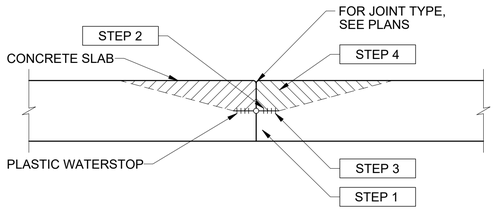
Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST
EC BUILDING:
SECTIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	003-S-003
SHEET	34 of 44



NOTES:

PLACEMENT SEQUENCE SHOWN REQUIRED ON BOTH SIDES OF JOINTS, IN ALL CONCRETE SLAB AND FOOTING POURS WITH HORIZONTALLY PLACED PLASTIC WATERSTOPS.

STEP 1

PLACE CONCRETE BELOW WATERSTOP FIRST, REMOVE ALL AIR VOIDS BY VIBRATING THOROUGHLY.

STEP 2

TO CONFIRM THERE ARE NO AIR VOIDS, LIFT WATERSTOP. A CONTINUOUS IMPRESSION OF THE WATERSTOP, INCLUDING EDGE OF BULB, SHOULD BE VISIBLE IN THE FRESH CONCRETE. CONTINUE THIS PROCEDURE ALONG THE ENTIRE POURED JOINT, END TO END. IF A CONTINUOUS IMPRESSION IS CONFIRMED, PROCEED WITH STEP 4. IF A VOID LARGER THAN 1/4 INCH IN DIAMETER IS PRESENT ANYWHERE IN THE WATERSTOP IMPRESSION, PROCEED WITH STEP 3.

STEP 3

IF A VOID LARGER THAN 1/4 INCH IN DIAMETER IS PRESENT IN THE WATERSTOP IMPRESSION, ADDITIONAL CONCRETE SHALL BE PLACED UNDER THE WATERSTOP, VIBRATED, AND STEP 2 REPEATED.

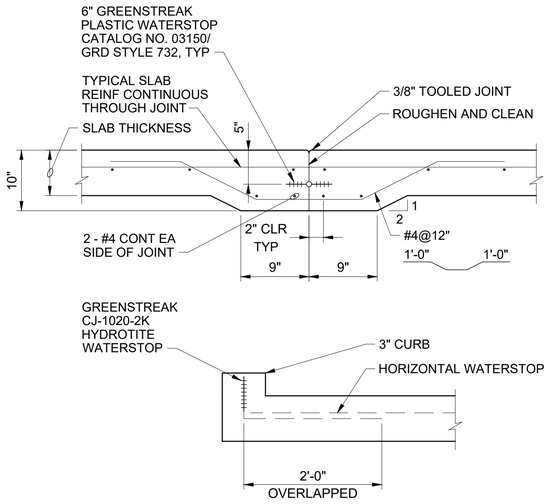
STEP 4

FINISH PLACING CONCRETE ABOVE THE WATERSTOP TO TOP OF SLAB.

CONCRETE PLACEMENT SEQUENCE

NTS

0315-133



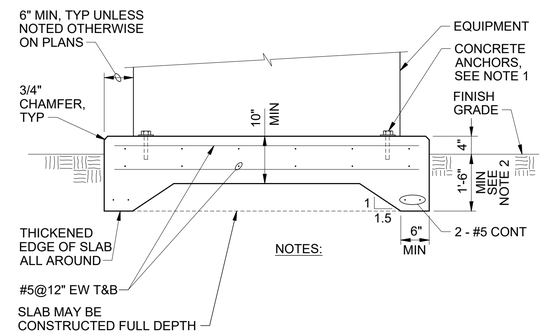
NOTE:

FOR CONCRETE PLACEMENT AROUND WATERSTOP, SEE (0315-133).

SLAB CONSTRUCTION JOINT

NTS

0315-141



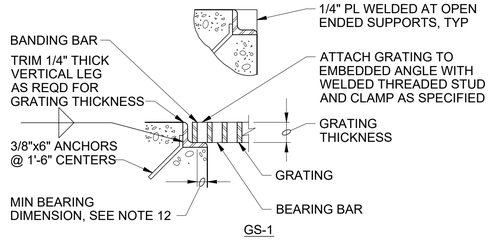
NOTES:

1. WHEN ANCHORAGE OF EQUIPMENT TO PAD IS REQUIRED, USE CONCRETE ANCHORS SPECIFIED.
2. PAD SIZE SHALL BE MINIMUM INDICATED OR AS SHOWN ON THE PLANS OR AS INDICATED BY THE MANUFACTURER AND APPROVED BY THE ENGINEER.
3. THE SIZE, NUMBER, TYPE, LOCATION, AND THREAD PROJECTION OF THE ANCHOR BOLTS SHALL BE DETERMINED BY THE EQUIPMENT MANUFACTURER AND AS APPROVED BY THE ENGINEER. ANCHOR BOLTS SHALL BE HELD IN POSITION WITH A TEMPLATE OR OTHER ACCEPTABLE MEANS, MATCHING THE BASE PLATE, WHILE PAD IS BEING PLACED.
4. EQUIPMENT BASES SHALL BE INSTALLED LEVEL UNLESS INDICATED OTHERWISE.
5. WEDGES, SHIMS, OR LEVELING NUTS SHALL BE USED TO SUPPORT THE BASE WHILE THE NON-SHRINK GROUT IS PLACED. WEDGES OR SHIMS THAT ARE LEFT IN PLACE SHALL NOT BE EXPOSED TO VIEW.

CONCRETE EQUIPMENT PAD

NTS

0330-056



GS-1

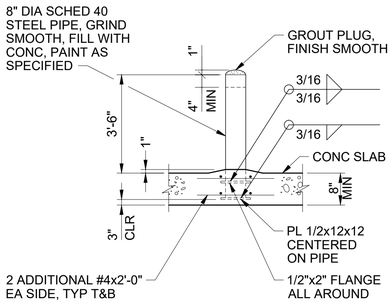
NOTES:

1. GRATING SHALL BE MANUFACTURED BY IKG INDUSTRIES OR OHIO GRATING INC.
2. LOAD CAPACITY SHALL BE 150 PSI.
3. INDIVIDUAL GRATING SECTIONS SHALL NOT EXCEED 3'-0" IN WIDTH OR WEIGH MORE THAN 150 POUNDS, UNLESS INDICATED OTHERWISE.
4. SHOP DRAWINGS BASED ON FIELD DIMENSIONS SHALL BE SUBMITTED TO THE ENGINEER PRIOR TO FABRICATION.
5. MATERIAL FOR SUPPORTS OF STEEL AND ALUMINUM GRATING TO BE SAME AS GRATING, EXCEPT METAL SUPPORTS THAT ARE TO BE EMBEDDED IN CONCRETE SHALL BE TYPE 316 STAINLESS STEEL.
6. FOR SERRATED BEARING BARS, INCREASE GRATING THICKNESSES SHOWN IN TABLES BY 1/4".
8. BEARING BAR THICKNESS FOR GRATING TO BE 3/16" MINIMUM.
9. BAND ALL EDGES. MATCH DEPTH OF BEARING BAR.
10. THE HORIZONTAL CLEARANCE BETWEEN THE GRATING AND GRATING SUPPORTS SHALL NOT BE LESS THAN 1/4" NOR GREATER THAN 1/2".
11. MIN BEARING HORIZONTAL DIMENSION = 1" FOR GRATING DEPTH 2 1/4" OR LESS.

STANDARD GRATING

NTS

0553-001



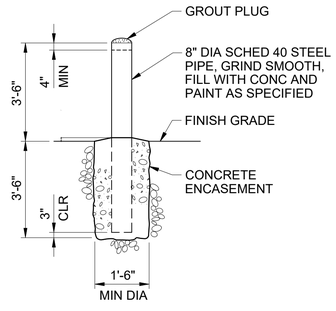
NOTE:

1. HOT DIP GALVANIZE AFTER FABRICATION.

GUARD POST - INTERIOR

NTS

0559-026



GUARD POST - EXTERIOR

NTS

3471-810

JACOBS

KAISER MEAD CUSTODIAL TRUST

EC BUILDING:
STANDARD DETAILS

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

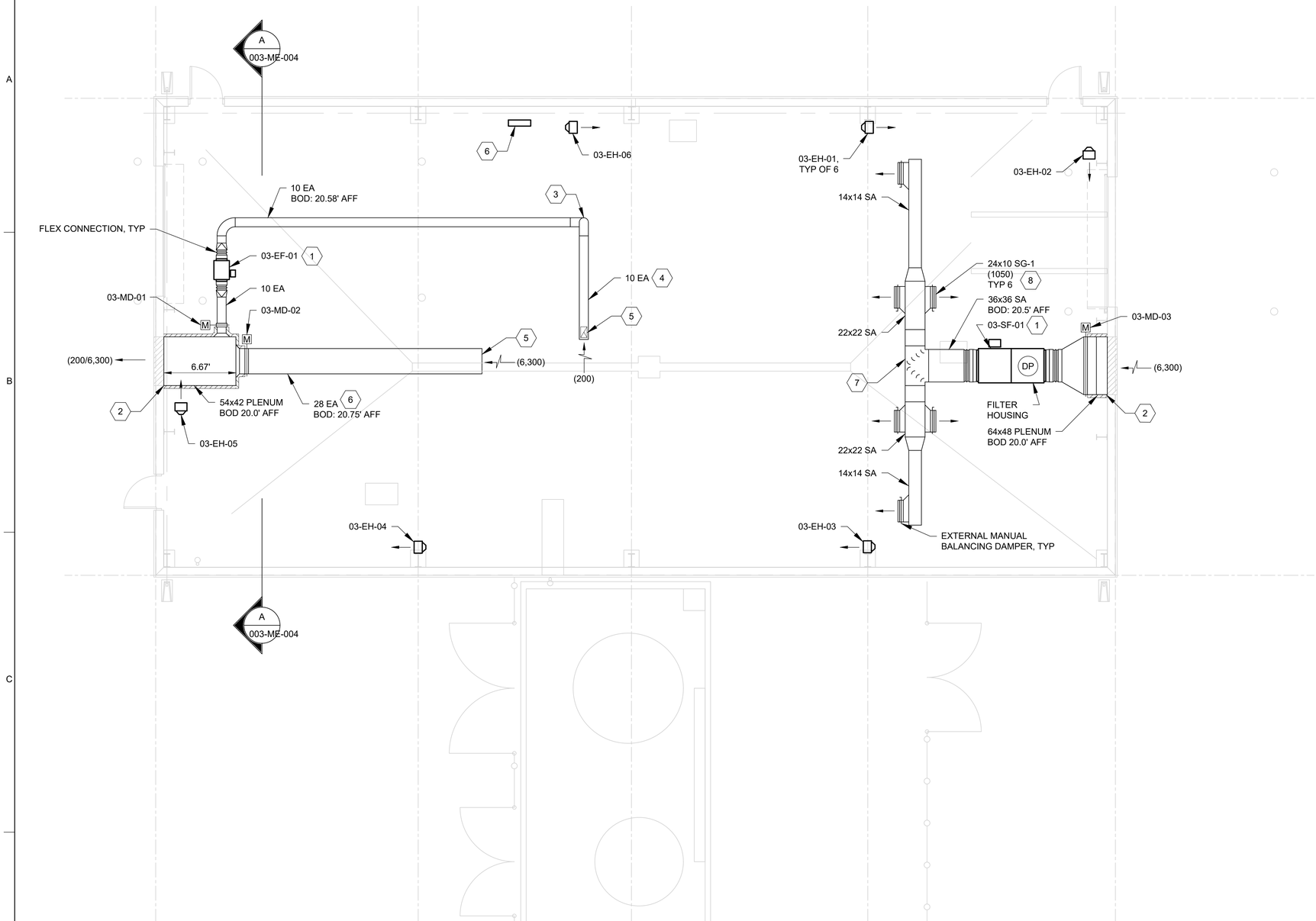
LIAO YANG
STATE OF WASHINGTON
49264
REGISTERED
PROFESSIONAL ENGINEER
04-03-2020

NO.	DATE	DR	CHK	APVD
0	04/03/2020	Liao Y.	Matt C.	Gary B.
	FINAL DESIGN - ISSUED FOR CONSTRUCTION		REVISION	
DSGN		KI	BY	Liao Y.
		JD	APVD	

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	003-S-004
SHEET	35 of 44



MECHANICAL FLOOR PLAN

3/16" = 1'-0"

N

0 3/16" 3/8" 3/4"

3/16" = 1'-0"

GENERAL NOTES

1. USE THE FOLLOWING VALUES FOR DETERMINING APPROPRIATE STRUCTURAL REINFORCMENT OF THE PRE-ENGINEERED METAL BUILDING:
   - A. WEIGHT OF 03-SF-01: 600 LBS
   - B. WEIGHT OF 03-EF-01: 90 LBS
   - C. WEIGHT OF DUCTWORK: 10.8 LBS / LINEAR FOOT
   - D. WEIGHT OF PLENUMS: 30.9 LBS / LINEAR FOOT

SHEET KEYNOTES

1. SUSPEND FAN FROM STRUCTURE OVERHEAD. PROVIDE DUCTWORK FLEX CONNECTION AT INLET AND OUTLET.
2. ATTACH PLENUM TO WALL LOUVER. SEE ARCHITECTURAL DRAWINGS FOR EXACT SIZE AND LOCATION. REFER TO DETAIL 1 ON SHEET 003-ME-004. PROVIDE INSULATION AS SHOWN AND IN ACCORDANCE WITH SECTION 23 07 00.
3. ROUTE DUCTWORK UP, ANGLED, TO ROOF APEX. TERMINATE DUCT 12" BELOW BOTTOM OF ROOF.
4. ROUTE DUCTWORK CLOSE TO ROOF.
5. AFFIX ALUMINUM 1/2" SCREEN MESH TO DUCT OPENINGS. REFER TO 23 31 13 FOR ADDITIONAL REQUIREMENTS.
6. MOUNT THERMOSTAT AT 4'-0" AFF. THERMOSTAT CONTROLS SUPPLY FAN 03-SF-01.
7. PROVIDE TEE FITTING WITH 22x36 OUTLETS AND REDUCE TO 22x22 DOWNSTREAM.
8. SUPPLY GRILLE (SG-1).
   MATERIAL: STEEL
   FINISH: BAKED WHITE ENAMEL
   ADJUSTIBLE FRONT HORIZONTAL AND REAR VERTICAL VANES ON 3/4" CENTERS.
   CONTINUOUS SPONGE RUBBER GASKET AT FACE FLANGE.
   1" MINIMUM FLAT RECTANGULAR FRAME
   MANUFACTURER AND PRODUCT: KRUEGER 880/5880 SERIES.

CARL JEFFREY SHANK
STATE OF WASHINGTON
49254
REGISTERED
PROFESSIONAL ENGINEER

04/02/2020

NO.	DATE	DSGN	DR	CHK	APVD	BY	APVD
0	04/03/2020	J CUTZ	R CATHERS	C SHANK	C SHANK	KI	JD

FINAL DESIGN - ISSUED FOR CONSTRUCTION

REVISION

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

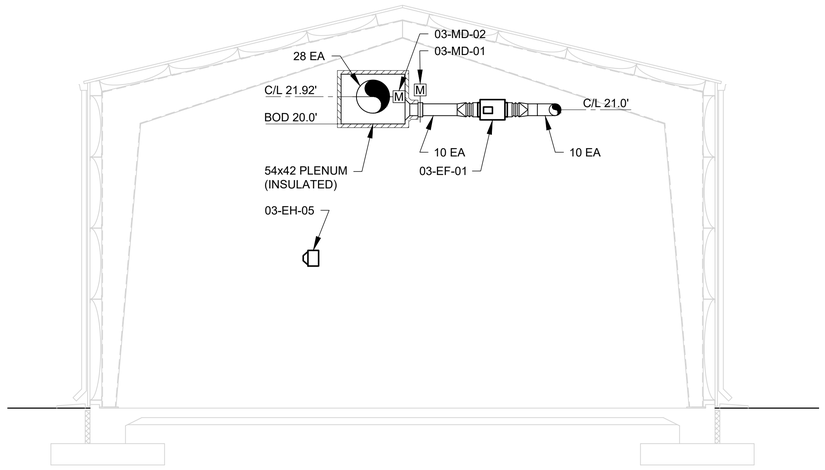
KAISER MEAD CUSTODIAL TRUST

EC BUILDING:
HVAC FLOOR PLAN

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	003-M-003
SHEET	36 of 44



A MECHANICAL SECTION
3/16"=1'-0"
ME-003

0 3/16" 3/8" 3/4"
3/16" = 1'-0"

SEQUENCES OF OPERATION

SUPPLY FAN 03-SF-01

THE SUPPLY FAN PROVIDES VENTILATION-COOLING AIR TO THE EC BUILDING AND IS A CONSTANT AIR VOLUME FAN.

THE SUPPLY FAN IS CONTROLLED VIA A LINE-VOLTAGE THERMOSTAT. REFER TO THE ELECTRICAL DRAWINGS FOR WIRING DIAGRAM.

WHEN THE SPACE TEMPERATURE IS 2 DEGREES F (ADJ.) ABOVE THE SPACE TEMPERATURE SETPOINT, THE SUPPLY FAN RUNS UNTIL THE SPACE TEMPERATURE RETURNS TO ITS SETPOINT.

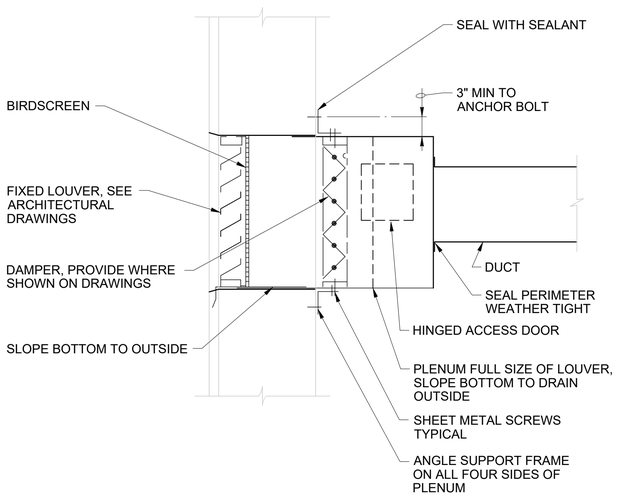
WHEN THE SUPPLY FAN RUNS, MOTORIZED DAMPERS 03-MD-02 AND 03-MD-03 SHALL OPEN. WHEN THE SUPPLY FAN IS OFF, MOTORIZED DAMPERS 03-MD-02 AND 03-MD-03 SHALL CLOSE.

THE MAXIMUM SPACE TEMPERATURE SETPOINT FOR THE EC BUILDING SHALL BE 95 DEGREES F (ADJ.)

EXHAUST FAN 03-EF-01

THE EXHAUST FAN IS A CONSTANT AIR VOLUME FAN AND PROVIDES HIGH-POINT EXHAUST IN THE EC BUILDING WHEN VENTILATION-COOLING AIR IS NOT REQUIRED.
THE EXHAUST FAN SHALL RUN WHEN THE SUPPLY FAN 03-SF-01 IS OFF. REFER TO THE ELECTRICAL DRAWINGS FOR WIRING DIAGRAM.

WHEN THE EXHAUST FAN RUNS, MOTORIZED DAMPER 03-MD-01 SHALL OPEN. WHEN THE EXHAUST FAN IS OFF, MOTORIZED DAMPER 03-MD-01 SHALL CLOSE.



1 LOUVER / PLENUM CONNECTION DETAIL
NO SCALE
ME-003

CARL JEFFREY SHANK
STATE OF WASHINGTON
49254
REGISTERED
PROFESSIONAL ENGINEER
04/02/2020

NO.	DATE		DR	CHK	APVD
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION	J CUTZ	R CATHERS	C SHANK
DSGN		REVISION			

	KI	BY	APVD
	JD	APVD	

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

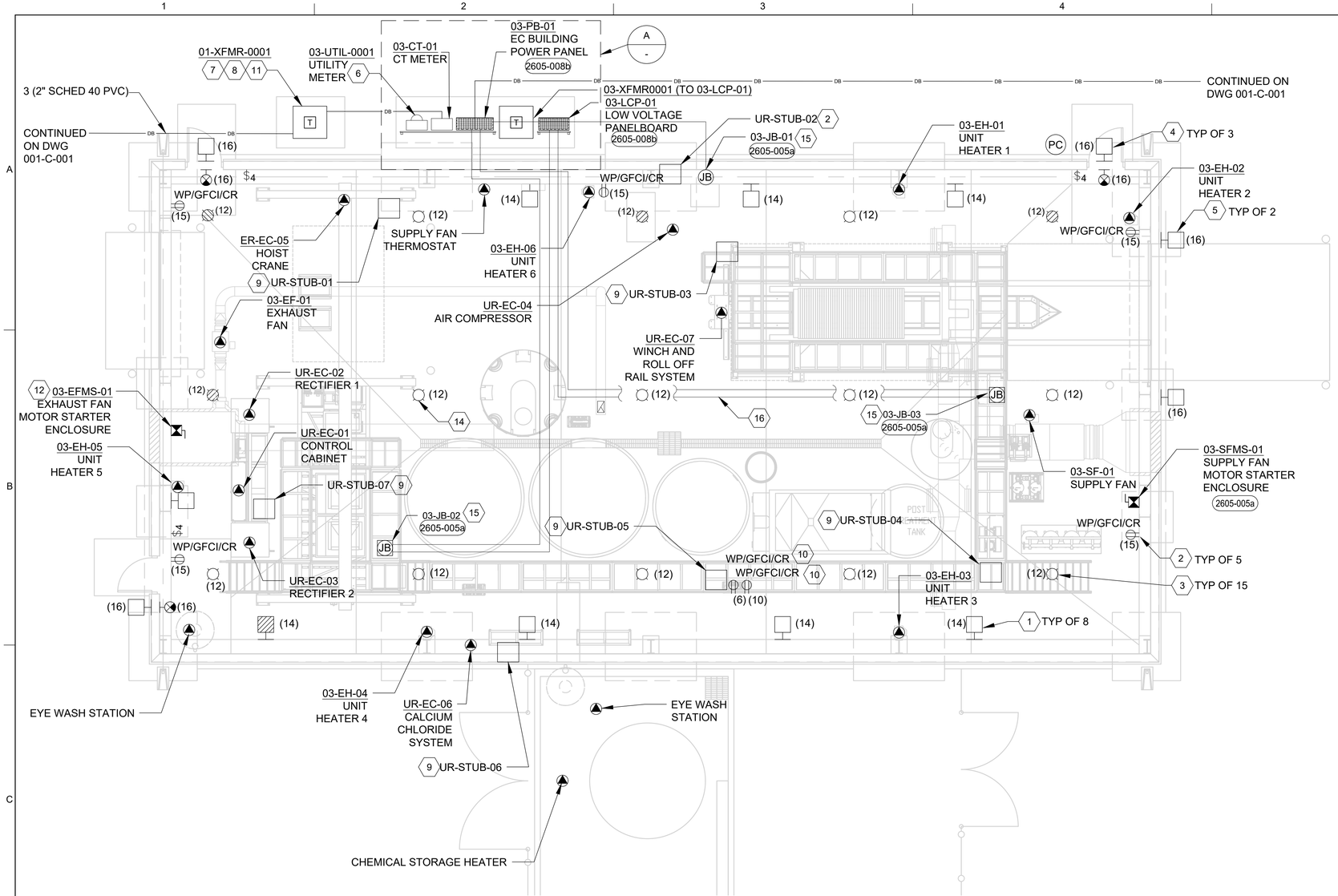
JACOBS

KAISER MEAD CUSTODIAL TRUST

EC BUILDING:
HVAC SECTIONS, DETAILS AND SEQUENCE OF OPERATIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	003-M-004
SHEET	37 of 44



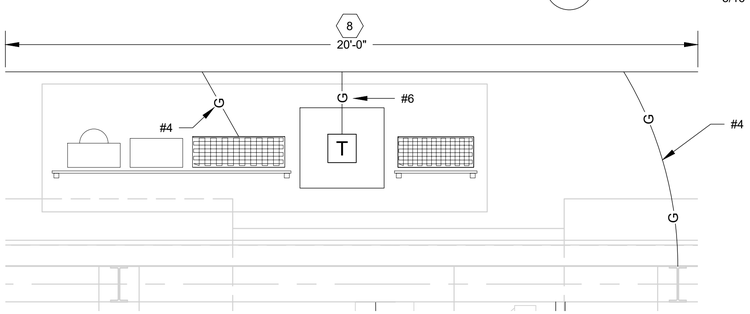
EC BUILDING ELECTRICAL FLOOR PLAN

3/16" = 1'-0"

N

0 3/16" 3/8" 3/4"

3/16" = 1'-0"



A SECTION

NTS

GENERAL NOTES

1. ALL LUMINAIRE AND RECEPTACLE CIRCUITS IN THIS FACILITY ARE FED FROM PANEL 03-LCP-01. SEE PANELBOARD SCHEDULES. NUMBERS IN PARENTHESES (N), ADJACENT TO LUMINAIRES AND RECEPTACLES DENOTE CIRCUIT NUMBERS.
2. PROVIDE AND INSTALL LITHONIA WST LED 25 WATT OR SIMILAR FOR WALL MOUNTED LUMINAIRES INDOOR AND OUTDOOR.
3. PROVIDE AND INSTALL LITHONIA JHBL 83 WATT OR SIMILAR FOR PENDANT MOUNTED LUMINAIRES INDOOR.
4. PROVIDE AND INSTALL LITHONIA LQM EXIT SIGN OR SIMILAR FOR EMERGENCY EXIT LIGHTING.
5. SUPPORT 30LBS. PER LUMINAIRE SUSPENDED FROM ROOF, TYP.

SHEET KEYNOTES

1. MOUNT LUMINAIRE 12'-0" AFF.
2. MOUNT RECEPTACLE 2'-6" AFF.
3. MOUNT RECEPTACLE 20'-0" AFF.
4. MOUNT RECEPTACLE 1'-6" ABOVE DOOR.
5. MOUNT RECEPTACLE 10'-0" ABOVE FINISHED GRADE.
6. PROVIDE 3/4" CONDUIT FROM CT CABINET TO UTILITY METER.
7. SIZED BY UTILITY. PROVIDE 2'-0" MINIMUM DISTANCE FROM EDGE OF TRANSFORMER TO EDGE OF CONCRETE PAD PER AVISTA REQUIREMENTS. SEE 2019 AVISTA ELECTRIC SERVICE REQUIREMENTS (BLUEBOOK) FOR PAD DIMENSIONS.
8. PROVIDE #4 BC 20'-0" MINIMUM CONCRETE-ENCASED ELECTRODE.
9. GENERAL AREA OF CONDUIT LOCATION. REFERENCE LEGEND NUMBER(S) CALLED OUT ON UNITED RENTALS SUBMITTAL FOR EXACT CONDUIT POINTS. CONTRACTOR TO ROUTE POWER CONDUCTORS BETWEEN EQUIPMENT AS SHOWN ON DRAWING 004-E-003.
10. RESERVED RECEPTACLE FOR EQUIPMENT. SEE PANEL SCHEDULES FOR EQUIPMENT REFERENCE.
11. CONCRETE PAD TO BE 1'-0" AWAY FROM EC BUILDING WALL. ADJUST EQUIPMENT LOCATION ACCORDINGLY.
12. FAN DISCONNECT INSIDE OF ENCLOSURE.
13. CONTROL CIRCUITE CONDUIT AND CONDUCTORS FOR UNITED RENTALS EQUIPMENT PROVIDED BY UNITED RENTALS.
14. UNSWITCHED LUMINAIRE.
15. SEE DWG 003-S-001 FOR CONDUIT PENETRATION STANDARD DETAIL SEE CABLE CLOCKS ON DWG 004-E-003 FOR CONDUIT SIZING.
16. DUCTBANK PATH UNDERSLAB. VERIFY PATH BEFORE START OF WORK.

BRIAN MACLEAN PILMER
STATE OF WASHINGTON
20111121
REGISTERED
PROFESSIONAL ENGINEER

05/08/2020

NO.	DATE	DSGN	DR	CHK	APVD
0	04/03/2020	M. ALEXANDER	T. KENDALL	B. PILMER	B. PILMER

FINAL DESIGN - ISSUED FOR CONSTRUCTION

REVISION	BY	APVD
	KI	JD

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

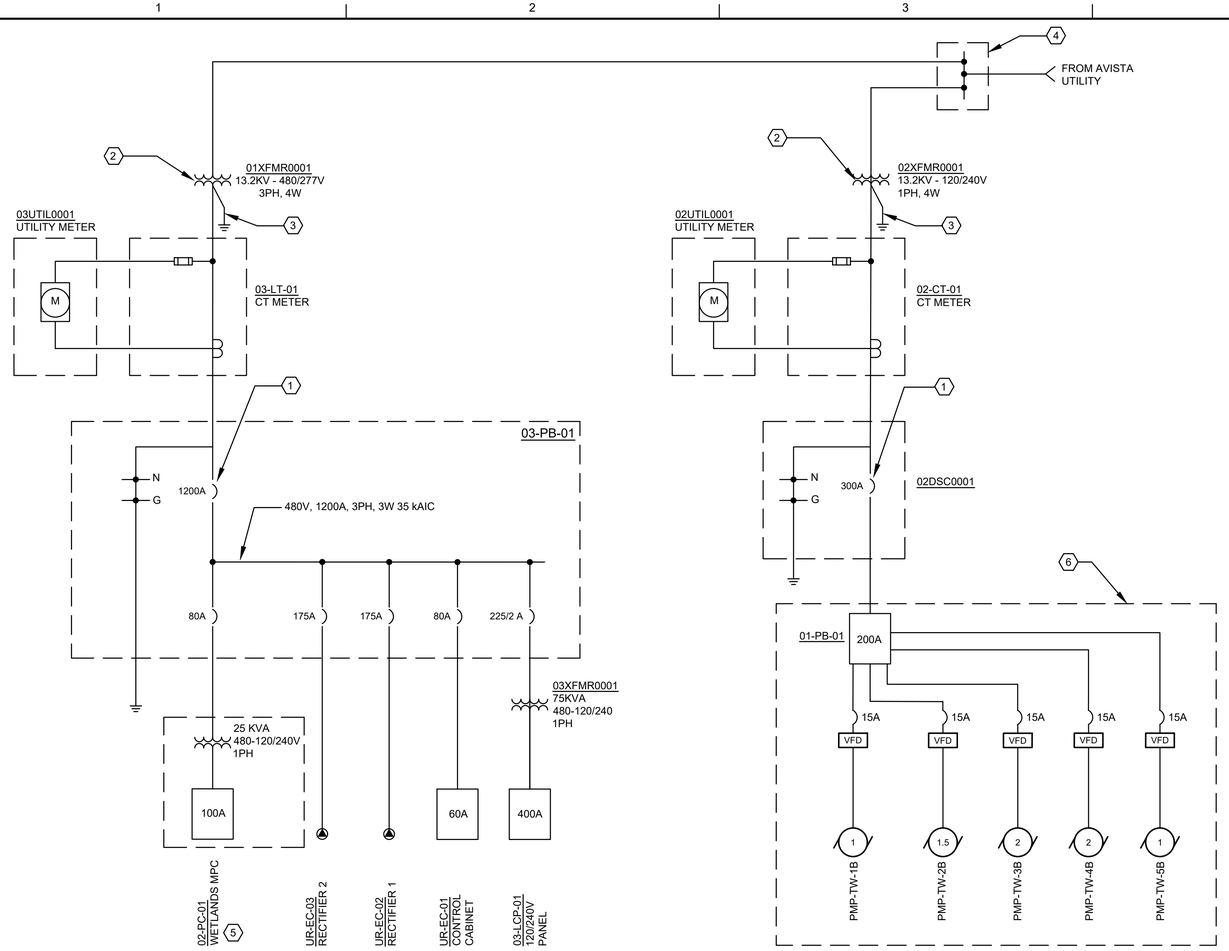
KAISER MEAD CUSTODIAL TRUST

EC BUILDING:
ELECTRICAL PLANS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	003-E-001
SHEET	38 of 44



GENERAL NOTES

1. CONTRACTOR TO PROVIDE CONDUITS, WIRING, AND EQUIPMENT PER AVISTA REQUIREMENTS. SEE PAGE 61 OF AVISTA 2019 ELECTRIC SERVICE REQUIREMENTS, SECTION 3.3.4. COORDINATE WITH UTILITY BEFORE START OF WORK.

SHEET KEYNOTES

1. SERVICE ENTRANCE RATED
2. SIZED BY UTILITY
3. LOW VOLTAGE GROUND ROD SUPPLIED BY UTILITY. INSTALLED BY CONTRACTOR. SEE AVISTA BLUE BOOK REQUIREMENTS.
4. CABLE JUNCTION PEDESTAL PROVIDED BY UTILITY. COORDINATE WITH UTILITY ON DUCT BANK SIZING.
5. SEE DWG 002-ME-001 FOR PANEL SCHEDULE INFORMATION.
6. PANEL SCHEDULE IS FOR SCHEMATIC AND GUIDANCE PURPOSES ONLY, AND MAY NOT REFLECT FINAL INSTALLED PANEL. FOLLOW REQUIREMENTS OUTLINED IN THE VENDOR PACKAGE PERFORMANCE SCOPE FOR THE EXTRACTION PUMPS AND CONTROLS DOCUMENT, ATTACHMENT D.

OVERALL ELECTRICAL ONLINE DIAGRAM

NTS

ELECTRICAL PANELBOARD SCHEDULE

PANEL: 03-LCP-01
VOLTAGE: 120/240 VAC, 1 PHASE, 3 WIRE
BUS SIZE: 400A
MAIN SIZE: 400/2 A
SCCR:

LOCATION: ELECTRO-COAGULATION
MOUNTING: STANCHION
FED FROM: 03XFMR0001
MAIN TYPE: BREAKER
NOTES: NEMA 4

CIRCUIT TITLE	BREAKER CKT NO.	AMP	POLE	LOAD, VA PHASE A	LOAD, VA PHASE B	LOAD, VA PHASE A	LOAD, VA PHASE B	POLE	BREAKER AMP	CKT NO.	CIRCUIT TITLE
03-EP-01 MAIN ELECTRICAL PANEL	1	30	2	1440				2	30	2	SPARE
---	3	---	---		1440			---	---	4	---
DUPLEX OUTLET MAIN SKID	5	20	1	144		1080		1	20	6	DUPLEX OUTLET POLYMER TANK
DUPLEX OUTLET MULTI MEDIA SKID	7	20	1		144		144	1	20	8	DUPLEX OUTLET CALC CHLORIDE TANK
DUPLEX OUT FILTER PRESS CONTROL	9	20	1	144		1440		1	20	10	DUPLEX OUTLET SUMP PUMP
SPARE	11	20	1				1162	1	20	12	LIGHTS INDOOR
SPARE	13	20	1			200		1	20	14	LIGHTS INDOOR
RECEPTACLE INDOOR	15	20	1		900		128	1	20	16	LIGHTS OUTDOOR
003-EH-01 - EC BLDG. UNIT HEATER 1	17	20	2	1368		1368		2	20	18	003-EH-02 - EC BLDG. UNIT HEATER 2
---	19	---	---		1368		1368	---	---	20	---
003-EH-03 - EC BLDG. UNIT HEATER 3	21	20	2	1368		1368		2	20	22	003-EH-04 - EC BLDG. UNIT HEATER 4
---	23	---	---		1368		1368	---	---	24	---
003-EH-05 - EC BLDG. UNIT HEATER 5	25	20	2	1368		1368		2	20	26	003-EH-06 - EC BLDG. UNIT HEATER 6
---	27	---	---		1368		1368	---	---	28	---
CHEMICAL STORAGE HEATER	29	40	2	4800		1120		1	20	30	HEAT TRACE (INTERIOR EYE WASH)
---	31	---	---		4800		210	1	20	32	HEAT TRACE (TO EXTERIOR EQUIP.)
SPACE	33	---	---					---	---	34	SPACE
SPACE	35	---	---					---	---	36	SPACE
SPACE	37	---	---					---	---	38	SPACE
SPACE	39	---	---					---	---	40	SPACE
SPACE	41	---	---					---	---	42	SPACE
TOTAL LOAD				10632	11388	7944	5748				

PHASE A LOAD (VA) = 18576
PHASE B LOAD (VA) = 17136
TOTAL LOAD (VA)= 35712

ELECTRICAL PANELBOARD SCHEDULE

PANEL: 01-PB-01
VOLTAGE: 120/240 VAC, 1 PHASE, 3 WIRE
BUS SIZE: 200A
MAIN SIZE: 200A
SCCR:

LOCATION: EXTRACTION WELLS
MOUNTING: WALL MOUNT
FED FROM: 02XFMR0001
MAIN TYPE: MAIN LUG
NOTES: NEMA 1

CIRCUIT TITLE	BREAKER CKT NO.	AMP	POLE	LOAD, VA PHASE A	LOAD, VA PHASE B	LOAD, VA PHASE A	LOAD, VA PHASE B	POLE	BREAKER AMP	CKT NO.	CIRCUIT TITLE
SPD	1	XX	2			373		2	15	2	PMP-TW-1B (THROUGH VFD-TW-1B-ENC)
---	3	---	---				373	---	---	4	---
PMP-TW-2B (THROUGH VFD-TW-2B-ENC)	5	15	2	550		745		2	15	6	PMP-TW-3B (THROUGH VFD-TW-3B-ENC)
---	7	---	---		550		745	---	---	8	---
PMP-TW-4B (THROUGH VFD-TW-4B-ENC)	9	15	2	745		373		2	15	10	PMP-TW-5B (THROUGH VFD-TW-5B-ENC)
---	11	---	---		745		373	---	---	12	---
FUTURE PUMP	13	15	2					2	15	14	FUTURE PUMP
---	15	---	---					---	---	16	---
FUTURE PUMP	17	15	2					2	15	18	FUTURE PUMP
---	19	---	---					---	---	20	---
FIT-TW-1B,TW-2B,TW-5B	21	15	1	150		100		1	15	22	FIT-TW-3B,TW-4B
FIT-TW (WELL TOTAL FLOW)	23	15	1		50			1	15	24	SPARE
SPARE	25	15	2			372		1	15	26	01-SF-01 SUPPLY FAN
---	27	---	---				120	1	15	28	HEAT TRACE
LIGHTS INDOOR	29	15	1	90		600		1	15	30	RECEPTACLE INDOOR
LIGHTS OUTDOOR	31	15	1		40		120	1	15	32	RECEPTACLE OUTDOOR
SPARE	33	15	1					2	30	34	SPARE
SPARE	35	15	1					---	---	36	---
SPACE	37	---	---					---	---	38	SPACE
SPACE	39	---	---					---	---	40	SPACE
SPACE	41	---	---					---	---	42	SPACE
TOTAL LOAD				1535	1385	2563	1731				

PHASE A LOAD (VA) = 4098
PHASE B LOAD (VA) = 3116
TOTAL LOAD (VA)= 7214

ELECTRICAL PANELBOARD SCHEDULE

PANEL: 03-PB-01
VOLTAGE: 480 VAC, 3 PHASE, 4 WIRE
BUS SIZE: 1200A
MAIN SIZE: 1200A
SCCR:

LOCATION: ELECTRO-COAGULATION BUILDING
MOUNTING: STANCHION
FED FROM: 01XFMR0001
MAIN TYPE:
NOTES: SERVICE ENTRANCE RATED CIRCUIT BREAKER, NEMA 4

CIRCUIT TITLE	BREAKER CKT NO.	AMP	POLE	LOAD, VA PHASE A	LOAD, VA PHASE B	LOAD, VA PHASE C	LOAD, VA PHASE A	LOAD, VA PHASE B	LOAD, VA PHASE C	POLE	BREAKER AMP	CKT NO.	CIRCUIT TITLE
SPD	1	XX	3				12480			3	90	2	VENDOR TANKLESS WATER HEATER
---	3	---	---					12480		---	---	4	---
---	5	---	---						12480	---	---	6	---
003-EF-01 - EXHAUST FAN	7	15	3	176			1242			3	15	8	003-SF-01 - SUPPLY FAN
---	9	---	---		176			1242		---	---	10	---
---	11	---	---			176			1242	---	---	12	---
02-PC-01 - WETLANDS MPC	13	60	2	14400								14	SPACE
---	15	---	---		14400		17856			2	225	16	03XFMR0001 (TO 03-LCP-01)
SPACE	17								17856	---	---	18	---
UR-EC-01 - CONTROL CABINET	19	80	3	5600			23200			3	175	20	UR-EC-02 - RECTIFIER 1
---	21	---	---		5600			23200		---	---	22	---
---	23	---	---			5600			23200	---	---	24	---
UR-EC-03 - RECTIFIER 2	25	175	3	23200			4320			3	30	26	UR-EC-04 - AIR COMPRESSOR
---	27	---	---		23200			4320		---	---	28	---
---	29	---	---			23200			4320	---	---	30	---
UR-EC-05 - HOIST	31	15	3	800			880			3	15	32	UR-EC-06 - CACL2 SYSTEM
---	33	---	---		800			880		---	---	34	---
---	35	---	---			800			880	---	---	36	---
UR-EC-07 - ROLL OFF BOX WINCH	37	15	3	768						3	15	38	SPARE
---	39	---	---		768					---	---	40	---
---	41	---	---			768				---	---	42	---
SPACE	43	---	---							3	15	44	SPARE
SPACE	45	---	---							---	---	46	---
SPACE	47	---	---							---	---	48	---
SPACE	49	---	---							---	---	50	SPACE
SPACE	51	---	---							---	---	52	SPACE
SPACE	53	---	---							---	---	54	SPACE
SPACE	55	---	---							---	---	56	SPACE
SPACE	57	---	---							---	---	58	SPACE
SPACE	59	---	---							---	---	60	SPACE
SPACE	61	---	---							---	---	62	SPACE
SPACE	63	---	---							---	---	64	SPACE
SPACE	65	---	---							---	---	66	SPACE
TOTAL LOAD				44944	44944	30544	42122	59978	59978				

PHASE A LOAD (VA) = 87066
PHASE B LOAD (VA) = 104922
PHASE C LOAD (VA) = 90522
TOTAL LOAD (VA)= 282510

05/08/2020

NO.	DATE	DSGN	DR	CHK	APVD	REVISION
1	05/01/2020	M. ALEXANDER	T. KENDALL	B. PILMER	B. PILMER	EXTRACTION SYSTEM ADDENDUM
0	04/03/2020					FINAL DESIGN - ISSUED FOR CONSTRUCTION
NO.	DATE			BY	APVD	REVISION
				KI	JD	
				KI	JD	

JACOBS

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

KAISER MEAD CUSTODIAL TRUST

EC UNIT:
ELECTRICAL ONE-LINE

VERIFY SCALE

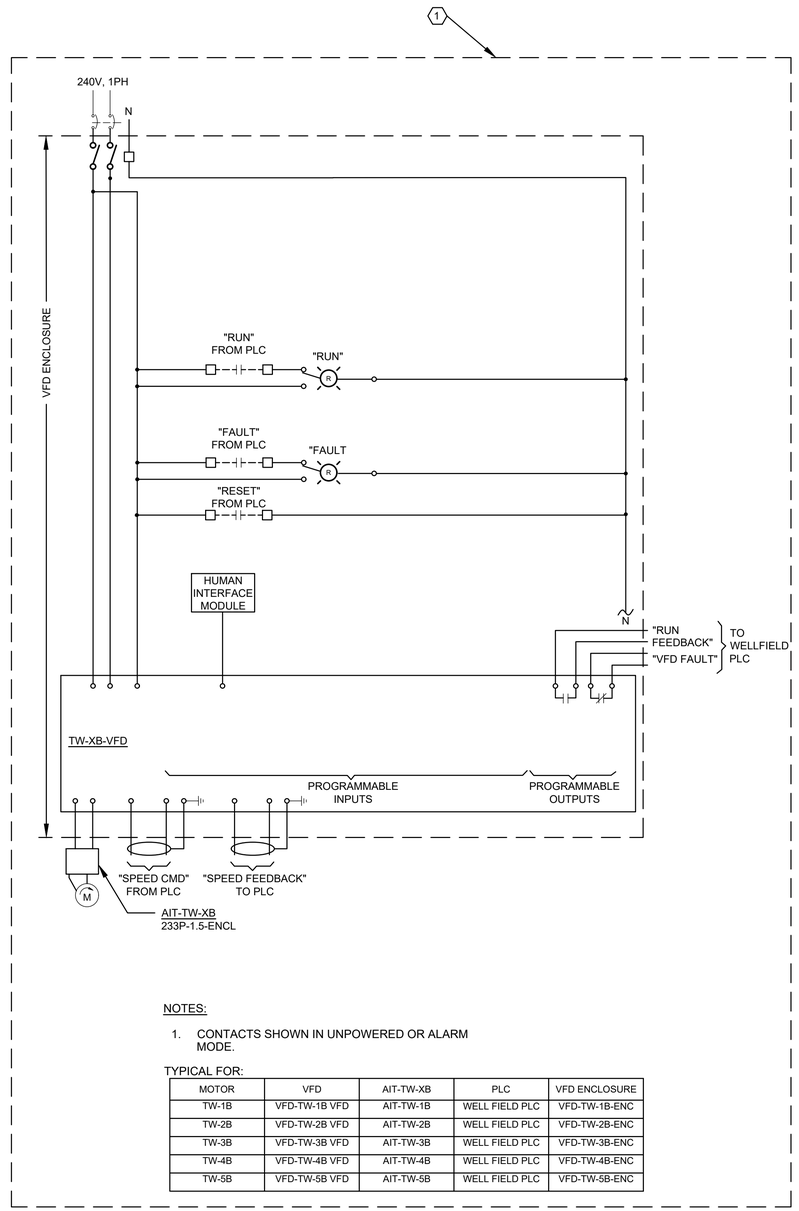
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	004-E-001
SHEET	39 of 44

$PWURL $PWPATH FILENAME: 004-E-001.dwg PLOT DATE: PLOT TIME:

SHEET KEYNOTES

1. MOTOR CONTROL DIAGRAM IS FOR SCHEMATIC AND GUIDANCE PURPOSES ONLY, AND MAY NOT REFLECT FINAL INSTALLED SYSTEM. FOLLOW REQUIREMENTS OUTLINED IN THE VENDOR PACKAGE PERFORMANCE SCOPE FOR THE EXTRACTION PUMPS AND CONTROLS DOCUMENT, ATTACHMENT D.



NOTES:

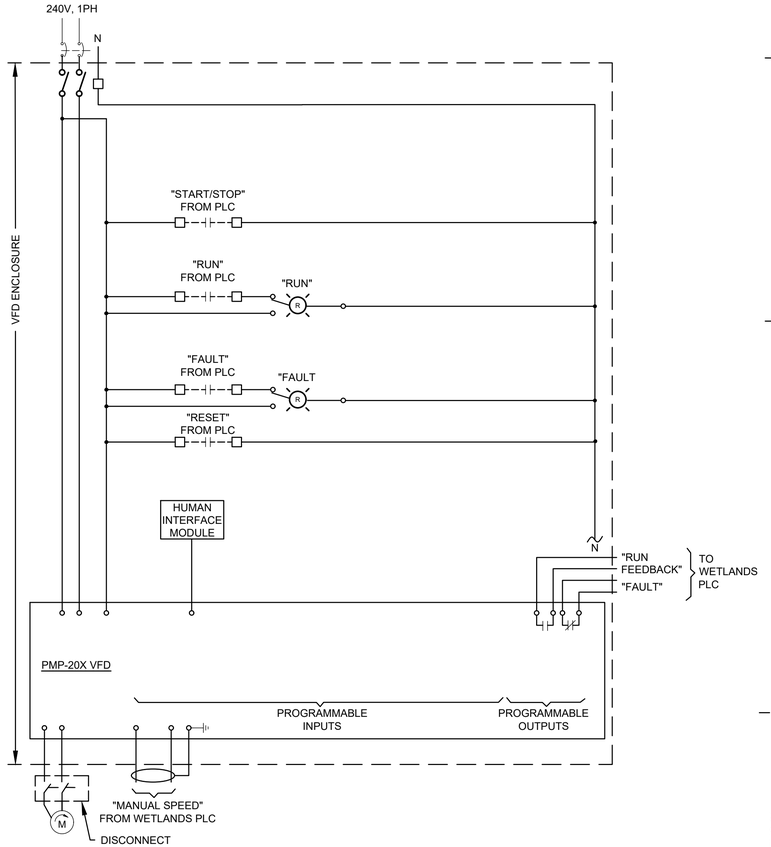
1. CONTACTS SHOWN IN UNPOWERED OR ALARM MODE.

TYPICAL FOR:

MOTOR	VFD	AIT-TW-XB	PLC	VFD ENCLOSURE
TW-1B	VFD-TW-1B VFD	AIT-TW-1B	WELL FIELD PLC	VFD-TW-1B-ENC
TW-2B	VFD-TW-2B VFD	AIT-TW-2B	WELL FIELD PLC	VFD-TW-2B-ENC
TW-3B	VFD-TW-3B VFD	AIT-TW-3B	WELL FIELD PLC	VFD-TW-3B-ENC
TW-4B	VFD-TW-4B VFD	AIT-TW-4B	WELL FIELD PLC	VFD-TW-4B-ENC
TW-5B	VFD-TW-5B VFD	AIT-TW-5B	WELL FIELD PLC	VFD-TW-5B-ENC

MOTOR CONTROL DIAGRAM - EXTRACTION WELLFIELD PUMPS

NTS



NOTES:

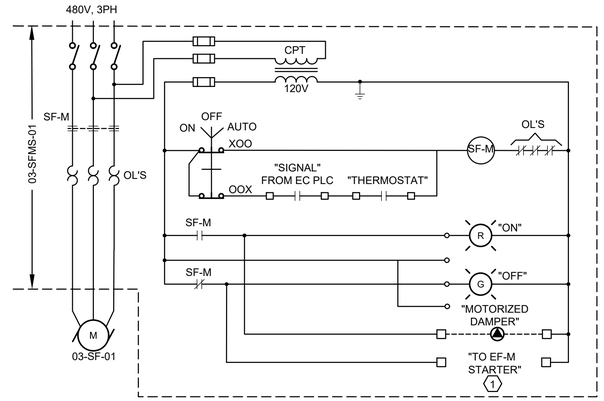
1. CONTACTS SHOWN IN UNPOWERED OR ALARM MODE.

TYPICAL FOR:

M	VFD	PLC	VFD ENCLOSURE
PMP-201	VFD-201	WETLANDS PLC	VFD-201-ENC
PMP-202	VFD-202	WETLANDS PLC	VFD-202-ENC

MOTOR CONTROL DIAGRAM - WETLANDS SUMP PUMPS

NTS



TYPICAL FOR:

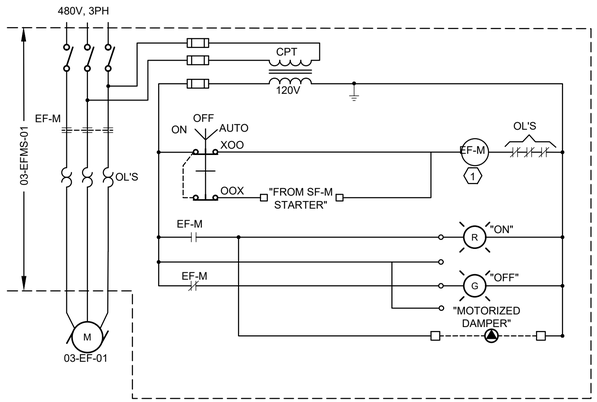
MOTORIZED DAMPER
03-MD-02
03-MD-03

NOTES:

1. SUPPLY CAN 03-SF-01 CONTACT CONTROLS THE EXHAUST FAN 03-EF-01 CONTACT. PROVIDE CONNECTIONS BETWEEN THE TWO FANS.

HVAC CONTROL DIAGRAM - SUPPLY FAN

NTS



TYPICAL FOR:

MOTORIZED DAMPER
03-MD-01

NOTES:

1. EXHAUST FAN 03-EF-01 CONTACT IS CONTROLLED BY SUPPLY FAN 03-SF-01 CONTACT. PROVIDE CONNECTIONS BETWEEN THE TWO FANS.

HVAC CONTROL DIAGRAM - EXHAUST FAN

NTS

BRIAN MACLEAN PILMER
STATE OF WASHINGTON
20111127
REGISTERED
PROFESSIONAL ENGINEER

05/08/2020

NO.	DATE	DSGN	DR	CHK	APVD
1	05/01/2020	M. ALEXANDER	T. KENDALL	B. PILMER	B. PILMER
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION			
		REVISION			

NO.	BY	APVD
1	KI	JD
0	KI	JD

EXTRACTION SYSTEM ADDENDUM

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

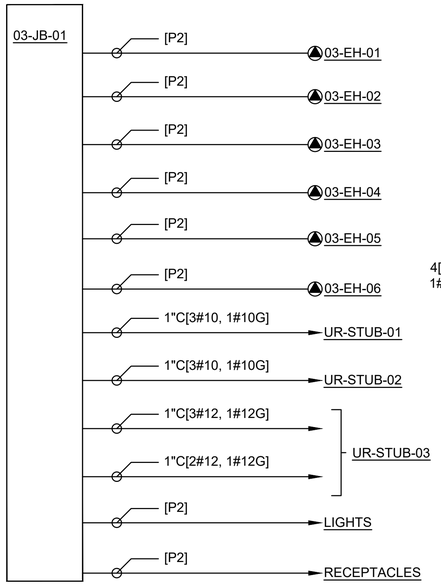
KAISER MEAD CUSTODIAL TRUST

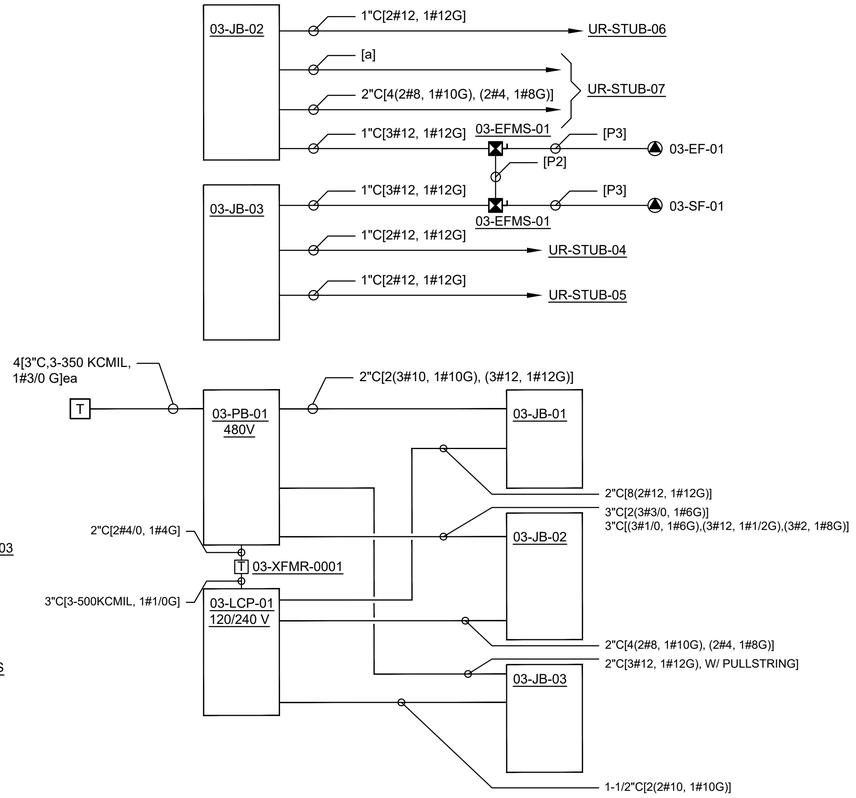
EC UNIT:
MOTOR CONTROLS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	004-E-002
SHEET	40 of 44





EC BUILDING

NTS

POWER CIRCUIT CALLOUTS			
[P1]	[1/2"FLEX, 2#12,#12G]	[P24]	[1"C,3#8,3#14,1#10G]
[P2]	[3/4"C,2#12,#12G]	[P25]	[1"C,3#8,4#14,1#10G]
[P3]	[3/4"C,3#12,#12G]	[P26]	[1"C,3#8,5#14,1#10G]
[P4]	[3/4"C,4#12,#12G]	[P27]	[1"C,2#6,1#10G]
[P5]	[3/4"C,5#12,#12G]	[P28]	[1"C,3#6,1#8G]
[P6]	[3/4"C,6#12,#12G]	[P29]	[1"C,3#6,2#14,1#8G]
[P7]	[3/4"C,7#12,#12G]	[P30]	[1"C,3#6,3#14,1#8G]
[P8]	[3/4"C,8#12,#12G]	[P31]	[1"C,3#6,4#14,1#8G]
[P9]	[3/4"C,3#12,2#14,1#12G]	[P32]	[1"C,3#6,5#14,1#8G]
[P10]	[3/4"C,3#12,3#14,1#12G]	[P33]	[1"C,3#4,1#8G]
[P11]	[3/4"C,3#12,4#14,1#12G]	[P34]	[11/4"C,3#4,3#14,1#8G]
[P12]	[3/4"C,3#12,5#14,1#12G]	[P35]	[11/4"C,3#4,5#14,1#8G]
[P13]	[3/4"C,3#12,6#14,1#12G]	[P36]	[11/4"C,3#3,1#6G]
[P14]	[3/4"C,3#12,7#14,1#12G]	[P37]	[11/4"C,3#3,3#14,1#6G]
[P15]	[3/4"C,2#14,#10G]	[P38]	[11/4"C,3#2,1#6G]
[P16]	[3/4"C,3#14,#10G]	[P39]	[11/4"C,3#1,1#6G]
[P17]	[3/4"C,3#10,2#14,1#10G]	[P40]	[11/2"C,3#1,3#14,1#6G]
[P18]	[3/4"C,3#10,3#14,1#10G]	[P41]	[11/2"C,3#2/0,1#4G]
[P19]	[3/4"C,3#10,4#14,1#10G]	[P41]	[2"C,3#3/0,1#4G]
[P20]	[3/4"C,3#10,5#14,1#10G]	[P43]	[2"C,3#4/0,1#3G]
[P21]	[1"C,2#8,#10G]		
[P22]	[1"C,3#8,#10G]		
[P23]	[1"C,3#8,2#14,1#10G]		

ANALOG CIRCUIT CALLOUTS	
[A1]	[3/4"C,1 TYPE 3]
[A2]	[1"C,2 TYPE 3]
[A3]	[1"C,1 TYPE 3]
[A4]	[1"C,4 TYPE 3]
[A5]	[1 1/4"C,5 TYPE 3]
[A6]	[1 1/4"C,6 TYPE 3]
[A7]	[1 1/2"C,7 TYPE 3]
[A8]	[1 1/2"C,8 TYPE 3]
[A9]	[1 1/2"C,9 TYPE 3]
[A10]	[2"C,10 TYPE 3]
[A11]	[2"C,11 TYPE 3]
[A12]	[2"C,12 TYPE 3]
[A13]	[2"C,13 TYPE 3]
[A14]	[2"C,14 TYPE 3]
[A15]	[3/4"C,1 TYPE 4]
[A16]	[3/4"C,2 TYPE 4]
[A17]	[1"C,3 TYPE 4]
[A18]	[1 1/4"C,4 TYPE 4]
[A19]	[1 1/4"C,5 TYPE 4]
[A20]	[1 1/4"C,6 TYPE 4]
[A21]	[1 1/2"C,7 TYPE 4]
[A22]	[1 1/2"C,8 TYPE 4]
[A23]	[2"C,9 TYPE 4]
[A24]	[3/4"C,1-4 pr. TYPE 5]
[A25]	[1"C,2-4 pr. TYPE 5]

CONTROL CIRCUIT CALLOUTS	
[C1]	[3/4"C,MSC]
[C2]	[3/4"C,2#14,1#14G]
[C3]	[3/4"C,3#14,1#14G]
[C4]	[3/4"C,4#14,1#14G]
[C5]	[3/4"C,5#14,1#14G]
[C6]	[3/4"C,6#14,1#14G]
[C7]	[3/4"C,7#14,1#14G]
[C8]	[3/4"C,8#14,1#14G]
[C9]	[3/4"C,9#14,1#14G]
[C10]	[3/4"C,10#14,1#14G]
[C11]	[3/4"C,11#14,1#14G]
[C12]	[3/4"C,12#14,1#14G]
[C13]	[3/4"C,13#14,1#14G]
[C14]	[3/4"C,14#14,1#14G]
[C15]	[3/4"C,15#14,1#14G]
[C16]	[3/4"C,16#14,1#14G]
[C17]	[3/4"C,17#14,1#14G]
[C18]	[3/4"C,18#14,1#14G]
[C19]	[3/4"C,19#14,1#14G]
[C20]	[1"C,20#14,1#14G]
[C21]	[1"C,21#14,1#14G]
[C22]	[1"C,22#14,1#14G]
[C23]	[1"C,23#14,1#14G]
[C24]	[1"C,24#14,1#14G]
[C25]	[1"C,25#14,1#14G]

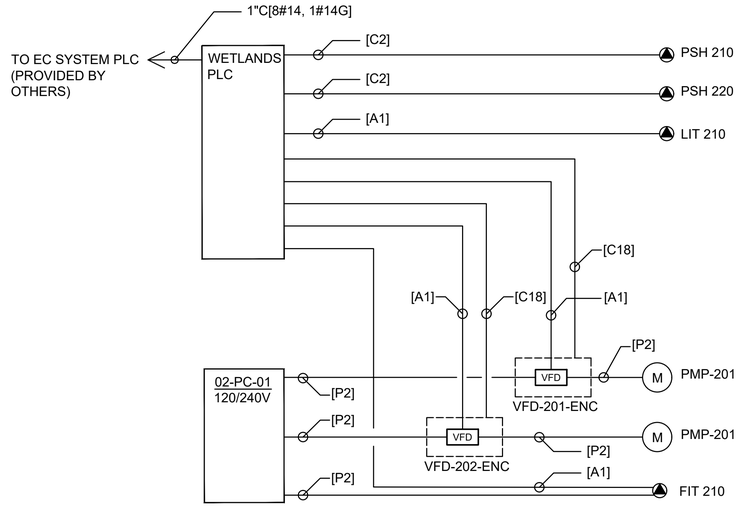
MULTICONDUCTOR POWER CABLE CIRCUIT CALLOUTS	
[PC1]	[3/4"C,1 (3C#12,1#12G] TYP 2]
[PC2]	[3/4"C,1 (3C#10,1#10G] TYP 2]
[PC3]	[1"C,1 (3C#8,1#10G] TYP 2]
[PC4]	[1 1/4"C,2 (3C#12,1#12G] TYP 2]
[PC5]	[1 1/2"C,2 (3C#10,1#10G] TYP 2]
[PC1A]	[3/4"C,1 (23C#12,1#12G] TYP 2]
[PC2A]	[3/4"C,1 (2C#10,1#10G] TYP 2]

EMPTY CONDUIT	
[EC-1]	[3/4"C,WITH PULL STRING]
[EC-2]	[1"C,WITH PULL STRING]
[EC-3]	[1 1/4"C,WITH PULL STRING]
[EC-4]	[1 1/2"C,WITH PULL STRING]
[EC-5]	[2"C,WITH PULL STRING]
[EC-6]	[3"C,WITH PULL STRING]
[EC-7]	[4"C,WITH PULL STRING]
[EC-8]	[5"C,WITH PULL STRING]

MISCELLANEOUS		
[a]	=	1-1/4"C[3#3, 1#8G], 1-1/2"C[3#2/0, 1#6G], 1-1/2"C[3#2/0, 1#6G], 1-1/4"C[3#3, 1#8G]

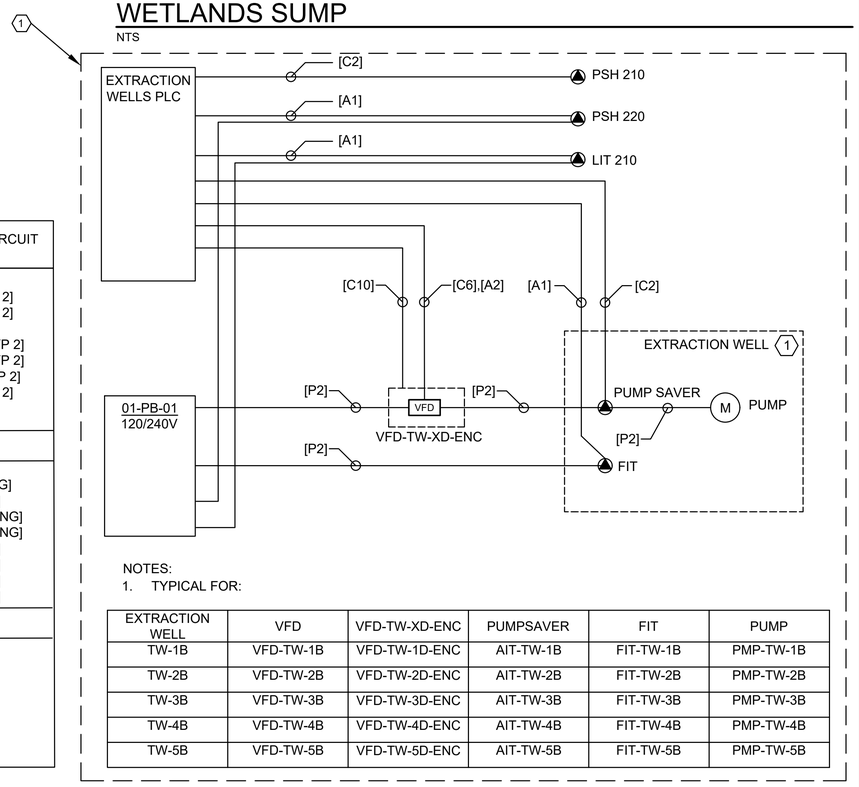
SHEET KEYNOTES

1. MOTOR CONTROL DIAGRAM IS FOR SCHEMATIC AND GUIDANCE PURPOSES ONLY, AND MAY NOT REFLECT FINAL INSTALLED SYSTEM. FOLLOW REQUIREMENTS OUTLINED IN THE VENDOR PACKAGE PERFORMANCE SCOPE FOR THE EXTRACTION PUMPS AND CONTROLS DOCUMENT, ATTACHMENT D.



WETLANDS SUMP

NTS



NOTES:
1. TYPICAL FOR:

EXTRACTION WELL	VFD	VFD-TW-XD-ENC	PUMPSAVER	FIT	PUMP
TW-1B	VFD-TW-1B	VFD-TW-1D-ENC	AIT-TW-1B	FIT-TW-1B	PMP-TW-1B
TW-2B	VFD-TW-2B	VFD-TW-2D-ENC	AIT-TW-2B	FIT-TW-2B	PMP-TW-2B
TW-3B	VFD-TW-3B	VFD-TW-3D-ENC	AIT-TW-3B	FIT-TW-3B	PMP-TW-3B
TW-4B	VFD-TW-4B	VFD-TW-4D-ENC	AIT-TW-4B	FIT-TW-4B	PMP-TW-4B
TW-5B	VFD-TW-5B	VFD-TW-5D-ENC	AIT-TW-5B	FIT-TW-5B	PMP-TW-5B

EXTRACTION WELLFIELD

NTS

05/08/2020

NO.	DATE	DSGN	DR	CHK	APVD
1	05/01/2020	M. ALEXANDER	T. KENDALL	B. PILMER	B. PILMER
0	04/03/2020	KI	KI	BY	APVD
		JD	JD		

EXTRACTION SYSTEM ADDENDUM
FINAL DESIGN - ISSUED FOR CONSTRUCTION
REVISION

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST

EC UNIT:
CABLE BLOCK DIAGRAMS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	004-E-003
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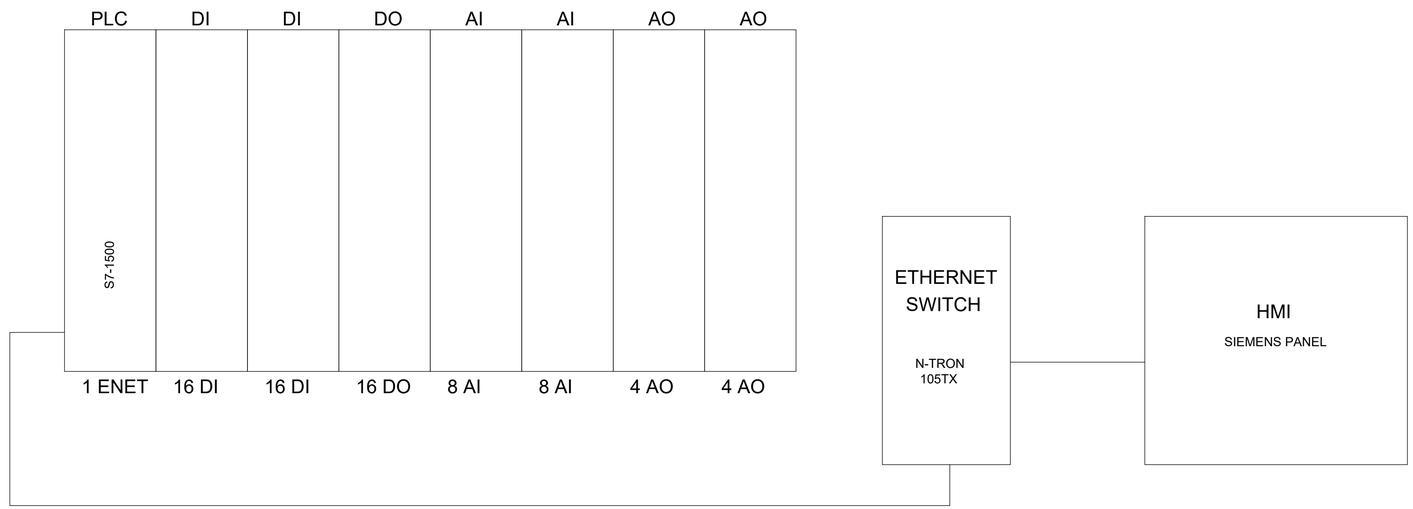
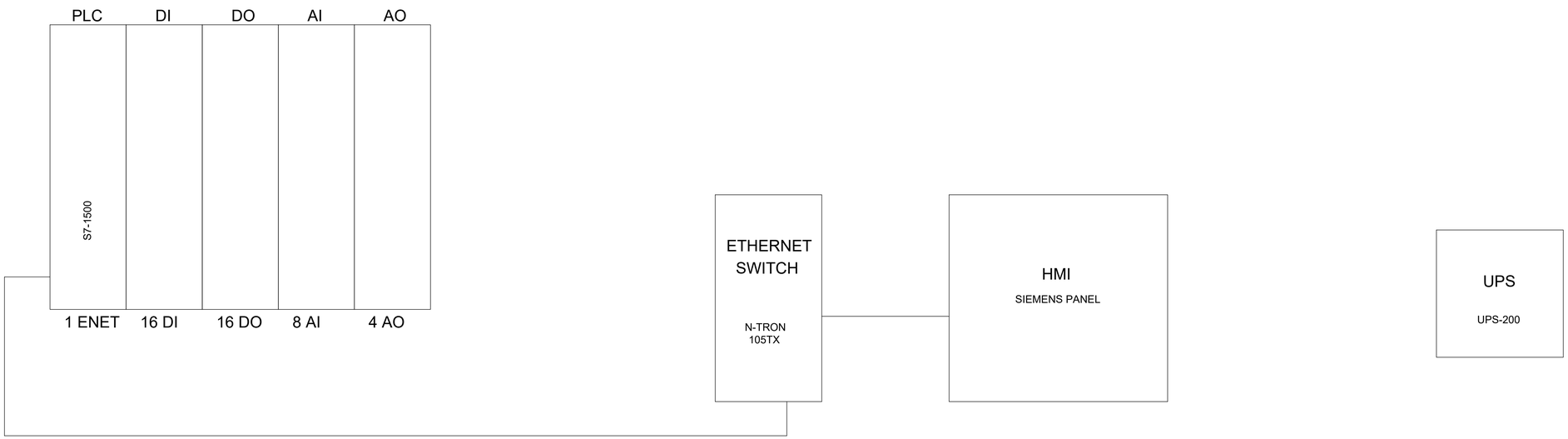
WELL FIELD PLC CONTROL PANEL



GENERAL NOTES

1. THE WELL FIELD PLC PANEL DIAGRAM IS FOR SCHEMATIC AND GUIDANCE PURPOSES ONLY, AND MAY NOT REFLECT FINAL INSTALLED SYSTEM. SYSTEM IS TO FOLLOW REQUIREMENTS OUTLINED IN THE "VENDOR PACKAGE PERFORMANCE SCOPE FOR THE EXTRACTION PUMPS AND CONTROLS" DOCUMENT, ATTACHMENT D.
2. THE WETLANDS PLC CONTROL PANEL IS TO BE PROVIDED ACCORDING TO SPECIFICATIONS 40 90 00 AND 40 91 00.

WETLANDS PLC CONTROL PANEL



JOSIAH CLEMENT THOMPSON
STATE OF WASHINGTON
52864
REGISTERED
PROFESSIONAL ENGINEER
05/07/2020

NO.	DATE	DSGN	DR	CHK	APVD	BY
1	05/01/2020	EXTRACTION SYSTEM ADDENDUM	JOSH T.	JOSH T.	STEVE B.	KI
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION			STEVE B.	KI
		REVISION			APVD	BY

JD JD STEVE B.

JACOBS

KAISER MEAD CUSTODIAL TRUST

PLC CONTROL PANEL NETWORKS

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

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PROJ	KMCT2019
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SHEET	42 of 44

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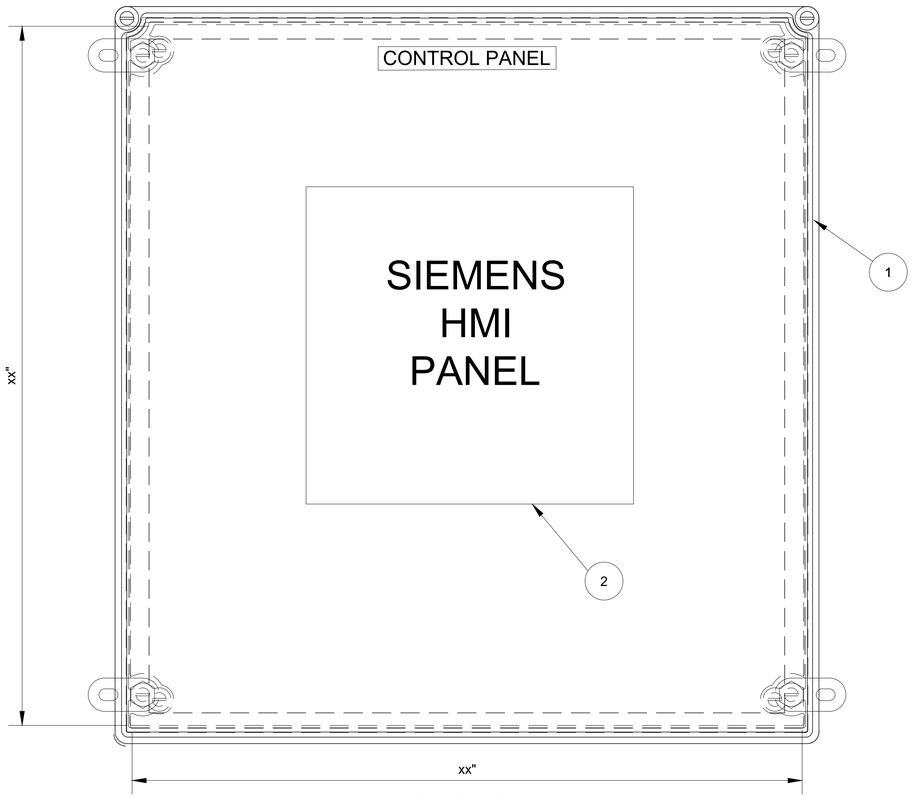
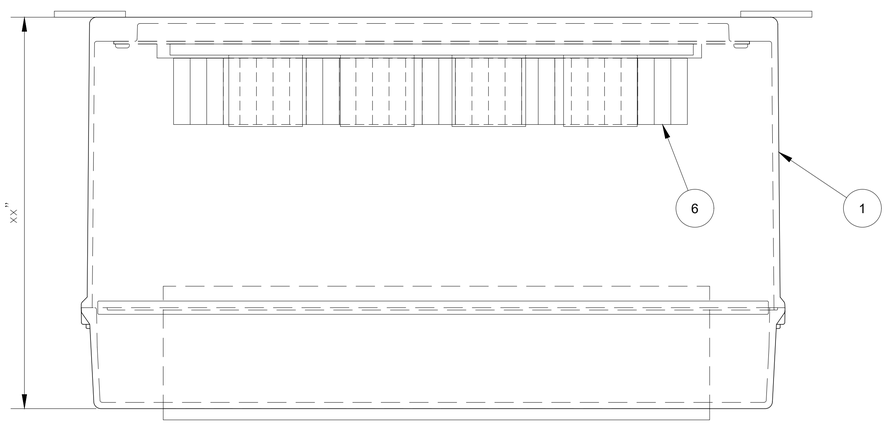
PLC/HMI CONTROL PANEL - WET LANDS SUMP

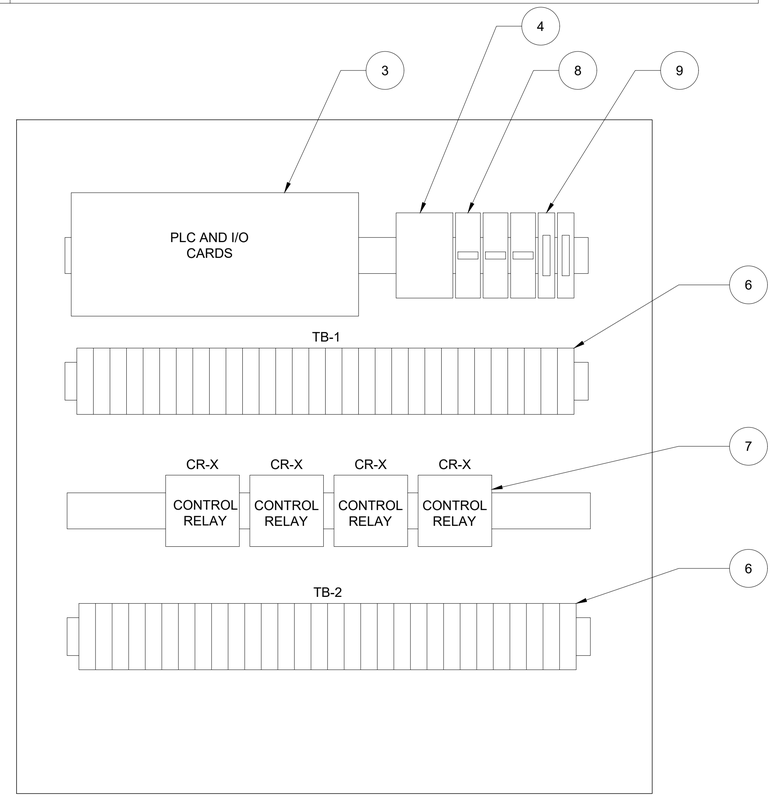


FRONT VIEW



TOP VIEW

MATERIAL LIST	
1	HxWxD" NEMA 4X ENCLOSURE
2	SIEMENS HMI PANEL
3	SIEMENS S7-1500 PLC AND I/O CARDS
4	24VDC POWER SUPPLY
5	NA
6	TERMINAL - I/O CIRCUITS SHALL HAVE INDICATION FUSES
7	CONTROL RELAY - AS NEEDED
8	CIRCUIT BREAKER
9	FUSE DISCONNECT



INTERIOR VIEW

GENERAL NOTES

1. FOR ABBREVIATIONS AND SYMBOLS REFER TO I&C LEGENDS IN GENERAL DRAWINGS SECTION
2. LAYOUT AND ARRANGEMENT OF PANEL FOR REFERENCE ONLY. CONTRACTOR TO PROVIDE PANEL DRAWING SET FOR APPROVAL - INCLUDING, BUT NOT LIMITED TO, COMPLETE BOM, WIRING DIAGRAMS, PANEL ELEVATIONS AND SPEC MANUALS FOR ALL EQUIPMENT PROVIDED.

JOSHUA CLEMENT THOMPSON
STATE OF WASHINGTON
52864
REGISTERED
PROFESSIONAL ENGINEER
05/07/2020

NO.	DATE	DSGN	DR	CHK	APVD	BY
1	05/01/2020	JOSH T.	JOSH T.	STEVE B.	STEVE B.	KI
0	04/03/2020					KI
			REVISION			BY
			FINAL DESIGN - ISSUED FOR CONSTRUCTION			KI
			EXTRACTION SYSTEM ADDENDUM			JD
						JD
						APVD

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST
PANEL ELEVATIONS

VERIFY SCALE
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0 1"

DATE	
PROJ	KMCT2019
DWG	004-I-002
SHEET	43 of 44

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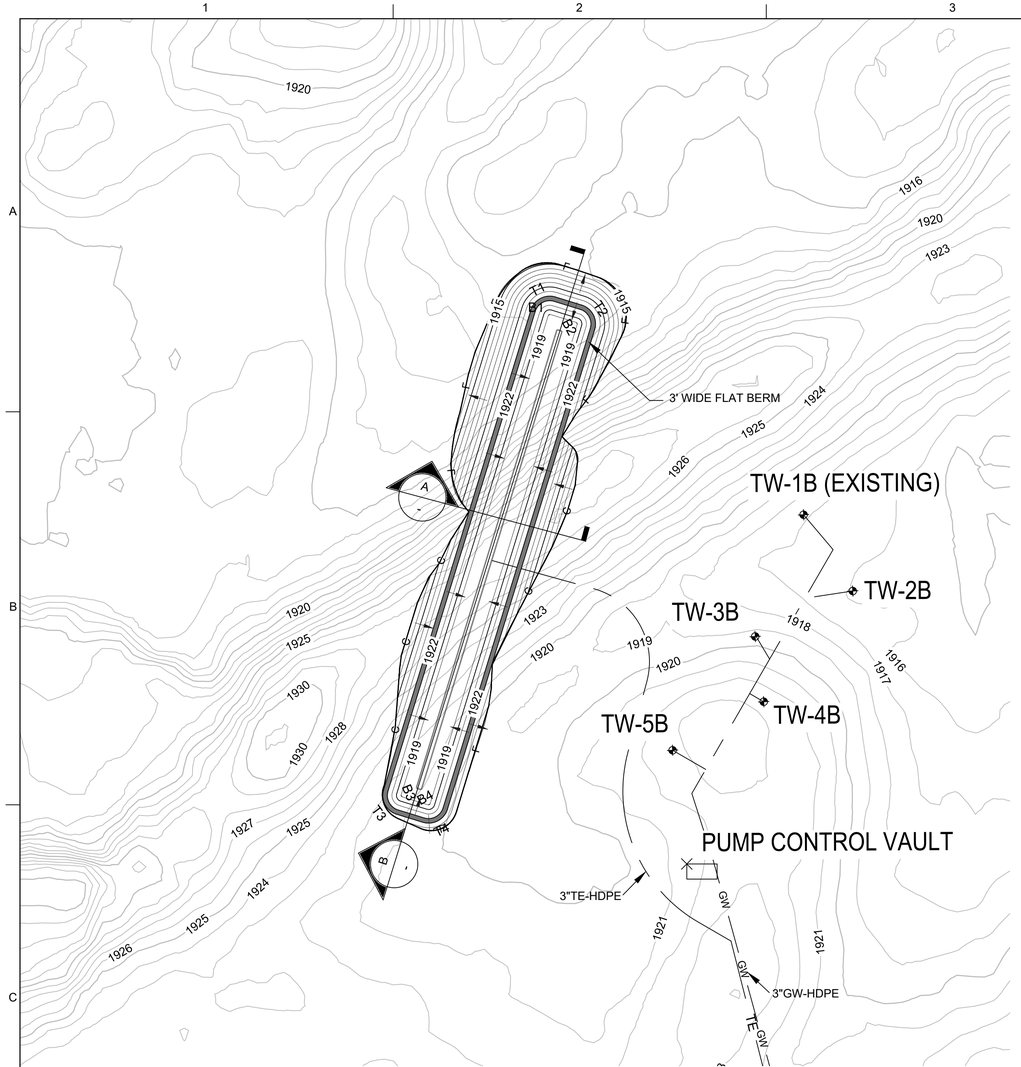


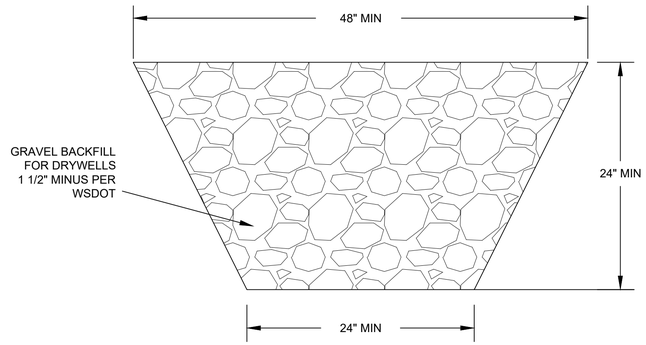
INFILTRATION BASIN CIVIL PLAN

1" = 50'-0"

N

0 50 100 150

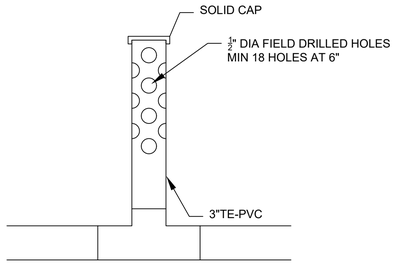
1"=50'-0"



INFILTRATION BASIN GRAVEL TRENCH DETAIL

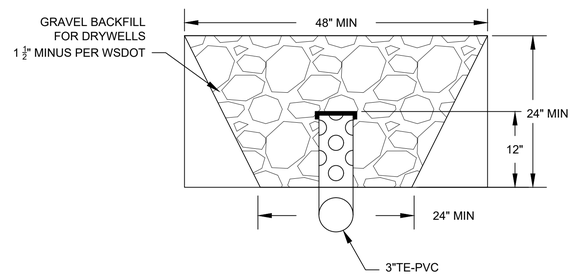
NTS

Curve Table							
Curve #	Length	Radius	Delta	NORTHING START	EASTING START	NORTHING END	EASTING END
B1	1.6	1.0	090.00°	296602.60	2487338.08	296601.94	2487336.83
B2	1.6	1.0	090.00°	296596.07	2487355.95	296597.32	2487355.29
B3	1.6	1.0	090.00°	296285.51	2487239.69	296284.26	2487240.36
B4	1.6	1.0	090.00°	296278.98	2487257.56	296279.64	2487258.81
T1	15.7	10.0	090.00°	296611.21	2487340.72	296604.58	2487328.23
T2	15.7	10.0	090.00°	296593.43	2487364.56	296605.92	2487357.93
T3	15.7	10.0	090.00°	296288.15	2487231.09	296275.66	2487237.72
T4	15.7	10.0	090.00°	296270.38	2487254.92	296277.00	2487267.42



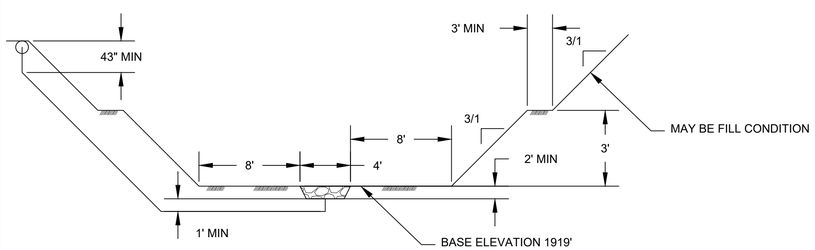
INFILTRATION BASIN FLOW RISER

NTS



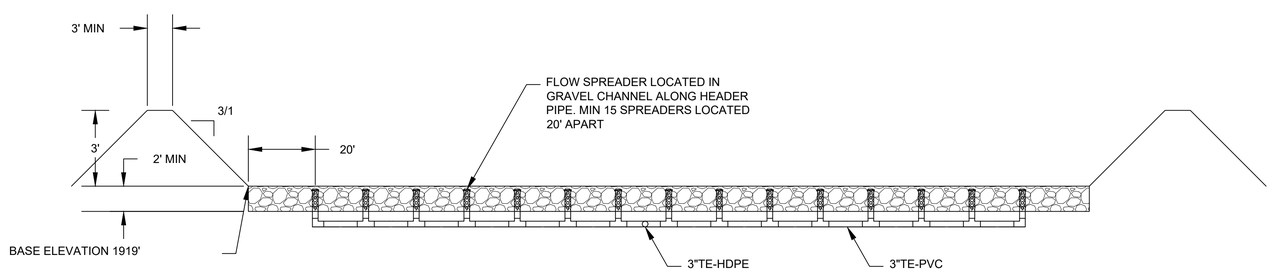
INFILTRATION BASIN GRAVEL TRENCH AT FLOW RISER

NTS



INFILTRATION BASIN SECTION A

NTS



INFILTRATION BASIN SECTION B

NTS

STUART W.J. BARTON
STATE OF WASHINGTON
21661
REGISTERED
PROFESSIONAL ENGINEER

2020-05-08

NO.	DATE	DR	CHK	APVD
1	05/01/2020	EXTRACTION SYSTEM ADDENDUM	KI	JD
0	04/03/2020	FINAL DESIGN - ISSUED FOR CONSTRUCTION	KI	JD
		REVISION	BY	APVD
DSGN	B. MARTIN	D. SPADO	S. BARTON	S. BARTON

Ground Water Extraction and Cleanup
Mead, Washington
Kaiser Mead Custodial Trust
-

JACOBS

KAISER MEAD CUSTODIAL TRUST
INFILTRATION BASIN
CIVIL PLANS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	
PROJ	KMCT2019
DWG	005-C-001
SHEET	44 of 44

$PWURL $PWPATH FILENAME: 005-C-001.dwg PLOT DATE: PLOT TIME:

Appendix B
Technical Specifications

KAISER MEAD CUSTODIAL TRUST

CONTRACT DOCUMENTS

for the construction of the

GROUNDWATER REMEDIATION INTERIM ACTION FOR EXTRACTION, TREATMENT, AND DISCHARGE

****

REVISION 1

****

JACOBS

Spokane, Washington

April 2020 [May 2020]

Project No. KMCT2019 Copy No._____

SEALS PAGE

SPECIFICATIONS

01 31 13, 01 31 19, 01 32 00, 01 33 00, 01 42 13, 01 43 33, 01 45 16.13, 01 45 33, 01 50 00, 01 57 13, 01 61 00, 01 64 00, 01 74 19, 01 77 00, 01 78 23, 01 91 14

Digitally Signed on

June 2, 2020

Kelly Irving

SPECIFICATIONS
01 88 15, 03 30 10

Digitally Signed on

April 2, 2020

Liao Yang

SPECIFICATIONS
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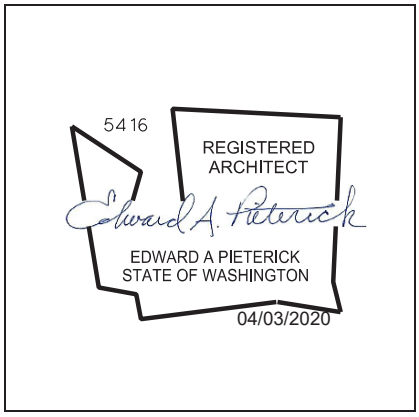

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April 2, 2020

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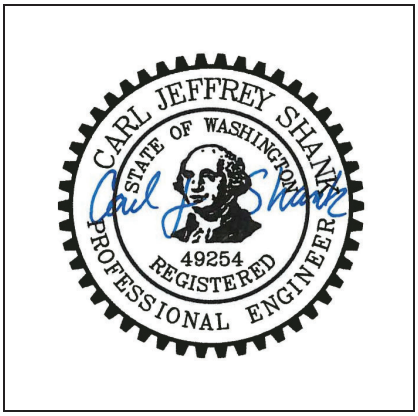

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April 2, 2020

Carl Shank

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Digitally Signed on

May 6, 2020

Brian Pilmer

SPECIFICATIONS
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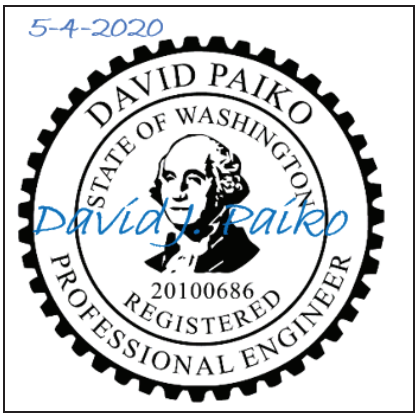

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May 3, 2020

David Paiko

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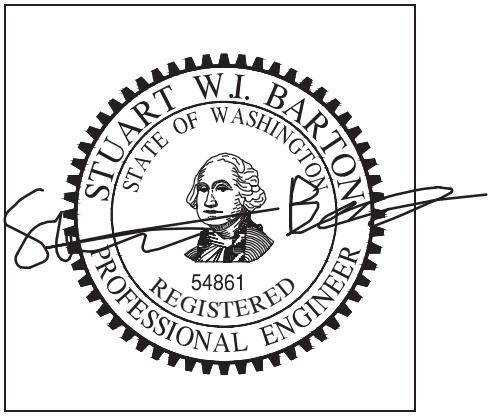

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April 2, 2020

Stuart Barton

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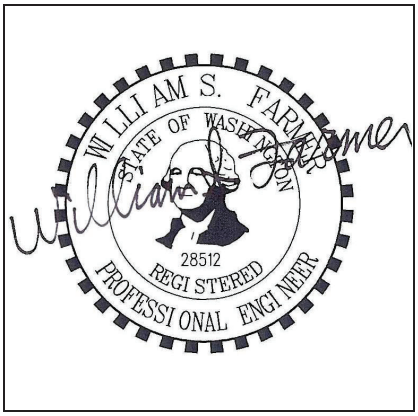

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April 2, 2020

Bill Farmer

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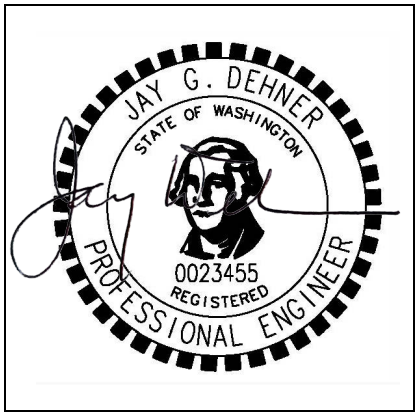

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June 2, 2020

Jay Dehner

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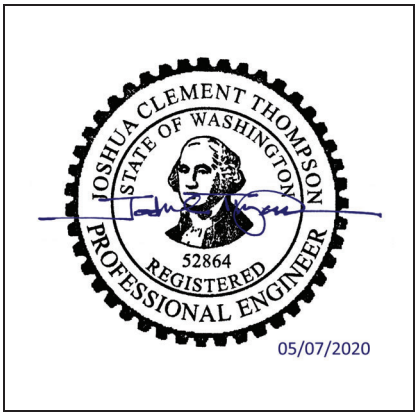

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May 7, 2020

Joshua Thompson

END OF SECTION

TABLE OF CONTENTS

END OF SECTION

SECTION 01 31 13
PROJECT COORDINATION

PART 1 GENERAL

1.01 RELATED WORK AT SITES

A. Two Main Project Sites: Extraction Wellfield Site and Treatment Site.

1. In addition to these two sites, access roads and trenches for utilities and water transport will be constructed to connect the two sites together.

B. Applications Software Development:

1. Contractor will perform programming of applications software for certain portions, namely Package A, of Process Instrumentation and Control Subsystem (PICS). Refer to Section 40 90 00, Instrumentation and Control for Process Systems, for detailed information pertaining to Contractor programming.
2. Allowance for interruptions to the Work because of testing by Contractor of Subcontractor developed applications software:
   a. During Functional Testing and Performance Testing, Subcontractor shall plan for interruption of testing of the Work to allow Contractor to investigate software problems, make software configuration changes, and conduct additional testing.

C. Package A – Extraction Well System: Subcontractor to provide a pumping system and pump control house at the extraction well field. Coordinate with Package B Subcontractor for interface as needed.

D. Package B – Civil/Mechanical: Subcontractor to provide civil and mechanical work necessary to construct access roads, wetlands, effluent pump station, infiltration basin, subgrade for Electro-Coagulation Building and trenching between two project sites. Coordinate with Packages A, C, and D Subcontractors.

E. Package C – Electro-Coagulation Building: Subcontractor to provide a pre-fabricated building with foundation and additional electrical to the wetlands effluent pump station. Coordinate with Packages B and D Subcontractors.

F. Package D – Electro-Coagulation Treatment System: Subcontractor to provide EC Treatment System. Coordinate with Packages B and C Subcontractors.

1.02 CONTRACTOR-FURNISHED PRODUCTS

A. Refer to Section 01 64 00, Contractor-Furnished Products.

1.03 UTILITY NOTIFICATION AND COORDINATION

A. Coordinate the Work with various utilities. Prior to commencement of any work, all required utility locates must be obtained and renewed per state and local requirements.

1. Underground Service Alert:
   a. Telephone: (811) or (800) 424-5555.

B. Notify Contractor for coordination with applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during Work.

1. Contractor: Mike Heden, Field Construction Manager, or as instructed by Jacobs.
   a. Telephone: (509) 464-7200 or (509) 953-7111.

1.04 ADJACENT FACILITIES AND PROPERTIES

A. Examination:

1. After Effective Date of Subcontract and before any Work is started, Contractor, Subcontractor, and affected property owners and utility owners shall make a thorough examination of pre-existing conditions including existing buildings, structures, and other improvements in vicinity of Work, as applicable, which could be damaged or impacted by construction operations.
2. Periodic reexamination shall be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.

B. Documentation:

1. Record and submit documentation of observations made on examination inspections.
2. Upon receipt, Contractor will review, sign, and return one record copy of documentation to Subcontractor to be kept on file in field office.
3. Such documentation shall be used as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of Subcontractor’s operations, and is for the protection of adjacent property owners, Contractor, and Agency.

1.05 REFERENCE POINTS AND SURVEYS

A. Contractor's Responsibilities:

1. Establish bench marks convenient to Work and at least every 500 feet on pipelines and roads.
2. Establish horizontal reference points or coordinate system with bench marks and reference points for Subcontractor's use as necessary to lay out Work.
3. Establish baseline from which facilities may be located.
4. Establish clearing limits, centerlines of roads and pipelines, set toe of fill and top of cut stakes, and set bench marks convenient for use as necessary to establish basic layout of the Work.

B. Location and elevation of bench marks are shown on Drawings.

C. Subcontractor's Responsibilities:

1. Provide additional survey and layout required to layout the Work.
2. Notify Contractor at least 3 working days in advance of time when grade and line to be provided by Contractor will be needed.
3. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
4. In event of discrepancy in data or staking provided by Contractor, request clarification before proceeding with Work.
5. Maintain complete accurate log of survey work as it progresses as a Record Document.
6. On request of Contractor, submit documentation.
7. Provide competent employee(s), tools, stakes, and other equipment and materials as Contractor may require to:
    a. Check layout, survey, and measurement work performed by others.
    b. Measure quantities for payment purposes.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CUTTING, FITTING, AND PATCHING

A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.

B. Obtain prior written authorization of Contractor before commencing Work to cut or otherwise alter:

1. Structural or reinforcing steel, structural column or beam, elevated slab, trusses, or other structural member.
2. Weather- or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.
4. Work of others.

C. Refinish surfaces to provide an even finish.

1. Refinish continuous surfaces to nearest intersection.
2. Refinish entire assemblies.
3. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and the Work is evident in finished surfaces.

D. Restore existing work, Underground Facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown.

E. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use recommended practice of manufacturer or appropriate trade association.

F. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.

G. Remove specimens of installed Work for testing when requested by Contractor.

END OF SECTION

SECTION 01 31 19
PROJECT MEETINGS

PART 1 GENERAL

1.01 GENERAL

A. The Contractor will schedule meetings throughout progress of the Work and prepare meeting agenda with regular participant input. The Contractor will conduct meetings, record notes to include significant proceedings and decisions, and reproduce and distribute copies of notes after each meeting to participants and parties affected by meeting decisions.

1.02 PRECONSTRUCTION CONFERENCE

A. Subcontractor shall be prepared to discuss the following subjects, as a minimum:

1. Project Overview:
   a. Project Description.
   b. Organization Chart.
2. Health, Safety, and Environment:
   a. Beyond Zero and Excellence in Safety Programs.
   b. Project Specific Health and Safety Requirements.
   c. Subcontractor’s Safety Plan and Representative.
   d. Drug Testing Policy.
   e. Employee Orientations.
   f. Pre-Work Safety Documentation.
   g. Daily/Weekly Safety Documentation.
   h. Safety Observation Reports (SOR).
   i. Hazardous Operations.
   j. Hazardous Communications.
   k. Personal Protective Equipment (PPE).
   l. Incident/Accident Reporting/OSHA Recordable Reporting.
3. Scheduling:
   a. Required schedules.
   b. Sequencing of critical path work items.
   c. Major product delivery and priorities.
   d. Weekly meetings.
   e. Subcontractor’s Manpower/Staffing.
4. Contract Administration:
   a. Bonds and insurance.
   b. Progress Payment Procedures.

c. Contract Change Management.
d. Notifications.

5. General Site Logistics:
   a. Use of Site, access, office and storage areas, security and temporary facilities.
   b. Site Authority.
   c. Emergency Response.
   d. Work Hours.
   e. General Coordination/Trade Stacking.
   f. Submittal schedule and procedures.
   g. RFI and submittal procedures.
   h. Operations and Maintenance Manuals.
6. Quality Control/Quality Assurance:
   a. Roles and Responsibilities.
   b. Permits.
   c. Inspections.
   d. Testing reports and offsite inspections.
   e. Record Drawings.
7. Review of Subcontractor's Scope of Work (SOW): SOW issues.
8. Outstanding issues.

B. Attendees will include (as a minimum):

1. Subcontractor's representative with full authority to make decisions on behalf of Subcontractor.
2. Subcontractor's superintendent.
3. Subcontractor's quality control representative.
4. Subcontractor's safety representative.
5. Contractor's representatives.
6. Others as appropriate.

1.03 PRELIMINARY SCHEDULES REVIEW MEETING

A. As set forth in Section 01 32 00, Construction Progress Documentation.

1.04 WEEKLY COORDINATION MEETINGS

A. Contractor will schedule and conduct weekly progress meetings to review safety, general work coordination, collection of daily reports, workforce for the day, quality control, and other matters needing discussion and resolution.

B. Attendees will include:

1. Contractor.
2. Subcontractor's representative with full authority to make decisions on behalf of Subcontractor.
3. Others as appropriate.

1.05 PREINSTALLATION MEETINGS

A. When required in individual specification sections or as directed by Contractor, convene at Site prior to commencing the Work of that section.

B. Require attendance of entities directly affecting, or affected by, the Work of that section or as directed by Contractor.

C. Notify Contractor a minimum of 4 days in advance of meeting date.

D. Unless provided in advance by Contractor, provide suggested agenda to include reviewing conditions of installation, preparation and installation or application procedures, and coordination with related Work and work of others.

1.06 FACILITY COMMISSIONING MEETINGS

A. Attend and participate in facility commissioning meetings.

B. Attendees will include:

1. Subcontractor's representative with full authority to make decisions on behalf of Subcontractor.
2. Subcontractors and equipment manufacturer's representatives whom Contractor deems to be directly involved in facility commissioning.
3. Contractor's personnel.
4. Others as required by Subcontract or as deemed necessary by Contractor.

1.07 SAFETY MEETINGS

A. Employee Safety Orientations:

1. Employees must have proof of Drug-Free Workplace Compliance prior to taking safety orientation.
2. Employees will receive a hard hat sticker at the close of orientation that must be visible at all times.
3. Safety Orientation usually takes 1 hour to 1.5 hours.

B. Monthly Mass Safety Meeting:

1. Attend monthly mass safety meetings to be held at Site or as directed by Contractor.
2. Meeting agenda shall include but not be limited to:
   a. Overall site safety performance.
   b. Safety issues.
   c. Project FSI reviews as required.
   d. Safety recognitions.
   e. Upcoming medium/high risk work activities.
   f. ESP progress.
   g. Other items deemed necessary by Contractor.
3. Employees working onsite shall attend.

C. Site Safety Drills: Held at Site as directed by Contractor and attended by staff.

1.08 OTHER MEETINGS

A. In accordance with Subcontract and as may be required by Contractor.

1.09 SUBMITTALS

A. Informational Submittal: Execution Plan.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXECUTION PLAN

A. Execution Plan of the Work shall describe at a minimum the following:

1. What safety risks are identified and how they will be mitigated through the course of the Work in accordance with Field Safety Instructions.
2. Overview of the Work and phases of the Work.
3. Detailed description of the Work in each phase.
4. Manpower and equipment utilized to perform the Work described by areas and crafts.
5. Deliveries, lay down area, and other areas needed to perform the Work along with durations and phases.
6. Installation of the Work by areas and phases in accordance with Contractor project schedule.
7. Quality Control of the Work for each discipline involved with the scope of work per requirements of Section 01 45 16.13, Subcontractor Quality Control.

8. Coordination of the Subcontractors' work needed to perform the Work.
9. The Contractor's assistance in specific areas of the Work.

B. The Contractor will determine if Execution Plan will be required to be submitted prior to performing work or in phases in addition to level of detail required.

END OF SECTION

SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Subcontractor's Supplemental Schedule: Submit to Contractor within 15 days after Effective Date of Agreement.
2. Six-Week Look Ahead Schedule: Submit on weekly basis, in conjunction with weekly Schedule Progress Meeting.
3. Initial Quantity Installation Histogram: Submit to Contractor within 30 days after Effective Date of Agreement. Applies to linear feet (LF) of yard pipe, LF of duct bank, cubic yards (CY) of concrete installed, number of pieces of process/HVAC equipment installed and number of instruments installed.
4. Actual Weekly Quantity Installation Report: Submit no later than Monday close of business following the end of the previous work week. Applies to the same items as shown in Subparagraph Initial Quantity Installation Histogram of this Article.

1.02 GENERAL DEFINITIONS

A. Baseline Project Schedule: Developed by Contractor with input required from the Subcontractor for all activities related to the execution of their Scope of Work. It is the basis for developing the Working Project Schedule.

B. Supplemental Schedule: Developed by Subcontractor. It is directly related to Baseline Project Schedule. Many detailed activities on Supplemental Project Schedule to One Activity on Baseline Project Schedule.

C. Working Project Schedule: Developed and maintained by Contractor. Working Project Schedule incorporates Subcontractor's approved Supplemental Schedule and is updated and used to track project progress throughout duration of Project.

D. Six-Week Look Ahead Schedule: Subset of Working Project Schedule. Contains activities 1 week prior to Data Date and 5 weeks after Data Date.

E. Rules of Credit: Rules for taking physical progress on an activity, based on giving weighted value to different phase of work, while installing a given resources; see Article Procedures, Paragraph Quantity Reporting.

1.03 PROCEDURES

A. Contractor has developed Baseline Project Schedule that Subcontractor shall comply with, along with updates to Baseline, for overall execution of the Work. Official project schedules will be created, maintained, and issued by Contractor, exclusively.

B. Subcontractor shall, within 30 days after award of Subcontract, prepare and submit to Contractor for approval a Supplemental Schedule showing Baseline Project Schedule activities broken down into more detail.

1. Supplemental Schedule shall be developed on Subcontractor's scheduling tools.
2. Output that is submitted back to Contractor shall be a Bar Chart showing each Baseline Project Schedule activities.
    a. Under each Baseline Project Schedule activity Subcontractor shall show detailed activities that have been developed.
    b. Total duration of detailed activities shall equal duration of Baseline Project Schedule activity.
3. If Subcontractor's Supplemental Schedule is not acceptable, Contractor will notify Subcontractor and provide comments on unacceptable items.
    a. Subcontractor shall make corrections and resubmit within 10 days of notification.
    b. Review and revision process will continue until Supplemental Schedule is accepted by Contractor.
4. After approval Contractor will integrate Supplemental Schedule into Baseline Project Schedule. From that point forward schedule will be known as the Working Project Schedule.
    a. Working Project Schedule will become basis for measuring Subcontractor's progress and schedule compliance and will always be compared against Baseline Project Schedule.
5. If Subcontractor fails to submit Supplemental Schedule within time prescribed, Contractor may withhold approval of progress payments until Subcontractor submits required Schedule.

C. Subcontractor shall submit weekly to Contractor actual progress information as required to allow Contractor to update the Working Project Schedule.

1. If, in opinion of Contractor, Subcontractor falls behind their activities contained in Working Project Schedule, or any subsequent updates, Subcontractor shall take steps necessary to improve its progress, including those that may be required by Contractor, without additional cost to Contractor.

2. In this circumstance, Contractor may require Subcontractor to increase number of workers and supervision, shifts, overtime operations, days of work or amount of construction plant, and to submit for approval additional Supplementary Schedule or schedules as deemed necessary by Contractor to demonstrate how approved rate of progress will be regained.

D. Subcontractor shall participate in a weekly schedule meeting.

1. Subcontractors onsite will participate in each weekly schedule meeting.
2. Meeting will cover Work completed during previous week and the Work to be completed in next 5 weeks following meeting. Each week Contractor will update schedule and issue a 6-Week Look Ahead Schedule report, back to Subcontractors.
3. In preparation for weekly meeting Subcontractor shall review and update previous week's 6-Week Look Ahead Schedule and be prepared to be an active participant in meeting discussions. One workday prior to schedule meeting, Subcontractor will informally submit their updated 6-week Look Ahead Schedule to the Contractor project scheduler.

E. Failure of Subcontractor to comply with requirements of Contractor under this clause shall be grounds for a determination by Contractor that Subcontractor is not prosecuting Subcontractor's Work with sufficient diligence to ensure completion within time specified in Subcontract. Upon making this determination, Contractor may take further contractual actions in accordance with the Terms and Conditions of the Subcontract.

F. Quantity Reporting:

1. Some Baseline Project Schedule activities, and subsequently the Working Project Schedule, can be resource loaded with Quantity Units of material to be installed and completed.
    a. Some typical examples would be cubic yards of concrete, linear feet of under slab piping, linear feet of aboveground piping, linear feet of yard piping, each equipment to be installed, linear feet of electrical duct bank, linear feet of under slab conduit number of pieces of electrical equipment, number of circuits for 480 volts, and number of loops for instrumentation.
    b. When a quantity unit appears on an activity and activity is progressed during the week, Subcontractor shall enter number of Units completed during previous week.
    c. A "stepped form of progress" on Quantity Units is allowed, but the "Rules of Credit" on this type of Progress reporting shall be

agreed to by Subcontractor and Contractor, in advance. A typical example of a "Stepped form of progress" is as follows:

1) Activity A has 550 cubic yards of concrete. Description of Activity A is "Form, Rebar, Pour Foundation Slab – Pour A – Bioreactor". Steps and percentages for this type of activity are:
   a) Step 1: Form equals 15 percent.
   b) Step 2: Rebar equals 45 percent.
   c) Step 3: Pour equals 40 percent.
2) If Activity A doesn't get completed in 1 week then Subcontractor is allowed to take credit on the steps, such as the example below:
   a) Step 1: Form equals 15 percent * 100 percent equals 15 percent.
   b) Step 2: Rebar equals 45 percent * 100 percent equals 45 percent.
   c) Step 3: Pour equals 40 percent * 0 percent equals 0 percent.
3) Subcontractor is allowed to take 60 percent credit on the 550 cubic yards, which equals 330 cubic yards.

2. Subcontractor is responsible for defining and presenting the "Rules of Credit" to Contractor if a "stepped progress" is formally requested. Contractor will approve, disapprove, or negotiate, depending on review of the "Rules of Credit" submitted by Subcontractor.

G. Schedule of Values:

1. Each item on SOV shall be directly related to activities on Working Project Schedule, with the exception of General Condition items.
2. If other than a General Condition item, Subcontractor shall be able to relate one activity, or a group of activities, on Working Project Schedule, to one item on Schedule of Values.
3. An activity on Working Project Schedule cannot be related to more than one item on SOV.
4. Submit proposed SOV to Contractor within 30 days after award of Subcontract.
5. SOV should match, as closely as possible, activities on Baseline Project Schedule.
6. Each line item on SOV will contain a value equal to the Work being done.
7. Aggregate of all items on SOV shall equal Contract Value.
8. Contractor will review submitted SOV for compliance with requirements on Contractor Project Accounting Procedures.
   a. Deviations will be negotiated with Subcontractor and resolved.

b. Subcontractor shall submit approved SOV as back-up to Subcontractor's Monthly Payment Request. Each line item in SOV shall list the following:
   1) Item description.
   2) Contractor-provided WBS accounting code.
   3) Total quantity and value of item.
   4) Total quantity and value earned as of previous payment request.
   5) Total quantity and value earned as of this payment request.
   6) Period quantity and value earned for this payment request.

c. Sum of each "value" column shall equal value shown on monthly payment request cover sheet, i.e., monthly invoice.

H. Change Management:

1. Subcontractor shall be responsible for reporting to Contractor, on a bimonthly basis, pending changes that are not part of existing Contract scope between Subcontractor and Contractor.
   a. Contractor will keep a Project Issue Log of pending change items, as they work their way through the system to either become a Change Order or are mutually agreed upon to be removed from Project Issue Log.
   b. Subcontractor shall be responsible for estimating value of each item and notifying Contractor if estimate changes.
   c. At a mutually agreed upon time and when Project Issue Log item is approved, estimated amount will become value that is transitioned into a Change Order.
2. When multiple items on Project Issue Log are approved within same time frame, they will be combined to form a single Change Order.
   a. Each Project Issue Log item will be listed separately on Change Order and the total value of Change Order will equal the sum of Project Issue Log items.
   b. When Project Issue Log item has been approved for transition into a Change Order, item will be flagged.
   c. After Change Order is issued, item will be closed on the Project Issue Log.

3. As Change Orders are approved and become part of the Contract between Subcontractor and Contractor, the SOV will be revised by adding a line item(s) for the Change Order and/or revising existing line items:
    a. The Working Project Schedule will also be revised to show new work being performed.
    b. If Change Order or combination of Change Orders is of sufficient magnitude, there is a possibility that Baseline Project Schedule will also be revised.

I. Manpower Reporting:

1. Within 30 days after Subcontract has been awarded, submit manpower histogram showing number of people Subcontractor plans to have onsite for duration of Subcontract.
    a. Histogram shall show average number of personnel Subcontractor will have onsite, per month.
    b. For each month describe percentage of workers that are attributed to different types of work.
        1) An example of this would be if Subcontract was awarded to one Subcontractor for yard pipe and excavation. In this example histogram would show an average of 30 workers onsite for a given month. Subcontractor shall describe how many of the 30 workers will be working on earthwork and how many would be working on yard pipe.
2. Each week Subcontractor shall submit a certified payroll to Contractor showing number of hours each individual working for Subcontractor worked during previous week.
    a. Certified Payroll Reports (if required) are due to Contractor within 10 working days after conclusion of a work week.
    b. Subcontractors shall flow-down the requirement for Certified Payroll Reports (if required) to their lower-tier subcontractors.
    c. Certified payroll shall include workers performing onsite activities.

1.04 ADJUSTMENT OF CONTRACT TIMES

A. Claims Based on Contract Times:

1. Where Contractor has not yet rendered formal decision on Subcontractor’s claim for adjustment of Contract Times, and parties are unable to agree as to amount of adjustment to be reflected in Project Schedule, Subcontractor shall reflect an interim adjustment in Project Schedule acceptable to Contractor.

2. It is understood and agreed that such interim acceptance will not be binding on Subcontractor or Contractor, and will be made only for purpose of continuing to schedule Work until such time as formal decision has been rendered as to an adjustment, if any, of the Contract Times.

1.05 DAILY DOCUMENTATION OF WORK

A. Subcontractor shall, on a daily basis, provide daily report showing, at a minimum, the following:

1. Work hours.
2. Manpower onsite listed by labor type and subcontractors.
3. Areas and activities where the Work occurred and manpower/equipment assigned to each or as requested by Contractor.
4. Equipment onsite identifying time used and length not used.
5. Deliveries of materials or equipment with quantities.
6. Safety issues, incidents, injuries, and near misses.
7. Weather conditions.
8. Materials installed and quantities.
9. Change work that was active that day listed by Project Issue number.

B. Contractor reserves right, in its sole discretion, to require additional information be incorporated into Daily Report.

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 DEFINITIONS

A. Submittals: Documents required to be submitted that convey information about systems, equipment, materials, products, and administrative matters.

1. Action Submittal: Written and graphic information submitted by Subcontractor that requires approval by the Contractor.
2. Informational Submittal: Information submitted by Subcontractor that requires Contractor's review and determination that submitted information is in accordance with the Conditions of the Subcontract.
3. Deferred Submittal: Information in accordance with 2018 IBC, submitted for portions of design that were not provided to the Authority Having Jurisdiction (AHJ) at time of permit application and that require finalization of design, documentation of life safety equipment and systems, and other submittals for permanent construction requiring preparation by Subcontractor's registered design professional. Deferred submittal to AHJ includes the Contractor's review documentation that submittal has been found to be in conformance with required codes and Project's design criteria. Deferred submittals are for documentation or approval by the AHJ prior to installation of that portion of the Work.
   a. Deferred Action Submittal: Final design, prepared and stamped by Subcontractor's registered design professional, of systems, components, equipment, building and nonbuilding structures, structural elements, as well as supports and anchorage, required to complete Project.
   b. Deferred Informational Submittals: Final design, prepared and stamped by Subcontractor's registered design professional, of systems, components, equipment, structural elements, as well as supports and anchorage, required to complete the Project.

1.02 PROCEDURES

A. Direct submittals to Contractor at the following, unless specified otherwise.

1. Instructions and address to be provided separately.

B. Submittal Registry: Within 30 calendar days from execution of Subcontract; submit registry of anticipated submittals to Contractor. Include items of work that will require approval, review, and other required comments, decisions or input to be received from Contractor before materials have been procured. Contractor will incorporate this approved submittal registry as submitted by Subcontractor and implement into the master submittal registry checklist to provide a tracking and scheduling control logic for Work.

C. Electronic Submittals: Submittals shall be made in electronic format. Contractor can assist in instructing the Subcontractor's personnel to use the electronic submittal system at no additional cost to the Subcontractor.

1. Provide submittal as an electronic file in Adobe Acrobat Portable Document Format (PDF).
2. Electronic files that contain more than 10 pages in PDF format shall contain internal bookmarking from an index page to major sections of the document.
3. PDF files shall be set to open "Bookmarks and Page" view.
4. Add general information to each PDF file, including title, subject, author, and keywords.
5. PDF files shall be set up to print legibly at 8.5-inch by 11-inch, 11-inch by 17-inch, or 22-inch by 34-inch.
6. Submit new electronic files for each resubmittal.
7. Include a copy of the Transmittal of Subcontractor's Submittal form, located at end of section, with each electronic file.
8. Provide authorization to reproduce and distribute each file as many times as necessary for Project documentation.
9. Final Submittal Record Copies: After initial and resubmittal information has been approved, consolidate information, review comments, and responses to comments into one conformed overall record copy. Provide one electronic copy of conformed record copy to Contractor to verify incorporation of previously submitted data, comments and responses.

D. Transmittal of Submittal:

1. Review each submittal and check for compliance with Contract Documents.
    a. Stamp each submittal with uniform approval stamp before submitting to Contractor.
    b. Subcontractor's reviewer name, date of approval, and statement certifying submittal has been reviewed, checked, and approved for compliance with Contract Documents.

c. Contractor will not review submittals that do not bear Subcontractor's approval stamp and will return them without action.

2. Complete, sign, and transmit with each submittal package, one Transmittal of Subcontractor's Submittal form attached at end of this section in format approved by Contractor.
3. Submittal Numbering:
   a. Number submittals as follows:
      1) (A) equals specification section number.
      2) (B) equals consecutive submittal number listed in (A), with a revision suffix indicating sequential review cycle of submittal.
   b. Example:
      1) 01 33 00-001-R1 indicates the first review cycle of the first submittal submitted under Section 01 33 00, Submittal Procedures.
      2) 01 33 00-001-R2 indicates the second review cycle of the first submittal submitted under Section 01 33 00, Submittal Procedures.
      3) 01 33 00-002-R1 indicates the first review cycle of the second submittal submitted under Section 01 33 00, Submittal Procedures.
4. Identify each submittal with the following:
   a. Submittal number.
   b. Specification section and paragraph to which submittal applies.
   c. Any and all deviations clearly noted and identified.
   d. Project title, Contractor, and project number.
   e. Date of transmittal.
   f. Names of Subcontractor or Supplier and manufacturer as appropriate.
5. Identify and describe on Transmittal of Subcontractor's Submittal form each deviation or variation from Subcontract Agreement.
6. Include a completed Submittal Registry Checklist with the Transmittal of Subcontractor's Submittal which indicates items from specification that is included in Submittal.

E. Format:

1. Do not base Shop Drawings on reproductions of Contract Documents.
2. Package submittal information by individual specification section. Do not combine different specification sections together in submittal package, unless otherwise directed in specification.

3. Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with Subcontract Agreement.

F. Timeliness: Schedule and submit in accordance with Section 01 32 00, Construction Progress Documentation, and requirements of individual specification sections.

G. Processing Time:

1. Time for review begins when Contractor receives submittal.
2. Contractor will act upon submittal and transmit response to Subcontractor not later than 30 calendar days after receipt, unless otherwise specified.
3. Resubmittals will be subject to same review time.
4. No adjustment of Contract Times or Price will be allowed as a result of delays in progress of Work caused by rejection and subsequent resubmittals or by processing of deferred submittals by AHJ.

H. Resubmittals: Clearly identify each correction or change made.

I. Incomplete Submittals:

1. Submittal will be returned for revision if preliminary review deems it incomplete.
2. When any of the following are missing, submittal will be deemed incomplete:
   a. Subcontractor’s review stamp; completed and signed.
   b. Transmittal of Subcontractor’s Submittal; completed and signed.

J. Submittals not required by Contract Documents: Will not be reviewed and will be returned stamped “Not Subject to Review.”

1.03 ACTION SUBMITTALS

A. General: Prepare and submit Action Submittals required by individual specification sections.

B. Shop Drawings:

1. Identify and Indicate:
   a. Applicable Contract Drawing and Detail number, products, units and assemblies, and system or equipment identification or tag numbers.

b. Equipment and Component Title: Identical to title shown on Drawings.
c. Critical field dimensions and relationships to other critical features of Work. Note dimensions established by field measurement.
d. Project-specific information drawn accurately to scale.

2. Manufacturer's standard schematic drawings and diagrams as follows:
   a. Modify to delete information that is not applicable to the Work.
   b. Supplement standard information to provide information specifically applicable to the Work.
3. Product Data: Provide as specified in individual specifications.
4. Deferred Submittal: See Drawings for list of deferred submittals.
   a. Subcontractor design drawings and product data related to permanent construction.
      1) Written and graphic information.
      2) Drawings.
      3) Cut sheets.
      4) Data sheets.
      5) Action item submittals requested in individual specification section.
   b. Prior to installation of indicated structural or nonstructural element, equipment, distribution system, or component or its anchorage, submit required supporting data and drawings for review and acceptance by Contractor. Documentation of review and approval provided on comment form, along with completed submittal, will be filed with permitting agency by Contractor and approved by permitting agency prior to installation.
5. Foreign Manufacturers: When proposed, include names and addresses of at least two companies that maintain technical service representatives close to Project.

C. Samples:

1. Copies: Two, unless otherwise specified in individual specifications.
2. Preparation: Mount, display, or package Samples in manner specified to facilitate review of quality. Attach label on unexposed side that includes the following:
   a. Manufacturer name.
   b. Model number.
   c. Material.
   d. Sample source.
3. Manufacturer's Color Chart: Units or sections of units showing full range of colors, textures, and patterns available.

4. Full-size Samples:
   a. Size as indicated in individual specification section.
   b. Prepared from same materials to be used for the Work.
   c. Cured and finished in manner specified.
   d. Physically identical with product proposed for use.

D. Action Submittal Dispositions:

1. Contractor will review, comment, stamp, and distribute as noted:
   a. Approved: Subcontractor may incorporate product(s) or implement Work covered by Submittal.
   b. Approved as Noted: Subcontractor may incorporate product(s) or implement Work covered by Submittal, in accordance with Contractor's notations.
   c. Partial Approval, Resubmit as Noted:
      1) Make corrections or obtain missing portions, and resubmit.
      2) Except for portions indicated, Subcontractor may begin to incorporate product(s) or implement Work covered by Submittal, in accordance with Contractor's notations.
   d. Revise and Resubmit: Subcontractor may not incorporate product(s) or implement Work covered by submittal.

1.04 INFORMATIONAL SUBMITTALS

A. General:

1. Prepare and submit Informational Submittals required by individual specification sections.
2. Contractor will review each submittal. If submittal meets conditions of the Subcontract Agreement, Contractor will forward copy to appropriate parties. If Contractor determines submittal does not meet conditions of the Subcontract Agreement and is therefore considered unacceptable, Contractor will reply with review comments to Subcontractor, and require Submittal be corrected and resubmitted.

B. Certificates:

1. General: Signed by officer or other individual authorized to sign documents on behalf of that entity.
2. Welding: In accordance with individual specification sections.
3. Installer: Prepare written statements on manufacturer's letterhead certifying installer complies with requirements as specified in individual specification section.

4. Material Test: Prepared by qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
5. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in individual specification sections.
6. Manufacturer's Certificate of Compliance: In accordance with Section 01 61 00, Common Product Requirements.
7. Manufacturer's Certificate of Proper Installation: In accordance with Section 01 43 33, Manufacturers' Field Services.

C. Closeout Submittals: In accordance with Section 01 77 00, Closeout Procedures.

D. Deferred Submittals: See Drawings for list of deferred submittals.

E. Manufacturer's Instructions: Written or published information that documents manufacturer's recommendations, guidelines, and procedures in accordance with individual specification section.

F. Operation and Maintenance Data: As required in Section 01 78 23, Operation and Maintenance Data.

G. Quality Control Documentation: As required in Section 01 45 16.13, Subcontractor Quality Control.

H. Special Guarantee: Supplier's written guarantee as required in individual specification sections.

I. Test, Evaluation, and Inspection Reports:

1. General: Shall contain signature of person responsible for test or report.
2. Factory:
    a. Identification of product and specification section, type of inspection or test with referenced standard or code.
    b. Date of test, Project title and number, and name and signature of authorized person.
    c. Test results.
    d. If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
    e. Provide interpretation of test results, when requested by Contractor.
    f. Other items as identified in individual specification sections.

3. Field:
    a. As a minimum, include the following:
        1) Project title and number.
        2) Date and time.
        3) Record of temperature and weather conditions.
        4) Identification of product and specification section.
        5) Type and location of test, Sample, or inspection, including referenced standard or code.
        6) Date issued, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
        7) If test or inspection deems material or equipment not in compliance with Subcontract Agreement, identify corrective action necessary to bring into compliance.
        8) Provide interpretation of test results, when requested by Contractor.
        9) Other items as identified in individual specification sections.

J. Training Data: In accordance with Section 01 43 33, Manufacturers' Field Services.

K. Informational Submittal Dispositions:

1. Contractor will review, comment, and distribute as noted:
    a. Meets Project Criteria: Subcontractor may incorporate product(s) or implement Work covered by submittal, if applicable.
    b. Meets Project Criteria with Incorporation of Comments: Subcontractor may incorporate product(s) or implement Work covered by submittal, if applicable, in accordance with Contractor's notations.
    c. Does Not Meet Project Criteria:
        1) Revise and resubmit.
        2) Subcontractor may not incorporate product(s) or implement Work covered by submittal, if applicable.

1.05 SUPPLEMENT

A. The supplement listed below, following "End of Section," is part of this specification.

1. Transmittal of Subcontractor's Submittal.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

JACOBS

TRANSMITTAL OF SUBCONTRACTOR'S SUBMITTAL

(ATTACH TO EACH SUBMITTAL)

DATE: _____

TO: _____ _____ _____ _____ _____ **FROM**: _____ Subcontractor _____ _____ _____	Submittal No.: _____ ☐ New Submittal ☐ Resubmittal Project: _____ Project No.: _____ Specification Section No.: _____ **(Cover only one section with each transmittal)** Schedule Date of Submittal: _____

SUBMITTAL TYPE:	☐ Shop Drawing	☐ Sample	☐ Informational
	☐ Deferred		

The following items are hereby submitted:

Number of Copies	Description of Item Submitted (Type, Size, Model Number, Etc.)	Spec. and Para. No.	Drawing or Brochure Number	Contains Variation to Subcontract	
				No	Yes

Subcontractor hereby certifies that (i) Subcontractor has complied with the requirements of Contract Documents Subcontract Agreement in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the Contract Documents and requirements of laws.

By: _____
Subcontractor (Authorized Signature)

SECTION 01 42 13
ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.01 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

A. Reference to standards and specifications of technical societies and reporting and resolving discrepancies associated therewith shall be as provided in Subcontract, and as may otherwise be required herein and in the individual Specification sections.

B. Work specified by reference to published standard or specification of government agency, technical association, trade association, professional society or institute, testing agency, or other organization shall meet requirements or surpass minimum standards of quality for materials and workmanship established by designated standard or specification.

C. Where so specified, products or workmanship shall also meet or exceed additional prescriptive or performance requirements included within Contract Documents to establish a higher or more stringent standard of quality than required by referenced standard.

D. Where two or more standards are specified to establish quality, product and workmanship shall meet or exceed requirements of most stringent.

E. Where both a standard and a brand name are specified for a product in Subcontract, proprietary product named shall meet or exceed requirements of specified reference standard.

F. Copies of standards and specifications of technical societies:

1. Copies of applicable referenced standards have not been bound in these Contract Documents.
2. Where copies of standards are needed by Subcontractor, obtain a copy or copies directly from publication source and maintain in an orderly manner at the Site as Work Site records, available to Subcontractor’s personnel, Sub-subcontractors, Agency, and Contractor.

1.02 ABBREVIATIONS

A. Abbreviations for Trade Organizations and Government Agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the Contract Documents, with abbreviations used.

1.	AA	Aluminum Association
2.	AABC	Associated Air Balance Council
3.	AAMA	American Architectural Manufacturers Association
4.	AASHTO	American Association of State Highway and Transportation Officials
5.	ABMA	American Bearing Manufacturers' Association
6.	ACI	American Concrete Institute
7.	AEIC	Association of Edison Illuminating Companies
8.	AGA	American Gas Association
9.	AGMA	American Gear Manufacturers' Association
10.	AI	Asphalt Institute
11.	AISC	American Institute of Steel Construction
12.	AISI	American Iron and Steel Institute
13.	AITC	American Institute of Timber Construction
14.	ALS	American Lumber Standards
15.	AMCA	Air Movement and Control Association
16.	ANSI	American National Standards Institute
17.	APA	APA – The Engineered Wood Association
18.	API	American Petroleum Institute
19.	APWA	American Public Works Association
20.	AHRI	Air-Conditioning, Heating, and Refrigeration Institute
21.	ASA	Acoustical Society of America
22.	ASABE	American Society of Agricultural and Biological Engineers
23.	ASCE	American Society of Civil Engineers
24.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
25.	ASME	American Society of Mechanical Engineers
26.	ASNT	American Society for Nondestructive Testing
27.	ASSE	American Society of Sanitary Engineering
28.	ASTM	ASTM International
29.	AWI	Architectural Woodwork Institute
30.	AWPA	American Wood Preservers' Association
31.	AWPI	American Wood Preservers' Institute
32.	AWS	American Welding Society
33.	AWWA	American Water Works Association
34.	BHMA	Builders Hardware Manufacturers' Association

35.	CBM	Certified Ballast Manufacturer
36.	CDA	Copper Development Association
37.	CGA	Compressed Gas Association
38.	CISPI	Cast Iron Soil Pipe Institute
39.	CMAA	Crane Manufacturers' Association of America
40.	CRSI	Concrete Reinforcing Steel Institute
41.	CS	Commercial Standard
42.	CSA	Canadian Standards Association
43.	CSI	Construction Specifications Institute
44.	DIN	Deutsches Institut für Normung e.V.
45.	DIPRA	Ductile Iron Pipe Research Association
46.	EIA	Electronic Industries Alliance
47.	EJCDC	Engineers Joint Contract Documents' Committee
48.	ETL	Electrical Test Laboratories
49.	FAA	Federal Aviation Administration
50.	FCC	Federal Communications Commission
51.	FDA	Food and Drug Administration
52.	FEMA	Federal Emergency Management Agency
53.	FIPS	Federal Information Processing Standards
54.	FM	FM Global
55.	Fed. Spec.	Federal Specifications (FAA Specifications)
56.	FS	Federal Specifications and Standards (Technical Specifications)
57.	GA	Gypsum Association
58.	GANA	Glass Association of North America
59.	GC	General Contractor
60.	HI	Hydraulic Institute
61.	HMI	Hoist Manufacturers' Institute
62.	IBC	International Building Code
63.	ICBO	International Conference of Building Officials
64.	ICC	International Code Council
65.	ICEA	Insulated Cable Engineers' Association
66.	IFC	International Fire Code
67.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
68.	IESNA	Illuminating Engineering Society of North America
69.	IFI	Industrial Fasteners Institute
70.	IGMA	Insulating Glass Manufacturer's Alliance
71.	IMC	International Mechanical Code
72.	INDA	Association of the Nonwoven Fabrics Industry
73.	IPC	International Plumbing Code
74.	ISA	International Society of Automation
75.	ISO	International Organization for Standardization
76.	ITL	Independent Testing Laboratory

77.	JIC	Joint Industry Conferences of Hydraulic Manufacturers
78.	MIA	Marble Institute of America
79.	MIL	Military Specifications
80.	MMA	Monorail Manufacturers' Association
81.	MSS	Manufacturer's Standardization Society
82.	NAAMM	National Association of Architectural Metal Manufacturers
83.	NACE	NACE International
84.	NBGQA	National Building Granite Quarries Association
85.	NEBB	National Environmental Balancing Bureau
86.	NEC	National Electrical Code
87.	NECA	National Electrical Contractor's Association
88.	NEMA	National Electrical Manufacturers' Association
89.	NESC	National Electrical Safety Code
90.	NETA	InterNational Electrical Testing Association
91.	NFPA	National Fire Protection Association
92.	NHLA	National Hardwood Lumber Association
93.	NICET	National Institute for Certification in Engineering Technologies
94.	NIST	National Institute of Standards and Technology
95.	NRCA	National Roofing Contractors Association
96.	NRTL	Nationally Recognized Testing Laboratories
97.	NSF	NSF International
98.	NSPE	National Society of Professional Engineers
99.	NTMA	National Terrazzo and Mosaic Association
100.	NWWDA	National Wood Window and Door Association
101.	OSHA	Occupational Safety and Health Act (both Federal and State)
102.	PCI	Precast/Prestressed Concrete Institute
103.	PEI	Porcelain Enamel Institute
104.	PPI	Plastic Pipe Institute
105.	PS	Product Standards Section-U.S. Department of Commerce
106.	RMA	Rubber Manufacturers' Association
107.	RUS	Rural Utilities Service
108.	SAE	SAE International
109.	SDI	Steel Deck Institute
110.	SDI	Steel Door Institute
111.	SJI	Steel Joist Institute
112.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
113.	SPI	Society of the Plastics Industry
114.	SSPC	The Society for Protective Coatings
115.	STI/SPFA	Steel Tank Institute/Steel Plate Fabricators Association
116.	SWI	Steel Window Institute

117.	TEMA	Tubular Exchanger Manufacturers' Association
118.	TCA	Tile Council of North America
119.	TIA	Telecommunications Industry Association
120.	UBC	Uniform Building Code
121.	UFC	Uniform Fire Code
122.	UL	Underwriters Laboratories Inc.
123.	UMC	Uniform Mechanical Code
124.	USBR	U.S. Bureau of Reclamation
125.	WCLIB	West Coast Lumber Inspection Bureau
126.	WI	Wood Institute
127.	WWPA	Western Wood Products Association

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 43 33
MANUFACTURERS' FIELD SERVICES

PART 1 GENERAL

1.01 DEFINITIONS

A. Person-Day: One person for 8 hours within regular working hours as established by the Contractor.

B. Standard Time: Shall mean 8 hours per day Monday through Friday, not to exceed 40 hours per week.

C. Overtime: Shall mean hours in excess of Standard Time.

1.02 SUBMITTALS

A. Informational Submittals:

1. Lesson Plan: Submit, in accordance with requirements of this Specification, proposed lesson plan not less than 30 calendar days prior to scheduled training and revise as necessary for acceptance prior to performance training.

1.03 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

A. Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system, with full authority by the equipment manufacturer to issue the certifications required of the manufacturer. Additional qualifications may be specified in the individual specification section.

B. Representative subject to acceptance by Contractor. No substitute representatives will be allowed unless prior written approval by such has been given.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

A. Furnish manufacturers' services, when required, to meet the requirements of this section.

B. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, or when a minimum time is not specified, time required to perform specified services shall be considered incidental.

C. Schedule manufacturer' services to avoid conflict with other onsite testing or other manufacturers' onsite services.

D. Determine, before scheduling services, that conditions necessary to allow successful testing have been met.

E. Only those days of service approved by Contractor will be credited to fulfill specified minimum services.

F. When required, manufacturer's onsite services shall include:

1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures.
2. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
3. Provide daily, copies of manufacturers' representatives field notes and data to Contractor.
4. Revisiting the Site as required to correct problems and until installation and operation are acceptable to Contractor.
5. Resolution of assembly or installation problems attributable to or associated with respective manufacturer's products and systems.
6. Assistance during component and systems testing, acceptance testing, and general evaluation.
7. Training of Operators in the operation and maintenance of respective product as required.

3.02 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

A. When required, a Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this section, shall be completed and signed by equipment manufacturer's representative.

B. Such form shall certify signing party is a duly authorized representative of manufacturer, is empowered by manufacturer to inspect, approve, and operate their equipment and is authorized to make recommendations required to ensure equipment is complete and operational.

3.03 TRAINING

A. General:

1. Furnish manufacturers' representatives for detailed classroom and hands-on training to the Owner's and/or Deign-Builder's personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.
2. Furnish trained, articulate personnel.
3. Manufacturer's representative shall be familiar with facility operation and maintenance requirements as well as with specified equipment.
4. The preliminary Operations and Maintenance Manual shall be approved prior to scheduling training session for specific components or systems.
5. Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee. Provide one electronic copy and 10 hard copies of completed training materials at the start of the first training session.
6. Contractor may digitally record training sessions and provide copies of the recordings to the Owner for future use by operations and maintenance personnel in training.

B. Training Schedule:

1. Coordinate training sessions with Contractor and manufacturer's representatives, and with submission of operations and maintenance manuals in accordance with Section 01 78 23, Operation and Maintenance Data.
2. Allow for up to two training sessions per training course to accommodate multiple shifts.
3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by the Contractor, and to allow full participation by manufacturers' representatives.
4. Coordinate with construction and commissioning activities as required in Subcontract Agreement or Purchase Order.

C. Lesson Plan:

1. When manufacturer or vendor training of the Owner's and/or Deign-Builder's personnel is required, prepare a lesson plan for each required course containing the following minimum information:
   a. Title and objectives.
   b. Recommended attendees for each session or portion of a session (such as managers, engineers, operators, and/or maintenance personnel).

c. Course description and goals.
d. Outline of course content to include at a minimum:
    1) Overview of components and/or system.
    2) Operating function and system theory.
    3) Startup and shutdown procedures.
    4) Alternative and emergency operation.
    5) Preventative maintenance.
    6) Corrective maintenance.
    7) Trouble-shooting.
    8) Specific safety procedures and precautions.
e. Estimated class duration for each session or portion of session.
f. Format (such as, lecture, self-study, demonstration, hands-on).
g. Instruction materials and equipment requirements.
h. Resumes of instructors providing training.

2. Do not perform training until Lesson Plan has been approved by Contractor.

3.04 SUPPLEMENT

A. The supplement listed below, following "End of Section," is part of this specification.

1. Manufacturer's Certificate of Proper Installation.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

Owner: *Kaiser Mead Custodial Trust*

Project: *Kaiser Mead Groundwater Remediation Interim Action*

Contract Number: _____

Specification Section: _____

Equipment/System: _____

Tag Number(s): _____

Serial Number(s): _____

I hereby certify that the above-referenced equipment/system has been:

Yes	No	NA	
☐	☐	☐	Installed in accordance with Manufacturer's recommendations.
☐	☐	☐	Serviced with proper initial lubricants.
☐	☐	☐	Electrical and mechanical connections meet quality & safety standards.
☐	☐	☐	All applicable safety equipment has been properly installed.
☐	☐	☐	Operated and rotates in the proper direction.
☐	☐	☐	Correct rotation verified and properly aligned/adjusted as necessary.
☐	☐	☐	Tested for vibration and meets requirements.
☐	☐	☐	Equipment as installed is ready to be operated by others and will reliably perform the function for which it is intended.
☐	☐	☐	Initial Volts (V) and Amps (A) recorded:

Ph1 (A-B): V_____ A_____
Ph2 (B-C): V_____ A_____
Ph3 (A-C): V_____ A_____

Comments:

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Representative: _____ Manufacturer: _____

Signature: _____ Date: _____

SECTION 01 45 16.13
SUBCONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.01 SQC SUBMITTALS

A. Informational Submittals:

1. SQC Plan: Submit, not later than 30 days after receipt of Notice to Proceed.
2. SQC Report: Submit, weekly, an original and one copy in report form.

1.02 CONTRACTOR'S QUALITY ASSURANCE

A. The Work is subject to The Owner's and Contractor's quality assurance inspection and testing at locations and at reasonable times before acceptance to ensure strict compliance with the terms of the Contract Documents.

B. Contractor's quality assurance inspections and tests are for the sole benefit of Contractor and do not:

1. Relieve Subcontractor of responsibility for providing adequate quality control measures;
2. Relieve Subcontractor of responsibility for damage to or loss of material before acceptance;
3. Constitute or imply acceptance; or
4. Affect continuing rights of Contractor after acceptance of completed Work.

C. The presence or absence of The Owner's and Contractor's quality assurance inspector does not relieve Subcontractor from any Contract requirement.

D. Promptly furnish safe and convenient access, and facilities, labor, and material reasonably needed for performing inspections and tests as may be required by Contractor.

E. Contractor may charge Subcontractor for additional cost of inspection or test when Work is not ready at time specified by Subcontractor for inspection or test, or when prior rejection makes re-inspection or retest necessary.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Maintain an adequate inspection system and perform such inspections as will ensure the Work conforms to the Subcontract Agreement.

B. Maintain complete inspection records and make them available at all times to Contractor.

C. Quality control system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the Subcontract Agreement and applicable codes and standards.

3.02 COORDINATION MEETING

A. After Preconstruction Conference, but before start of construction, and prior to acceptance of the SQC Plan, schedule a meeting with Contractor to discuss quality control system.

B. Develop a mutual understanding of system details, including forms for recording SQC operations, control activities, testing, administration of system for both onsite and offsite Work, and interrelationship of Subcontractor's management and control with Contractor's quality assurance.

C. There may be occasions when subsequent conferences may be called by either party to reconfirm mutual understandings or address deficiencies in SQC system or procedures that may require corrective action by Subcontractor's.

3.03 QUALITY CONTROL ORGANIZATION

A. SQC System Manager:

1. Designate an individual within Subcontractor's organization who will be responsible for overall management of SQC and have authority to act in SQC matters for Subcontractor.
2. SQC System Manager shall be an experienced construction person, with a minimum of 3 year's construction experience on similar type Work.
3. Identify an alternate for SQC System Manager to serve with full authority during SQC System Manager's absence. Requirements for the alternate shall be the same as for designated SQC System Manager.

B. SQC Staff:

1. Designate a SQC staff, available at Site at all times during progress, with complete authority to take action necessary to ensure compliance with the Subcontract. SQC staff members shall be subject to acceptance by Contractor.
2. SQC staff shall take direction from SQC System Manager in matters pertaining to QC.
3. SQC staff must be of sufficient size to ensure adequate QC coverage of Work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties, but must be fully qualified by experience and technical training to perform their assigned QC responsibilities and must be allowed sufficient time to carry out these responsibilities.
4. The actual strength of SQC staff may vary during any specific Work period to cover the needs of Project. Add additional staff when necessary for a proper SQC organization.

C. Organizational Changes: Obtain Contractor's acceptance before replacing any member of SQC staff. Requests for changes shall include name, qualifications, duties, and responsibilities of proposed replacement.

3.04 QUALITY CONTROL PHASING

A. SQC shall include at least three phases of control to be conducted by SQC System Manager for all definable features of Work, as follows:

1. Preparatory Phase:
   a. Notify Contractor at least 48 hours in advance of beginning any required action of preparatory phase.
   b. Includes meeting conducted by SQC System Manager and attended by superintendent, other SQC personnel (as applicable), and foreman responsible for the definable feature. SQC System Manager shall instruct applicable SQC staff as to acceptable level of workmanship required in order to meet Contract requirements.
   c. Document results of preparatory phase meeting by separate minutes prepared by SQC System Manager and attached to QC report.
   d. Perform prior to beginning Work on each definable feature of Work:
      1) Review applicable Contract Specifications.
      2) Review applicable Contract Drawings.
      3) Verify materials and equipment have been tested, submitted, and approved.

4) Verify provisions have been made to provide required control inspection and testing.
5) Examine the Work area to verify required preliminary Work has been completed and is in compliance with the Contract.
6) Perform physical examination of required materials, equipment, and sample Work to verify they are on hand, conform to approved Shop Drawing or submitted data, and are properly stored.
7) Review appropriate activity hazard analysis to verify safety requirements are met.
8) Review procedures for constructing the Work, including repetitive deficiencies.
9) Document construction tolerances and workmanship standards for that phase of the Work.
10) Check to verify plan for the Work to be performed, if so required, has been accepted by Contractor.

2. Initial Phase:
   a. Accomplish at the beginning of a definable feature of Work:
      1) Notify Contractor at least 48 hours in advance of beginning initial phase.
      2) Perform prior to beginning Work on each definable feature of Work:
         a) Review minutes of preparatory meeting.
         b) Check preliminary Work to verify compliance with Contract requirements.
         c) Verify required control inspection and testing.
         d) Establish level of workmanship and verify it meets minimum acceptable workmanship standards. Comparison with sample panels is appropriate.
         e) Resolve differences.
         f) Check safety to include compliance with and upgrading of safety plan and activity hazard analysis. Review activity analysis with each worker.
      3) Separate minutes of this phase shall be prepared by SQC System Manager and attached to QC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.
      4) Initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.
3. Follow-up Phase:
   a. Perform daily checks to verify continuing compliance with Contract requirements, including control testing, until completion of the particular feature of Work.

b. Daily checks shall be made a matter of record in SQC documentation and shall document specific results of inspections for features of Work for day or shift.
c. Conduct final follow-up checks and correct deficiencies prior to start of additional features of Work that will be affected by the deficient Work. Constructing upon or concealing nonconforming Work will not be allowed.

4. Additional Preparatory and Initial Phases: Additional preparatory and initial phases may be conducted on the same definable features of Work as determined by Contractor if quality of ongoing Work is unacceptable; or if there are changes in applicable QC staff or in onsite production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.05 QUALITY CONTROL PLAN

A. General:

1. Plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used.
2. An interim plan for the first 30 days of operation will be considered.
3. Construction permitted to begin only after acceptance of SQC Plan or acceptance of an interim plan applicable to the particular feature of Work to be started.
4. Work outside of the features of Work included in an accepted interim plan will not be permitted to begin until acceptance of a SQC Plan or another interim plan containing the additional features of Work to be started.

B. Content:

1. Plan shall cover the intended SQC organization and shall include the following, as a minimum:
   a. Organization: Description of quality control organization, including chart showing lines of authority and acknowledgment that SQC staff will implement the three-phase control system (see Article Quality Control Phasing) for aspects of the Work specified.
   b. SQC Staff: Name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.

c. Letters of Authority: Copy of letter to SQC System Manager signed by authorized official of firm, describing responsibilities and delegating sufficient authorities to adequately perform the functions of SQC System Manager, including authority to stop Work which is not in compliance with the Subcontract Agreement. SQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities and responsibilities. Copies of these letters will also be furnished to Contractor.

d. Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of Sub-subcontractors, offsite fabricators, suppliers and purchasing agents.

e. Inspection Test Plan (ITP):
   1) Provide list of required tests and inspections for Project.
   2) Identify in ITP inspection hold points, i.e., when work must stop momentarily so a required inspection can be conducted and the Work approved before the Work can continue.

f. Testing: Control, verification and acceptance testing procedures for each specific test to include test name, frequency, specification paragraph containing test requirements, personnel and laboratory responsible for each type of test, and an estimate of number of tests required.

g. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests, including documentation.

h. Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.

i. Reporting procedures, including proposed reporting formats; include a copy of the SQC report form.

C. Acceptance of Plan: Acceptance of Subcontractor's basic and addendum SQC plan is required prior to start of construction. Acceptance is conditional and will be predicated on satisfactory performance during construction. Contractor reserves the right to require Subcontractor to make changes in SQC plan and operations including removal of personnel, as necessary, to obtain quality specified.

D. Notification of Changes: After acceptance of SQC plan, notify Contractor, in writing, a minimum of 7 calendar days prior to a proposed change. Proposed changes are subject to acceptance by Contractor.

3.06 QUALITY CONTROL REPORT

A. As a minimum, prepare SQC report for every 7 calendar days. Account for all days throughout life of Subcontract. Reports shall be signed and dated by SQC System Manager. Include copies of test reports and copies of reports prepared by QC staff.

B. Maintain current records of quality control operations, activities, and tests performed, including the Work of Sub-subcontractors and Suppliers.

C. Records shall be on an acceptable form and shall be a complete description of inspections, results of inspections, daily activities, tests, and other items, including but not limited to the following:

1. Subcontractor/Sub-subcontractors and their areas of responsibility.
2. Operating plant/equipment with hours worked, idle, or down for repair.
3. Work performed today, giving location, description, and by whom. When network schedule is used, identify each phase of Work performed each day by activity number.
4. Test and control activities performed with results and references to specification/drawing requirements. Control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
5. Material received with statement as to its acceptability and storage.
6. Identify submittals reviewed, with Subcontract reference, by whom, and action taken.
7. Offsite surveillance activities, including actions taken.
8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
9. List instructions given/received and conflicts in Drawings and Specifications.
10. Subcontractor’s verification statement.
11. Indicate description of trades working on Project, number of personnel working, weather conditions encountered, and delays encountered.
12. These records shall cover both conforming and deficient features and shall include statement that equipment and materials incorporated in file work and workmanship comply with Subcontract.

3.07 SUBMITTAL QUALITY CONTROL

A. Submittals shall be as specified in Section 01 33 00, Submittal Procedures. The SQC organization shall be responsible for certifying submittals are in compliance with Subcontract requirements. Contractor will furnish copies of test report forms upon request by Subcontractor. Subcontractor may use other forms as approved.

3.08 TESTING QUALITY CONTROL

A. Testing Procedure:

1. Perform tests specified or required to verify control measures are adequate to provide a product which conforms to Subcontract requirements. Perform following activities and record following data:
   a. Verify testing procedures comply with Subcontract requirements.
   b. Verify facilities and testing equipment are available and comply with testing standards.
   c. Check test instrument calibration data against certified standards.
   d. Verify recording forms and test identification control number system, including test documentation requirements, have been prepared.
   e. Documentation:
      1) Record results of tests taken, both passing and failing, on SQC report for date taken.
      2) Include specification paragraph reference, location where tests were taken, and sequential control number identifying test.
      3) Actual test reports may be submitted later, if approved by Contractor with a reference to test number and date taken.
      4) Provide directly to Contractor an information copy of tests performed by offsite or commercial test facility. Test results shall be signed by an engineer registered in state where tests are performed.
      5) Failure to submit timely test reports, as stated, may result in nonpayment for related Work performed and disapproval of the test facility for Subcontract.

B. Testing Laboratories: Laboratory facilities, including personnel and equipment, utilized for testing soils, concrete, asphalt and steel shall meet criteria detailed in ASTM D3740 and ASTM E329, and be accredited by American Association of Laboratory Accreditation (AALA), National Institute of Standards and Technology (NIST), National Voluntary Laboratory Accreditation Program (NVLAP), American Association of State Highway

and Transportation Officials (AASHTO), or other approved national accreditation authority. Personnel performing concrete testing shall be certified by American Concrete Institute (ACI).

3.09 COMPLETION INSPECTION

A. SQC System Manager shall conduct inspection of the Work at completion of Work or a milestone established by a completion time stated in Subcontract.

B. Punchlist:

1. SQC System Manager shall develop punchlist of items which do not conform to the Subcontract requirements.
2. Include punchlist in SQC report, indicating estimated date by which deficiencies will be corrected.
3. SQC System Manager or staff shall make second inspection to ascertain that deficiencies have been corrected and so notify Contractor.
4. These inspections and deficiency corrections required shall be accomplished within time stated for completion of entire Work or a particular increment thereof if Project is divided into increments by separate completion dates.

END OF SECTION

SECTION 01 45 33
SPECIAL INSPECTION, OBSERVATION, AND TESTING

PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for Special Inspection, Observation, and Testing required in accordance with 2015 IBC (International Building Code) and is in addition to and supplements requirements included in Statement of Special Inspections shown on Drawings.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. International Code Council (ICC):
   a. International Building Code (IBC).
   b. Evaluation Service (ICC-ES) Reports and Legacy Reports.

1.03 SUBMITTALS

A. Informational Submittals:

1. Subcontractor’s Statement of Responsibility.
2. Fabricator’s Certificate of Compliance.

1.04 DEFINITIONS

A. Agencies and Personnel:

1. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.
2. Registered Design Professional in Responsible Charge: An individual who is registered or licensed to practice their respective design profession as defined by statutory requirements of professional registration laws of state or jurisdiction in which Project is to be constructed.

B. Statement of Special Inspections: Detailed written procedure contained on Drawings establishing systems and components subject to Special Inspection, Observation, and Testing during construction, type and frequency of testing,

extent and duration of Special Inspection, and reports to be completed and distributed by Special Inspector.

C. Special Inspection:

1. Special Inspection: Inspection required of materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with approved Contract Documents and referenced standards.
2. Special Inspection, Continuous: Full-time observation of work requiring Special Inspection by an approved Special Inspector who is present in area where the Work is being performed.
3. Special Inspection, Periodic: Part-time or intermittent observation of the Work requiring Special Inspection by an approved Special Inspector who is present in area where the Work has been or is being performed, and at completion of the Work.

D. Structural Systems and Components:

1. Diaphragm: Component of structural lateral load resisting system consisting of roof, floor, or other membrane or bracing system acting to transfer lateral forces to vertical resisting elements of structure.
2. Drag Strut or Collector: Component of structural lateral load resisting system consisting of diaphragm or shear wall element that collects and transfers diaphragm shear forces to vertical force-resisting elements or distributes forces within diaphragm or shear wall.
3. Seismic-Force-Resisting System: That part of structural lateral load resisting system that has been considered in the design to provide required resistance to seismic forces identified on Drawings.
4. Wind Force Resisting System: That part of the structural system that has been considered in the design to provide required resistance to wind forces identified on Drawings.

E. Nonstructural Components:

1. Architectural Component Supports: Structural members or assemblies of members which transmit loads and forces from architectural systems or components to structure, including braces, frames, struts, and attachments.
2. Electrical Component Supports: Structural members or assemblies which transmit loads and forces from electrical equipment to structure, including braces, frames, legs, pedestals, and tethers, as well as elements forged or cast as part of component for anchorage.

3. Mechanical and Plumbing Component Supports: Structural members or assemblies which transmit loads and forces from mechanical or plumbing equipment to structure, including braces, frames, skirts, legs, saddles, pedestals, snubbers, and tethers, as well as elements forged or cast as part of component for anchorage.

1.05 STATEMENT OF SPECIAL INSPECTIONS REQUIREMENTS

A. Designated Systems for Inspection: Refer to Drawings.

B. Special Inspection and associated testing of shop fabrication and field construction will be performed by an approved accredited independent agency. Design-Builder will secure and pay for services of firm/laboratory to perform Special Inspection and associated testing.

C. Code required Special Inspection with associated testing and Professional Observation, as provided in Statement of Special Inspections Plan on Drawings and further provided in this section, is for benefit of Agency and does not:

1. Relieve Subcontractor of responsibility for providing adequate quality control measures.
2. Relieve Subcontractor of responsibility for damage to or loss of material before acceptance.
3. Constitute or imply acceptance.
4. Affect continuing rights after acceptance of completed Work.

D. The presence or absence of code required Special Inspector and Professional Observer does not relieve Subcontractor from Contract requirements.

E. Subcontractor is responsible for additional costs associated with Special Inspection and Testing and Observation when Work is not ready at time identified by Subcontractor and Special Inspectors and Professional Observer are onsite, but not able to provide services.

F. Subcontractor is responsible for associated costs for additional Special Inspection and Testing and Professional Observation by Special Inspectors and Professional Observers required because of rejection of materials of in place Work that cannot be made compliant to Contract Document without additional inspections and observation and testing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Provide access to shop or Site for Special Inspection and Testing and Professional Observation requirements.

B. Notify Design-Builder in advance of required Special Inspection and Professional Observation no later than 48 hours prior to date of Special Inspection and Professional Observation.

C. Submit Subcontractor’s Statement of Responsibility for each subcontractor constructing or installing components of the project requiring Special Inspection.

D. Submit Fabricator's Certificates of Compliance for approved fabricators.

3.02 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

1. Subcontractor’s Statement of Responsibility.
2. Fabricator’s Certificate of Compliance.

END OF SECTION

SUBCONTRACTOR'S STATEMENT OF RESPONSIBILITY

_____
(Project)

_____
(Name of Company)

_____
(Business Address)

(_____) _____ (_____) _____
(Telephone) (Fax)

I, (We) hereby certify that I am (we are) aware of the Special Inspection and Testing requirements contained in Contract Documents for this Project for seismic force-resisting systems, and for components including architectural, mechanical, and electrical components, as listed in Statement of Special Inspections on Drawings, and that:

1. I, (We) are aware of the systems and the requirements for Special Inspection for responsible seismic force-resisting systems and acknowledge our responsibility in the implementation of the Statement of Special Inspections for the construction of the following systems/components:

Facility	Lateral Force-Resisting System/Component
EC Building	Moment Frames and Braced Frames

2. The following person is hereby identified as exercising control over requirements of this section for the Work designated above:

   Name: _____

   Qualifications: _____

   _____

   _____

(Print name and official title of person signing this form)

Signed by: _____

Date: _____

Project Name: _____

FABRICATOR'S CERTIFICATE OF COMPLIANCE

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per Section 1704.2.5 of IBC2015 IBC must submit Fabricator's Certificate of Compliance at the completion of fabrication.

_____
(Project)

_____
(Fabricator's Name)

_____
(Business Address)

_____
(Certification or Approval Agency)

_____
(Certification Number)

_____
(Date of Last Audit or Approval)

Description of structural members and assemblies that have been fabricated:

_____

_____

_____

_____

_____

I hereby certify that items described above were fabricated in strict accordance with approved construction documents.

_____
(Name and Title) type or print

_____
(Signature and Date)

Attach copies of fabricator's certification or building code evaluation service report and fabricator's quality control manual.

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals: Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.

1.02 MOBILIZATION

A. Mobilization shall include, but not limited to, the following:

1. Obtaining required permits.
2. Moving Subcontactor's field office and equipment required for operations onto Site.
3. Installing temporary construction power, wiring, and lighting facilities.
4. Providing onsite communication facilities, including telephones.
5. Providing onsite sanitary facilities and potable water facilities as contracted and as required by Laws and Regulations, and governing agencies.
6. Arranging for and erection of Subcontactor's work and storage yard.
7. Posting OSHA required notices and establishing safety programs and procedures.
8. Having Subcontactor's superintendent at Site full time.
9. Complying with Contractor's Site Utilization Plan.

B. Use area designated for Subcontactor's temporary facilities as shown on Drawings.

1.03 PROTECTION OF WORK AND PROPERTY

A. Comply with Contractor's Health and Safety Action Plan (HASP) while on The Owner's property.

B. Use of Explosives: No blasting or use of explosives will be allowed onsite.

1.04 VEHICULAR TRAFFIC

A. Traffic Control Plan: Adhere to Contractor's Site Utilization Plan.

B. Traffic Routing Plan: Show sequences of construction affecting use of roadways.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TEMPORARY UTILITIES

A. Power: Electric power will not be available at or near Site until June 1, 2020. Subcontractor will determine amount required for their work.

B. Lighting: Provide task lighting to meet applicable safety requirements to allow erection, application, or installation of materials and equipment, and observation or inspection of the Work.

C. Heating, Cooling, and Ventilating:

1. Provide as required to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions for installation of materials, and to protect materials, equipment, and finishes from damage because of temperature or humidity. Costs for temporary heat shall be borne by Subcontractor responsible for constructing structure or building as specified in Subcontract.
2. Provide adequate forced air ventilation of enclosed areas to cure installed materials, to dispense humidity, and to prevent hazardous accumulations of dust, fumes, vapors, or gases.
3. Costs for installation, maintenance, operation, removal, and fuel consumed for heating/cooling/ventilation shall be the responsibility of the Subcontractor.
4. Provide portable unit heaters, complete with controls, oil-fired or gas-fired, and suitably vented to outside as required for protection of health and property.

D. Water: Construction and potable water are not available at the Site.

E. Sanitary and Personnel Facilities: Contractor/Archer Western will provide and maintain facilities onsite for Subcontractor’s employees.

F. Telephone Service:

1. Subcontractor: Arrange and provide onsite telephone service for use during construction, if Subcontractor determines it necessary. Costs for installation, maintenance, operation, and removal of phone services shall be the responsibility of the Subcontractor.

3.02 PROTECTION OF WORK AND PROPERTY

A. General:

1. Perform Work within right-of-way and easements in a systematic manner that minimizes inconvenience to property owners and the public.
2. Maintain in continuous service existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and other utilities encountered along line of the Work, unless other arrangements satisfactory to Contractor have been made.
3. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
4. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
5. In areas where Subcontractor's operations are adjacent to or near a utility, such as gas, telephone, television, electric power, water, sewer, or irrigation system, and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by Subcontractor.
6. Notify property owners, Contractor, and utility offices that may be affected by construction operation at least 2 days in advance unless indicated otherwise in Subcontract Documents. Before exposing a utility, obtain utility owner's permission. Should service of utility be interrupted due to Contractor's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.
7. Do not impair operation of existing sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures.

B. Signs and Equipment:

1. Conform to permitting agencies and Contractor requirements.
2. Provide at obstructions, such as material piles and equipment.
3. Use to alert general public of construction hazards, which would include surface irregularities, unramped walkways, grade changes, and trenches or excavations in roadways and in other public access areas.

C. Trees and Plantings: Protect from damage and preserve trees, shrubs, and other plants outside limits of the Work and within limits of the Work, which are designated on Drawings to remain undisturbed.

D. Existing Structures:

1. Where Subcontractor contemplates removal of small structures such as mailboxes, signposts, and culverts that interfere with Subcontractor's operations, obtain approval of property owner and Contractor.
2. Move mailboxes to temporary locations accessible to postal service.
3. Replace items removed in their original location and a condition equal to or better than original.

E. Finished Construction: Protect finished floors and concrete floors exposed as well as those covered with composition tile or other applied surfacing.

F. Waterways: Keep ditches, culverts, and natural drainages continuously free of construction materials and debris. Coordinate construction through irrigation ditches with property owner and farmer. Temporary diversion canals may be required.

G. Dewatering: Construct, maintain, and operate cofferdams, channels, flume drains, sumps, pumps, or other temporary diversion and protection works. Furnish materials required, install, maintain, and operate necessary pumping and other equipment for environmentally safe removal and disposal of water from the various parts of the Work. Maintain foundations and parts of the Work free from water.

H. Endangered and Threatened Species:

1. Take precautions necessary and prudent to protect native endangered and threatened flora and fauna.
2. Notify Contractor of construction activities that might threaten endangered and threatened species or their habitats.

3.03 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Subcontractor to comply with requirements of regional air quality control board's permit.
2. Burning is not allowed.

3. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in construction area a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.

B. Noise Control:

1. Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels.
2. Noise Control Plan: Propose plan to mitigate construction noise and to comply with noise control ordinances, including method of construction, equipment to be used, and acoustical treatments.

C. Water Pollution Control:

1. Divert sanitary sewage and nonstorm waste flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to existing waterway.
2. Prior to commencing excavation and construction, obtain Contractor's agreement with detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and dewatering pump discharges.
3. Comply with Section 01 57 13, Temporary and Permanent Erosion and Sediment Control, for stormwater flow and surface runoff.
4. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.

3.04 STORAGE YARDS AND BUILDINGS

A. Coordinate requirements with Section 01 61 00, Common Product Requirements.

B. Temporary Storage Yards: Construct temporary storage yards for storage of products that are not subject to damage by weather conditions.

C. Temporary Storage Buildings:

1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored.
2. Arrange or partition to provide security of contents and ready access for inspection and inventory.

3. Store combustible materials (paints, solvents, fuels) in a well-ventilated and remote building meeting safety standards.

3.05 ACCESS ROADS AND DETOURS

A. Construct access roads as shown and within easements, rights-of-way, or Project limits. Utilize existing roads where shown.

B. Maintain drainage ways. Install and maintain culverts to allow water to flow beneath access roads. Provide corrosion-resistant culvert pipe of adequate strength to resist construction loads.

C. Provide gravel, crushed rock, or other stabilization material, as necessary, to permit access by all motor vehicles at all times.

D. Maintain road grade and crown to eliminate potholes, rutting, and other irregularities that restrict access.

E. Where access road crosses existing fences, install and maintain gates.

F. Upon completion of construction, restore ground surface disturbed by access road construction to original grade. Replace damaged or broken culverts with new culvert pipe of same diameter and material.

3.06 PARKING AREAS

A. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, Agency's operations, or construction operations.

B. Parking facilities for personnel working on Project will be provided.

C. Use area designated on Drawings for parking of Subcontractor's and Subcontractor's employees' vehicles.

3.07 VEHICULAR TRAFFIC

A. Comply with Laws and Regulations regarding closing or restricting use of public streets or highways. No public or private road shall be closed, except by written permission of proper authority. Ensure the least possible obstruction to traffic and normal commercial pursuits.

B. Conduct the Work to interfere as little as possible with public travel, whether vehicular or pedestrian.

C. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.

D. Road Closures: Maintain satisfactory means of exit for persons residing or having occasion to transact business along route of the Work. If it is necessary to close off roadway or alley providing sole vehicular access to property, submit plan to Contractor for approval.

E. Maintenance of traffic is not required if Subcontractor obtains written permission from tenant of private property, or from authority having jurisdiction over public property involved, to obstruct traffic at designated point.

F. When flaggers and guards are required by regulation or when deemed necessary for safety, furnish them with the required Personal Protective Equipment (PPE) and other regulation traffic control devices.

END OF SECTION

SECTION 01 57 13
TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. This section covers Work necessary for minimizing erosion and preventing the discharge of sediment during and after construction and land disturbing activities. The Work shall include the furnishing of all labor, materials, tools, and equipment to perform the Work and services necessary as herein specified and as indicated on Drawings. This shall include installation, maintenance, and final removal of all temporary soil erosion and sediment control measures.

B. The minimum areas requiring soil erosion and sediment control best management practices (BMPs) are areas of land disturbance (from grading, excavation, filling, and other land disturbing activities) and those shown in the Stormwater Pollution Prevention Plan (SWPPP). The right is reserved to modify use, location and quantities of soil erosion and sediment control BMPs based on activities of the Subcontractor.

C. Subcontractor shall provide an erosion and sedimentation control specialist (ESCS) responsible for the implementation, maintenance and oversight of all erosion and sedimentation control activities, including submittals, SWPPP development and implementation, dust control measures, emergency activities, repairs and removal of temporary controls in accordance with Washington's Construction Stormwater Program including the 2019 Stormwater Manual for Eastern Washington.

D. Subcontractor shall be responsible for phasing Work in areas allocated for their exclusive use during Project, including proposed stockpile areas, to restrict sediment transport. This will include installation of temporary erosion control devices, ditches, or other BMPs.

E. Areas set aside for Subcontractor's use during Project may be temporarily developed to provide satisfactory working, staging, and administrative areas for their exclusive use. Preparation of these areas shall be in accordance with other requirements contained within these Specifications and shall be performed in a manner to prevent the discharge of sediment from the area.

F. Permanent stockpiles are not allowed.

G. Sediment transport and erosion from working/temporary stockpiles shall be controlled and restricted from moving beyond immediate stockpile area by

implementing the BMPs identified in the approved SWPPP. Additionally, Subcontractor shall implement the dust control BMP measures. Subcontractor shall keep these erosion and sediment control BMPs in operational condition by regular cleaning, regrading, and maintenance. Stockpiles remaining in place longer than 14 calendar days shall be considered permanent stockpiles for purposes of erosion and sediment control.

H. Subcontractor shall maintain the erosion and sediment control BMPs identified in the approved SWPPP during Project for duration of their activities. Formal inspections made jointly by Subcontractor and Contractor shall be conducted per the schedule identified in the approved SWPPP to evaluate Subcontractor's conformance to requirements of Specifications and approved SWPPP.

I. Replacement or repair of failed or overloaded silt fences, check dams, or other temporary erosion and sediment control BMPs shall be performed by Subcontractor within 2 days after receiving written notice from Contractor.

J. Unpaved earth drainage ditches shall be regraded as needed to maintain original grade and remove sediment buildup. If a ditch becomes difficult to maintain, Subcontractor shall cooperate with Contractor and install additional erosion control devices such as check dams, temporary paving, or silt fences as directed by Contractor.

K. The Subcontractor may propose BMPs or BMP locations other than those identified in the Design Builder's approved SWPPP if the BMP or BMP location provides equivalent erosion and sediment control and with Design Builder's approval.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. D638, Standard Test Method for Tensile Properties of Plastics.
   b. D3776/D3776M, Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
   c. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in Xenon Arc Type Apparatus.
   d. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
2. U.S. Department of Agriculture: Urban Hydrology for Small Watersheds; Soil Conservation Service Engineering Technical Release No. 55, 1986.

3. U.S. Weather Bureau: Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years, Technical Paper No. 40, 1981.

1.03 SYSTEM DESCRIPTION

A. Erosion and Sediment Flood Control: Provide, maintain, and operate temporary facilities to minimize erosion and prevent sediment releases.

B. Soil erosion minimization and sedimentation control may consist of the following elements:

1. Construction and maintenance of permanent and temporary storm drainage piping and channel systems, as necessary.
2. Construction and maintenance of temporary erosion and sediment control BMPs such as silt fences, fiber rolls, and check dams.
3. Construction and maintenance of tracking controls such as stabilized construction entrance/exit and tire wash.
4. Implementation of nonstructural BMPs such as dust control measures, rough grading, temporary or permanent stabilization measures, to minimize erosion and prevent sedimentation.

C. Activities shall follow BMPs per Washington's Construction Stormwater Program including the 2019 Stormwater Manual for Eastern Washington.

1.04 SUBMITTALS

A. Informational Submittals: Schedule for installation of drainage, erosion, and sedimentation control BMPs.

B. Stormwater Inspector and ESCS qualifications.

C. SWPPP and eNotice of Intent.

1.05 QUALITY ASSURANCE

A. Water pollution control shall comply with procedures in these specifications and associated plans.

B. Dust emission control shall comply with measures in these specifications and associated plans.

PART 2 PRODUCTS

2.01 SEDIMENT AND EROSION CONTROLS

A. As specified in these specifications and associated plans.

PART 3 EXECUTION

3.01 PREPARATION

A. Subcontractor shall be responsible for phasing Work in areas allocated for their exclusive use during Project, including proposed stockpile areas and installation of temporary erosion control devices, ditches, or other facilities.

B. Areas set aside for Subcontractor's use during Project may be temporarily developed to provide satisfactory working, staging, and administrative areas. Preparation of these areas shall be in accordance with other requirements contained within Specifications and completed in a manner to control sediment transport away from area.

3.02 STORMWATER POLLUTION PREVENTION PLAN IMPLEMENTATION

A. SWPPP implementation shall in be compliance with the approved SWPPP and these specifications and associated plans under the supervision of the ESCS.

B. Erosion and Sediment Control:

1. Construction operations shall be carried out in such a manner that erosion and water pollution will be minimized, including the implementation of "good housekeeping" source control measures. Subcontractor shall comply with state and local laws concerning pollution abatement.
2. Extreme care shall be taken when hauling any earth, sand, gravel, stone, debris, or any other substance over any public street. Occurrences of material blown, spilled, or tracked over and upon said public or adjacent private property are prohibited and shall be immediately remedied. Discharge of debris is prohibited.
3. Non-stormwater discharge is prohibited, except as specified in the approved SWPPP and these specifications and associated plans. Discharge of hazardous substances is prohibited.
4. All paved areas shall be kept clear of earth material and debris. The site shall be maintained so as to prevent sediment-laden runoff to any storm drainage system, including existing drainage swales and watercourse, to the extent necessary for compliance with the approved SWPPP and these specifications and associated plans.

5. Subcontractor shall install and maintain construction entrances prior to commencement of grading. All construction vehicle traffic entering onto the paved roads must cross stabilized construction entrance ways as specified in the approved SWPPP. Tracking of mud or debris onto public streets, or onto adjacent public or private property, is prohibited and shall be removed immediately by the Subcontractor.
6. Grading operations that leave denuded slopes shall be protected with temporary or permanent stabilization measures within 14 days of completion or suspension of activity.
7. Sanitary facilities shall be maintained on the site in a manner to prevent inadvertent discharge or leakage of sanitary wastes by anchoring the facilities, placing sanitary facilities in locations away from construction traffic, and/or by providing secondary containment systems to capture leaked wastes.
8. Subcontractor shall provide BMP dust control as required by appropriate federal, state, and agency requirements.
9. Subcontractor shall provide a sufficient number of concrete washout areas to prevent fresh concrete, concrete fines, or cement laden mortar from leaving the Project site.
10. The approved SWPPP may not cover all the situations that may arise during construction due to unanticipated field conditions. Variations and additions may be made to the plan in the field after receiving approval from the ESCS and notifying Contractor and Subcontractor.
11. BMP installation shall be in accordance Spokane County SWPPP manuals and project details.

C. Minimum BMP Maintenance Requirements:

1. Repair of BMP deficiencies caused by environmental factors (e.g., soil erosion, wind, sun exposure) or construction in accordance with the approved SWPPP.
2. Inspection of sediment traps, berms, rills, gullies, swales and other sediment control BMPs before, during, and after each storm event or predicted rainfall in accordance with the approved SWPPP and these specifications and associated plans. This also includes repair or cleaning of BMPs as needed.

3.03 FIELD QUALITY CONTROL

A. At a minimum, conduct inspections jointly with Contractor on the schedule identified in the SWPPP to evaluate conformance to requirements of Specifications.

B. Replace or repair failed or overloaded silt fences, sediment wattles, or other BMPs in accordance with the approved SWPPP and these specifications and associated plans after Site inspections.

C. Inspections and repairs shall be in accordance with the approved SWPPP.

3.04 MAINTENANCE

A. Promptly repair or replace structural BMP (e.g., silt fence, sediment wattle, construction entrance/exit) that becomes damaged.

B. Provide and maintain soil stabilization BMPs at all times.

C. Regrade unpaved earth drainage ditches as needed to maintain original grade and remove sediment buildup. If ditch becomes difficult to maintain, install additional erosion control devices such as check dams, temporary paving, or silt fences as directed by Contractor.

D. Inspect, repair, and replace as necessary erosion control measures during the time period from start of construction to completion of construction.

3.05 CLEANING/SITE RESTORATION

A. Prior to Demobilization:

1. Stabilize disturbed areas as indicated in the approved SWPPP.
2. Dress sediment deposits remaining after fence has been removed to conform to existing grade. Prepare and seed graded area as required in the approved SWPPP.
3. Remove all temporary BMPs after site or disturbed areas have been stabilized.
4. Remove all Subcontractor-generated garbage and trash (including concrete washout waste and debris) from the site.

END OF SECTION

SECTION 01 61 00
COMMON PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 DEFINITIONS

A. Products:

1. New items for incorporation in the Work, whether purchased by Contractor or Owner for the Project, or taken from previously purchased stock, and may also include existing materials or components required for reuse.
2. Includes the terms material, equipment, machinery, components, subsystem, system, hardware, software, and terms of similar intent and is not intended to change meaning of such other terms used in Contract Documents, as those terms are self-explanatory and have well recognized meanings in construction industry.
3. Items identified by manufacturer's product name, including make or model designation, indicated in manufacturer's published product literature, that is current as of the date of the Contract Documents.

1.02 DESIGN REQUIREMENTS

A. Where Contractor design is specified, design of installation, systems, equipment, and components, including supports and anchorage, shall be in accordance with provisions of latest edition of 2015 International Building Code (IBC) by International Code Council.

1. Refer to Design Criteria in Drawing No. 000-S-001.

1.03 ENVIRONMENTAL REQUIREMENTS

A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at 1,950 feet above sea level.

B. Provide equipment and devices installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of 0 degrees F to 110 degrees F.

1.04 PREPARATION FOR SHIPMENT

A. When practical, factory assemble products. Mark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable protective coating.

B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and Contractor, equipment number, and approximate weight. Include complete packing list and bill of materials with each shipment.

C. Extra Materials, Special Tools, Test Equipment, and Expendables:

1. Furnish as required by individual Specifications.
2. Schedule:
    a. Ensure that shipment and delivery occurs concurrent with shipment of associated equipment.
    b. Transfer to Owner shall occur immediately subsequent to Contractor's acceptance of equipment from Supplier.
3. Packaging and Shipment:
    a. Package and ship extra materials and special tools to avoid damage during long term storage in original cartons insofar as possible, or in appropriately sized, hinged-cover, wood, plastic, or metal box.
    b. Prominently displayed on each package, the following:
        1) Manufacturer's part nomenclature and number, consistent with Operation and Maintenance Manual identification system.
        2) Applicable equipment description.
        3) Quantity of parts in package.
        4) Equipment manufacturer.
4. Deliver materials to Site.
5. Replace extra materials and special tools found to be damaged or otherwise inoperable at time of transfer to Owner.

D. Request a minimum 7-day advance notice of shipment from manufacturer. Upon receipt of manufacturer's advance notice of shipment, promptly notify Field Construction Manager of anticipated date of arrival.

E. Factory Test Results: Reviewed and accepted by Engineer before product shipment as required in individual Specification sections.

1.05 DELIVERY AND INSPECTION

A. Deliver products in accordance with accepted current Progress Schedule and coordinate to avoid conflict with the Work and conditions at Site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.

B. Deliver products in undamaged condition, in manufacturer's original container or packaging, with identifying labels intact and legible. Include on label, date of manufacture and shelf life, where applicable.

C. Unload products in accordance with manufacturer's instructions for unloading or as specified. Record receipt of products at Site. Promptly inspect for completeness and evidence of damage during shipment.

D. Remove damaged products from Site and expedite delivery of identical new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.06 HANDLING, STORAGE, AND PROTECTION

A. Handle and store products in accordance with manufacturer's written instructions and in a manner to prevent damage. Store in approved storage yards or sheds provided in accordance with Section 01 50 00, Temporary Facilities and Controls. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by Owner.

B. Manufacturer's instructions for material requiring special handling, storage, or protection shall be provided prior to delivery of material.

C. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to ensure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered, but not installed in the Work.

D. Store electrical, instrumentation, and control products, and equipment with bearings in weather-tight structures maintained above 60 degrees F. Protect electrical, instrumentation, and control products, and insulate against moisture, water, and dust damage. Connect and operate continuously space heaters furnished in electrical equipment.

E. Store fabricated products above ground on blocking or skids, and prevent soiling or staining. Store loose granular materials in well-drained area on solid

surface to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

F. Store finished products that are ready for installation in dry and well-ventilated areas. Do not subject to extreme changes in temperature or humidity.

G. After installation, provide coverings to protect products from damage due to traffic and construction operations. Remove coverings when no longer needed.

H. Hazardous Materials: Prevent contamination of personnel, storage area, and Site. Meet requirements of product specification, codes, and manufacturer's instructions.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide manufacturer's standard materials suitable for service conditions, unless otherwise specified in the individual Specifications.

B. Where product specifications include a named manufacturer, with or without model number, and also include performance requirements, named manufacturer's products must meet the performance specifications.

C. Like items of products furnished and installed in the Work shall be end products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, manufacturer's services, and implement same or similar process instrumentation and control functions in same or similar manner.

D. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.

E. Provide interchangeable components of the same manufacturer, for similar components, unless otherwise specified.

F. Equipment, Components, Systems, and Subsystems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and shall comply with applicable OSHA, state, and local health and safety regulations.

G. Regulatory Requirement: Coating materials shall meet federal, state, and local requirements limiting the emission of volatile organic compounds and for worker exposure.

H. Safety Guards: Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal. Use 16-gauge or heavier; galvanized steel, aluminum coated steel, or galvanized or aluminum coated 1/2-inch mesh expanded steel. Provide galvanized steel accessories and supports, including bolts. For outdoors application, prevent entrance of rain and dripping water.

I. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark.

J. Equipment Finish:

1. Provide manufacturer’s standard finish and color, except where specific color is indicated.
2. If manufacturer has no standard color, provide equipment with finish as approved by Engineer.

K. Special Tools and Accessories: Furnish to Owner, upon acceptance of equipment, all accessories required to place each item of equipment in full operation. These accessory items include, but are not limited to, adequate oil and grease (as required for first lubrication of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, handwheels, chain operators, special tools, and other spare parts as required for maintenance.

L. Lubricant: Provide initial lubricant recommended by equipment manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by Owner.

M. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the

Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 FABRICATION AND MANUFACTURE

A. General:

1. Manufacture parts to U.S.A. standard sizes and gauges.
2. Two or more items of the same type shall be identical, by the same manufacturer, and interchangeable.
3. Design structural members for anticipated shock and vibratory loads.
4. Use 1/4-inch minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
5. Modify standard products as necessary to meet performance Specifications.

B. Lubrication System:

1. Require no more than weekly attention during continuous operation.
2. Convenient and accessible; oil drains with bronze or stainless steel valves and fill-plugs easily accessible from the normal operating area or platform. Locate drains to allow convenient collection of oil during oil changes without removing equipment from its installed position.
3. Provide constant-level oilers or oil level indicators for oil lubrication systems.
4. For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.

2.03 SOURCE QUALITY CONTROL

A. Where Specifications call for factory testing to be witnessed by Engineer, notify Engineer not less than 14 days prior to scheduled test date, unless otherwise specified.

B. Calibration Instruments: Bear the seal of a reputable laboratory certifying instrument has been calibrated within the previous 12 months to a standard endorsed by the National Institute of Standards and Technology (NIST).

C. Factory Tests: Perform in accordance with accepted test procedures and document successful completion.

PART 3 EXECUTION

3.01 INSPECTION

A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the Site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage that necessitates procurement of new products will be considered delays within Contractor's control.

3.02 MANUFACTURER'S CERTIFICATE OF COMPLIANCE

A. When so specified, a Manufacturer's Certificate of Compliance, a copy of which is attached to this section, shall be completed in full, signed by entity supplying the product, material, or service, and submitted prior to shipment of product or material or execution of the services.

B. Engineer may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.

C. Such form shall certify proposed product, material, or service complies with that specified. Attach supporting reference data, affidavits, and certifications as appropriate.

D. May reflect recent or previous test results on material or product, if acceptable to Engineer.

3.03 INSTALLATION

A. Equipment Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. No shimming between machined surfaces is allowed.

C. Install the Work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Repaint painted surfaces that are damaged prior to equipment acceptance.

E. Do not cut or notch any structural member or building surface without specific approval of Engineer.

F. Handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's instructions, and as may be specified. Retain a copy of manufacturers' instruction at Site, available for review at all times.

G. For material and equipment specifically indicated or specified to be reused in the Work:

1. Use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
2. Arrange for transportation, storage, and handling of products that require offsite storage, restoration, or renovation. Include costs for such Work in the Contract Price.

3.04 FIELD FINISHING

A. In accordance with Section 09 90 00, Painting and Coating, and individual Specification sections.

3.05 ADJUSTMENT AND CLEANING

A. Perform required adjustments, tests, operation checks, and other startup activities.

3.06 LUBRICANTS

A. Fill lubricant reservoirs and replace consumption during testing, startup, and operation prior to acceptance of equipment by Owner.

3.07 SUPPLEMENT

A. The supplement listed below, following "End of Section," is part of this specification.

1. Manufacturer's Certificate of Compliance.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER: _____

PROJECT NAME: _____

PROJECT NO: _____

PRODUCT, MATERIAL, OR SERVICE SUBMITTED: _____

Comments: _____

_____

_____

_____

_____

_____

I hereby certify that the above-referenced product, material, or service called for by the Contract for the named Project will be furnished in accordance with all applicable requirements. I further certify that the product, material, or service are of the quality specified and conform in all respects with the Contract requirements, and are in the quantity shown.

Date of Execution: _____, 20___

Manufacturer: _____

Manufacturer's Authorized Representative *(print)*: _____

_____

(Authorized Signature)

SECTION 01 64 00
CONTRACTOR-FURNISHED PRODUCTS

PART 1 GENERAL

1.01 DEFINITIONS

A. Supplier: The party under separate contract with Contractor to furnish the products or special services specified herein.

B. Subcontractor: Party under contract with Contractor to inspect, offload, store, maintain, and install the Contractor-furnished products.

1.02 INFORMATION FURNISHED BY CONTRACTOR

A. The following information relating to Contractor-furnished products will be provided to Subcontractor for use in performing the Work under this section:

1. Supplier contact information.
2. Supplier Shop Drawings.
3. Storage and maintenance instructions.
4. Installation instructions.
5. Operation and Maintenance Manual.

B. The Drawings prepared by Contractor and Shop Drawings prepared by Suppliers, are required to complete the Work and are to be considered together. The Supplier Shop Drawings indicate work and equipment to be provided or performed by others. The reference to others on Supplier-prepared Shop Drawings shall be understood to mean Subcontractor.

C. In cases where the Work shown on Supplier Shop Drawings is also shown or indicated to be done differently on Contractor's Drawings and Specifications all such Work shall be in accordance with the Supplier Shop Drawings. Subcontractor is responsible for installation of equipment and materials regardless of the source of the supply.

1.03 SUBCONTRACTOR'S RESPONSIBILITY FOR COMPLETE SYSTEM

A. Subcontractor shall have complete responsibility for receiving, handling, storing, installing, adjusting, cleaning, maintaining, lubricating, documenting and weather protection of Contractor-furnished products. Refer to information furnished by Contractor that will assist in determining requirements.

B. Contractor will provide and coordinate construction of interconnecting structures, equipment, piping, piping support systems, electrical and instrumentation work, and appurtenances to achieve installation and operation of Contractor-furnished products as shown and specified and as required to provide a complete and functional system.

1.04 TRANSFER OF PRODUCTS

A. Unless indicated otherwise, items will be furnished delivery duty paid (DDP) per INCOTERMS 2010 to Project Site.

B. Upon delivery, conduct with Contractor a joint inspection for the purpose of identifying product, general verification of quantities, and observation of apparent condition. Such inspection will not be construed as final or as receipt of a product that, as a result of subsequent inspections and tests, is determined to be nonconforming.

C. Damaged or incomplete products to be returned for replacement will not be unloaded, except as necessary to expedite return shipment. Contractor will submit claims for transportation damage and expedite replacement of damaged, defective, or deficient items.

D. Indicate signed acceptance of delivery on a copy of the invoice.

E. If Subcontractor is not prepared to accept delivery of Contractor-furnished products by either the specified Estimated Date of Arrival or such Contractor-confirmed delivery date, as specified herein, associated costs incurred by Contractor shall be borne by Subcontractor. Such costs may include, but not be limited to, demurrage, interest, insurance costs, additional administrative and engineering costs, additional factory and field technical support, additional storage and reshipping costs, cost escalation, and extended warranty costs due.

1.05 UNLOADING, STORAGE, AND MAINTENANCE

A. Subsequent to transfer, Subcontractor shall have complete responsibility for unloading Contractor-furnished products. Unload product in accordance with manufacturers' instructions or as specified.

B. Store products onsite in accordance with Suppliers' written storage and maintenance instructions. Be prepared to store products for minimum durations determined by Contractor for each set of Contractor-furnished products.

C. Store, protect, and maintain product to prevent damage until final acceptance of completed Work. Damage to or loss of products after date of transfer to Subcontractor shall be repaired to original condition, or replaced with new identical products, at discretion of Contractor.

D. After transfer to Subcontractor, maintain complete inventory of Contractor-furnished products.

1.06 SCHEDULING AND SEQUENCING

A. Include sequencing constraints specified herein as part of Progress Schedule.

B. Contractor will keep Subcontractor informed of probable delivery date changes.

C. Contractor will confirm delivery date with Subcontractor 5 days prior to scheduled delivery, and within 48 hours of expected delivery time.

D. Where a preinstallation meeting is required by this section, provide a minimum of 30 days' advance written notice to Contractor of proposed date for starting installation.

E. Provide a minimum of 30 days' notice to Contractor that Contractor-furnished product is ready for special services listed herein to be furnished by Contractor through its contract with Supplier. Subcontractor shall bear cost of all damages assessed to Contractor by Supplier resulting from delays caused by Subcontractor.

1.07 EXTRA MATERIALS

A. Inspect, inventory, secure/house, protect extra materials and special tools until turned over to Contractor. Provide inventory list and updates when requested by Contractor.

1.08 PREINSTALLATION MEETING

A. Arrange and attend a preinstallation meeting with Contractor to review general procedures, erection and installation instructions, and installation sequence.

B. Additional meetings prior to installation may be required, as determined by Contractor, to transmit Contractor's installation instructions to Subcontractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in conformance with Contractor-furnished product Shop Drawings and installation instructions.

B. Provide interconnecting structures, equipment, piping, electrical and instrumentation work, finish painting, and appurtenances to achieve a complete and functional system.

C. Provide foundation pads for Contractor-furnished products as shown. Verify exact dimensions and configuration of pads, including penetrations, with Contractor-furnished product Shop Drawings.

D. Anchor Bolts:

1. Where required, provide anchor bolts, fasteners, washers, and templates needed for installation of Contractor-furnished product.
2. Size and locate anchor bolts in accordance with Contractor-furnished product Shop Drawings and installation instructions.

E. Mechanical and electrical equipment shall be properly aligned, plumb and level, with no stresses on connecting piping or conduit.

F. Verify direction of motor rotation before starting equipment drives.

G. Verify operability and safety of electrical system needed to operate equipment. Check electrical system for continuity, phasing, grounding, and proper functions.

3.02 FIELD FINISHING

A. Products will be delivered with prime coat(s) or finish coat(s) applied.

1. Touch up or repair damage to coatings resulting from unloading, storage, installation, testing, and startup.
2. If finish coats are damaged extensively after transfer, completely repaint.
3. Touch up, repair, or complete repainting shall match color of original paint, and shall be fully compatible with applied primers and finish.

3.03 PRODUCT PROTECTION

A. Immediately after installation, lubricate components in accordance with manufacturer's instructions.

B. Follow manufacturer's instructions for protection and maintenance during storage, after installation but prior to testing and startup, and after startup but prior to acceptance.

C. Furnish incidental supplies including lubricants, cleaning fluids, and similar products as needed for protecting and maintaining the Contractor-furnished products.

END OF SECTION

SECTION 01 74 19
CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Salvaging nonhazardous construction waste.
2. Recycling nonhazardous construction waste.
3. Disposing of nonhazardous construction waste.

1.02 DEFINITIONS

A. Construction Waste: Building and Site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and Site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.03 PERFORMANCE REQUIREMENTS

A. Practice efficient waste management in use of materials in course of the Work.

B. Use reasonable means to divert construction and demolition waste from landfills and incinerators.

C. Facilitate recycling and salvage of materials.

D. Unless otherwise noted in Contract Documents, construction waste management and disposal offsite is the responsibility of Contractor and will be done at Contractor's expense. Subcontractors shall comply with requirements of this section or as directed by Contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PLAN IMPLEMENTATION

A. Implement waste management plan as approved by Contractor.

1. Comply with Section 01 50 00, Temporary Facilities and Controls, for operation, termination, and removal requirements.

B. Subcontractor's Waste Management Coordinator: Engage waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.

C. Training: Train workers, Sub-subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Site.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

3.02 RECYCLING CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by onsite workers.

B. Recycling Receivers and Processors: Contractor will locate and arrange services of receivers and processors.

C. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

D. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to recycling process.

E. Procedures:

1. Separate recyclable waste from other waste materials, trash, and debris.
2. Separate recyclable waste by type at Site to maximum extent practical according to approved construction waste management plan.
3. Use Contractor provided appropriately marked containers or bins for controlling recyclable waste until they are removed from Site.
   a. Inspect containers and bins for contamination and remove contaminated materials if found.
4. Stockpile processed materials onsite without intermixing with other materials.
5. Place, grade, and shape stockpiles to drain surface water; cover to prevent windblown dust.
6. Store components off ground and protect from weather.

3.03 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Site. For pallets that remain onsite, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

C. Gypsum Board:

1. Stack large clean pieces on wood pallets or in container and store in dry location.
2. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

END OF SECTION

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Submit prior to application for final payment.
   a. Record Documents, including all approved "conformed" submittals.
   b. Insurance Continuation of Coverage.
   c. Final Claims Statement.
   d. Settlement/Payment of Claims Affidavit.
   e. Special bonds, Special Guarantees, and Service Agreements.
   f. Consent of Surety to Final Payment (if applicable).
   g. Conditional Lien Waiver for Final Payment.
   h. Request for Substantial Completion Certification letter.
   i. Releases from Agreements.
   j. Final Application for Payment: Submit in accordance with procedures and requirements stated in Subcontract and/or Purchase Order.
   k. Spare parts.
   l. Warranties.
   m. Final approved O&M Manuals.

1.02 RECORD DOCUMENTS

A. Quality Assurance:

1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
2. Accuracy of Records:
   a. Coordinate changes within record documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change.
   b. Purpose of Project record documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.

3. Make entries within 48 hours after receipt of information that a change in the Work has occurred.
4. Prior to submitting each request for progress payment, request Contractor's review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents will result in a deferral or rejection by Contractor to recommend whole or any part of Subcontractor's Application for Payment, either partial or final.

1.03 RELEASES FROM AGREEMENTS

A. Furnish Contractor written releases from property owners or public agencies where side agreements or special easements have been made, or where Subcontractor's operations have not been kept within Agency's construction right-of-way.

B. In the event Subcontractor is unable to secure written releases:

1. Inform Contractor of the reasons.
2. Contractor or its representatives will examine Site, and Contractor will direct Subcontractor to complete the Work that may be necessary to satisfy terms of side agreement or special easement.
3. Should Subcontractor refuse to perform this Work, Contractor reserves right to have it done by separate contract and deduct cost of same from Contract Price, or require Subcontractor to furnish a satisfactory bond in a sum to cover legal claims for damages.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 MAINTENANCE OF RECORD DOCUMENTS

A. General:

1. Promptly following commencement of Contract Times, secure from Contractor at no cost to Subcontractor, one complete set of Contract Documents.
2. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.

B. Preservation:

1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
2. Make documents and Samples available at all times for observation by Contractor.
3. Contractor will review record documentation biweekly.

C. Making Entries on Drawings:

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
   a. Color Coding:
      1) Green when showing information deleted from Drawings.
      2) Red when showing information added to Drawings.
      3) Blue and circled in blue to show notes.
2. Date entries.
3. Call attention to entry by “cloud” drawn around area or areas affected.
4. Legibly mark to record actual changes made during construction, including, but not limited to:
   a. Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
   b. Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.
   c. Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
   d. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
   e. Changes made by Addenda, Change Order, and Requests for Information and Clarification using consistent symbols for each and showing appropriate document tracking number.

3.02 FINAL CLEANING

A. At completion of the Work or of a part thereof and immediately prior to Contractor's request for certificate of Substantial Completion; or if no certificate is issued, immediately prior to Contractor's notice of completion, clean entire Site or parts thereof, as applicable.

1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to Contractor.
2. Remove grease, dirt, dust, paint or plaster splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
3. Repair, patch, and touch up marred surfaces to specified finish and match adjacent surfaces.
4. Clean all windows.
5. Clean and wax wood, vinyl, or painted floors.
6. Broom clean exterior paved driveways and parking areas.
7. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
8. Rake clean all other surfaces.
9. Replace air-handling filters and clean ducts, blowers, and coils of ventilation units operated during construction.
10. Leave water courses, gutters, and ditches open and clean.

B. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

END OF SECTION

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SUMMARY

A. Detailed information for the preparation, submission, and Contractor's review of Operations and Maintenance (O&M) and Asset Data, as required by individual specification sections.

1.02 DEFINITIONS

A. Preliminary Data: Initial and subsequent submissions for Contractor's review.

B. Final Data: Contractor accepted data, submitted as specified herein.

C. Maintenance Operation: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

D. Asset Data: Compliant with asset management requirements.

1.03 SEQUENCING AND SCHEDULING

A. O&M Data:

1. Preliminary Data:
   a. Do not submit until Shop Drawing for equipment or system has been reviewed and approved by Contractor.
   b. Submit within 30 days following approval of Shop Drawing for equipment of system.
2. Final Data: Submit 30 days prior to shipment and installation.

B. Asset Data: Submit preliminary and final Asset Data concurrent with operation and maintenance data.

1.04 DATA FORMAT

A. Prepare preliminary and final data in the electronic form.

B. Format:

1. Cover Page:
   a. Identify manual with typed or printed title “OPERATION AND MAINTENANCE DATA” and list:
      1) Project title.
      2) Designate applicable system, equipment, material, or finish.
      3) Identity of separate structure as applicable.
      4) Identify volume number if more than one volume.
      5) Identity of general subject matter covered in manual.
      6) Identity of equipment name, equipment number, and specification section.
2. Title Page:
   a. Subcontractor or Supplier name, address, and telephone number.
   b. Sub-subcontractor, Supplier, installer, or maintenance contractor’s name, address, and telephone number, as appropriate.
      1) Identify area of responsibility of each.
      2) Provide name and telephone number of local source of supply for parts and replacement.
3. Table of Contents:
   a. Neatly typewritten and arranged in systematic order with consecutive page numbers.
   b. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
4. Equipment List: Provide list of all tagged equipment with description.
5. Text: Manufacturer’s printed data, or neatly typewritten.
6. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.
7. Manual to follow section organization in Electronic Document Requirements found in Article Supplements following End of Section.

C. Electronic Requirements:

1. Portable Document Format (PDF):
   a. Submit Operation and Maintenance data in PDF format on CD.
   b. Arrange by specification number and name.
   c. Link TOC sections to major sections in manual or create PDF bookmarks to each section.
   d. Files to be fully functional and viewable in most recent version of Adobe Acrobat.
   e. PDF File Document Properties:
      1) Initial View: Page only.
      2) Page Number: One.

3) Magnification: Fit width.
4) Page Layout: Single page.
5) Window Options: Resize to initial.
6) Window Options: Searchable PDF.
7) Window Options: “Linked” Table of Contents.

f. Microsoft Office Documents:
1) Maintenance Summary Form: Excel form provided by Contractor.
2) Operating Procedures: Word format.
3) Asset Management: Data format.
a) Electronic format only in template prepared by Contractor.
b) Submit in Excel.

g. Manual to follow section organization in Electronic Document Requirements found in Article Supplements following End of Section.

h. File to be completely text searchable (OCR).

1.05 SUBMITTALS

A. Informational:

1. Preliminary Data:
a. Submit electronic copy for Contractor’s review.
b. If data meets conditions of the Contract:
1) Contractor’s comments will be returned to Subcontractor or Supplier.
2) Subcontractor or Supplier must prepare and submit Final Data as specified.
c. If data does not meet conditions of the Contract:
1) Contractor’s comments will be returned to Subcontractor or Supplier.
2) Subcontractor or Supplier must resubmit.

2. Final Data: Submit one electronic copy in format specified herein.

1.06 O&M DATA FOR EQUIPMENT AND SYSTEMS

A. Content for Each Unit (or Common Units) and System:

1. Product Data:
a. Include only those sheets that are pertinent to specific product.
b. Clearly annotate each sheet to:
1) Identify specific product or part installed.
2) Identify data applicable to installation.

3) Delete references to inapplicable information.

c. Function, normal operating characteristics, and limiting conditions.

d. Performance curves, engineering data, nameplate data, and tests.

e. Complete nomenclature and commercial number of replaceable parts.

f. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.

g. Spare parts ordering instructions.

h. Where applicable, identify installed spares and other provisions for future work (for example, reserved panel space, unused components, wiring, terminals).

2. As-installed, color-coded piping diagrams.

3. Charts of valve tag numbers, with the location and function of each valve.

4. Drawings:

a. Supplement product data with Drawings as necessary to clearly illustrate:

1) Format:

a) Provide reinforced, punched, binder tab; bind in with text.

b) Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.

c) Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.

d) Identify Specification section and product on Drawings and envelopes.

2) Relations of component parts of equipment and systems.

3) Control and flow diagrams.

4) Coordinate drawings with Project record documents to assure correct illustration of completed installation.

5. Instructions and Procedures: Within text, as required to supplement product data.

a. Format:

1) Organize in consistent format under separate heading for each different procedure.

2) Provide logical sequence of instructions for each procedure.

3) Provide information sheet for Contractor's personnel, including:

a) Proper procedures in event of failure.

b) Instances that might affect validity of equipment warranty.

b. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
c. Operating Procedures:
    1) Startup, break-in, routine, and normal operating instructions.
    2) Test procedures and results of factory tests where required.
    3) Regulation, control, stopping, and emergency instructions.
    4) Description of operation sequence by control manufacturer.
    5) Shutdown instructions for both short and extended duration.
    6) Summer and winter operating instructions, as applicable.
    7) Safety precautions.
    8) Special operating instructions.
d. Maintenance and Overhaul Procedures:
    1) Routine maintenance.
    2) Guide to troubleshooting.
    3) Disassembly, removal, repair, reinstallation, and re-assembly.
    4) Required maintenance for long-term storage and/or shutdown.
e. Client equipment tag name list with description.

B. Content for Each Electric or Electronic Item or System:

1. Description of Unit and Component Parts:
    a. Function, normal operating characteristics, and limiting conditions.
    b. Performance curves, engineering data, nameplate data, and tests.
    c. Complete nomenclature and commercial number of replaceable parts.
    d. Interconnection wiring diagrams, including control and lighting systems.
2. Circuit Directories of Panelboards.
3. Electrical service.
4. Control requirements and interfaces.
5. Communication requirements and interfaces.
6. List of electrical relay settings, and control and alarm contact settings.
7. Electrical interconnection wiring diagram, including as applicable, single-line, three-line, schematic and internal wiring, and external interconnection wiring.
8. As-installed control diagrams by control manufacturer.
9. Operating Procedures:
    a. Routine and normal operating instructions.
    b. Startup and shutdown sequences, normal and emergency.
    c. Safety precautions.
    d. Special operating instructions.

10. Maintenance Procedures:
    a. Routine maintenance.
    b. Guide to troubleshooting.
    c. Adjustment and checking.
    d. List of relay settings, control and alarm contact settings.
11. Manufacturer's printed operating and maintenance instructions.
12. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

C. Maintenance Summary:

1. Compile individual Maintenance Summary Forms for each applicable equipment item, respective unit or system, and for components or sub-units. Fill out sections completely.
2. Format:
    a. Use Maintenance Summary Form bound with this section.
    b. Each Maintenance Summary may take as many pages as required.
    c. Use only 8-1/2-inch by 11-inch size paper.
    d. Complete using Excel on form provided.
3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
4. Recommended Spare Parts:
    a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
    b. "Unit" is the unit of measure for ordering the part.
    c. "Quantity" is the number of units recommended.
    d. "Unit Cost" is the current purchase price.
5. Provide pertinent nameplate data for each piece of equipment; include specific serial numbers and tag numbers.

1.07 ASSET DATA FOR EQUIPMENT AND SYSTEMS

A. Asset Data in accordance with Asset Management Information found in Article Supplements following End of Section.

B. Complete the Asset Management Information Form for each piece of equipment, filling in applicable information.

1.08 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are part of this Specification.

1. Maintenance Summary Form.
2. Electronic Document Requirements.
3. Electronic Asset Management Information.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

MAINTENANCE SUMMARY FORM

PROJECT: _____ CONTRACT NO.: _____

1. EQUIPMENT ITEM_____

2. MANUFACTURER _____

3. EQUIPMENT/TAG NUMBER(S) _____

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____

5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____

6. MANUFACTURER'S LOCAL REPRESENTATIVE _____

   a. Name _____ Telephone No. _____

   b. Address _____

7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	Frequency	Lubricant (If Applicable)
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR INVENTORY

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

ELECTRONIC DOCUMENT REQUIREMENTS

Description	File Contents
General Information	Cover Page Information
	Title page Information
	Table of Contents
	Specifications
	Design Criteria
	Warrantee
	Bond Information
	Service Contracts
	Bill of Materials
Installation Instructions	All Datasheets
	All Catalog Cuts
	Installation Drawings
	Installation Details & Procedures
Initial Settings & Calibration	Calibration Datasheet
	Final Calibration Settings
	Testing & Certification Data
	Calibration Procedures
Operating Strategies	Process Procedures
	Startup Procedures
	Shutdown Procedures
	Abnormal Conditions
	Control Modes
	Standard Operating Procedures

Description	File Contents
Maintenance & Troubleshooting	Equipment Checklists
	Spare Part Lists
	Inspection Procedures
	Lubrication Procedures
	Maintenance Procedures
	I&C Documentation & Configuration
	Software manuals
Figures, Drawings, & Misc	All Drawings
	Diagrams
	Charts
Safety & Emergency Information	Safety Procedures
	Emergency Procedures
	MSDS Information
	OSHA Regulations

ELECTRONIC ASSET MANAGEMENT INFORMATION

Notes:
1. Enter information electronically on form provided by Contractor.
2. Enter information separately (e.g., one entry for motor, one entry for driven unit.

1	Asset Description (Equipment/ Tag Number(s))	TO BE COMPLETED BY CONTRACTOR
2	Added to Hierarchy?	TO BE COMPLETED BY CONTRACTOR
3	Depreciable?	TO BE COMPLETED BY CONTRACTOR
4	Asset Record Type	TO BE COMPLETED BY CONTRACTOR
5	Asset ID Number	TO BE COMPLETED BY CONTRACTOR
6	Added to MAXIMO?	TO BE COMPLETED BY CONTRACTOR
7A	Asset Location?	TO BE COMPLETED BY CONTRACTOR
7B	Association with other Asset (part of another asset)?	TO BE COMPLETED BY CONTRACTOR
7C	SCADA Tag #	
8	Purchasing Information	
9	Method of Acquisition	TO BE COMPLETED BY CONTRACTOR
10	Source of Funding (i.e., Grants, Bonds, etc.)	TO BE COMPLETED BY CONTRACTOR
11	Purchase Document Number	
12	Stationary or Mobile	TO BE COMPLETED BY CONTRACTOR
13A	Purchase or Replacement (Book) Value	
13B	Warranty Expiration Date	
13C	Vendor	
14	Manufacturer’s Information	
15	Manufacturer's Name	
16	Model Number	
17	Serial Number	
18	Make	

19	Motor/Electrical Information	
20	Voltage	
21	Amperage	
22	Frequency	
23	Phases	
24	HP	
25	Frame	
26	RPM	
27	Power Factor	
28	Max KVAR	
29	Nominal Efficiency	
30	Rating	
31	Design	
32	Enclosure	
33	Code	
34	Insulation Class	
35	Max Ambient Temp	
36	Service Factor	
37	Grease	
38	DE Bearing	
39	OE Bearing	
40	Type	
41	Pump Information	
42	GPM	
43	Pump Type	
44	Pump Size	
45	Number of Stages	
46	Impeller Diameter	
47	Rotation	
48	Seal Type	

49		
50	Valve Information	
51	Valve Rebuild Kit No.	
52	Valve Size	
53	Valve Body	
54	Valve Plug Type	
55	Valve Plug Face Type	
56	Valve Seat Type	
57	Valve Temperature Rating	
58	Valve Flange Type	
59	Valve Flange Material	
60	Valve Material	
61	Valve Liner	
62	Valve Type	
63	Instrument Information	
64	Instrument Measurement Type	
65	Instrument Unit of Measure	
66	Instrument Element Type	
67	Instrument Range	
68	Instrument Proof Pressure	
69	Instrument Maximum Measurement	
70	Instrument Material	
71	Instrument Deadband	
72	Instrument Output	
73	Instrument Software Revision	
74	Instrument Flange Type	
75	Instrument Flange Material	
76	Instrument Liner	
77	Instrument Accuracy	

78	Instrument Readability	
79	Instrument Type	
80	Fans	
81	Type	
82	Size	
83	CFM	
84		
85	HVAC	
86	Compressor Volts	
87	Compressor Phase	
88	Compressor HZ	
89	Compressor RLA	
90	Compressor LRA	
91	Refrigerant	
92	Fan Motor Volts	
93	Fan Motor Phase	
94	Fan Motor Hz	
95	Fan FLA	
96	Fan HP	
97	Test Pressure Gauge Low	
98	Test Pressure Gauge High	
99		
100	Transformers	
101	Primary Voltage	
102	Secondary Voltage	
103	Hertz	
104	Phases	
105	Imp	

SECTION 01 88 15
ANCHORAGE AND BRACING

PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for anchorage and bracing of equipment, distribution systems, and other nonstructural components required in accordance with the 2015 International Building Code (IBC), for seismic, wind, gravity, soil, and operational loads.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Institute of Steel Construction (AISC) 360, Specification for Structural Steel Buildings.
2. American Society of Civil Engineers (ASCE): ASCE 7, Minimum Design Loads for Buildings and Other Structures.
3. International Building Commission: 2015 IBC.
4. International Code Council (ICC): International Building Code (IBC).

1.03 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.

B. Designated Seismic System: Architectural, electrical, and mechanical system or their components for which component importance factor is greater than 1.0.

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

A. General:

1. Anchorage and bracing systems shall be designed by a qualified professional engineer registered in the State of Washington.

2. Design anchorage and bracing of architectural, mechanical, and electrical components and systems in accordance with this section, unless a design is specifically provided within Contract Documents or where exempted hereinafter.
3. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for gravity, seismic, wind, and operational loading.
4. Anchor and brace piping and ductwork, whether exempt or not exempt for this section, so that lateral or vertical displacement does not result in damage or failure to essential architectural, mechanical, or electrical equipment.
5. Architectural Components: Includes, but are not limited to, nonstructural walls and elements, partitions, cladding and veneer, access flooring, signs, cabinets, suspended ceilings, and glass in glazed curtain walls and partitions.
6. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
7. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.
8. Design seismic anchorage and bracing for:
    a. Equipment and components that weigh more than 400 pounds.
    b. Equipment weighing more than 20 pounds that has center of mass located more than 4 feet above adjacent finished floor.
    c. Mechanical and electrical components that are not provided with flexible connections between components and associated ductwork, piping, or conduit.
    d. Distribution systems that weigh more than 5 pounds per foot that have center of mass located more than 4 feet above adjacent finished floor.
9. Design seismic anchorage and bracing for Designated Seismic Systems regardless of weight or mounting height.
    a. Component Important Factor:
        1) Ip equals 1.0, unless noted otherwise.
        2) Ip shall be taken as 1.5 if any of the following conditions apply:
            a) Component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems and egress stairways.
            b) Component contains hazardous materials.
            c) Component is in or attached to Risk Category IV structure and is needed for continued operation of facility or its failure could impair continued operation of facility.
        3) Per Section 01 61 00, Common Product Requirements.

10. For components exempted from design requirements of this section, provide bolted, welded, or otherwise positively fastened attachments to supporting structure.

B. Design Loads:

1. Gravity: Design anchorage and bracing for self-weight and superimposed loads on components and equipment.
2. Wind: Design anchorage and bracing for wind criteria provided in Section 01 61 00, Common Product Requirements, and on General Structural Notes on Drawings for exposed architectural components and exterior and wind-exposed mechanical and electrical equipment. Alternately, manufacturer certification may be provided for components such as roofing and flashing to verify attachments meet Project-specific design criteria.
3. Operational:
   a. For loading supplied by equipment manufacturer for IBC required load cases.
   b. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), water hammer, and other load-inducing conditions.
   c. Locate braces to minimize vibration to or movement of structure.
4. Seismic:
   a. In accordance with 2015 IBC, Section 1613, and Chapter 13 of ASCE 7.
   b. Design anchorage and bracing for design criteria listed on General Structural Notes on Drawings.

C. Seismic Design Requirements:

1. Nonstructural Components: Design as nonbuilding structures for components with weights greater than or equal to 25 percent of effective seismic weight of overall structure.
2. Analyze local region of body of nonstructural component for load transfer of anchorage attachment if component Ip equals 1.5.
3. The following are exempt from requirements for provision of seismic anchorages and bracing, in addition to those items specifically exempted in ASCE 7, Part 13.5 for architectural components and Part 13.6 for electrical and mechanical equipment:
   a. Furniture, except storage cabinets and bookshelves over 6 feet tall.
   b. Temporary or movable equipment.
4. Fire protection sprinkler systems designed and constructed in accordance with NFPA 13 shall be considered to meet requirements of Chapter 13 of ASCE 7.

5. Provide support drawings and calculations for electrical distribution components if any of the following conditions apply:
   a. Conduit diameter is greater than 2.5-inch trade size.
   b. Total weight of bus duct, cable tray, or conduit supported by trapeze assemblies exceeds 10 pounds per foot.
6. Other seismic design and detailing information identified in ASCE 7, Chapter 13, is required to be provided for new and modified or noted architectural, mechanical and electrical components, systems, or equipment.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. List of architectural, mechanical, and electrical equipment requiring Contractor-designed anchorage and bracing, unless specifically exempted.
   b. Manufacturers' engineered seismic and nonseismic hardware product data sealed by a civil or structural engineer registered in the State of Washington.
   c. Attachment assemblies' drawings including seismic attachments; include connection hardware, braces, and anchors or anchor bolts for nonexempt components, equipment, and systems.
   d. Drawings for seismic attachment assemblies include connection hardware, braces, and anchors (or anchor bolts) for modified, nonexempt existing components, equipment, and systems where a combination of new and existing systems or components' final condition would require anchorage or bracing under this specification for new equipment.
   e. Submittal will be rejected if proposed anchorage method would create excessive stress to supporting member. Revise anchorages and strengthen structural support to eliminate overstressed condition.

B. Informational Submittals:

1. Anchorage and Bracing Calculations: For attachments, braces, and anchorages, include IBC and Project-specific criteria as noted on General Structural Notes on Drawings, in addition to manufacturer's specific criteria used for design; sealed by a civil or structural engineer registered in the State of Washington.
2. Manufacturer's hardware installation requirements.

C. Deferred Submittals:

1. Submitted seismic anchorage drawings and calculations for Designated Seismic Systems are identified as IBC deferred submittals and will be submitted to and must be accepted by AHJ prior to installation of component, equipment, or distribution system.
2. Submit deferred Action Submittals such as Shop Drawings with supporting deferred informational submittals such as calculations no less than 12 weeks in advance of installation of component, equipment or distribution system to be anchored to structure.

1.06 SOURCE QUALITY CONTROL

A. Owner-furnished shop fabrication related special inspections and testing are provided in Project's Statement of Special Inspections on Drawings, and Section 01 45 33, Special Inspection, Observation, and Testing.

B. Owner-furnished shop fabrication related special inspections and testing are provided in Project's Statement of Special Inspections on Drawings, and Section 01 45 33, Special Inspection, Observation, and Testing.

PART 2 PRODUCTS

2.01 GENERAL

A. Design and construct attachments and supports transferring seismic and nonseismic loads to structure of materials and products suitable for application and in accordance with design criteria shown on Drawings and nationally recognized standards.

B. Provide anchor bolts of the size, minimum embedment, and spacing designated in calculations submitted by Subcontractor and accepted by Design Engineer.

C. Provide post-installed anchors of the size, minimum embedment, and spacing designated in calculations submitted by Subcontractor and accepted by Design Engineer.

D. Do not use powder-actuated fasteners or sleeve anchors for seismic attachments and anchorage where resistance to tension loads is required. Do not use expansion anchors, other than undercut anchors, for nonvibration isolated mechanical equipment rated over 10 hp.

PART 3 EXECUTION

3.01 GENERAL

A. Make attachments, bracing, and anchorage in such a manner that component lateral force is transferred to lateral force resisting system of structure through a complete load path.

B. Design, provide, and install overall seismic anchorage system to provide restraint in all directions, including vertical, for each component or system so anchored.

C. Provide snubbers in each horizontal direction and vertical restraints for components mounted on vibration isolation systems where required to resist overturning.

D. Provide piping anchorage that maintains design flexibility and expansion capabilities at flexible connections and expansion joints.

1. Piping and ductwork suspended more than 12 inches below supporting structure shall be braced for seismic effects to avoid significant bending of hangers and their attachments unless high or limited deformability piping is used per ASCE 7, Section 13.6.8 or HVAC ducts have a cross-sectional area of less than 6 square feet or weigh 17 pounds per foot or less.

E. Anchor tall and narrow equipment such as motor control centers and telemetry equipment at base and within 12 inches from top of equipment, unless approved otherwise by Design Engineer.

3.02 INSTALLATION

A. Do not install components or their anchorages or restraints prior to review and acceptance by Design Engineer.

B. Notify Construction Manager upon completion of installation of seismic restraints in accordance with Section 01 45 33, Special Inspection, Observation, and Testing.

3.03 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan on Drawings.

B. Provide any other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections.

END OF SECTION

SECTION 01 91 14
EQUIPMENT TESTING AND FACILITY STARTUP

PART 1 GENERAL

1.01 DESCRIPTION

A. Contractor will establish requirements for and coordinate testing and startup activities for the Facility. Subcontractors and Suppliers shall integrate testing and startup activities through Contractor and shall assist Contractor in conducting final Acceptance Test. Except as described elsewhere, Subcontractors and Suppliers shall supply labor, materials, and support equipment necessary for testing and startup activities.

1.02 DEFINITIONS

A. Facility: Entire Project, or an agreed-upon portion, including all of its unit processes.

B. Acceptance Test: Test conducted by Contractor to demonstrate and document performance of entire operating Facility, both manually and automatically. Such demonstration is for purposes of (i) verifying to Contractor and City that Facility performs as a whole, and (ii) documenting performance characteristics of completed Facility for City's records.

C. Component Test: Test or tests conducted by Subcontractor or Supplier in presence of Contractor to demonstrate installed equipment meets manufacturer's installation, calibration, functional, and adjustment requirements and other requirements as specified.

D. Performance Test: Test or tests conducted by Subcontractor or Supplier in presence of Contractor in the field under actual conditions to demonstrate that the equipment or systems meet specified performance requirements when specified in individual equipment sections.

E. Precommissioning: Initial physical inspections and documentation by Subcontractor to confirm readiness for commissioning activities.

F. Systems Test: Test(s) conducted by Contractor with assistance from Subcontractors and Suppliers as necessary to demonstrate manual and automatic operation of Facility unit processes.

1.03 SUBMITTALS

A. The following shall be submitted to the Contractor:

1. Manufacturer's Certificate of Proper Installation per Section 01 43 33, Manufacturers' Field Services.
2. Copies of manufacturer's field service technician's reports summarizing the results of the initial inspections, operations, adjustments, and testing.
3. Additional testing plans and/or reports when specified in the individual equipment specifications.
4. Logs of time spent by manufacturer's representatives performing services on the Job site.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Facility Commissioning Meetings: Attend Contractor Commissioning Meetings, in accordance with requirements of Section 01 31 19, Project Meetings, to discuss safety protocol, scheduling, test methods, materials, chemicals and liquids required, operations interface, and Subcontractor and Supplier involvement.

B. Subcontractor's Commissioning Representative:

1. Designate and furnish one or more personnel to coordinate and expedite testing and facility startup. Designated personnel are subject to approval of Contractor prior to commencing Work at the Facility.
2. Representative(s) shall be present during commissioning meetings and shall be available at all times during testing and startup.

C. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required for testing and startup.

D. Provide sufficient personnel for Subcontractor and equipment manufacturers to support Project schedule to not cause project delays. Schedule all other ongoing work by Subcontractor or Supplier to not interfere with or delay testing and startup.

E. Contractor will:

1. Provide test water, power, chemicals, natural gas, and other items as required for startup, unless otherwise indicated.

2. Operate process units and facility with support of Subcontractor.
3. Provide labor and materials as required for laboratory analyses of water quality parameters, unless otherwise specified.
4. Furnish assistance of manufacturer's representative(s) for Contractor furnished equipment.
5. Make available spare parts, special tools, and operation and maintenance information for Contractor furnished equipment.
6. Perform preventative maintenance activities on process equipment after receipt of Manufacturer's Certificate of Proper Installation.

F. Subcontractor shall:

1. Furnish assistance of manufacturer's representative(s) as specified for Subcontractor-furnished equipment.
2. Make available spare parts, special tools, and operation and maintenance information for Subcontractor-furnished equipment.
3. Perform, and maintain log of, preventative and/or corrective maintenance activities (whether Contractor furnished or Subcontractor-furnished) on process equipment until receipt of Manufacturer's Certificate of Proper Installation.
4. Perform, and maintain log of, preventative and/or corrective maintenance for HVAC equipment until Substantial Completion.
5. Schedule other ongoing work by subcontractor to not interfere with or delay commissioning activities.

3.02 PRECOMMISSIONING

A. Precommissioning and physical inspection of equipment and facilities shall be performed by the subcontractor for a completed area or facility, including both Subcontractor-furnished and Contractor furnished equipment.

B. Subcontractor shall complete all construction and testing activities required to verify each item in the Precommissioning Checklist has been completed as provided at the end of this section.

C. Upon completion of physical construction of a facility or area, subcontractor shall provide to the Contractor a completed and signed Precommissioning Checklist. Contractor must sign and approve the Precommissioning Checklist before Precommissioning is deemed to have been successfully completed.

D. In general, Precommissioning Checklists shall be completed on a facility or process area basis (e.g., sand ballasted clarification) unless otherwise agreed upon with the Contractor.

E. Subcontractor shall coordinate timing of Precommissioning completion with Contractor in order for Contractor to coordinate commissioning activities accordingly.

3.03 COMPONENT TESTING

A. Preparation:

1. Complete installation before testing.
2. Furnish qualified manufacturers' representatives, when required by individual Specification sections.
3. Obtain and submit from equipment manufacturer's representative Manufacturer's Certificate of Proper Installation Form, in accordance with Section 01 43 33, Manufacturers' Field Services, when required by individual Specification sections.
4. Cleaning and Checking:
    a. Prior to beginning component testing:
        1) Calibrate testing equipment in accordance with manufacturer's instructions.
        2) Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
        3) Lubricate equipment in accordance with manufacturer's instructions.
        4) Turn rotating equipment by hand when possible to confirm that equipment is not bound.
        5) Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
        6) Check power supply to electric-powered equipment for correct voltage.
        7) Adjust clearances and torque.
        8) Test piping for leaks and flush.
5. Ready-to-test determination will be by Contractor based at least on the following:
    a. Acceptable Operation and Maintenance Data.
    b. Notification by Subcontractor of equipment readiness for testing and completion of Precommissioning Checklist.
    c. Adequate completion of work adjacent to, or interfacing with, equipment to be tested.
    d. Availability and acceptability of manufacturer's representative, when specified, to assist in testing of respective equipment.
    e. Satisfactory fulfillment of other specified manufacturer's responsibilities.

f. Equipment and electrical tagging complete to the extent necessary to perform testing.

3.04 SYSTEMS TESTING

A. After successful completion of component testing, Contractor will conduct systems testing on unit processes. Unit processes will be defined by Contractor and will consist of distinct areas or processes or sub-processes within the Facility.

B. Subcontractor and Supplier will assist Contractor in performance of the System Tests. Assistance will include equipment adjustments and modifications as necessary to continue progress of Systems Test or corrective actions should significant interruption be experienced.

3.05 PERFORMANCE TESTING

A. Test equipment for proper performance at actual operating conditions when specified in individual equipment Sections.

B. When performance testing is specified in individual equipment Sections:

1. Ready-to-test determination will be by the Contractor.
2. Demonstrate equipment meets specified performance requirements.
3. Provide certified copies of test results.
4. Performance testing may be conducted concurrently or separately from other testing specified herein.

C. If Performance Testing for individual equipment or systems is able to be performed with the use of clean water while fully demonstrating that performance criteria can be met (i.e., prior to the actual production of drinking water), then Performance Testing may be completed prior to Substantial Completion when agreed upon with the Contractor prior to performing the testing.

3.06 ACCEPTANCE TESTING

A. After successful completion of component and systems testing of the Facility unit processes, Contractor will conduct the acceptance test for the Facility. The acceptance test will require 14 days of uninterrupted operation of the Facility while maintaining performance requirements of the Facility throughout the duration of the test.

B. Subcontractor and Supplier will assist Contractor in performance of the acceptance test. Assistance will include equipment adjustments and modifications, as necessary, to maintain uninterrupted operation during the acceptance test or corrective actions should interruptions be experienced requiring a restart of the Acceptance Test.

3.07 SUPPLEMENT

A. The supplement listed below, following "End of Section," is part of this specification.

1. Precommissioning Check List.

END OF SECTION

PRECOMMISSIONING CHECK LIST

AREA/SYSTEM: _____

The following activities should be checked and verified to document handover from construction to commissioning. Unsatisfactory items that are critical to performing testing safely must be corrected prior to handover. Unsatisfactory items that are not critical to performing testing must be documented in the handover punch list, and testing may commence.

Item	Yes	No	N/A	Initials	Date
General Verifications					
Construction complete per the P&IDs as required to commence testing: concrete complete, piping installed, pipe supports installed, equipment installed and powered, and instruments installed and powered. Note architectural components or other features that do not impact start up do not have to be completed.	☐	☐	☐		
Leak testing completed satisfactorily for all water holding basins.	☐	☐	☐		
Applicable O&M manuals reviewed, complete, and available onsite.	☐	☐	☐		
Area clean and safe for work.	☐	☐	☐		
Grating, safety rails, and walkways installed.	☐	☐	☐		
Lock-Out-Tag-Out is in place per FSI if required for mechanical or electrical isolation.	☐	☐	☐		
Mechanical Verifications					
Utilities are properly connected to commence testing: - Utility water - Potable water - Service air - HVAC - Safety showers - Natural gas	☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐		
Leak and pressure testing completed satisfactorily for all piping systems.	☐	☐	☐		
Leak testing completed for pneumatic controls and instrument air piping.	☐	☐	☐		
Flanges and gaskets tight and checked for leakage. Inspect screwed joints for leakage.	☐	☐	☐		
Screwed joints and mating devices checked for leakage.	☐	☐	☐		

Item	Yes	No	N/A	Initials	Date
Pipe supports and seismic bracing installed.	☐	☐	☐		
Downstream piping reviewed for potential water hammer during initial startup.	☐	☐	☐		
Low point drains connected to drain piping and routed to appropriate drainage collection system.	☐	☐	☐		
Hand valves in place, positioned for proper flow direction, and freely OPEN/CLOSE by hand.	☐	☐	☐		
Motor valves in place, positioned for proper flow direction, and freely OPEN/CLOSE by hand.	☐	☐	☐		
Air release valves and blowoff vents installed.	☐	☐	☐		
Rust preservatives, oils, and temporary protective coverings removed from equipment.	☐	☐	☐		
Lubrication/coolant flushed and recharged. Recharge only with lubricant recommended by manufacturer.	☐	☐	☐		
Fuel flushed, filled, and available.	☐	☐	☐		
Packing installed loose, seals, O-rings, and miscellaneous seals checked and adjusted.	☐	☐	☐		
Rotation direction arrows installed and pointing in correct direction.	☐	☐	☐		
Alignment to manufacturer's tolerances of equipment complete (only if alignment not completed by vendors).	☐	☐	☐		
Adjust V-belt tension and variable pitch sheaves.	☐	☐	☐		
Mounting apparatus, bolts, etc. properly installed and tightened. Temporary supports and other foreign objects removed.	☐	☐	☐		
Shaft guards installed (or available for installation during startup with manufacturer).	☐	☐	☐		
Safety devices and equipment are installed, fully functional, adjusted, and tested (or available for installation during startup with manufacturer).	☐	☐	☐		
Electrical/I&C Verifications					
Third party electrical tests and adjustments have been completed (insulation resistance, continuity, direct current high potential tests, etc.).	☐	☐	☐		
Power is available to equipment and instruments.	☐	☐	☐		
PLCs installed, wired, pulled, and terminated.	☐	☐	☐		
Fiber-optic Network installed and tested.	☐	☐	☐		
Point to point checks have been satisfactorily completed from the equipment/device to the PLC.	☐	☐	☐		

Item	Yes	No	N/A	Initials	Date
Commissioning Verifications					
Walkthrough with commissioning team has been completed.	☐	☐	☐		
Commissioning punch list items have been documented.	☐	☐	☐		
If any of the above are marked “NO”, provide explanation or comment and details of any agreed action:					
Comments:					
Certification: This document certifies that the construction and installation of the area/system and its associated equipment complies with the Specifications and Design-Build Agreement documents and that this area/system is ready to commence commissioning.					
Verified by Subcontractor:	Name:				
Date:	Signature:				
Approved by Commissioning Team:	Name:				
Date:	Signature:				

SECTION 03 30 10
STRUCTURAL REINFORCED CONCRETE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards (latest edition) which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 301, Specifications for Structural Concrete.
   b. 318, Building Code Requirements for Structural Concrete and Commentary.
   c. 347, Guide to Formwork for Concrete.
   d. 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   e. SP-66, Detailing Manual.
2. ASTM International (ASTM):
   a. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   b. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   c. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   d. C33, Standard Specification for Concrete Aggregates.
   e. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   f. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   g. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
   h. C150, Standard Specification for Portland Cement.
   i. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   j. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
   k. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   l. C311, Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete.
   m. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.

n. C595, Standard Specification for Blended Hydraulic Cements.
o. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
p. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
q. C1602/C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.

3. Concrete Reinforcing Steel Institute (CRSI):
   a. Manual of Standard Practice.
   b. Recommended Practice for Placing Reinforcing Bars.
4. National Institute of Standards and Technology (NIST): Handbook 44, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices.
5. National Ready Mixed Concrete Association (NRMCA).

1.02 DEFINITIONS

A. Defective Area: Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4 inch in diameter, cracks in containment structures and walls that are 0.010-inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections.

1.03 DESIGN REQUIREMENTS

A. Design formwork in accordance with ACI 347 and ACI 301 to provide specified concrete finishes.

B. When high range water reducer (superplasticizer) is used in concrete mix, forms shall be designed for full hydrostatic pressure per ACI 347.

C. Limit panel deflection to 1/240th of each component span to achieve tolerances specified.

1.04 SUBMITTALS

A. Action Submittals:

1. Reinforcing steel prepared in accordance with CRSI Manual of Standard Practice and ACI SP-66 Detailing Manual:
   a. Bending lists.
   b. Placing drawings.

2. Product Data: Admixtures, premolded joint filler, curing compound, and patching materials.
3. Design Data: Complete data on the concrete mix design, including tremie concrete mix design (if required), aggregate gradations, and admixtures, in accordance with ASTM C94.
4. Repair product data sheets for horizontal surface cracks epoxy resins for injection of cracks.
5. Manufacturer's recommended surface preparation procedures and application instructions for epoxy resins.
6. Mix Designs:
    a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
    b. Documentation of average strength for each proposed mix design in accordance with ACI 301.
    c. Manufacturer's Certificate of Compliance, for the following:
        1) Portland cement.
        2) Fly ash.
        3) Aggregates, including specified class designation for coarse aggregate.
        4) Admixtures.
        5) Concrete producer has verified compatibility of constituent materials in design mix.
    d. Admixtures: Manufacturer's catalog cut sheets and product data sheets for each admixture used in proposed mix designs.

B. Informational Submittals:

1. Manufacturer's application instructions for curing compound.
2. Repair System: Manufacturer's preparation and installation instructions.
3. Concrete Repair: written description of equipment proposed for concrete removal and surface preparation.
4. Ready-mix delivery tickets for each truck in accordance with ASTM C94/C94M.

1.05 QUALITY ASSURANCE

A. Concrete: Unless otherwise specified, meet the requirements of ACI 301 and ACI 318.

B. Repair System Applicator: Trained and experienced applicator endorsed by repair mortar system manufacturer.

C. Batch Plant: Currently certified by the National Ready Mixed Concrete Association.

D. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work.

E. Preinstallation Conference:

1. Required Meeting Attendees:
   a. Contractor, including pumping, placing and finishing, and curing subcontractors.
   b. Ready-mix producer.
   c. Admixture representative.
   d. Testing and sampling personnel.
   e. Engineer of Record.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Engineer of Record of location and time.
3. Agenda shall include:
   a. Admixture types, dosage, performance, and redosing at Site.
   b. Mix designs, test of mixes, and Submittals.
   c. Placement methods, techniques, equipment, consolidation, and form pressures.
   d. Slump and placement time to maintain slump.
   e. Finish, curing, and water retention.
   f. Protection procedures for weather conditions.
   g. Other specified requirements requiring coordination.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Unload, store, and handle bars in accordance with CRSI publication “Placing Reinforcing Bars.”

1.07 ENVIRONMENTAL REQUIREMENTS

A. Do not use curing compound where solvents in the curing compounds are prohibited by state or federal air quality laws.

PART 2 PRODUCTS

2.01 GENERAL

A. Products shall be in accordance with requirements of ACI 301 unless otherwise noted.

2.02 FORMWORK

A. Form Materials:

1. For exposed areas, use hard plastic finished plywood overlaid waterproof particle board, or steel in “new and undamaged” condition, of sufficient strength and surface smoothness to produce specified finish.
2. For unexposed areas, use new shiplap or plywood.

B. Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.

C. Form Ties:

1. Material: Steel.
2. Spreader Inserts:
   a. Conical or spherical type.
   b. Design to maintain positive contact with forming material.
   c. Furnish units that will leave no metal closer than 1.5 inches to concrete surface when forms, inserts, and tie ends are removed.
3. Wire ties not permitted.

2.03 CONCRETE

A. Ready-mixed: In accordance with ASTM C94/C94M, Option C.

B. Materials: Unless otherwise specified, in accordance with ACI 301.

1. Cementitious Materials:
   a. Portland Cement: ASTM C150, Type II.
2. Pozzolonic Mineral Admixture: ASTM C618, Class F. When fly ash is used, the minimum amount shall be 15 percent by weight of total cementitious materials, unless otherwise specified.
3. Aggregates: Furnish from one source.
   a. Natural Aggregates:
      1) Free from deleterious coatings and substances in accordance with ASTM C33, except as modified herein.
      2) Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.

b. Coarse Aggregate:
   1) Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
   2) Materials Passing 200 Sieve: 0.5 percent maximum.
   3) Limit deleterious substances in accordance with ASTM C33, Table 3 for exposed concrete.
c. Fine Aggregates:
   1) Clean, sharp, natural sand.
   2) Materials Passing 200 Sieve: 4 percent maximum.
   3) Limit deleterious substances in accordance with ASTM C33, Table 1 with material finer than 200 sieve limited to 3 percent, coal and lignite limited to 0.5 percent.
d. Mixing Water and Ice: In accordance with ASTM C1602/ C1602M, except maximum content of chloride ions shall be 500 ppm.
e. Admixtures: Furnish from one manufacturer.
   1) Characteristics: Compatible with each other and free of chlorides or other corrosive chemicals.
   2) Air-Entraining: ASTM C260.
   3) Water-Reducing: ASTM C494/C494M, Type A or Type D.
   4) Superplasticizers: ASTM C494/C494M, Type F or Type G.
   5) Fly Ash: ASTM C618, Class F.

C. Mix Design:

1. Select and proportion ingredients using trial batches; sample, cure and test concrete mix through approved independent testing laboratory in accordance with ACI 301.
2. Minimum Allowable 28-day Compressive Field Strength: 4,000 psi for containment floor slabs and 3,000 psi for foundation and equipment pads; when cured and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
3. Minimum Allowable 56-day Compressive Field Strength: 4,500 psi for containment floor slabs, when cured and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
4. Water-Cementitious Materials Ratio: 0.40, maximum for containment floor slabs and 0.45 for foundation and equipment pads.
5. Cementitious Content: Shall be in accordance with requirements of Table 4.1.2.9 of ACI 301.
6. Coarse Aggregate Size: 1 inch and smaller, unless noted otherwise.

7. Slump Range: 3 inches to 5 inches for concrete without superplasticizers; 4-1/2 inches to 8 inches for concrete with superplasticizers.
8. Air Content: 3 percent to 5 percent. Test in accordance with ASTM C231.
9. Water Reducers: Use in all concrete.
10. High Range Water Reducers (Superplasticizers): Use at Contractor's option.
11. Fly Ash: Use at Contractor's option. Maximum 25 percent, minimum 15 percent of total weight of fly ash plus cement.
12. Truck Mixers: For every truck, test slump of samples taken per ASTM C94/C94M. Where specified slump is more than 4 inches, and if slump tests differ by more than 2 inches, discontinue use of truck mixer unless causing condition is corrected and satisfactory performance is verified by additional slump tests.
13. Mixing: Minimum 70 and maximum 270 revolutions of mixing drum. Nonagitating equipment is not allowed.

2.04 REINFORCING STEEL

A. Deformed Steel Reinforcing Bars: ASTM A615/A615M, Grade 60 and ASTM A706/A706M, Grade 60, for reinforcing to be welded.

B. Fabrication: Follow CRSI Manual of Standard Practice.

2.05 ANCILLARY MATERIALS

A. Premolded Joint Filler:

1. Bituminous Type: ASTM D994 or ASTM D1751.

B. Tie Wire:

1. Black, soft-annealed 16-gauge wire.
2. Nylon-, epoxy-, or plastic-coated wire.

C. Bar Supports and Spacers:

1. Use precast concrete bar supports and side form spacers or wire bar supports over existing construction, unless noted otherwise.
2. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports.

D. Nonshrink Grout: BASF Building System, Inc., Shakopee, MN; Master Flow 928.

E. Tie Hole Patching:

1. Roughen surface in accordance with manufacturer's recommendation.
2. Product shall show no segregation.
3. Minimum strength at 1 day 4,000 psi.
4. Manufacturers and Products:
   a. Dayton Superior Corp., Kansas City, KS; Poly Fast LPL.
   b. Euclid Chemical Co., Cleveland, OH; Verticoat.
   c. Sika Corp., Lyndhurst, NJ; Sika Top 123 Plus.
   d. Or approved equal.

F. Curing Compound:

1. Water-based, high solids content nonyellowing curing compound meeting requirements of ASTM C309 except as noted below, or ASTM C1315.
   a. Moisture Loss: 0.40 kg per square meter per 72 hours maximum.
   b. Capable of meeting moisture retention at manufacturer's specified application rate.
2. Manufacturers and Products:
   a. BASF, Shakopee, MN; Masterkure.
   b. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
   c. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
   d. Vexcon Chemical, Inc., Philadelphia, PA; Starseal 1315.
   e. Dayton Superior; Safe Cure and Seal 30 Percent.
   f. Or approved equal.

2.06 HIGH EARLY STRENGTH REPAIR MORTAR

A. Repair of horizontal concrete surfaces.

B. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco T 415.

2.07 EPOXY INJECTION RESIN

A. Injection of concrete cracks in slab.

B. Products: BASF Construction Chemicals, LLC-Building Systems, Shakopee, MN; SCB Concresive Series products.

2.08 PATCHING MATERIAL

A. Polymer-modified, cementitious based, chloride resistant, flowable, gray in color, working time of 20 minutes minimum. Provide bonding agent as recommended by manufacturer.

B. Manufacturers and Products:

1. BASF Building Systems, Shakopee, MN; MBT P&R Emaco S66 CI.
2. Sika Corp., Lyndhurst, NJ; SikaTop - Series of Products.
3. Or approved equal.

2.09 SOURCE QUALITY CONTROL

A. Cement: Test for total chloride content.

B. Fly Ash: Test in accordance with ASTM C311.

C. Batch Plant Inspection: Construction Manager shall have access to and have right to inspect batch plants, cement mills, and supply facilities of suppliers, manufacturers, and Subcontractors, providing products included in these Specifications.

1. Weighing Scales: Tested and certified within tolerances set forth in the NIST Handbook No. 44.
2. Batch Plant Equipment: Either semiautomatic or fully automatic in accordance with ASTM C94/C94M.

PART 3 EXECUTION

3.01 GENERAL

A. Execution shall be in accordance with requirements of ACI 301 unless otherwise noted.

3.02 FORMWORK

A. Form Construction:

1. Construct forms and provide smooth-form finish in accordance with ACI 301 and ACI 347.
2. Form 3/4-inch bevels at concrete edges, unless otherwise shown. Do not bevel tops of wall.
3. Make joints tight to prevent escape of mortar and to avoid formation of fins.
4. Brace as required to prevent distortion during concrete placement.

5. On exposed surfaces locate form ties in uniform pattern or as shown.
6. Construct so ties remain embedded in the member with no metal within 1 inch of concrete surface when forms, inserts, and tie ends are removed.

B. Form Removal:

1. Nonsupporting forms (walls and similar parts of Work) may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:
   a. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
   b. Curing and protection operations are maintained.
2. Remove forms with care to prevent scarring and damaging the surface.
3. Prior to form removal, provide thermal protection for concrete being placed.

3.03 PLACING REINFORCING STEEL

A. Unless otherwise specified, place reinforcing steel in accordance with CRSI Recommended Practice for Placing Reinforcing Bars.

B. Splices and Laps:

1. Top Bars: Horizontal bars placed such that 12 inches of fresh concrete is cast below in single placement.
2. Lap Splice Reinforcing: Per structural notes on Drawings.
3. Tie splices with 16-gauge annealed wire as specified in CRSI Standard.

3.04 PLACING CONCRETE

A. Prior to placing concrete, remove water from surface, and debris and foreign material from forms. Check reinforcing steel for proper placement and correct discrepancies.

B. Before depositing new concrete on old concrete, clean surface using sandblast or bushhammer or other mechanical means to obtain a 1/4-inch rough profile.

C. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 2 feet deep. Place within 1-1/2 hours after adding cement to mix.

D. Do not subject concrete to any procedure that will result in segregation. Three feet maximum vertical drop to final placement, when not guided with chutes or other devices to prevent segregation due to impact with reinforcing.

3.05 CONSOLIDATION

A. Vibrate concrete as follows:

1. Consolidate concrete with internal vibrators with a minimum frequency of 8,000 cycles per minute and amplitude required to consolidate being placed.
2. Apply approved vibrator at points spaced not farther apart than vibrator's effective radius.
3. Apply close enough to forms to vibrate surface effectively but not damage form surfaces.
4. Vibrate until concrete becomes uniformly plastic.
5. Vibrator must penetrate fresh placed concrete and into previous layer of fresh concrete below.

3.06 CONSTRUCTION JOINTS

A. Locate as shown or as approved.

3.07 PREMOLDED JOINT FILLER INSTALLATION

A. Sufficient in width to completely fill joint space where shown.

B. Drive nails approximately 1 foot 6 inches on center through filler, prior to installing, to provide anchorage embedment into concrete during concrete placement.

C. Secure premolded joint filler in forms before concrete is placed.

3.08 FINISHING

A. Exterior Slabs and Sidewalks:

1. Bull float with wood float, wood trowel, and lightly trowel with steel trowel.
2. Finish with broom to obtain nonskid surface.
3. Finish exposed edges with steel edging tool.
4. Mark sidewalks transversely at 5-foot intervals with jointing tool.

3.09 FINISHING AND PATCHING FORMED SURFACES

A. Fill form tie holes with an approved patching material.

B. Knock off projections exceeding 1/2 inch in height.

C. Leave surface with texture imparted by the forms.

D. Cut out honeycombed and defective areas.

E. Cut edges perpendicular to surface at least 1 inch deep. Do not feather edges. Soak area with water for 24 hours.

F. Patch with polymer-modified repair material. Follow manufacturer's application instructions.

G. Finish surfaces to match adjacent concrete.

H. Keep patches damp for minimum spray with curing compound to minimize shrinking.

3.10 PROTECTION AND CURING

A. Protect fresh concrete from direct rays of sunlight, drying winds, and wash by rain.

B. Keep concrete slabs continuously wet for a 7-day period. Intermittent wetting is not acceptable.

C. Water curing the floor slabs.

D. Cure formed surfaces with curing compound applied in accordance with manufacturer's directions as soon as forms are removed and finishing is completed.

E. Remove and replace concrete damaged by freezing.

3.11 HORIZONTAL SURFACE CRACK REPAIRS

A. Per manufacturer's instructions.

3.12 INJECTION OF EPOXY RESIN

A. Per manufacturer's instruction.

3.13 NONSHRINK GROUT

A. Per grout manufacturer's instructions.

3.14 FIELD QUALITY CONTROL

A. General:

1. Provide adequate facilities for safe storage and proper curing of concrete test cylinders onsite for first 24 hours, and for additional time as may be required before transporting to test lab.
2. Provide concrete for testing of slump, air content, and for making cylinders from the point of discharge into forms. When concrete is pumped, Samples used shall be taken from discharge end of pump hose.
3. Evaluation will be in accordance with ACI 301 and Specifications.
4. Specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
5. Frequency of testing may be changed at discretion of Construction Manager.
6. Pumped Concrete: Take concrete samples for slump (ASTM C143/ C143M) and test cylinders (ASTM C31/C31M and ASTM C39/C39M).
7. Reject concrete represented by cylinders failing to meet strength and air content specified.

B. Concrete Strength Test:

1. Unless otherwise specified, one specimen at age of 7 days for information, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance.
2. Concrete with specified 56-day strength, test one specimen at age of 7 days for information, two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 56 days for acceptance. Should results of 28-day tests meet specified requirement for 56-day strength, 56-day tests will not be required.
3. If result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing by 7 additional days.
4. Provide a minimum of one spare test specimen per sample. Test spare cylinder as directed by Construction Manager.

C. High Range Water Reducer (Superplasticizer) Admixture Segregation Test: Test each truck prior to use on job.

1. Segregation Test Objective: Concrete with 4-inch to 8-inch slump must stay together when slumped. Segregation is assumed to cause mortar to flow out of mix even though aggregate may stay piled enough to meet slump test.
2. Test Procedure: Make slump test and check for excessive slump and observe to see if mortar or moisture flows from slumped concrete.
3. Reject concrete if mortar or moisture separates and flows out of mix.

END OF SECTION

SECTION 09 90 00
PAINTING AND COATING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
   a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines—Enamel and Tape—Hot-Applied.
   b. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
   c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
2. Environmental Protection Agency (EPA).
3. NACE International (NACE): SP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. NSF International (NSF): 61, Drinking Water System Components - Health Effects.
5. Occupational Safety and Health Act (OSHA).
6. Research Council on Structural Connections (RCSC): Specification for Structural Joints using High-Strength Bolts.
7. The Society for Protective Coatings (SSPC):
   a. PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements.
   b. PA 10, Guide to Safety and Health Requirements for Industrial Painting Projects.
   c. SP 1, Solvent Cleaning.
   d. SP 2, Hand Tool Cleaning.
   e. SP 3, Power Tool Cleaning.
   f. SP 5, White Metal Blast Cleaning.
   g. SP 6, Commercial Blast Cleaning.
   h. SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
   i. SP 10, Near-White Blast Cleaning.
   j. SP 11, Power Tool Cleaning to Bare Metal.
   k. SP 13, Surface Preparation of Concrete.
   l. SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.

m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.

1.02 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. HCl: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness, mils.
5. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
6. Mil: Thousandth of an inch.
7. PPDS: Paint Product Data Sheet.
8. PSDS: Paint System Data Sheet.
9. PVC: Polyvinyl Chloride.
10. SFPG: Square Feet per Gallon.
11. SFPGPC: Square Feet per Gallon per Coat.
12. SP: Surface Preparation.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Data Sheets:
      1) For each product, furnish a Paint Product Data Sheet (PPDS), the manufacturer’s technical data sheets, and paint colors available (where applicable). The PPDS form is appended to the end of this section.
      2) For each paint system, furnish a Paint System Data Sheet (PSDS). The PSDS form is appended to the end of this section.
      3) Technical and performance information that demonstrates compliance with specification.
      4) Furnish copies of paint system submittals to the coating applicator.
      5) Indiscriminate submittal of only manufacturer’s literature is not acceptable.
   b. Detailed chemical and gradation analysis for each proposed abrasive material.

2. Samples:
    a. Proposed Abrasive Materials: Minimum 5-pound sample for each type.
    b. Reference Panel:
        1) Surface Preparation:
            a) Prior to start of surface preparation, furnish a 4-inch by 4-inch steel panel for each grade of sandblast specified herein, prepared to specified requirements.
            b) Provide panel representative of the steel used; prevent deterioration of surface quality.
            c) Panel to be reference source for inspection upon approval by Engineer.

B. Informational Submittals:

1. Applicator's Qualification: List of references substantiating experience.
2. Coating manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
4. Manufacturer's written verification that submitted material is suitable for the intended use.
5. Coating for Faying Surfaces: Manufacturer's test results that show the proposed coating meets the slip resistance requirements of the AISC Specification for Structural Joints using ASTM A325 or ASTM A490 bolts.
6. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
7. Manufacturer's written instructions and special details for applying each type of paint.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
2. Perform surface preparation and painting in accordance with recommendations of the following:
    a. Paint manufacturer's instructions.

b. SSPC PA 10.
c. Federal, state, and local agencies having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.

B. Storage:

1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.

1.06 PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.

B. Minimum of 5 years' verifiable experience in manufacture of specified product.

C. Each of the following manufacturers is capable of supplying most of the products specified herein:

1. Sherwin-Williams.

2. PPG.

2.02 ABRASIVE MATERIALS

A. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

A. General:

1. Manufacturer's highest quality products suitable for intended service.
2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

B. Products:

Product	Definition
Acrylic Latex (Flat)	Flat latex
Alkyd Enamel	Optimum quality, gloss or semigloss finish as required, medium long oil
Alkyd Wood Primer	Flat alkyd
Bituminous Paint	Single-component, coal-tar pitch based
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type 70% volume solids minimum, suitable for immersion service
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, nonshrinking, suitable for application to concrete and masonry. Approved for potable water contact and conforming to NSF 61, where required
Epoxy Primer—Ferrous Metal	Anticorrosive, converted epoxy primer containing rust-inhibitive pigments

Product	Definition
Epoxy Primer—Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish

2.04 MIXING

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

2.05 SHOP FINISHES

A. Shop Blast Cleaning: Reference Paragraph Shop Coating Requirements.

B. Surface Preparation: Provide Engineer minimum 7 days' advance notice to start of shop surface preparation work and coating application work.

C. Shop Coating Requirements:

1. When required by equipment specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of

equipment manufacturer's standard coating with field coating manufacturer.

D. Pipe:

1. Ductile Iron Pipe:
   a. Use SSPC standards as a guide for desired prepared surface. Follow recommendations of pipe and coating manufacturers for means and methods to achieve SSPC-equivalent surface.
   b. The surface preparation and application of the primer shall be performed by pipe manufacturer.
   c. For high performance (epoxy) coatings, follow additional recommendations of pipe and coating manufacturers.
   d. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.
2. Steel Pipe:
   a. Surface preparation and application of primer and finish coats shall be performed by pipe manufacturer.
   b. For pipe with epoxy lining, do not place end cap seals until pipe lining material has sufficiently dried.

PART 3 EXECUTION

3.01 GENERAL

A. Provide Engineer minimum 7 days' advance notice to start of field surface preparation work and coating application work.

B. Perform the Work only in presence of Engineer, unless Engineer grants prior approval to perform the Work in Engineer's absence.

C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.

3.02 EXAMINATION

A. Factory Finished Items:

1. Schedule inspection with Engineer before repairing damaged factory-finished items delivered to Site.
2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.

B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering.

E. Protect surfaces adjacent to or downwind of Work area from overspray.

3.04 SURFACE PREPARATION

A. Metal Surface Preparation:

1. Where indicated, meet requirements of SSPC Specifications summarized below:
    a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
    b. SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
    c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.
    d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
    e. SP 6, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations

caused by stains of rust, stains of mill scale, or stains of previously applied coatings.

f. SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.

g. SP 10, Near-White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.

h. SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power-assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.

i. SP 16, Brush Blasting of Non-Ferrous Metals: A brush-off blast cleaned non-ferrous metal surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, metal oxides (corrosion products), and other foreign matter. Intact, tightly adherent coating is permitted to remain. A coating is considered tightly adherent if it cannot be removed by lifting with a dull putty knife. Bare metal substrates shall have a minimum profile of 19 micrometers (0.75 mil).

2. The words “solvent cleaning,” “hand tool cleaning,” “wire brushing,” and “blast cleaning,” or similar words of equal intent in these Specifications or in paint manufacturer’s specification refer to the applicable SSPC Specification.
3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers’ recommendations for wet blast additives and first coat application shall apply.
4. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.
5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
7. Welds and Adjacent Areas:
   a. Prepare such that there is:
      1) No undercutting or reverse ridges on weld bead.

2) No weld spatter on or adjacent to weld or any area to be painted.
3) No sharp peaks or ridges along weld bead.

b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

8. Preblast Cleaning Requirements:
   a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
   b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
   c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.
9. Blast Cleaning Requirements:
   a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
   b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
   c. Use only dry blast cleaning methods.
   d. Do not reuse abrasive, except for designed recyclable systems.
   e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
10. Post-Blast Cleaning and Other Cleaning Requirements:
   a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
   b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

B. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation:

1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
2. Brush blast in accordance with SSPC SP 16.
3. Obtain and follow coating manufacturer's recommendations for additional preparation that may be required.

C. Concrete Surface Preparation:

1. Do not begin until 30 days after concrete has been placed.
2. Meet requirements of SSPC SP 13.
3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
4. Brush-off blast clean to remove loose concrete and laitance, and provide a tooth for binding. Upon approval by Engineer, surface may be cleaned by acid etching method. Approval is subject to producing desired profile equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces shall not be allowed.
5. Secure coating manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
6. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

D. Wood Surface Preparation:

1. Replace damaged wood surfaces or repair in a manner acceptable to Engineer prior to start of surface preparation.
2. Solvent clean (mineral spirits) knots and other resinous areas and coat with shellac or other knot sealer, prior to painting. Remove pitch by scraping and wipe clean with mineral spirits or turpentine prior to applying knot sealer.
3. Round sharp edges by light sanding prior to priming.
4. Filler:
    a. Synthetic-based wood putty approved by paint manufacturer for paint system.
    b. For natural finishes, color of wood putty shall match color of finished wood.
    c. Fill holes, cracks, and other surface irregularities flush with surrounding surface and sand smooth.
    d. Apply putty before or after prime coat, depending on compatibility and putty manufacturer's recommendations.
    e. Use cellulose type putty for stained wood surfaces.
5. Ensure surfaces are clean and dry prior to painting.

E. Existing Painted Surfaces to be Repainted Surface Preparation:

1. Detergent wash and freshwater rinse.
2. Clean loose, abraded, or damaged coatings to substrate by hand or power tool, SP 2 or SP 3.
3. Feather surrounding intact coating.

4. Apply one spot coat of specified primer to bare areas, overlapping prepared existing coating.
5. Apply one full finish coat of specified primer to entire surface.
6. If an aged, plural-component material is to be topcoated, contact coating manufacturer for additional surface preparation requirements.
7. Application of Cosmetic Coat:
    a. It is assumed that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified.
    b. Check compatibility by application to a small area prior to starting painting.
    c. If lifting or other problems occur, request disposition from Engineer.
8. Perform blasting as required to restore damaged surfaces. Materials, equipment, procedures shall meet requirements of SSPC.

3.05 SURFACE CLEANING

A. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
6. Repair or replace surface damaged by blast cleaning.

B. Acid Etching:

1. After precleaning, spread the following solution by brush or plastic sprinkling can: One part commercial muriatic acid reduced by two parts water by volume. Adding acid to water in these proportions gives an approximate 10 percent solution of HCl.
2. Application:
    a. Rate: Approximately 2 gallons per 100 square feet.
    b. Work acid solution into surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.
    c. Acid will react vigorously for a few minutes, during which time brushing shall be continued.

d. After bubbling subsides (10 minutes), hose down remaining slurry with high pressure clean water.
e. Rinse immediately to avoid formation on the surface of salts that are difficult to remove.
f. Thoroughly rinse to remove any residual acid surface condition that may impair adhesion.

3. Ensure surface is completely dry before application of coating.
4. Apply acid etching to obtain a “grit sandpaper” surface profile. If not, repeat treatment.

C. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
2. Meet requirements of SSPC SP 1.

3.06 APPLICATION

A. General:

1. The intention of these Specifications is for new, interior and exterior wood, concrete, and metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.
2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
3. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer’s written instructions for these requirements. Do not immerse coating until completion of curing cycle.
4. Apply coatings in accordance with these Specifications and paint manufacturers’ printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
5. Sand wood lightly between coats to achieve required finish.
6. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
7. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
8. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.

9. Water-Resistant Gypsum Board: Use only solvent type paints and coatings.
10. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
11. Keep paint materials sealed when not in use.
12. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.

B. Galvanized Metal, Copper, and Nonferrous Metal Alloys:

1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
2. Prepare surface and apply primer in accordance with System No. 10 specification.
3. Apply intermediate and finish coats of the coating system appropriate for the exposure.

C. Porous Surfaces, Such as Concrete and Masonry:

1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
   a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

D. Film Thickness and Coverage:

1. Number of Coats:
   a. Minimum required without regard to coating thickness.
   b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
2. Application Thickness:
   a. Do not exceed coating manufacturer's recommendations.
   b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
   a. Perform with properly calibrated instruments.

b. Recoat and repair as necessary for compliance with specification.
c. Coats are subject to inspection by Engineer and coating manufacturer's representative.

4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.
6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.07 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work.

B. System No. 5 Exposed Metal—Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer—Ferrous Metal	1 coat, 2.5 MDFT
	Polyurethane Enamel	1 coat, 3 MDFT

1. Use on the following items or areas:
   a. Exposed metal surfaces located inside or outside of structures and exposed to weather and the following specific surfaces:
      1) Interior Structural Steel.
      2) Exterior and Interior Bollards.

C. System No. 10 Galvanized Metal, Copper, and Nonferrous Metal Alloy Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Epoxy Primer—Other	As recommended by coating manufacturer Remaining coats as required for exposure

1. Use on the following items or areas:
   a. Galvanized surfaces requiring painting.
   b. After application of System No. 10, apply finish coats as required for exposure.

D. System No. 22 Chemical-Resistant Wall, Heavy-Duty—Concrete:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Epoxy Filler/Surfacer	1 coat as required to fill voids and smooth surface; apply to 100 percent of surface.
	High Build Epoxy	1 coat, 160 SFPG
	High Build Epoxy, Gloss	1 coat, 160 SFPG

1. Use on the following items or areas:
   a. Sump and trench walls and floors.

E. System No. 27 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with manufacturer's recommendations	
	Bituminous Paint	1 coat, 10 MDFT

1. Use on aluminum surfaces embedded or in contact with concrete or dissimilar metals.

3.08 ARCHITECTURAL PAINT SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown on Drawings or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

B. System No. 103 Wood, Flat (Interior or Exterior):

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Wood Surface Preparation	Alkyd Wood Primer	1 coat, 400 SFPG
	Acrylic Latex (Flat)	2 coats, 350 SFPGPC

1. Use on the following items or areas:
   a. Wood Siding and Trim of Pump Control Building.
      1) Color to be selected by Owner.

C. System No. 106 Galvanized Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Manufacturer's Recommended Primer	1 coat, as recommended by manufacturer
	Alkyd Enamel (Semigloss)	2 coats, 4 MDFT

1. Use on the following items or areas:
   a. Hollow metal frames and doors.
   b. Overhead Coiling doors that are not factory finished.

3.09 COLORS

A. Provide as selected by Owner or Engineer.

B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

3.10 FIELD QUALITY CONTROL

A. Testing Equipment:

1. Provide calibrated electronic type dry film thickness gauge to test coating thickness specified in mils.
2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.
3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.

B. Testing:

1. Thickness and Continuity Testing:
   a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
   b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE SP0188.
   c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE SP0188.
   d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.

C. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.

D. Unsatisfactory Application:

1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
3. Repair defects in accordance with written recommendations of coating manufacturer.

E. Damaged Coatings, Pinholes, and Holidays:

1. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
2. Remove rust and contaminants from metal surface. Provide surface cleanliness and profile in accordance with surface preparation requirements for specified paint system.
3. Feather edges and repair in accordance with recommendations of paint manufacturer.
4. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.11 MANUFACTURER'S SERVICES

A. In accordance with Section 01 43 33, Manufacturers' Field Services, coating manufacturer's representative shall be present at Site as follows:

1. On first day of application of any coating system.
2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
3. As required to resolve field problems attributable to or associated with manufacturer's product.
4. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.12 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.

B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.

C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.13 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Paint System Data Sheet (PSDS).
2. Paint Product Data Sheet (PPDS).

END OF SECTION

PAINT SYSTEM DATA SHEET (PSDS)

Complete this PSDS for each coating system, include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PSDS.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number (Proprietary)**	**Min. Coats, Coverage**

PAINT PRODUCT DATA SHEET (PPDS)

Complete and attach manufacturer's Technical Data Sheet to this PPDS for each product submitted. Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio: _____

Maximum Permissible Thinning: _____

Ambient Temperature Limitations: min.: _____ max.: _____

Surface Temperature Limitations: min.: _____ max.: _____

Surface Profile Requirements: min.: _____ max.: _____

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.

SECTION 13 34 19
METAL BUILDING SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Architectural Manufacturers' Association (AAMA):
   a. 101, Standard Specifications for Windows, Doors, and Unit Skylights.
   b. 605, Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.
   c. 606.1, Voluntary Guide Specifications and Inspection Methods for Integral Color Anodic Finishes for Architectural Aluminum.
2. American Institute of Steel Construction (AISC):
   a. 360, Specification for Structural Steel Buildings.
   b. RCSC Specification for Structural Joints Using ASTM A325 or A490 Bolts.
   c. Design Guide 3: Serviceability Design Considerations for Steel Buildings.
3. American Iron and Steel Institute (AISI): Specification for the Design of Cold-Formed Steel Structural Members.
4. American Welding Society (AWS): D1.1/D1.1M, Structural Welding Code - Steel.
5. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   c. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
   d. A490/A490M, Standard Specification for Structural Bolts, Alloy Steel, Heat-Treated, 150 ksi Minimum Tensile Strength.
   e. A529/A529M, Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality.
   f. A572/A572M, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
   g. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   h. A792/A792M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

i. A992/A992M, Standard Specification for Steel for Structural Shapes.
j. C991, Standard Specification for Flexible Fibrous Glass Insulation for Metal Buildings.
k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
l. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
m. E2190, Standard Specification for Insulating Glass Unit Performance and Evaluation.
n. E1514, Standard Specification for Structural Standing Seam Steel Roof Panel Systems.
o. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

6. International Accreditation Service, Inc. (IAS): Quality Certification Program.
7. International Code Council (ICC): International Building Code (IBC).
8. Metal Building Manufacturer's Association (MBMA): Metal Building Systems Manual.
9. Steel Door Institute (SDI): A250.8, Standard Steel Doors and Frames.
10. UL: 580, Tests for Uplift Resistance of Roof Assemblies.

1.02 SYSTEM DESCRIPTION

A. Complete building package using manufacturer's standard components.

B. Primary Framing System: Clear span rigid frame.

C. Lateral Support System in Longitudinal Direction: Cross bracing, located as shown on Drawings.

D. Include: Doors, louvers, insulation, and roof accessories.

1.03 DESIGN REQUIREMENTS

A. Applicable Building Code: The 2015 International Building Code (IBC), as amended by the State of Washington and local agencies. Refer to the Drawing No. 000 – S – 001, Structural General Notes for Design Criteria.

B. Additional loads suspended from roof structures and walls are indicated in the Mechanical, HVAC, and Electrical Drawings.

C. Deflection Criteria:

1. In accordance with AISC Design Guide 3 recommendations. Conformance is required to deflection criteria as stated in the Appendix.
2. Applies to primary and secondary framing members, bracing members, roof panels, and wall cladding.

D. Design Standards:

1. AISC 360.
2. AISC RCSC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts.
3. AISI Specification for the Design of Cold-Formed Steel Structural Members.
4. AWS D1.1/D1.1M.

E. Consider prying action of bolts for bolted moment-resistant connections in primary framing.

F. Design column bases as pinned, unless specifically indicated otherwise.

1.04 SUBCONTRACTOR/METAL BUILDING MANUFACTURER COORDINATION

A. Submit metal building shop drawings and obtain approval prior to forming foundation concrete or fabricating foundation reinforcing steel. Confirm size of concrete column pilasters for steel column baseplates and its associated anchor bolt template.

B. Verify interface of building components with foundation and coordinate required foundation revisions with Engineer.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer’s literature and technical data.
   b. Drawings Stamped by Designer:
      1) Drawings shall be specifically prepared for this Project.
      2) Mark out details that do not apply to Project.
      3) Show design load criteria, material specifications for framing members and connections, roof framing plan with dimensions and member sizes, baseplate details showing anchor bolt size and bolt layout, elevations of wall framing

and bracing, instructions for temporary bracing, framing around roof and wall openings, details for joining and sealing of roof panels and wall cladding, and sections and details for all components and accessories.

c. Anchorage and bracing drawings, as required by Section 01 88 15, Anchorage and Bracing.

d. Painting System: Specifications; include paint manufacturer's name, product trade name, and preparation for shop and field coats.

2. Samples: Minimum 2-inch by 3-inch metal for components requiring color selection.

B. Informational Submittals:

1. Structural Calculations Stamped by Designer:
   a. Complete analysis and design of structural components and connections in accordance with design requirements indicated.
   b. Summary of building column reactions to foundation level for load cases.
   c. Mark out calculations that do not apply to Project.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Manufacturer's written instructions for shipping, handling, storage, protection, and erection or installation of building and components.
4. Manufacturer: IAS Quality Certification: IAS certificate showing name and address of manufacturer, effective date, and category of certification.
5. Erector:
   a. IAS Quality Certification: IAS certificate showing name and address of erector, effective date, and category of certification, or, in lieu of IAS certification, documentation of past 5 years' experience record to include project name, location, date of completion, building manufacturer, and name and phone number of Owner's contact person.
   b. Certification of approval by manufacturer.
6. Manufacturer's Certificate of Proper Installation.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Designer: Registered professional engineer valid in same state as Project.
2. Manufacturer: IAS Quality Certification: Metal Building Systems (MB).

3. Erector:
   a. IAS Quality Certification as Certified Steel Erector (CSE), or 5 years of experience in erection of metal building systems in lieu of IAS certification.
   b. Approval by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect building components and accessories from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Deliver to Site with parts individually tagged.

C. Store on wood blocking or pallets, flat and off ground, to keep clean and to prevent damage or permanent distortion. Support bundles so there is no danger of tipping, sliding, rolling, shifting, or material damage. Cover with tarpaulins or other suitable weathertight ventilated covering.

D. Protect finish of metal panels by application of removable plastic film or other suitable material placed between panels. Do not allow panels to come in contact with other material that would result in scratching, denting, staining or other damage to panel finish.

1.08 SPECIAL GUARANTEE

A. Furnish manufacturer’s extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of Owner, removal and replacement of Work specified in this Specification section found defective during a minimum period of 5 years and as stated below after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work.

B. Conditions:

1. Finish on metal roof, wall panels, flashing, and trim will not chalk, crack, check, blister, peel, flake, chip, or lose adhesion for 5 years.
2. Roofing will remain weathertight for 20 years.

PART 2 PRODUCTS

2.01 BUILDING SYSTEM MANUFACTURERS

A. Products manufactured or supplied by the following, and meeting these Specifications, may be used on this Project:

1. Butler Manufacturing Co., Kansas City, MO.
2. Garco Building Systems, Airway Heights, WA.
3. Varco-Pruden Buildings, Memphis, TN.

B. Building layout as shown on Drawings is based on products of Butler Manufacturing Co.

2.02 COMPONENTS

A. Structural Framing and Bracing:

1. Primary Framing: ASTM A36/A36M, ASTM A529/A529M, ASTM A572/A572M, or ASTM A992 with 3/16-inch minimum thickness and factory primer compatible with finish coating.
2. Secondary Framing: Steel for cold-formed galvanized channel and z-sections shall be ASTM A653/A653M, Structural Steel (SS) Grade 33 or High-Strength Low-Alloy Steel (HSLAS) Grade 50 Type A or B, with G60 galvanized coating and minimum design thickness equal to 0.0346 inch.
3. Bracing:
   a. ASTM A36/A36M or ASTM F1554, Grade 36, for threaded rod, or ASTM A36/A36M for rolled shapes.
   b. Do not use wire rope or cable for permanent bracing.
4. Bolted Connections:
   a. Primary Framing: ASTM A325 or ASTM A490/A490M high-strength bolted connections.
   b. Secondary Framing: ASTM A307 or ASTM A325.

B. Roof and Wall Panels:

1. Material:
   a. ASTM A653/A653M or ASTM A792/A792M preformed ribbed steel panels.
      1) Butler; MR24, or approved equal.
   b. Minimum 24-gauge galvanized steel with roll-formed corrugations for structural stiffness and appearance.

c. Finish: Factory-applied baked enamel, in color selected by Engineer.

2. Roof Panel System:
   a. ASTM E1514 structural standing seam steel roof panel system.
   b. Panels: One piece from eave to ridge, with concealed clips and fasteners to purlins to allow for thermal movement over 120-degree ambient temperature range.
   c. Sidelap Joints: Fabricate with a factory caulked, mechanically seamed cleat.
   d. Tested and certified to meet UL 580, Class 90 wind uplift rating.
3. Wall Panel System:
   a. One piece from eave to sill, with base trim at sill.
   b. Sidelaps: Interlocking ribs with concealed fasteners.
      1) 26-gallon eShadowwall® siding by Butler, or approved equal.

2.03 ACCESSORIES

A. Hollow Metal Doors, Frames, and Hardware:

1. Furnish 14-gauge pressed steel frames and 16-gauge full flush hollow metal doors meeting SDI A250.8, Grade II, Model 1.
   a. Foam Insulation Core: Minimum R-4.
2. Furnish hardware including hinges, panic hardware with lock sets, automatic closing devices, full weatherstripping, and thresholds.
   a. Hinge:

No.	Type Description	Stanley	Mc-Kinney	Lawrence	BHMA
H1	Regular weight, two ball-races, full mortise, stainless steel	FBB191-32D	TB2314	BB4101-32D	A5112

   b. Lock:

No.	Type Description	
L16	Lock by exit device manufacturer; furnish cylinders for keying to other locks as required	Key Locks as directed by Owner

c. Panic Hardware:

No.	Type Description	Sargent	VonDuprin	BHMA
X1	Rim type, active leaf; with removable mullion for pairs	8813ETJ	99L	Type 108

d. Closer:

No.	Type Description	LCN	Sargent	BHMA
C4	Parallel arm with integral stop	4110 Cush-N-Stop Series	351-PS Series	C02021

e. Threshold:

No.	Type Description	Pemko	Reese
T2	Saddle (serrated, 4" x 1/4")	270A	S404A

f. Weatherstripping:

No.	Type Description	Pemko	Reese
W1	Rubber or vinyl bulb at jambs and head, and at meeting stiles of pairs	S88D	797B
	Door shoe	222DV	DB596DF
	Rain drip	346D	R201D

B. Roll-Up Doors: Furnish insulated formed interlocking galvanized steel slats chemically treated for paint adherence.

1. Design to resist specified wind loads.
2. Curtain: Insulated slat curtain, coiled on pipe of sufficient size to carry door load.
3. Counterbalance with helical springs contained in pipe.
4. House coil in sheet metal hood with internal weatherstripping.
5. Construct door with suitable opening and closing action, steel track, and ball bearing rollers.
6. Furnish accessories and fasteners required for a complete installation to include inside locking device.
7. Operation: Manual Chain operation.
8. Thermal Resistance: Minimum R-8.
9. Air Infiltration Rate: Less than 1.0 cfm per square foot.

C. Fixed Louvers:

1. Material: 20-gauge galvanized steel Storm Proof Louver; factory finish to match wall panels.
2. Free Airflow: Minimum 50 percent.
3. Weather Projection: 60 percent or more.
4. Insect Screen: Manufacturer's standard 14 mesh to 18 mesh.

D. Metal Building Blanket Insulation:

1. Wall Insulation: ASTM C991, Type II, glass fiber batt insulation with white vinyl vapor barrier backing having a Water Vapor Permeance Rating of 0.1 maximum, ASTM E96/E96M, Procedure A.
   a. Average U-value of wall system shall be U 0.052.
2. Roof Insulation: ASTM C991, Type II, glass fiber batt insulation with white vinyl vapor barrier backing having a Water Vapor Permeance Rating of 0.1 maximum, ASTM E96/E96M, Procedure A.
   a. Average U-value of roof system shall be U 0.031.
3. Flame Spread: ASTM E84, less than 25.

E. Thermal Blocks: High-density, 3/4-inch-thick extruded polystyrene, for installation over structural framing members.

F. Trim: Factory-formed and factory-painted ridge cap, rake trim, simple eave trim, panel side trim, corner trim, door trim, and other trim as necessary.

G. Gutter Fascia and Downspouts:

1. Material: ASTM A653/A653M, 26-gauge galvanized steel.
2. Gutter Fascia:
   a. Prefinish.
   b. Furnish hangers with factory-applied paint.
3. Preformed Corner Closures: Furnish to match configuration of gable fascia.
4. Downspouts:
   a. Configuration: Nominal 4-inch corrugated rectangular box with minimum 11 square inches of cross section area.
   b. Factory finish to match wall panels.

H. Miscellaneous: Furnish fasteners, metal-backed neoprene washers, weatherstripping, sealants, roof jacks, roof curbs, gaskets, and other items as required for a complete installation.

2.04 FABRICATION

A. Factory Fabricate: To manufacturer's written standards, MBMA Metal Building Systems Manual, and AISC Specification for Structural Steel Buildings.

B. Building Parts: Accurate and true to dimension to facilitate building erection without cutting, fitting, or other alterations.

C. Welded Connections: In accordance with AWS D1.1/D1.1M.

D. Shop Primer for Primary Framing:

1. Surface Preparation and Primer: As specified in Section 09 90 00, Painting and Coating.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine supporting concrete foundation and anchor bolt placement for compliance with requirements for installation tolerances and other conditions affecting performance of metal building.

3.02 BUILDING ERECTION

A. Erect building system in accordance with manufacturer's standards and instructions.

B. Provide temporary bracing in accordance with MBMA standards and as required for safe installation.

C. Structural Framing:

1. Do not field cut or alter primary or secondary framing members.
2. Installation and Tolerances: In accordance with MBMA Metal Building Systems Manual.

D. Roof and Wall Panels:

1. Field cutting of panels by torch is not permitted.
2. Attach panels to structural supports to maintain a weathertight seal while allowing for thermal and structural movement.
   a. Install exposed fasteners in true vertical and horizontal alignment.

b. Field seam side laps of standing seam roof panels using electrically operated seaming machine.
c. Use proper tools to install screw fasteners to compress neoprene washer without damaging washer or stripping metal.

3. Install manufacturer's standard joint sealants, gaskets, and closure strips as required for weathertight installation.
4. Install roof curbs for roof top equipment.
5. Field Cutting and Patching: Perform in manner not to impair appearance, weathertightness, or structural capacity of panel system.

3.03 REPAIR, CLEANING, AND PAINTING

A. Immediately following erection, remove unused material, screws, fasteners, and other debris from completed installation. Use caution in removing metal cuttings from surface of prefinished metal panels.

B. Replace damaged, dented, buckled, or discolored metal panels.

C. Repair damaged painted and galvanized surfaces as specified in Section 09 90 00, Painting and Coating.

D. Finish Painting: As specified in Section 09 90 00, Painting and Coating.

3.04 FIELD QUALITY CONTROL

A. Special inspection will be provided by Owner.

3.05 MANUFACTURER'S SERVICES

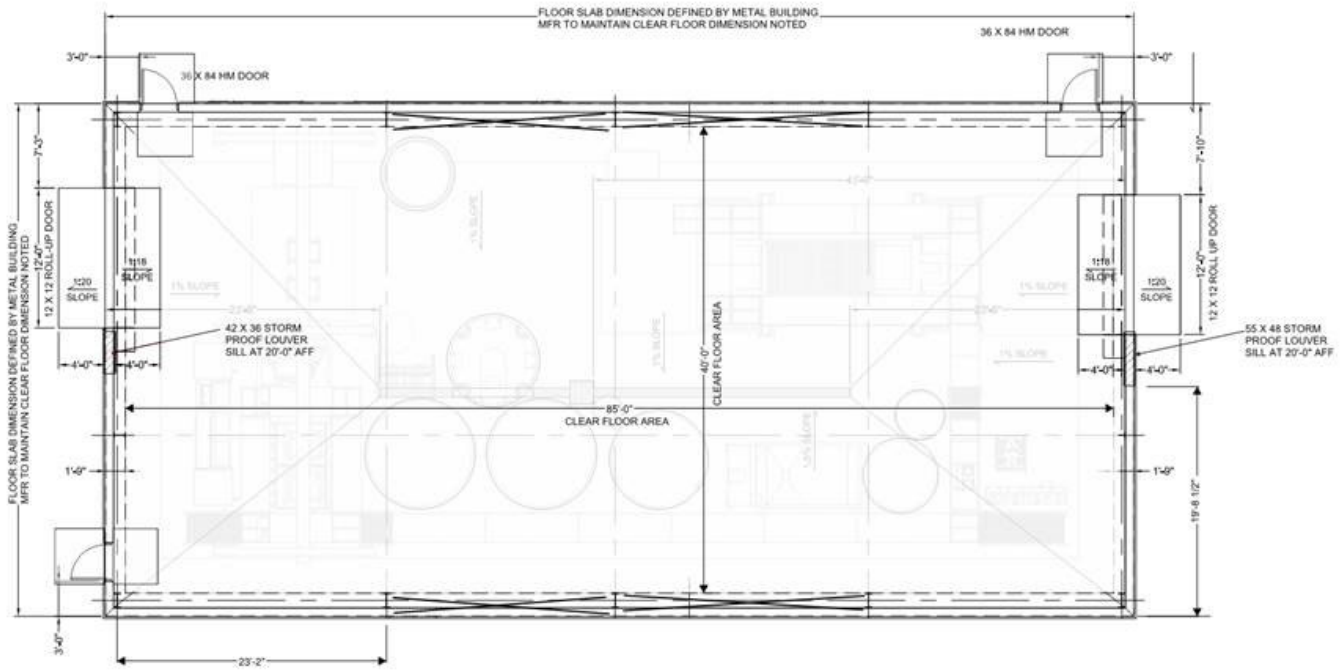
A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection, and certification of proper installation.

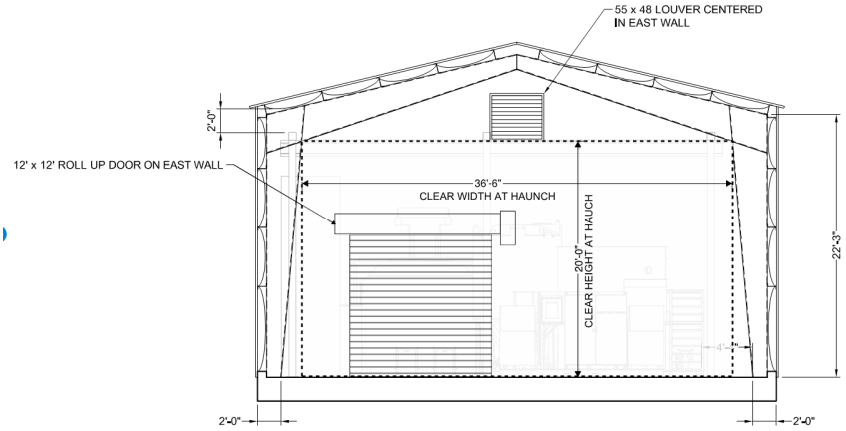
3.06 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Building Plan and Section.

END OF SECTION





BUILDING PLAN AND SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Air Moving and Conditioning Association, Inc. (AMCA): 203, Field Performance Measurement of Fan Systems.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE): HVAC Applications Handbook.
3. Associated Air Balance Council (AABC): National Standards for Field Management and Instrumentation Total System Balance.
4. National Environmental Balancing Bureau (NEBB):
   a. Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
   b. Procedural Standards for Measuring Sound and Vibration.
5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): HVAC Testing, Adjusting, and Balancing Manual.

1.02 SUBMITTALS

A. Informational Submittals:

1. Submit detailed test and balance procedures, including test conditions for systems to be tested, prior to beginning the Work.
2. Written verification of calibration of testing and balancing equipment.
3. Balancing Log Report following completion of system adjustments including test results, adjustments, and rebalancing procedures.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide materials, tools, test equipment, computers and instrumentation required to complete the work included.

B. Test Hole Plugs: Plug test holes in ducts with plugs made for that purpose and replace any insulation removed to specified conditions.

C. Drives for Belt-Driven Fans:

1. Furnish cast iron or flanged steel sheaves.
2. Sheaves and belt combination shall be capable of providing 150 percent of motor horsepower.

PART 3 EXECUTION

3.01 GENERAL

A. Adjust and balance air systems in accordance with standard procedures and recognized practices of the AABC or SMACNA.

B. Adjust and balance the following systems:

1. Supply and exhaust air systems.

3.02 ADJUSTING AND BALANCING AIR SIDE

A. Preparation:

1. Prior to beginning the Work, perform the following activities:
   a. Review shop drawings and installed system for adequate and accessible balancing devices and test points.
   b. Recommend to Engineer, dampers that need to be added or replaced in order to obtain proper air control.
   c. Verify proper startup procedures have been completed on the system.
   d. Verify controls installation is complete and system is in stable operation under automatic control.
   e. Verify test instruments have been calibrated to a recognized standard and are within manufacturer’s recommended calibration interval before beginning the Work.

B. General:

1. When adjustments are made to a portion of a fan system, reread other portions of that same system to determine effects imposed by adjustments. Readjust as necessary.
2. Lock and mark final positions of balancing dampers with permanent felt pen.

C. Equipment Data:

1. Collect the following data and included in final report:
   a. Type of unit.
   b. Equipment identification number.
   c. Equipment nameplate data (including manufacturer, model, size, type, and serial number).
   d. Motor data (frame, hp, volts, FLA rpm, and service factor).
   e. Sheave manufacturer, size, and bore.
   f. Belt size and number.
   g. Sheave centerline distance and adjustment limits.
   h. Starter and motor overload protection data.
   i. Include changes made during course of system balancing.

D. Fan Systems:

1. Measure fan system performance in accordance with AMCA 203.
2. In each system at least one airpath from fan to final branch duct termination shall have dampers fully open. Achieve final air quantities by adjusting fan speed.
3. Adjust Fan Air Volumes:
   a. Adjust fan speeds and motor drives for required equipment air volumes, with allowable variation of plus 10 percent minus 0 percent.
   b. After final adjustments, do not operate motor above nameplate amperage on any phase.
   c. After final adjustments, do not operate fan above maximum rated speed.
   d. Perform airflow test readings under simulated or actual conditions of full cooling, full heating, minimum outside air, full outside air and exhaust, and full return air.
   e. Provide and make drive and belt changes on motors or fans as required to adjust equipment to specified conditions. Drives shall be able to deliver 150 percent of motor horsepower. Provide written notice to air handling unit manufacturer and Engineer and Engineer if drive or belt changes were made.
4. Adjust outside air dampers, return air dampers, relief air dampers, exhaust air dampers, and motorized louvers for maximum and minimum air requirements.
5. Read and record static pressures at unit inlet and discharge, each filter set, coils, dampers, plenums, and mixing dual-duct or adjustable-volume boxes, on every supply, return, and exhaust fan for each test condition.
6. Read and record motor amperage on all phases for each test condition.

E. Air Outlets and Inlets:

1. In each system at least one air path from fan to final branch duct termination shall have dampers fully open.
2. Adjust air volumes on supply diffusers and grilles, and on return and exhaust grilles, to the quantity shown, with allowable variation of plus or minus 10 percent.
3. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and noise where possible.
4. After final adjustments are made secure dampers to prevent movement and mark final positions with permanent felt pen.

3.03 FIELD QUALITY CONTROL

A. Performance Testing:

1. Electric Heating Coil Testing:
   a. Adjust system as required to achieve full output from coil.
   b. Read and record amperages and voltages for all phases.

B. Balancing Log Report Requirements:

1. Include narrative description for each system explaining TAB methodology and assumptions used. Clearly identify test conditions for tests performed. Include control setpoint.
2. Log and record operational information from every test for each system, as necessary to accomplish services described.
3. Include equipment data for units tested.
4. Include reduced set of HVAC Drawings or system schematic diagrams with each element uniquely identified and indexed to balance log.
5. Indicate recorded site values, and velocity and mass correction factors used to provide equivalent standard air quantities.
6. Include separate section in log, if necessary, describing operating difficulties in air systems that could not be eliminated by specified procedures. Identify these problems by system and location within building; include outline or summary of condition and its effect on building, and describe corrective actions attempted and recommended.

C. Quality Control Verification:

1. After adjustments have been completed and balance logs submitted, balancing and testing agency shall be available to demonstrate the following:
   a. Air balancing procedures, vibration tests, and verification of test results.
   b. Perform spot tests on a maximum of 20 percent of total diffusers and grilles, on two air handling fan devices per building with measuring equipment used in original tests, at random points selected by Contractor.
   c. Results of these spot tests shall agree with balance logs within plus or minus 10 percent. Where this accuracy cannot be verified, rebalance portions of system as requested by Contractor.
   d. At completion of rebalance procedures, perform another spot test if required to verify results.

END OF SECTION

SECTION 23 07 00
HVAC INSULATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Heating, Refrigerating & Air-Conditioning Engineers, Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. Association of the Nonwoven Fabric Industry (INDA). IST 80.6, Water Resistance (Hydrostatic Pressure).
3. ASTM International (ASTM):
    a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
    b. C547, Standard Specification for Mineral Fiber Pipe Insulation.
    c. C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
    d. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
    e. C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.
    f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
    g. G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
    h. G22, Standard Practice for Determining Resistance of Plastics to Bacteria.
4. National Fire Protection Association (NFPA):
    a. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
    b. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
    c. 259, Standard Test Method for Potential Heat of Building Materials.
5. UL.

1.02 DEFINITIONS

A. Cold Air Ductwork: Designed to convey mechanically cooled air or return ducts in such systems.

B. Warm Air Ductwork: Designed to convey mechanically heated air or return ducts in such systems.

1.03 SUBMITTALS

A. Action Submittals: Product description, list of materials and thickness for each service or equipment scheduled, locations, and manufacturer's installation instructions.

B. Informational Submittals: Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

1.04 QUALITY ASSURANCE

A. Materials furnished under this specification shall be standard, cataloged products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.

B. Provide materials by firms engaged in the manufacture of insulation products of the types and characteristics specified herein, whose products have been in use for not less than 5 years.

C. UL listing or satisfactory certified test report from an approved testing laboratory is required to indicate fire hazard ratings for materials proposed for use do not exceed those specified.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Stamp or Label:

1. Every package or standard container of insulation, jackets, cements, adhesives and coatings delivered to Project Site for use must have manufacturer's stamp or label attached, giving name of manufacturer, brand, and description of material.
2. Insulation Packages and Containers: Marked "asbestos-free."

PART 2 PRODUCTS

2.01 GENERAL

A. Insulation Exterior: Cleanable, grease-resistant, nonflaking, and nonpeeling.

B. Insulation: Conform to referenced publications and specified temperature ranges and densities in pounds per cubic foot.

C. Insulation for Fittings, Flanges, and Valves: Premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.

D. Fire Resistance:

1. Insulation, Adhesives, Vapor Barrier Materials and Other Accessories, Except as Specified Herein: Noncombustible.
2. Do not use fugitive or corrosive treatments to impart flame resistance.
3. Flame proofing treatments subject to deterioration resulting from the effects of moisture or high humidity are not acceptable.
4. Provide materials including facings, mastics, and adhesives, with fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with ASTM E84 (NFPA 255) methods.

E. Materials exempt from fire-resistant rating:

1. Nylon anchors.
2. Treated wood inserts.

F. Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:

1. Polyurethane insulation.
2. PVC casing.
3. Fiberglass-reinforced plastic casing.

2.02 DUCT INSULATION

A. Type D1—Blanket (ASTM C553, Type 1, Class B3):

1. Fiberglass, nominal 1 pcf density blanket, K factor 0.31 maximum at 75 degrees F mean, with factory-applied FSK (foil-scrim-kraft) vapor barrier jacket, for temperatures to 250 degrees F.

2. Manufacturers and Products:
   a. CertainTeed; Duct Wrap.
   b. Johns Manville; Microlite.
   c. Owens/Corning Fiberglass; Soft R.
   d. Knauf; Ductwrap.

B. Type D2—Board:

1. Fiberglass, minimum 2.75 pcf density board, K factor 0.23 maximum at 75 degrees F mean, with factory-applied FSK (foil-scrim-kraft) vapor barrier jacket, for temperatures from 0 degree F to 450 degrees F.
2. Manufacturers and Products:
   a. CertainTeed; CertaPro Commercial Board.
   b. Knauf; Duct Slab.
   c. Owens/Corning Fiberglass; TIW.
   d. Johns Manville; 1000 Series Spin-Glass.

PART 3 EXECUTION

3.01 INSTALLATION OF DUCTWORK INSULATION

A. General: Install insulation products in accordance with the manufacturer's written instructions and in accordance with recognized industry practices.

B. Install insulation materials with smooth and even surfaces.

C. Clean and dry ductwork prior to insulation. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

D. Maintain integrity of vapor-barrier on ductwork insulation and protect it to prevent puncture and other damage. Tape all punctures.

E. Seal longitudinal and circumferential joints with FSK tape, and finish with fiberglass mesh fabric embedded in vapor barrier mastic.

F. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.

G. Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.

H. Refer to Section 23 31 13, Metal Ducts and Accessories, for installation of internal duct liner.

3.02 INSTALLATION OF INSULATION FINISH SYSTEMS

A. Use a continuous friction type joint to hold jacket in-place, providing positive weatherproof seal over entire length of jacket.

B. Secure circumferential joints with preformed snap straps containing weatherproof sealant.

C. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.

D. Do not use screws or rivets to fasten the fitting covers.

E. Install removable prefabricated aluminum covers on exterior flanges and unions.

F. Caulk and seal all exterior joints to make watertight.

3.03 DUCTWORK INSULATION REQUIREMENTS

A. Sheet Metal Intake and Exhaust Plenums:

1. At all intake and exhaust louvers, plenums, and up to connecting dampers, as shown on Drawings, and in accordance to WA State Energy Code (2015 IECC), C403.2.8.
2. Type D1.
3. Provide insulation thickness equivalent to R-19.

3.04 INSULATION FINISH REQUIREMENTS

A. Ductwork Insulation (Exposed to View, Indoors): Factory finish.

B. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

3.05 FIELD QUALITY CONTROL

A. Test factory-applied materials assembled. Field-applied materials may be tested individually.

END OF SECTION

SECTION 23 31 13
METAL DUCTS AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Air Movement and Control Association (AMCA): 500, Test Methods for Louvers, Dampers and Shutters.
2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbook.
3. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
4. Association of the Nonwoven Fabrics Industry (INDA): IST 80.6, Water Resistance (Hydrostatic Pressure).
5. ASTM International (ASTM):
    a. A36/A36M, Standard Specification for Carbon Structural Steel.
    b. A90/A90M, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
    c. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
    d. A176, Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip.
    e. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
    f. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
    g. A568/A568M, Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
    h. A653/A653M, Standard Specifications for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
    i. A700, Standard Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment.
    j. A924/A924M, Specification for General Requirements for Sheet Steel, Metallic-Coated by the Hot-Dip Process.

k. A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
l. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
m. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
n. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
o. C916, Standard Specification for Adhesives for Duct Thermal Insulation.
p. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
q. C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.
r. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
s. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.

6. National Air Duct Cleaners Association (NADCA): General Specifications for the Cleaning of Commercial Heating, Ventilation and Air Conditioning Systems.
7. National Fire Protection Association (NFPA):
   a. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
   b. 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
   c. 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
   d. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   e. 259, Standard Test Method for Potential Heat of Building Materials.
   f. 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.
8. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. Duct Construction Standards.
   b. Guidelines for Seismic Restraints of Mechanical Systems.

c. Fibrous Glass Duct Construction Standards.
d. Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.
e. HVAC Air Duct Leakage Test Manual.

9. UL:
a. 181, Standard for Safety Factory-Made Air Ducts and Connectors.
b. 214, Standard for Tests for Flame-Propagation of Fabrics and Films.
c. 555, Standard for Safety Fire Dampers.
d. 555S, Standard for Safety Smoke Dampers.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. cfm: Cubic feet per minute.
2. fpm: Feet per minute.
3. pcf: Pounds per cubic foot.
4. WC: Water column.

B. Sealing Requirements:

1. For the purpose of duct systems sealing requirements specified in this section, the following definitions apply:
a. Seams: Joining of two longitudinally (in direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on perimeter are deemed to be joints.
b. Joints, duct surface connections including:
1) Girth joints.
2) Branch and subbranch intersections.
3) Duct collar tap-ins.
4) Fitting subsections.
5) Louver and air terminal connections to ducts.
6) Access door, and access panel frames and jambs.
7) Duct, plenum, and casing abutments to building structures.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data:
   a. Rectangular and Rigid Round Ductwork:
      1) Schedules of duct systems, materials, joints, sealing, gage and reinforcement.
      2) SMACNA Figure Numbers for each shop fabricated item.
      3) Reinforcing details and spacing.
      4) Seam and joint construction details.
      5) Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
   b. Ductwork Accessories:
      1) Manufacturer's product data including catalog sheets, diagrams, standard schematic drawings, installation instructions and details, details of materials, construction, dimensions of individual components, and finishes, including the following items:
         a) Fittings and volume control damper installation (both manual and automatic) details.
         b) Duct liner.
         c) Sealing materials.
         d) Dampers; include leakage, pressure drop, and maximum back pressure data.
         e) Duct-mounted access panels and doors.
         f) Flexible ducts.
         g) Sheet metal fasteners.
2. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

1.04 QUALITY ASSURANCE

A. Industry Standards:

1. Unless otherwise indicated or specified, sheet metal ductwork shall be constructed and installed in accordance with SMACNA Duct Construction Standards relevant to ductwork system being provided. These standards are herein referenced as the SMACNA Manual, unless otherwise indicated.
2. Comply with ASHRAE Fundamentals Handbook recommendations, except as otherwise indicated.
3. NFPA Compliance: NFPA 90A and NFPA 90B.

B. Changes or alterations to layout or configuration of duct system shall be:

1. Proposed layout shall provide original design results, without increasing system total pressure.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect ductwork from dirt, water, and debris. During storage on Job Site, keep ends of ductwork covered to prevent foreign objects and water from entering ductwork.

B. Deliver sealant materials to Site in original unopened containers labeled with manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

C. Store and handle sealant materials in compliance with manufacturers' recommendations to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

D. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

PART 2 PRODUCTS

2.01 GENERAL

A. Specified components of this ductwork system, including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

B. Internally Lined Ductwork: Duct sizes indicated for internally lined ducts are the clear inside dimensions, and shall be increased in both dimensions by twice the thickness of the liner.

C. Ductwork thinner than 26-gauge will not be allowed.

D. Ductwork Interior Surfaces:

1. Smooth.
2. No sheet metal parts, tabs, angles, or other items may project into air ducts, unless otherwise specified.
3. Seams and joints shall be external.

4. For ductwork that is required to be reinforced, use only external reinforcing.

2.02 SHEET METAL MATERIALS

A. Construct metal duct systems from galvanized steel.

B. Where no specific ductwork materials are indicated in Specifications or on Drawings, galvanized steel sheet metal shall be basis of Contract.

C. Galvanized Steel Ductwork:

1. Comply with ASTM A653/A653M and ASTM A924/924M.
2. Product Name: Steel Sheet, Zinc Coated (Galvanized Steel).
3. Sheet Designation: CS Type B.
4. Applicable Specification: ASTM A653/A653M.
5. (Zinc) Coating Designation: G90.
6. Coating designation in accordance with Test Method A, ASTM A90/ A90M. and ASTM A924/A924M.
7. Provide mill-phosphatized finish for ducts exposed to view and for ducts scheduled to be painted.
8. Provide sheet metal packaged and marked as specified in ASTM A700.

D. Exposed Ductwork: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discoloration, and other imperfections, including those which would impair painting.

E. Reinforcement Shapes and Plates: Unless otherwise indicated, provide reinforcements of same material as ductwork.

2.03 DUCT SEALING MATERIALS

A. General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

B. Adhesives, Cements, Sealant, and Installation Accessories: As recommended by duct manufacturer for application.

C. Solvent-Based Sealants:

1. Ultraviolet light resistant.
2. Mildew resistant.
3. Flashpoint: Greater than 70 degrees F, SETA CC.

4. Manufacturers and Products:
    a. Hardcast, Inc.; Versagrip 102.
    b. Rectorseal; AT-33.
    c. Childers; CP-140.

D. Water-Based Sealants:

1. Listed by manufacturer as nonflammable in wet and dry state.
2. Manufacturers and Products:
    a. Foster; Series 32.
    b. Childers; CP-145A, 146.
    c. Rectorseal; Airlok 181.

2.04 DUCTWORK FASTENERS

A. General:

1. Rivets, bolts, or sheet metal screws.
2. Ductwork fasteners shall be same metal as duct being supported, unless otherwise noted.

B. Self-Drilling Screws:

1. Galvanized Steel Ductwork System: Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated carbon steel with zinc electroplated finish.

2.05 DUCTWORK PRESSURE CLASS

A. Construct duct systems to pressure classifications indicated as follows:

1. Supply Ducts and Intake Plenums: 3-inch WC.
2. Exhaust Ducts and Exhaust Plenums: 2-inch WC, negative pressure.

B. Where no specific duct pressure designations are indicated in Specifications or on Drawings, 2-inch WC pressure class shall be basis of Contract.

2.06 RECTANGULAR DUCTWORK

A. Fabricate rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless specified otherwise.

B. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20-gauge or less, with more than 10 square feet of unbraced panel area, as indicated in SMACNA Manual, unless they are lined or are externally insulated.

2.07 RECTANGULAR DUCTWORK FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.

B. Elbows:

1. Fit square-turn elbows with vane side rails.
2. Shop fabricate double-blade turning vanes of same material as ductwork.
3. Fabricate with equal inlet and outlet.
4. Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.

2.08 RIGID ROUND DUCTWORK

A. Construct rigid round ducts in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless specified otherwise.

B. Basic Round Diameter: As used in this Article, is inside diameter of size of round duct.

C. Where space limitations prevent use of round duct or where shown on Drawings, provide ductwork of flat oval construction hydraulically equivalent to round ductwork.

D. Fabricate round ducts with spiral seam construction, except where diameters exceed 72 inches. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams.

2.09 RIGID ROUND DUCTWORK FITTINGS

A. Construct rigid round ductwork fittings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless otherwise specified.

B. 90-Degree Tees, Laterals, and Conical Tees: Fabricate to conform to SMACNA manual with metal thicknesses specified for longitudinal seam straight duct.

C. Diverging Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.

D. Elbows:

1. Fabricate in stamped (die-formed), pleated, or segmented (gored) construction 1.5 times elbow diameter. Two piece segment elbows are not allowed, except with turning vanes.
2. Segmented Elbows: Fabricate with welded construction.
3. Round Elbows 8 Inches and Smaller:
   a. Stamped elbows for 45-degree and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees configuration.
   b. Fabricate nonstandard bend angle configurations or nonstandard sized (for example, 3-1/2 inches and 4-1/2 inches) elbows with segmented construction.
4. Round Elbows 9 Inches Through 14 Inches:
   a. Segmented or pleated elbows for 30, 45, 60, and 90 degrees.
   b. Fabricate nonstandard bend angle configurations or nonstandard sized (for example, 9-1/2 inches and 10-1/2 inches) elbows with segmented construction.

2.10 ROUND DUCTWORK BRANCH CONNECTIONS

A. Branch duct connections (taps) to round duct mains shall be made using factory fabricated fittings.

B. Field installed taps are not acceptable.

2.11 DUCTWORK HANGERS AND SUPPORTS

A. General:

1. Attachments, hangers, and supports for ductwork shall be in accordance with SMACNA Manual referenced for type of duct system being installed.
2. Duct hanging system shall be composed of three elements; upper attachment to building, hanger itself, and lower attachment to duct.
3. Wire hangers are not acceptable.
4. Hanger Spacing:
   a. Ducts Up to 60 Inches in Largest Dimension: 10 feet, maximum.
   b. Ducts Over 61 Inches in Largest Dimension: 8 feet, maximum.

B. Construction Materials:

1. Supporting devices including, but not limited to, angles used for support and bracing, baseplates, rods, hangers, straps, screws, bolts shall be as follows:
   a. Galvanized Steel Ductwork:
      1) Indoors: Carbon steel, zinc electroplated.
      2) Outdoors: Carbon steel, hot-dipped galvanized after fabrication.

C. Building Attachments:

1. Concrete inserts, powder-actuated fasteners, or structural steel fasteners appropriate for building materials.
2. Do not use powder-actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.
3. Upper Attachment (Concrete):
   a. Drive pin fastener and expansion nail anchor may be used for ducts up to 18-inch maximum dimension.
   b. Threaded stud fastener may be used for ducts up to 36-inch maximum dimension.
   c. Concrete attachments shall be made of steel.

D. Duct Fasteners: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials and conforming to requirements of Article Ductwork Fasteners.

E. Trapeze and Riser Supports: Steel shapes conforming to ASTM A36/A36M, hot-dipped galvanized after fabrication.

2.12 DUCTWORK FLEXIBLE CONNECTIONS

A. General:

1. Factory fabricated metal-edged fabric flexible connectors for commercial or industrial applications.
2. Sheet metal permanently secured to fabric with double fabric fold, double metal crimp.
3. Comply with NFPA 90A and NFPA 90B requirements.
4. Airtight and waterproof.

B. Materials:

1. Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
2. Metal Edges: Construct from same material as ductwork, unless otherwise noted.
3. Fabric:
   a. Comply with NFPA 701 or UL 214 (except teflon coated).
   b. Woven polyester or nylon for most applications.
   c. Woven fiberglass for high temperature applications.
   d. Coating: Vinyl.

C. Construction:

1. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA Manual.
2. Standard Metal Edged Connectors: Strip of fabric 3 inches wide attached to two strips of 3-inch-wide sheet metal.
3. Wide Metal Edged Connectors: Strip of fabric 4 inches wide attached to two strips of 4-inch-wide sheet metal.
4. Extra Wide Metal Edged Connectors: Strip of fabric 6 inches wide attached to two strips of 6-inch-wide sheet metal.

D. Manufacturers and Products:

1. Ductmate; PROflex, Commercial.
2. Ventfabrics.
3. Duro-Dyne.

2.13 DUCT INSPECTION DOORS

A. General:

1. Insulated, gasketed, and at least 15 inches by 15 inches when duct dimensions are large enough.
2. On ductwork where largest side dimension is less than 16 inches, furnish inspection doors at least 8 inches by 8 inches.
3. Complete with necessary hardware and either Amerlock 10 or Ventlok No. 100 latches, and Ventlok Series No. 100 hinges.
4. Fabricated of same material as ductwork.

B. Casing and Plenum Access Doors:

1. Size: 57 inches high by 24 inches wide minimum where possible.
2. Complete with hardware, hinges, seals, and latch handles.
3. Doors and frames shall be designed to close with pressure.
4. Latch Handles: Ventlok, Series No. 260.
5. Hinges: Ventlok, Series No. 200 and No. 300.

C. Manufacturers:

1. Ventlok.
2. Duro-Dyne.
3. Flexmaster.

2.14 MANUAL DAMPERS

A. Butterfly Manual Dampers (Round Duct):

1. Fabricate from two gauges heavier than duct in which installed, of same material as ductwork.
2. Align operating handle with damper blade.
3. Provide 2-inch standoff bracket for insulated duct systems.
4. Damper Manufacturers and Products:
   a. Ruskin; Model MDRS25.
   b. American Warming and Ventilating.
5. Operator Manufacturers and Products:
   a. Accessible Ductwork: Ventlok; Type 620 or Type 635.

B. Manual Opposed-Blade Balancing Dampers (Rectangular Duct):

1. Externally operated gang airfoil, damper blades.
2. Fabricate from same material as ductwork.
3. Stainless steel or nylon sleeve bearings.
4. Construction shall have interlocking edges and maximum 10-inch blade width.
5. Manufacturers and Products:
   a. Ruskin; CD102.
   b. American Warming and Ventilating; Model VC-31.

2.15 BACK DRAFT DAMPERS

A. General: Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA 500.

B. Steel Frame, Nonmetallic Blades:

1. Fabrication:
   a. Frame: 2 inches by minimum 18-gauge (51 mm by minimum 1.6 mm) galvanized steel with windstops to reduce backflow.
   b. Blades:
      1) Style: Single piece, independent.
      2) Action: Parallel.
      3) Material: Noncombustible, neoprene coated fiberglass.
      4) Orientation: Horizontal.
      5) Width: Maximum 6 inches (152 mm).
   c. Mounting:
      1) Suitable for mounting in vertical or horizontal airflow up positions.
      2) Configured for vertical.
   d. Finish: Mill galvanized.
2. Performance Data:
   a. Temperature Rating: Withstand minus 30 degrees F to 200 degrees F (minus 34 degrees C to 93 degrees C).
   b. Maximum Back Pressure: 4-inch WC (1.0 kPa).
   c. Maximum System Air Velocity: 1,000 fpm (5.1 m/s).
   d. Maximum Spot Air Velocity: 1,200 fpm (6.1 m/s).
3. Manufacturer and Product: Ruskin; Model NMS2.

2.16 CONTROL DAMPERS (03-MD-01, 03-MD-02, 03-MD-03)

A. General:

1. Specification applies to control dampers, except those specified to be furnished with equipment.
2. Furnish opposed-blade type for proportional action and parallel-blade type for two-position action, except where indicated otherwise.

B. Standard Duty Control Dampers:

1. Frame:
   a. Nominal 5 inches deep, minimum 16-gauge (127 mm by minimum 1.6 mm) roll formed, hat-shaped channel, reinforced at corners. (Structurally equivalent to 13-gauge (2.3 mm) U-channel.)
   b. Material: Galvanized steel.

2. Blades:
   a. Style: Single skin with three longitudinal grooves, minimum.
   b. Orientation: Horizontal or vertical with thrust washers, as indicated on Drawings.
   c. Minimum 14-gauge (2 mm) equivalent thickness.
   d. Material: Galvanized steel.
   e. Width: Nominal 6 inches (152 mm).
3. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.
4. Seals:
   a. Blade Seals: Inflatable PVC-coated fiberglass material and galvanized steel. Mechanically attached to blade edge.
   b. Jamb Seals: Flexible metal compression type.
5. Linkage: Concealed in frame.
6. Axles:
   a. Minimum 1/2 inch (13 mm) diameter, hex-shaped, mechanically attached to blade.
   b. Material: Plated steel.
7. Performance Data:
   a. As follows:
      1) Temperature Rating: Withstand minus 76 degrees F to 350 degrees F.
      2) CLOSED Position: Maximum pressure of 13 inches w.g. at a 12-inch blade length.
      3) OPEN Position: Maximum air velocity of 6,000 feet per minute.
      4) Leakage: Equivalent to Class 1 damper per ACMA 511 and in accordance with the Washington State Energy Code.
      5) Pressure Drop: Maximum 0.05 inch w.g. at 1,500 feet per minute across 24-inch by 24-inch damper.
8. Accessories:
   a. As follows:
      1) Actuator: Refer to Article Control Damper Operators, for requirements.
9. Manufacturers and Products:
   a. Ruskin; Model CD-35.
   b. American Warming and Ventilating.
   c. TAMCO.

2.17 CONTROL DAMPER OPERATORS

A. General:

1. Drawings and Control Diagrams indicate only one damper motor for each motorized damper (M).
2. Select actual quantity of motors required to operate each damper in accordance with size of damper provided.
3. Coordinate exact quantity of damper motors with electrical work to ensure that necessary wiring and conduit is provided for installation.
4. Provide operators for motorized dampers and motorized louvers.

B. Electric Damper Operators:

1. Performance:
   a. As follows:
      1) 120V, 60-Hz, two-position.
      2) Fail Position: Closed.
2. Mounting: External side plate.
3. Ample power to overcome friction of damper linkage and air pressure acting on damper blades.
4. Furnished with external adjustable stops to limit stroke.
5. Operators on modulating dampers that are to be sequenced with other control devices shall have full relay type pilot positioner and interconnecting linkage to provide mechanical feedback that will accurately position and control damper.
6. Intake, relief, and exhaust dampers shall close and return dampers shall open on control failure, unless indicated otherwise.
7. Operating Torque:
   a. Provide multiple independent damper sections, each with separate actuator, as needed to provide minimum of 120 percent of operating torque required by damper(s).
   b. Required damper operating torque for actuator sizing calculations shall include friction of damper linkage and 1-inch WC air pressure on damper blades:
      1) Opposed-Blade Dampers: Minimum 5 inch-pounds per square foot of damper area, unless higher values are recommended by damper manufacturer.
      2) Parallel-Blade Dampers: Minimum 7 inch-pounds per square foot of damper area, unless higher values are recommended by damper manufacturer.
8. Manufacturer and Product: Belimo; Model AFBUP-S.

2.18 EXTERNAL DUCT INSULATION

A. Refer to Section 23 07 00, HVAC Insulation.

2.19 MISCELLANEOUS ACCESSORIES

A. Accessories Hardware:

1. Instrument Test Holes:
   a. Cast metal, material to suit duct material, including screw cap and gasket and flat mounting gasket.
   b. Size to allow insertion of pitot tube and other testing instruments.
   c. Provide in length to suit duct insulation thickness.
2. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline, and grease.

2.20 DUCTWORK IDENTIFICATION

A. Painted Identification Materials:

1. Stencils: Standard metal stencils, prepared for required applications with letter sizes generally comply with recommendations of ASME A13.1 for piping and similar applications, but not less than 1-1/4-inch high letters for ductwork and not less than 3/4-inch-high letters for access door signs and similar operational instructions.
2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray can form and grade.
3. Identification Paint: Standard identification enamel of colors indicated or in accordance with ASME A13.1 for colors for systems not identified herein.

B. Nomenclature:

1. Include the following:
   a. Direction of air flow.
   b. Duct service (supply, exhaust).

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Miscellaneous:

1. Install sheet metal ductwork and flexible ductwork in accordance with SMACNA Manual, NFPA 90A, and NFPA 90B.
2. Install ductwork using manufacturer's recommended adhesives, cement, sealant, and insulation accessories.
3. Align ductwork accurately at connections, within 1/8-inch misalignment tolerance and with internal surfaces smooth.
4. Interface Between Ductwork and Louvers: At locations where ductwork is connected to louver for either intake or exhaust purposes, ductwork shall be installed, sloped, and connected to louver so water entering ductwork system positively drains back to and out of louver.

B. Ductwork Location:

1. Locate ductwork runs vertically and horizontally, unless otherwise indicated.
2. Avoid diagonal runs wherever possible.
3. As indicated by diagrams, details, and notations or, if not otherwise indicated, run ductwork in shortest route that does not obstruct usable space or block access for servicing building and equipment.
4. In general, install as close to bottom of structure as possible.
5. For ductwork concealed above ceiling, maximize clearance between bottom of ductwork and top of ceiling construction.
6. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
7. Ductwork that must transition and drop below piping or other ductwork shall be transitioned back to bottom of structure immediately adjacent to obstruction.

C. Control Dampers:

1. Install at locations indicated on Drawings and in accordance with manufacturer's instructions.
2. Install square and free from racking with blades running horizontally.
3. Operate opposed blade dampers from a power blade or drive axle.
4. Bracing:
   a. Install for multiple section assemblies to support assembly weight and to hold against system pressure.
   b. Install at every horizontal and vertical mullion.

D. Penetrations:

1. Provide duct sleeves or prepared openings for duct mains, duct branches, and ducts passing through roofs, walls and ceilings.
2. Clearances:
   a. For uninsulated ducts, allow 1-inch clearance between duct and sleeve, except at grilles, registers, and diffusers.
   b. For insulated ducts, allow 1-inch clearance between insulation and sleeve, except at grilles, registers, and diffusers.
3. Closure Collars:
   a. Minimum 4 inches wide on each side of walls or floors where sleeves or prepared openings are installed.
   b. Fit collars snugly around ducts and insulation.
   c. Same gauge and material as duct.
   d. Grind edges of collar smooth to preclude tearing or puncturing insulation covering or vapor barrier.
   e. Use fasteners with maximum 6-inch centers on collars.
4. Packing: Mineral fiber in spaces between sleeve or opening and duct or duct insulation.

E. Concealment:

1. Wherever possible in finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction, or above suspended ceiling.
2. Do not encase horizontal runs in solid partitions, except as specifically shown.
3. Limit clearance to 1 inch where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.

F. Coordination with Other Trades:

1. Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of ductwork system.
2. Ductwork shall be configured, positioned, and installed to permit installation of light fixtures as indicated on Drawings.
3. Coordinate ductwork layout with suspended ceiling, lighting and sprinkler head layouts and similar finished work.
4. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures.

3.02 RECTANGULAR DUCTWORK

A. General:

1. Where possible, install ductwork so seams and joints will not be cut for installation of grilles, registers, or ceiling outlets.
2. If cutting of seams or joints is unavoidable, reinforce cut portion to original strength.

B. Low Pressure Taps:

1. Use bell mouth or conical fittings with integral locking quadrant damper. Spin-in fitting shall be sealed at duct tap with a gasket or sealed with sealant as specified for medium pressure ductwork.
2. Determine location of spin-in after outlet location is determined.
3. Fitting shall be securely attached to shaft to prevent damper from rotating around shaft.

C. Fittings:

1. Use bell-mouth or conical tee fittings for round duct takeoffs from rectangular mains.
2. Use 45-degree entry fittings conforming to SMACNA requirements for rectangular takeoffs from rectangular or round mains.
3. Make offsets with maximum angle of 45 degrees.
4. Use fabricated fittings for changes in directions, changes in size and shape, and connections.

D. Rectangular Ductwork Transverse Joints:

1. Install each run with a minimum of joints.
2. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
3. Mechanical Joint Option:
    a. Construct transverse joints with Ductmate 25/35 duct connector systems, Ductmate W.D.C.I. Heavy/Lite duct connector systems, or Ductlok J/E duct connector system. Slip-on duct flange connectors shall have integral sealant pocket with permanently flexible sealant.
    b. When using Ductmate W.D.C.I. Heavy/Lite system, construct ductwork in accordance to the Ductmate W.D.C.I. Heavy J and Light H Assembly Manual and Duct Construction Standards.

c. When using Ductlok J/E duct connector system, construct ductwork in accordance with Ductlok's Rectangular Duct Construction Manual for Low, Medium, and High Pressure.
d. For longitudinal seams, use Pittsburgh lock seam sealed internally with permanently elastic sealer such as Ductmate 5511M mastic.
e. Conform to SMACNA Class A sealing requirements.

3.03 RIGID ROUND DUCTWORK

A. General: Except where interrupted by fittings, install round ducts in lengths as long as possible to minimize joints.

B. Rigid Round Ductwork Joints:

1. Rigid round ductwork joints shall be in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless otherwise specified.
2. Single and Double Wall Supply and Return System Joints:
   a. Less than 36 Inches: Slip coupling.
   b. 36 Inches and Larger: Flanged connector, Van Stone, or welded companion flange type.
3. Single and Double Wall Exhaust and Return System Joints:
   a. Spiral Seam Duct: Welded flanged connector.
   b. Longitudinal Seam Duct: Van Stone flange connector.

3.04 DUCTWORK HANGERS AND SUPPORTS

A. Install ductwork with support systems in accordance with SMACNA Manual, unless otherwise noted.

B. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type, which will hold ducts true-to-shape and to prevent buckling.

C. Install additional bracing on ductwork as required, to prevent ballooning or breathing.

D. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

E. Support vertical ducts at maximum interval of 16 feet and at each floor.

F. Upper attachments to structures shall have allowable load not exceeding 1/4 of failure (proof test) load, but are not limited to specific methods indicated.

G. In new construction, install concrete insert prior to placing concrete.

3.05 FLEXIBLE CONNECTIONS

A. Flexible Collars and Connections:

1. Use between fans and ducts.
2. For round ducts, securely fasten flexible connections by zinc-coated steel clinch-type draw bands.
3. For rectangular ducts, lock flexible connections to metal collars.

3.06 DAMPERS

A. General:

1. Inspection:
   a. Inspect areas to receive dampers.
   b. Notify Engineer of conditions that would adversely affect installation or subsequent utilization of dampers.
   c. Do not proceed with installation until unsatisfactory conditions are corrected.
2. Install dampers at locations indicated on Drawings and in accordance with manufacturer's installation instructions.
3. Install square and level.
4. Handle damper using sleeve or frame. Do not lift damper using blades or jack-shaft.
5. Damper blades and hardware shall operate freely without obstruction.
6. Damper blades and hardware that bind within frame or obstructed by adjacent construction will not be acceptable.
7. When installed, damper frames shall be gasketed or caulked to eliminate leakage between duct and damper frames.
8. Head and sill shall have stops.
9. Suitable for installation in mounting arrangement shown.
10. Do not compress or stretch damper frame into duct or opening.

B. Manual Dampers:

1. Provide balancing dampers for grilles and diffusers as indicated on Drawings in branch duct as near main as possible.
2. Add or remove balancing dampers as requested by air balancing firm for necessary control of air.

C. Back Draft Dampers:

1. Install dampers square and free from racking with blades running horizontally.

2. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

3.07 ACCESS DOORS

A. Ductwork: Install access doors in ductwork, in accordance with manufacturer's instructions.

3.08 EXTERNAL DUCT INSULATION

A. Refer to Section 23 07 00, HVAC Insulation.

3.09 MISCELLANEOUS ACCESSORIES

A. Inspection Plates and Test Holes:

1. Where required in ductwork for balance measurements.
2. Test holes shall be airtight and noncorrosive with screw cap and gasket.
3. Extend cap through insulation.

3.10 DUCT SEALING

A. Seal duct seams and joints as follows:

1. In accordance with the following:
   a. Pressure Classifications Greater than 3-Inch WC: Transverse joints, longitudinal seams, and duct penetrations.
   b. Pressure Classification Between 2-Inch and 3-Inch WC: Transverse joints and longitudinal seams.
   c. Pressure Classification Less than 2-Inch WC: Transverse joints only.

B. If no specific duct sealing requirements are specified, requirements of SMACNA manual shall govern.

C. Seal externally insulated ducts prior to insulation installation.

D. Seal all audible leaks.

3.11 BALANCING OF AIR SYSTEMS

A. Perform air balancing in accordance with requirements of Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.12 PROTECTION OF INSTALLED WORK

A. Open ends of installed ductwork systems shall be covered to prevent dust, foreign objects and water from entering ductwork.

B. Ductwork systems shall not be used for air conveyance until adequate air filtration devices are installed in air handling equipment, to prevent ingress of construction dust.

3.13 CLEANING

A. Ductwork shall be cleaned of rust, dust, and debris, both internally and externally, before placing in operation.

B. Before installing air outlets, use air handler to blow dry air through entire system at maximum attainable velocity. Provide temporary air filters for this operation.

C. If duct systems are found to contain construction debris at time of construction completion Contractor shall provide complete ductwork system cleaning in accordance with NADCA Standards.

END OF SECTION

SECTION 23 34 00
HVAC FANS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Acoustical Society of America (ASA): S2.19, Mechanical Vibration—Balance Quality Requirements of Rigid Rotors—Part 1, Determination of Permissible Residual Unbalance.
2. Air Movement and Control Association International (AMCA):
   a. 99, Standards Handbook.
   b. 201, Fans and Systems.
   c. 203, Field Performance Measurement of Fan Systems.
   d. 204, Balance Quality and Vibration Levels for Fans.
   e. 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
   f. 300, Reverberant Room Method for Sound Testing of Fans.
   g. 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
3. American Bearing Manufacturers Association (ABMA): 9, Load Ratings and Fatigue Life for Ball Bearings.
4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
5. ASTM International (ASTM):
   a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
   b. D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
   c. D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   d. D3363, Standard Test Method for Film Hardness by Pencil Test.
   e. D4167, Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.
   f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
6. National Electrical Manufacturers Association (NEMA).
7. National Fire Protection Association (NFPA): 45, Standard on Fire Protection for Laboratories Using Chemicals.
8. Occupational Safety and Health Act (OSHA).

9. Society for Protective Coatings (SSPC):
    a. SP 3, Power Tool Cleaning.
    b. SP 5, White Metal Blast Cleaning.
    c. SP 6, Commercial Blast Cleaning.
    d. SP 10, Near-White Blast Cleaning.
10. UL: 507, Safety Standard for Electric Fans.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Alternating Current.
2. CISD: Chemical Industry, Severe-Duty.
3. dB: Decibel.
4. DWDI: Double Width, Double Inlet.
5. FRP: Fiberglass Reinforced Plastic.
6. hp: Horsepower.
7. ODP: Open Drip Proof.
8. SWSI: Single Width, Single Inlet.
9. TEFC: Totally Enclosed, Fan Cooled.
10. UV: Ultraviolet.
11. XP: Explosion Proof.

1.03 SUBMITTALS

A. Action Submittals:

1. Provide following for specified products:
    a. Identification as referenced in Contract Documents.
    b. Manufacturer’s name and model number.
    c. Descriptive specifications, literature, and drawings.
    d. Dimensions and weights.
    e. Fan sound power level data (reference 10 to power minus 12 watts) at design operating point.
    f. Fan Curves:
        1) Performance Curves Indicating:
            a) Relationship of flow rate to static pressure for various fan speeds.
            b) Brake horsepower curves.
            c) Acceptable selection range (surge curves, maximum revolutions per minute).
            d) Static pressure, capacity, horsepower demand and overall efficiency required at duty point, including drive losses.

2) For variable air volume applications, indicate operating points at 100, 80, 60, and 40 percent of design capacity on fan curves including data to indicate effect of capacity control devices such as inlet vanes on flow, pressure, and brake horsepower.

g. Capacities and ratings.
h. Construction materials.
i. Fan type, size, class, drive arrangement, discharge, rotation, and bearings.
j. Wheel type, diameter, maximum revolutions per minute for fan class, operating revolutions per minute, and tip speed.
k. Motor data, including service factor and operating horsepower, as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
l. Fan shaft first critical speed.
m. Belt service factor.
n. Drive assembly horsepower rating.
o. Sheave horsepower rating.
p. Power and control wiring diagrams, including terminals and numbers.
q. Factory run test and vibration test reports.
r. Vibration isolation.
s. Factory finish system.
t. Color selection charts where applicable.

2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
3. “Or-Equal” Equipment:
   a. Where submitted equipment results in change to fan inlet or outlet ductwork configuration shown on Drawings, submit system effect factor calculations indicating increased static pressure requirements as described in AMCA 201.
   b. Where submitted equipment results in change to ductwork and equipment configuration shown on Drawings, submit detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement to equipment furnished.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Recommended procedures for protection and handling of products prior to installation.
3. Manufacturer’s installation instructions.

4. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following:
   a. Motors specified to be premium efficient type.
5. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
6. Test reports.
7. Operation and maintenance data in conformance with Section 01 78 23, Operation and Maintenance Data. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE

A. Performance Ratings: Tested in accordance with AMCA 210.

B. Sound Ratings: Tested in accordance with AMCA 300.

C. Fabrication: In accordance with AMCA 99.

1.05 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts:

Item	Quantity
Vee Belts	One complete set per unit
Filters	Two complete sets per filter housing

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 EQUIPMENT SCHEDULES

A. Some specific equipment requirements are listed in Equipment Schedule. Refer to Article Supplements.

2.02 GENERAL

A. Spark Resistant Construction: Fans required to be spark resistant shall comply with requirements of AMCA 99-0401.

B. Operating Limits: Fans designated to meet a specified fan class shall comply with requirements of AMCA 99-2408.

C. Acoustical Levels: Equipment selections shall produce sound power levels in each octave band no greater than shown in Equipment Schedule.

D. Fan Drives:

1. Drive assembly shall be sized for a minimum 140 percent of fan motor horsepower rating.
2. Furnish multiple drive belts where motor horsepower is 2 hp or larger.
3. Sheaves:
   a. Capable of providing 150 percent of motor horsepower.
   b. Unless otherwise noted, furnish belt-driven fans with cast iron or flanged steel sheaves.
4. Drive Adjustment:
   a. When fixed-pitch sheaves are furnished, accomplish system air balancing by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves.
   b. Provide trial and final sheaves, as well as drive belts, as required.
5. Fan Shafts: First critical speed of at least 125 percent of fan maximum operating speed.
6. Provide speed test openings at shaft locations.
7. Belts: Oil and heat resistant, nonstatic type.
8. Motors:
   a. Motors 20 hp or Smaller:
      1) Variable pitch V-belt sheaves allowing at least 20 percent speed variation.
      2) Final operating point shall be at approximate sheave midpoint.
   b. Motors Larger than 20 hp: Fixed-pitch sheaves.
   c. Furnish motors for V-belt drives with adjustable rails or bases.
9. Weather Cover: For outdoor applications, factory fabricated drive assembly of same material as fan housing, unless specified otherwise.
10. Belt and Shaft Guards:
    a. Easily removable and to enclose entire drive assembly, meeting federal, OSHA, and State of Washington requirements.
    b. Guard faces of expanded metal having minimum 60 percent free area for ventilation.
    c. Bright yellow finish.

E. Finishes:

1. Carbon Steel Parts: Factory finish as follows, unless indicated otherwise.
   a. Parts cleaned and chemically pretreated with phosphatizing process.

b. Alkyd enamel primer.
c. Air dry enamel topcoat.

2. Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.
3. Stainless Steel Parts: Finished smooth and left unpainted.
4. Fiberglass Parts: Finished in accordance with Paragraph Fiberglass Material.

2.03 INLINE FAN, CENTRIFUGAL, SQUARE (01-SF-01, 03-SF-01, 03-EF-01)

A. General:

1. Factory-assembled, centrifugal, inline fan, square housing configuration; including housing, fan wheel, drive assembly, motor and accessories.
2. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Housing:

1. Construction: Minimum 18-gauge galvanized steel.
2. Integral duct collars.
3. Removable side panels, for ease of service.
4. Field convertible for side air discharge configuration.
5. Predrilled universal mounting brackets for vertical or horizontal installation.
6. Inlets: Aerodynamic aluminum venturi.
7. Corrosion-resistant fasteners.
8. Drive belt and bearings separated from air steam by enclosure.

C. Wheel:

1. Centrifugal backward inclined, 100 percent aluminum construction.
2. Precision machined cast aluminum hub.
3. Die-formed airfoil or backward inclined blades.
4. Matched to inlet venturi.
5. Attached to fan shaft with split taper lock bushing.

D. Shaft, Bearings, Drive:

1. Shafts:
   a. Turned, ground and polished carbon steel.
   b. Keyed for sheave installation.
2. Bearings:
   a. Grease lubricated, precision antifriction ball, self-aligning, pillow block style, relubricatable or sealed type.

b. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours operation at maximum cataloged operating speed.

3. Drives:
   a. In accordance with Paragraph Fan Drives.
   b. Factory set to specified fan revolutions per minute.
   c. Type: Belt or Direct, as indicated in Equipment Schedule.
   d. Arrangement: As scheduled in Equipment Schedule.

E. Accessories:

1. Provide as scheduled in Equipment Schedule and as follows:
   a. Belt Guard: Sheet metal construction, OSHA type.
   b. Motor and Drive Cover:
      1) Factory fabricated, OSHA type.
      2) Sheet metal construction, same material as fan housing.
      3) Vented, openings sufficient size for proper motor cooling.
      4) Fan speed controller.
   c. Filter Box:
      1) Attached to fan inlet.
      2) Box construction to match fan housing.
      3) Integral duct collars.
      4) Pleated panel disposable filters. Nonwoven reinforced 100 percent synthetic fabric media with a metal support grid and heavy-duty beverage board enclosing frame. Minimum MERV 8 efficiency per ASHRAE 52.2. Minimum 30 percent dust spot efficiency.
      5) Filter Media Thickness: 2 inches.
      6) Initial clean filter resistance of 0.28-inch WC. Maximum filter resistance of 0.9-inch WC.
      7) Filter Pressure Gauge: Furnish each filter bank with air filter gauge (Dwyer Magnehelic) with connecting polypropylene tubing and adjustable signal flag.
   d. Vibration Isolation:
      1) Suitable for structurally supported horizontal configuration.
      2) Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 30 percent and 60 percent of maximum deflection.
      3) Sized to match the weight of each fan.
   e. Thermostat (ET-1):
      1) Modulating electric type, except where two-position action is required.
      2) Temperature Scale: Furnish 40 degrees F to 110 degrees F dial.
      3) Concealed adjustments.

4) Adjustable sensitivity.
5) Insulating back where exterior wall mounting is indicated.
6) Nonlocking wire protective guard.

f. Bearing Lubrication Lines:
1) Extended to outside of fan housing.
2) Terminate with zerk fittings.

2. Corrosion Protection Coating:
a. Provide factory-applied corrosion protection coating on the following:
1) Wheel.
2) Housing.
3) Accessories.
4) Interior surfaces in contact with airstream.

F. Manufacturers and Products:

1. Greenheck; Model BSQ (Belt); SQ (Direct).
2. Loren Cook; Model SQNB (Belt); SQND (Direct).

2.04 MOTORS

A. General:

1. Fan motors shall comply with provisions of Section 26 20 00, Low-Voltage AC Induction Motors.
2. Provide integral self-resetting overload protection on single-phase motors.
3. Motors for fans specified for use with variable frequency drives shall be inverter duty type.
4. Motors shall not operate into service factor in any case.

B. Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:

1. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
2. Winding Thermal Protection: None.
3. Space Heater: No.
4. Number of Speeds: Single.
5. Number of Windings: One.
6. Motor Efficiency: Premium efficient.
7. Shaft Type: Solid, carbon steel.
8. Mounting: As required for fan arrangement.
9. Service Factor: 1.15.

2.05 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 316 stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch-high engraved block type black enamel filled equipment identification number and letters as shown on Drawings.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

2.06 SOURCE QUALITY CONTROL

A. General:

1. Fan shall operate at single stable point as indicated by fan curve. Fans having two potential operating points are not acceptable.
2. Fan and motor combination shall be capable of delivering 110 percent of scheduled air quantity and static pressure. Motor shall not operate into motor service factor in any listed case.
3. Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA 203, Appendix L.

B. Testing Provisions:

1. Provide tachometer access holes large enough to accept standard tachometer drive shaft.
2. Center punch fan shaft to accommodate tachometer readings.

C. Acoustical Levels:

1. Perform noise tests in accordance with AMCA 300 and AMCA 301.
2. Fan sound power levels (dB, Reference 10^{-12} Watts) shall be no greater than scheduled values.

D. Balancing:

1. Unless noted otherwise, each fan wheel shall be statically and dynamically balanced to ASA S2.19 Grade G6.3.
2. Fans controlled by variable frequency drives shall be dynamically balanced at speeds 25 percent, 50 percent, 75 percent, and 100 percent of design revolutions per minute.

E. Vibration Test:

1. Each fan furnished with 5 hp or larger motor shall have factory run vibration test, including vibration signatures taken on each bearing in horizontal, vertical, and axial direction.
2. Vibration reading as measured at scheduled rotational speed shall not exceed the following values when fan is rigidly mounted:
   a. Belt Drive (except Vane Axial): 0.15 inch per second peak velocity.
   b. Belt Drive Vane Axial: 0.08 inch per second peak velocity.
   c. Direct Drive: 0.08 inch per second peak velocity.
3. Written records of run test and vibration test shall be made available upon request.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install fans level and plumb.

B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

C. Scroll Drains: Pipe drain connection through running trap to floor drain.

D. Labeling:

1. Label fans in accordance with Article Accessories.
2. Mark exhaust fans serving fume hoods with arrows to indicate proper direction of rotation, in accordance with NFPA 45.

E. Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.

F. Connections:

1. Refer to Section 23 31 13, Metal Ducts and Accessories.
2. Isolate duct connections to fans.
3. Install ductwork adjacent to fans to allow proper service and maintenance.

3.02 FIELD QUALITY CONTROL

A. Functional Tests:

1. Verify blocking and bracing used during shipping are removed.

2. Verify fan is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.
3. Verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify cleaning and adjusting are complete.
5. Disconnect fan drive from motor; verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
6. Reconnect fan drive system; align and adjust belts and install belt guards.
7. Verify lubrication for bearings and other moving parts.
8. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork are in fully open position.

B. Performance Tests:

1. Starting Procedures:
   a. Energize motor and adjust fan to indicated revolutions per minute.
   b. Measure and record motor voltage and amperage.
2. Operational Test:
   a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   b. Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.
   c. Test and adjust control safeties.
   d. Replace damaged and malfunctioning controls and equipment.

3.03 MANUFACTURER'S SERVICES

A. Manufacturer's Representative:

1. Present at site or classroom designated by Owner for minimum person-days listed below, travel time excluded:
   a. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
   b. 1 person-day for facility startup.

3.04 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Balancing:

1. Perform air system balancing as specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
2. Replace fan and motor sheaves as required to achieve design airflow.

E. Vibration Testing:

1. If vibration limits described therein are exceeded, rebalance equipment in-place until design tolerances are met.
   a. Vibration readings as measured at actual rotational speed shall not exceed the following values:
      1) Belt Drive, Flexibility Mounted: 0.25 inch per second peak velocity.
      2) Belt Drive, Rigidly Mounted: 0.16 inch per second peak velocity.

3.05 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. On completion of installation, internally clean fans according to manufacturers' written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

3.06 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this Specification.

1. Fan Schedule.

END OF SECTION

FAN SCHEDULE

SYMBOL	SERVICE	TYPE	FAN DATA								SOUND DATA								ELECTRICAL DATA					MAXIMUM DIMENSIONS				MANUFACTURER AND MODEL NO.	APPLICABLE REMARKS
			AIRFLOW			SPEED	DRIVE	WHEEL		MAXIMUM	MAX. FAN SOUND POWER LEVEL dB (RE 10^{-12} W)								MOTOR					PHYSICAL SIZE INCHES			WEIGHT		
			MAXIMUM CFM	@ SP IN. WG.	MINIMUM CFM	RPM	TYPE	TYPE	MIN DIA INCH	BHP	@ MID OCTAVE BAND FREQUENCY (Hz)								HP	RPM	ENCLOSURE	VOLT	PH	L	W	H	LBS.		
											63	125	250	500	1K	2K	4K	8K											
01-SF-01	PUMPHOUSE SUPPLY	INLINE SQUARE CENTRIFUGAL	500	1.5	500	2061	DIRECT	BI	14	0.39	91	84	79	79	76	75	69	61	1/2	2800	ODP	120	1	22	19	19	120	LOREN COOK; MODEL SQN-D VF	A, B, C, D, E, F
03-EF-01	EC BUILDING EXHAUST	INLINE SQUARE CENTRIFUGAL	200	0.45	200	1193	BELT	BI	12	0.08	80	81	59	55	49	44	49	38	1/4	1800	TEFC	460	3	24	18	18	90	GREENHECK; MODEL BSQ-80-4	E
03-SF-01	EC BUILDING SUPPLY	INLINE SQUARE CENTRIFUGAL	6300	2.25	6300	1195	BELT	BI	21	4.2	92	82	86	74	73	61	54	52	5	1800	TEFC	460	3	34	38	38	450	GREENHECK; MODEL BSQ-240-50	C, E, F

REMARKS:

A: FAN MOUNTED SPEED CONTROL.
B: PROVIDE ORIFICE PLATE FOR HIGH STATIC-LOW FLOW CONDITION.
C: PROVIDE FILTER BOX W/MERV 8 FILTERS AND MAGNEHELIC GAUGE.
D: PROVIDE EC VARI-FLOW MOTOR/DRIVE PACKAGE.
E: REFER TO SECTION 23 34 00 FOR ADDITIONAL REQUIREMENTS.
F: PROVIDE THERMOSTAT.

ABBREVIATIONS:

FC: FORWARD CURVED
BI: BACKWARD INCLINED
AF: AIR FOIL

CABINET FAN, CENTRIFUGAL
INLINE FAN, CENTRIFUGAL, SQUARE INLINE
INLINE FAN, DUCT BOOSTER
INLINE FAN, TUBE AXIAL
INLINE FAN, TUBULAR CENTRIFUGAL
INLINE FAN, FIBERGLASS TUBULAR CENTRIFUGAL
INLINE FAN, VANEAXIAL
PORTABLE EXHAUST FAN
ROOF GRAVITY AIR INLET/RELIEF HOOD, ROUND
ROOF GRAVITY AIR INLET/RELIEF HOOD, LOUVERED
ROOF FAN, CENTRIFUGAL DOWNBLAST
ROOF FAN, CENTRIFUGAL UPBLAST
ROOF FAN, KITCHEN, CENTRIFUGAL UPBLAST
ROOF FAN, FIBERGLASS CENTRIFUGAL UPBLAST
ROOF FAN, HOODED PROPELLER UPBLAST, STANDARD DUTY
ROOF FAN, HOODED PROPELLER UPBLAST, HEAVY DUTY
ROOF SUPPLY AIR UNIT, FILTERED
UTILITY BLOWER, CENTRIFUGAL SWSI, HEAVY DUTY
UTILITY BLOWER, CENTRIFUGAL SWSI, STANDARD DUTY
UTILITY BLOWER, FIBERGLASS CENTRIFUGAL SWSI
WALL FAN, PROPELLER, STANDARD DUTY
WALL FAN, PROPELLER, HEAVY DUTY
WALL FAN, FIBERGLASS PROPELLER
WALL FAN, CENTRIFUGAL
WALL FAN, FIBERGLASS, CENTRIFUGAL

3600 TEFC
1800 ODP
1200 CHEM DUTY
1800/900 XP
1800/1200

SECTION 23 82 00
TERMINAL HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Air Moving and Conditioning Association (AMCA): 300, Reverberant Room Method for Sound Testing of Fans.
2. American Gas Association (AGA).
3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 90.1 IP/SI, Energy Standard for Buildings, Except Low-Rise Residential Buildings.
4. ASTM International (ASTM):
   a. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   b. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
5. Canadian Gas Association (CGA).
6. Electrical Test Laboratories (ETL).
7. National Electrical Manufacturer's Association (NEMA).
8. National Fire Protection Association (NFPA):
   a. 54, National Fuel Gas Code.
   b. 70, National Electrical Code (NEC).
   c. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
9. Sheet Metal and Air Conditioning Contractors' National Assoc., Inc. (SMACNA): Ducted Electric Heat Guide for Air Handling Systems.
10. UL: Product Directories.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Alternating Current.
2. CISD: Chemical Industry, Severe-Duty.
3. dB: Decibel.
4. DWDI: Double Width, Double Inlet.
5. FRP: Fiberglass Reinforced Plastic.
6. hp: Horsepower.
7. ODP: Open Drip Proof.
8. PSC: Permanent Split Capacitor.

9. SWSI: Single Width, Single Inlet.
10. TEFC: Totally Enclosed, Fan Cooled.
11. UV: Ultraviolet.
12. XP: Explosion Proof.

1.03 SUBMITTALS

A. Action Submittals:

1. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics.
2. Manufacturer's standard finish color selection for cabinet finishes.
3. Performance data, including sound power level data (reference 10 to minus 12 power watts) at design operating point, shall be based on AMCA 300.

B. Informational Submittals:

1. Manufacturer's test reports for the following:
   a. Electric duct heater.
2. Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt the arrangement or details shown to the equipment furnished.
3. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE

A. Heating Equipment: Minimum operating efficiencies, specified in the State of Washington Energy Code.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Equipment Schedules: Refer to Article Supplement.

2.02 UNIT HEATER, ELECTRIC, WALL

A. Characteristics:

1. Horizontal air delivery suspended electric unit heater.
2. UL listed and CSA certified.

3. Cabinet Casing:
   a. Corrosion-resistant drawn-formed steel finished with baked on polyester powder paint finish.
   b. Top: Two threaded holes for threaded rod suspension.
   c. Bottom: Hinged panel for service access to wiring and controls.
4. Elements:
   a. Nickel-chromium resistance wire surrounded with magnesium oxide and sheathed in steel spiral-finned tubes.
   b. Kilowatt rating as specified.
5. Motor and Propeller Fan:
   a. Single motor and propeller.
   b. Motor shall be totally enclosed, continuous-duty, with automatic resetting, thermal overload protection.
   c. Propeller fan shall be directly connected to motor shaft and be statically balanced.
   d. Mount motor to unit with rubber vibration absorbing material.
6. Electrical:
   a. Built-in control circuit transformer (where required) to provide a single-source power connection.
   b. Provide built-in transformers and built-in fuse blocks with factory-supplied fuses on models with 480-volt, three-phase power supply to permit 240-volt motor operation.
   c. Enclose electrical control components in separate junction box.
7. Controls: Operated by wall or unit mounted line-voltage thermostat as specified.

B. Manufacturer and Product: Chromolox; Model LUH.

2.03 ELECTRICAL

A. General:

1. Units shall include high and low voltage terminal block connections.
2. Control voltage to indoor unit fan shall be 24 volts.
3. Motor Starters/Contactors: Factory installed with unitary equipment, unless otherwise noted.
4. Disconnects: Factory installed nonfused disconnects or circuit breakers on each unit, unless otherwise noted.

B. Motors:

1. Refer to Section 26 20 00, Low-Voltage AC Induction Motors, for general requirements.

2. Unless otherwise stated, electric motors shall comply with the following:
   a. Voltage, Phase, Horsepower, Synchronous Speed: Refer to Equipment Schedule for motor driven equipment.
   b. Enclosure: ODP, unless specified otherwise.
   c. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
   d. Winding Thermal Protection: Manufacturer's standard.
   e. Space Heater: Manufacturer's standard.
   f. Multispeed Motors, Synchronous Speed, Number of Windings: Manufacturer's standard.
   g. Efficiency: Minimum efficiency per Section 26 20 00, Low-Voltage AC Induction Motors.

2.04 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 316 stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification number and letters as shown on Drawings.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

2.05 SOURCE QUALITY CONTROL

A. Functional Test:

1. Perform manufacturer's standard factory test on equipment.
2. Test equipment actually furnished.
3. Equipment with Electric Resistance Heating Coils: Test with 2,000-volt dielectric test.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install in strict compliance with manufacturer's instructions. Maintain clearances around unit as listed in manufacturer's recommendations.

B. Electric Unit Heaters, All Types:

1. Bottom of unit shall be a minimum of 8 feet above finish floor, unless indicated otherwise.

2. Heater shall be permanently mounted in position indicated with a fixed power supply.
3. Install so obstructions do not block heater air inlet or outlet.

3.02 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification.

1. Unit Heaters Schedule.

END OF SECTION

UNIT HEATERS SCHEDULE

SYMBOL	LOCATION	TYPE	AIR SIDE DATA					ELEC. HEAT DATA					MOUNTING HEIGHT (MIN.) FEET	MAXIMUM DIMENSIONS				MANUFACTURER AND MODEL NO.	APPLICABLE REMARKS
			SUPPLY AIRFLOW CFM	THROW FEET	MOTOR RPM	MOTOR POWER HP	DELTA T DEG. F	CAPACITY kW	MCA	MOCP	VOLT	PH		PHYSICAL SIZE INCHES L	W	H	WEIGHT LBS.		
03-UH-01	EC BUILDING	ELECTRIC, WALL	410	12	1650	1/40	21	2.6	14.25	25	240	1	8	14	9	16	32	CHROMOLOX LUH-02-21-34-40	A, B
03-UH-02	EC BUILDING	ELECTRIC, WALL	410	12	1650	1/40	21	2.6	14.25	25	240	1	8	14	9	16	32	CHROMOLOX LUH-02-21-34-40	A, B
03-UH-03	EC BUILDING	ELECTRIC, WALL	410	12	1650	1/40	21	2.6	14.25	25	240	1	8	14	9	16	32	CHROMOLOX LUH-02-21-34-40	A, B
03-UH-04	EC BUILDING	ELECTRIC, WALL	410	12	1650	1/40	21	2.6	14.25	25	240	1	8	14	9	16	32	CHROMOLOX LUH-02-21-34-40	A, B
03-UH-05	EC BUILDING	ELECTRIC, WALL	410	12	1650	1/40	21	2.6	14.25	25	240	1	8	14	9	16	32	CHROMOLOX LUH-02-21-34-40	A, B
03-UH-06	EC BUILDING	ELECTRIC, WALL	410	12	1650	1/40	21	2.6	14.25	25	240	1	8	14	9	16	32	CHROMOLOX LUH-02-21-34-40	A, B

REMARKS:

A: INCLUDE WALL SWIVEL MOUNTING BRACKET, MODEL NO. WUH-01A
B: REFER TO SECTION 23 82 00 FOR ADDITIONAL REQUIREMENTS.

SECTION 26 05 02
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to Division 26, Electrical. Work specified herein shall be performed as if specified in the individual sections.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. National Electrical Contractors Association (NECA): National Electrical Installation Standards.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. Z535.4, Product Safety Signs and Labels.
3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.03 DESIGN REQUIREMENTS

A. Provide anchorage and bracing design drawings, calculations, and related information where required under Section 01 88 15, Anchorage and Bracing.

B. Provide seismic certification per requirements of Section 01 45 33, Special Inspection, Observation, and Testing, where required in that section for electrical equipment listed.

1.04 ELECTRIC SERVICE DIVISION OF RESPONSIBILITY

A. Incoming underground electrical service facilities provided by the serving utility as part of its normal obligation to customers is work provided outside this Contract. Under this Contract, provide customer required service provisions and electrical work including, but not limited to, primary trench and backfill, primary duct system, transformer pad site preparation, transformer pad, utility vault excavation, junction cabinet pad site preparation and pad, metering components and associated conduit, and secondary facilities. Utility vaults, utility transformers, and junction cabinets are provided by Avista as shown on Drawings. Schedule and coordinate work of serving utility as required to provide electric service to the Work.

B. Provide all utility provisions in accordance with Avista Blue Book, current addition. Coordinate with the utility company prior to start of work.

1.05 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' data for the following:
   a. Electrical service components.
   b. Nameplates, signs, and labels.
2. Anchorage and bracing drawings and catalog information, as required by Section 01 88 15, Anchorage and Bracing, for loads in Section 01 61 00, Common Product Requirements.

B. Informational Submittals: Anchorage and bracing calculations, as required by Section 01 88 15, Anchorage and Bracing, for loads in Section 01 61 00, Common Product Requirements.

1.06 QUALITY ASSURANCE

A. Provide the Work in accordance with NFPA 70. Where required by Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.

B. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark or label.

C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.

1.07 ENVIRONMENTAL CONDITIONS

A. The following areas are classified nonhazardous, wet, and corrosive. Use materials and methods required for such areas.

1. Areas within EC-building.

B. The following areas are classified nonhazardous and wet. Use materials and methods required for such areas.

1. Outdoor above grade areas not covered above.

C. The following areas are classified as indoor dry. Use materials and methods required for such areas:

1. Pump Control Vault: This classification is for guidance purposes only, and may not reflect final pump control vault. Follow requirements in Vendor Package Performance Scope of work.

PART 2 PRODUCTS

2.01 GENERAL

A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

B. Material and equipment installed in heated and ventilated areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of 40 degrees F to 104 degrees F.

C. Materials and equipment installed outdoors shall be capable of continuous operation at their specified rating within the ambient temperature range stated in Section 01 61 00, Common Product Requirements.

D. Equip panels installed outdoors in direct sun with sun shields.

2.02 EQUIPMENT FINISH

A. Manufacturer’s standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance with light gray color finish as approved by Engineer.

2.03 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws:

1. Stainless steel.
2. Adhesive: Single-part, room temperature vulcanizing adhesive suitable for the environment and materials installed. Use adhesive on NEMA 4 or NEMA 4X enclosures only.

C. Color: White, engraved to a black core.

D. Letter Height:

1. Pushbuttons/Selector Switches: 1/8 inch.
2. Other Electrical Equipment: 1/4 inch.

2.04 SIGNS AND LABELS

A. Sign size, lettering, and color shall be in accordance with NEMA Z535.4.

PART 3 EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of Engineer.

B. Check approximate locations of light fixtures, switches, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify Engineer in writing.

C. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Keep openings in boxes and equipment closed during construction.

E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of Engineer. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.

3.02 ANCHORING, BRACING, AND MOUNTING

A. Equipment anchoring and mounting shall be in accordance with manufacturer’s requirements for Project design criteria provided in Section 01 61 00, Common Product Requirements, to meet the requirements of Section 01 88 15, Anchorage and Bracing.

3.03 COMBINING CIRCUITS INTO COMMON RACEWAY

A. Unless already shown on Drawings, do not combine power, signal, or control circuits into common raceways without authorization of Engineer except as noted below.

1. Power circuits from loads in same general area to same source location (such as: panelboard, switchboard, low voltage motor control center).
   a. Lighting Circuits: Combine no more than three circuits to a single raceway. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
   b. Receptacle Circuits, 120 Volt Only: Combine no more than three circuits to a single raceway. Provide a separate neutral conductor for each circuit. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
   c. All Other Power Circuits: Do not combine power circuits without authorization of Engineer.

3.04 NAMEPLATES, SIGNS, AND LABELS

A. Arc Flash Protection Warning Signs:

1. Field mark panelboards to warn qualified persons of potential arc-flash hazards. Locate marking so to be clearly visible to persons before working on energized equipment.
2. Use arc flash hazard warning signs provided by Engineer. Use arc flash hazard boundary, energy level, PPE level and description, shock hazard, bolted fault current, and equipment name from study required in Section 26 05 70, Electrical Systems Analysis, as basis for warning signs.

B. Available Fault Current Signs:

1. Install label on service equipment to indicate the maximum available fault current at the equipment. Labels shall be of sufficient durability for the environment in which the equipment is installed. Labels shall include the following information:
   a. Equipment name or identification.
   b. Available fault current at the equipment.
   c. Date the fault current calculations were performed.
2. Use bolted fault current and equipment name from study required in Section 26 05 70, Electrical Systems Analysis, as basis for the label.

3. Where existing electrical systems are modified, completely remove existing fault current labels if present, and install new labels in accordance with the above requirements.

C. Multiple Power Supply Sign: Install permanent plaque or directory at each service disconnect location denoting other services, feeders, and branch circuits supplying the building, and the area served by each.

D. Equipment Nameplates:

1. Provide a nameplate to label electrical equipment including switchgear, switchboards, motor control centers, panelboards, motor starters, transformers, terminal junction boxes, disconnect switches, switches and control stations.
2. Switchgear, motor control center, transformer, and terminal junction box nameplates shall include equipment designation.
3. Disconnect switch, starter, and control station nameplates shall include name and number of equipment powered or controlled by that device.
4. Switchboard and panelboard nameplates shall include equipment designation, service voltage, and phases.

3.05 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.06 CLEANING AND TOUCHUP PAINTING

A. Cleaning: Throughout the Work, clean interior and exterior of devices and equipment by removing debris and vacuuming.

B. Touchup Paint:

1. Touchup scratches, scrapes and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.

2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory finish, that meets requirements of Specification, and is acceptable to Engineer.

3.07 PROTECTION FOLLOWING INSTALLATION

A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation and contact surfaces.

B. When equipment intended for indoor installation is installed at Contractor's convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to Engineer.

END OF SECTION

SECTION 26 05 04
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A1011/A1011M, Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low Alloy Formability.
   b. E814, Method of Fire Tests of Through-Penetration Fire Stops.
2. Canadian Standards Association (CSA).
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 18, Standard for Shunt Power Capacitors.
4. International Society of Automation (ISA): RP12.06.01, Wiring Practices for Hazardous (Classified) Locations Instrumentation–Part 1: Intrinsic Safety.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C12.1, Code for Electricity Metering.
   c. C12.6, Phase-Shifting Devices Used in Metering, Marking and Arrangement of Terminals.
   d. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
   e. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
   f. KS 1, Enclosed and Miscellaneous Distribution Switches (600 Volts Maximum).
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. UL:
   a. 98, Standard for Enclosed and Dead-Front Switches.
   b. 248, Standard for Low Voltage Fuses.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   e. 508, Standard for Industrial Control Equipment.
   f. 810, Standard for Capacitors.

g. 943, Standard for Ground-Fault Circuit-Interrupters.
h. 1059, Standard for Terminal Blocks.
i. 1479, Fire Tests of Through-Penetration Fire Stops.

1.02 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' data for the following:
   a. Control devices.
   b. Control relays.
   c. Circuit breakers.
   d. Fused switches.
   e. Nonfused switches.
   f. Fuses.
   g. Magnetic contactors.
   h. Enclosures: Include enclosure data for products having enclosures.
2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals: Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

PART 2 PRODUCTS

2.01 MOLDED CASE CIRCUIT BREAKER THERMAL MAGNETIC, LOW VOLTAGE

A. General:

1. Type: Molded case.
2. Trip Ratings: 15 amps to 800 amps.
3. Voltage Ratings: 120, 240, 277, 480, and 600V ac.
4. Suitable for mounting and operating in any position.
5. UL 489.

B. Operating Mechanism:

1. Overcenter, trip-free, toggle type handle.
2. Quick-make, quick-break action.
3. Locking provisions for padlocking breaker in OPEN position.
4. ON/OFF and TRIPPED indicating positions of operating handle.
5. Operating handle to assume a CENTER position when tripped.

C. Trip Mechanism:

1. Individual permanent thermal and magnetic trip elements in each pole.
2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
3. Two and three pole, common trip.
4. Automatically opens all poles when overcurrent occurs on one pole.
5. Test button on cover.
6. Calibrated for 40 degrees C ambient, unless shown otherwise.
7. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

D. Short Circuit Interrupting Ratings:

1. Equal to, or greater than, available fault current or interrupting rating shown.
2. Not less than the following rms symmetrical currents for the indicated trip ratings:
   a. Up to 100A, less than 250V ac: 10,000 amps.
   b. Up to 100A, 250V ac to 600V ac: 14,000 amps.
   c. Over 100A: 22,000 amps.
3. Series Connected Ratings: Do not apply series connected short circuit ratings in NEC 700 Emergency Systems.

E. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel).

1. Ground fault sensor shall be rated same as circuit breaker.
2. Push-to-test button.

F. Magnetic Only Type Breakers: Where shown; instantaneous trip adjustment which simultaneously sets magnetic trip level of each individual pole continuously through a 3X to 10X trip range.

G. Accessories: Shunt trip, auxiliary switches, handle lock ON devices, mechanical interlocks, key interlocks, unit mounting bases, double lugs as shown or otherwise required. Shunt trip operators shall be continuous duty rated or have coil-clearing contacts.

H. Connections:

1. Supply (line side) at either end.
2. Mechanical wire lugs, except crimp compression lugs where shown.

3. Lugs removable/replaceable for breaker frames greater than 100 amperes.
4. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.

I. Enclosures for Independent Mounting:

1. See Article Enclosures.
2. Service Entrance Use: Breakers in required enclosure and required accessories shall be UL 489 listed.
3. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position. Provide bypass feature for use by qualified personnel.

2.02 FUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. UL 98 listed for use and location of installation.

B. NEMA KS 1.

C. Short Circuit Rating: 200,000 amps rms symmetrical with Class R, Class J, or Class L fuses installed.

D. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

E. Connections:

1. Mechanical lugs, except crimp compression lugs where shown.
2. Lugs removable/replaceable.
3. Suitable for 75 degrees C rated conductors at NEC 75 degrees C ampacity.

F. Fuse Provisions:

1. 30-amp to 600-amp rated shall incorporate rejection feature to reject all fuses except Class R.
2. 601-amp rated and greater shall accept Class L fuses, unless otherwise shown.

G. Enclosures: See Article Enclosures.

H. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.03 NONFUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Lugs: Suitable for use with 75 degrees C wire at NEC 75 degrees C ampacity.

D. Auxiliary Contact:

1. Operation: Make before power contacts make and break before power contacts break.
2. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.

E. Enclosures: See Article Enclosures.

F. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.04 FUSE, 250-VOLT AND 600-VOLT

A. Power Distribution, General:

1. Current-limiting, with 200,000 ampere rms interrupting rating.
2. Provide to fit mountings specified with switches.
3. UL 248.

B. Power Distribution, Ampere Ratings 1 Amp to 600 Amps:

1. Class: RK-1.
2. Type: Dual element, with time delay.
3. Manufacturers and Products:
   a. Bussmann; Types LPS-RK (600 volts) and LPN-RK (250 volts).
   b. Littelfuse; Types LLS-RK (600 volts) and LLN-RK (250 volts).

C. Power Distribution, Ampere Ratings 601 Amps to 6,000 Amps:

1. Class: L.
2. Double O-rings and silver links.
3. Manufacturers and Products:
   a. Bussmann; Type KRP-C.
   b. Littelfuse, Inc.; Type KLPC.

D. Cable Limiters:

1. 600V or less; crimp to copper cable, bolt to bus or terminal pad.
2. Manufacturer and Product: Bussmann; K Series.

E. Ferrule:

1. 600V or less, rated for applied voltage, small dimension.
2. Ampere Ratings: 1/10 amp to 30 amps.
3. Dual-element time-delay, time-delay, or nontime-delay as required.
4. Provide with blocks or holders as indicated and suitable for location and use.
5. Manufacturers:
   a. Bussmann.
   b. Littlefuse, Inc.

2.05 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Light: Push-to-test LED, full voltage.

D. Pushbutton Color:

1. ON or START: Red, unless stated otherwise on Drawings.
2. OFF or STOP: Green, unless stated otherwise on Drawings.

E. Pushbutton and selector switch lockable in OFF position where indicated.

F. Legend Plate:

1. Material: Aluminum.
2. Engraving: Enamel filled in high contrasting color.
3. Text Arrangement: 11-character/spaces on one line, 14-character/spaces on each of two lines, as required, indicating specific function.
4. Letter Height: 7/64 inch.

G. Manufacturers and Products:

1. Heavy-Duty, Oil-Tight Type:
   a. General Electric Co.; Type CR 104P.
   b. Square D Co.; Type T.
   c. Eaton/Cutler-Hammer; Type 10250T.

2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
   a. Square D Co.; Type SK.
   b. General Electric Co.; Type CR 104P.
   c. Eaton/Cutler-Hammer; Type E34.
   d. Crouse-Hinds; Type NCS.

2.06 TERMINAL BLOCK, 600 VOLTS

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:

1. Capable of wire connections without special preparation other than stripping.
2. Capable of jumper installation with no loss of terminal or rail space.
3. Individual, rail mounted.

I. Marking system, allowing use of preprinted or field-marked tags.

J. Manufacturers:

1. Weidmuller, Inc.
2. Ideal.
3. Electrovert USA Corp.

2.07 MAGNETIC CONTROL RELAY

A. Industrial control with field convertible contacts rated 10 amps continuous, 7,200VA make, 720VA break.

B. NEMA ICS 2, Designation: A300 (300 volts).

C. Latching Attachment: Mechanical latch, having unlatching coil and coil clearing contacts.

D. Manufacturers and Products:

1. Eaton/Cutler-Hammer; D26 Type M.
2. General Electric Co.; Type CR120A.
3. Square D; Type X.

2.08 MAGNETIC CONTACTOR

A. UL listed.

B. Electrically operated, electrically held.

C. Main Contacts:

1. Power driven in one direction with mechanical spring dropout.
2. Silver alloy with wiping action and arc quenchers.
3. Continuous-duty, rated 20 amperes.
4. Poles: As shown.

D. Control: As shown.

E. Auxiliary Contacts: One normally open and one normally closed, rated 7200VA make, 720VA break, at 600V, A600 per NEMA ICS 5.

F. Enclosures: See Article Enclosures.

G. Manufacturers and Products:

1. Eaton/Cutler-Hammer; Class A201.
2. General Electric Co.; CR 353.
3. Square D Co.; Class 8910.

2.09 SUPPORT AND FRAMING CHANNELS

A. Carbon Steel Framing Channel:

1. Material: Rolled, mild strip steel, 12-gauge minimum, ASTM A1011/ A1011M, Grade 33.
2. Finish: Hot-dip galvanized after fabrication.

B. Paint Coated Framing Channel: Carbon steel framing channel with electro-deposited rust inhibiting acrylic or epoxy paint.

C. PVC-Coated Framing Channel: Carbon steel framing channel with 40-mil polyvinyl chloride coating.

D. Stainless Steel Framing Channel: Rolled, Type 316 stainless steel, 12-gauge minimum.

E. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.
3. Aickinstrut.

2.10 ENCLOSURES

A. Finish: Sheet metal structural and enclosure parts shall be completely painted using an electrodeposition process so interior and exterior surfaces as well as bolted structural joints have a complete finish coat on and between them.

B. Color: Manufacturer's standard color (gray) baked-on enamel, unless otherwise shown.

C. Barriers: Provide metal barriers within enclosures to separate wiring of different systems and voltage.

D. Enclosure Selections:

1. Except as shown otherwise, provide electrical enclosures according to the following table:

Enclosures			
Location	**Finish**	**Environment**	**NEMA 250 Type**
Indoor		Dry	12
Indoor and Outdoor		Wet	3R except VFDs VFD Enclosures 4
Indoor and Outdoor		Wet and Corrosive	4X 316 Stainless Steel or FRP if needed

PART 3 EXECUTION

3.01 GENERAL

A. Install equipment in accordance with manufacturer's recommendations.

3.02 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Install heavy-duty, oil-tight type in nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations, unless otherwise shown.

B. Install heavy-duty, watertight and corrosion-resistant type in nonhazardous, outdoor, or normally wet areas, unless otherwise shown.

3.03 SUPPORT AND FRAMING CHANNEL

A. Install where required for mounting and supporting electrical equipment, raceway, and cable tray systems.

B. Channel Type:

1. Interior, Wet or Dry (Noncorrosive) Locations:
   a. PVC-Coated Conduit: PVC coated.
   b. Steel Raceway and Other Systems Not Covered: Carbon steel or paint coated.
2. Interior, Corrosive (Wet or Dry) Locations:
   a. PVC Conduit: Type 316 stainless steel or nonmetallic.
   b. PVC-Coated Steel Conduit and Other Systems Not Covered: Type 316 stainless steel, nonmetallic, or PVC-coated steel.
3. Outdoor, Noncorrosive Locations:
   a. Steel Raceway: Carbon steel or paint coated framing channel, except where mounted on aluminum handrail, then use aluminum framing channel.

C. Paint cut ends prior to installation with the following:

1. Carbon Steel Channel: Zinc-rich primer.
2. Painted Channel: Rust-inhibiting epoxy or acrylic paint.
3. PVC-Coated Channel: PVC patch.

END OF SECTION

SECTION 26 05 05
CONDUCTORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Association of Edison Illuminating Companies (AEIC): CS 8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 kV through 46 kV.
2. ASTM International (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. B3, Standard Specification for Soft or Annealed Copper Wire.
   c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   d. B496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
3. Insulated Cable Engineer's Association, Inc. (ICEA):
   a. S-58-679, Standard for Control Cable Conductor Identification.
   b. S-73-532, Standard for Control Thermocouple Extensions and Instrumentation Cables.
4. National Electrical Manufacturers' Association (NEMA):
   a. CC 1, Electric Power Connectors for Substations.
   b. WC 57, Standard for Control, Thermocouple Extension, and Instrumentation Cables.
   c. WC 70, Standard for Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
5. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
6. Telecommunications Industry Association (TIA): TIA-568-C, Commercial Building Telecommunications Cabling Standard.
7. UL:
   a. 13, Standard for Safety for Power-Limited Circuit Cables.
   b. 44, Standard for Safety for Thermoset-Insulated Wires and Cables.
   c. 62, Standard for Safety for Flexible Cord and Cables.
   d. 486A-486B, Standard for Safety for Wire Connectors.
   e. 486C, Standard for Safety for Splicing Wire Connectors.

f. 510, Standard for Safety for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
g. 854, Standard for Safety for Service-Entrance Cables.
h. 1277, Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
i. 1569, Standard for Safety for Metal-Clad Cables.
j. 1581, Standard for Safety for Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data:
   a. Wire and cable.
   b. Wire and cable accessories.
2. Cable Pulling Calculations:
   a. Ensure submitted and reviewed before cable installation.
   b. Provide for the following cable installations:
      1) Multiconductor 600-volt cable sizes larger than 2 AWG that cannot be hand pulled.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70. Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark.

PART 2 PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 70.

B. Conductor Type:

1. 120-Volt and 277-Volt Lighting, 10 AWG and Smaller: Solid copper.
2. 120-Volt Receptacle Circuits, 10 AWG and Smaller: Solid copper.
3. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN-2, except for sizes No. 6 and larger, with XHHW-2 insulation.

D. Flexible Cords and Cables:

1. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 70.

2.02 600-VOLT RATED CABLE

A. General:

1. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 70,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Type 3, 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.

1. Outer Jacket: 45-mil nominal thickness.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
3. Dimension: 0.31-inch nominal OD.
4. Conductors:
    a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
    b. 20 AWG, seven-strand tinned copper drain wire.
    c. Insulation: 15-mil nominal PVC.
    d. Jacket: 4-mil nominal nylon.
    e. Color Code: Pair conductors, black and red.
5. Manufacturers:
    a. Okonite Co.
    b. Alpha Wire Corp.
    c. Belden.

2.03 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.04 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33+, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arc and Fireproofing:
    a. 30-mil, elastomer.
    b. Manufacturers and Products:
        1) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
        2) Plymouth; 53 Plyarc, with 77 Plyglas glass cloth tapebinder.

B. Identification Devices:

1. Sleeve:
    a. Permanent, PVC, yellow or white, with legible machine-printed black markings.
    b. Manufacturers and Products:
        1) Raychem; Type D-SCE or ZH-SCE.
        2) Brady, Type 3PS.
2. Heat Bond Marker:
    a. Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.
    b. Self-laminating protective shield over text.
    c. Machine printed black text.
    d. Manufacturer and Product: 3M Co.; Type SCS-HB.
3. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
4. Tie-On Cable Marker Tags:
    a. Chemical-resistant white tag.
    b. Size: 1/2 inch by 2 inches.
    c. Manufacturer and Product: Raychem; Type CM-SCE.

5. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulug.
      3) ILSCO.
2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
   a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
   b. Seamless.
   c. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO; ILSCONS.
3. Self-Insulated, Freespring Wire Connector (Wire Nuts):
   a. UL 486C.
   b. Plated steel, square wire springs.
   c. Manufacturers and Products:
      1) Thomas & Betts.
      2) Ideal; Twister.
4. Self-Insulated, Set Screw Wire Connector:
   a. Two piece compression type with set screw in brass barrel.
   b. Insulated by insulator cap screwed over brass barrel.
   c. Manufacturers:
      1) 3M Co.
      2) Thomas & Betts.
      3) Marrette.

D. Cable Lugs:

1. In accordance with NEMA CC 1.
2. Rated 600 volts of same material as conductor metal.
3. Uninsulated Crimp Connectors and Terminators:
   a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
   b. Manufacturers and Products:
      1) Thomas & Betts; Color-Keyed.
      2) Burndy; Hydent.
      3) ILSCO.

4. Uninsulated, Bolted, Two-Way Connectors and Terminators:
   a. Manufacturers and Products:
      1) Thomas & Betts; Locktite.
      2) Burndy; Quiklug.
      3) ILSCO.

E. Cable Ties:

1. Nylon, adjustable, self-locking, and reusable.
2. Manufacturer and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation:

1. Thermally stabilized cross-linked polyolefin.
2. Single wall for insulation and strain relief.
3. Dual Wall, adhesive sealant lined, for sealing and corrosion resistance.
4. Manufacturers and Products:
   a. Thomas & Betts; SHRINK-KON.
   b. Raychem; RNF-100 and ES-2000.

2.05 PULLING COMPOUND

A. Nontoxic, noncorrosive, noncombustible, nonflammable, water-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Approved for intended use by cable manufacturer.

D. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

E. Manufacturers:

1. Ideal Co.
2. Polywater, Inc.
3. Cable Grip Co.

2.06 WARNING TAPE

A. As specified in Section 26 05 33, Raceway and Boxes.

2.07 SOURCE QUALITY CONTROL

A. Conductors 600 Volts and Below: Test in accordance with UL 44 and UL 854.

PART 3 EXECUTION

3.01 GENERAL

A. Conductor installation shall be in accordance with manufacturer's recommendations.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Terminate conductors and cables, unless otherwise indicated.

E. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors.

F. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

G. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches on center.

H. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering area 1-1/2 inches to 2 inches wide.
2. 8 AWG and Smaller: Provide colored conductors.

3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts, Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts, Three-Phase, Four-Wire, Delta, Center Tap, Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Brown Orange Yellow
Note: Phase A, B, C implies direction of positive phase rotation.		

4. Tracer: Outer covering of white with identifiable colored strip, other than green, in accordance with NFPA 70.

3.03 CIRCUIT IDENTIFICATION

A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Not Appearing in Circuit Schedules:

1. Assign circuit name based on device or equipment at load end of circuit.
2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

C. Method:

1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.
2. Cables and Conductors 2 AWG and Larger:
   a. Identify with marker plates or tie-on cable marker tags.
   b. Attach with nylon tie cord.
3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors 6 AWG and larger, unless specifically indicated or approved by Engineer.

C. Connections and Terminations:

1. Install wire nuts only on solid conductors. Wire nuts are not allowed on stranded conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
3. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors 12 AWG and smaller.
4. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors 4 AWG through 2/0 AWG.
5. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors 3/0 AWG and larger.
6. Install uninsulated terminators bolted together on motor circuit conductors 10 AWG and larger.
7. Place no more than one conductor in any single-barrel pressure connection.
8. Install crimp connectors with tools approved by connector manufacturer.
9. Install terminals and connectors acceptable for type of material used.
10. Compression Lugs:
    a. Attach with a tool specifically designed for purpose. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
    b. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:

1. Insulate uninsulated connections.
2. Indoors: Use general purpose, flame retardant tape or single wall heat shrink.
3. Outdoors, Dry Locations: Use flame retardant, cold- and weather-resistant tape or single wall heat shrink.
4. Below Grade and Wet or Damp Locations: Use dual wall heat shrink.

F. Cap spare conductors with UL listed end caps.

G. Cabinets, and Panels:

1. Remove surplus wire, bridle and secure.
2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:

1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer’s instructions.
3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
4. Cable Protection:
   a. Under Infinite Access Floors: May install without bundling.
   b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under floor or grouped into bundles at least 1/2 inch in diameter.
   c. Maintain integrity of shielding of instrumentation cables.
   d. Ensure grounds do not occur because of damage to jacket over shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
2. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC).
3. UL.

1.02 SUBMITTALS

A. Action Submittals:

1. Product data for the following:
    1) Exothermic weld connectors.
    2) Mechanical connectors.
    3) Compression connectors.
    4) Ground rods.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, provide material and equipment labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by UL:
    a. Confirm conformance with UL standards.
    b. Supply with an applied UL listing mark.

PART 2 PRODUCTS

2.01 GROUND ROD

A. Material: Copper-clad steel.

B. Diameter: Minimum 3/4 inch.

C. Length: 10 feet.

2.02 GROUND CONDUCTORS

A. As specified in Section 26 05 05, Conductors.

2.03 CONNECTORS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.
2. Indoor Weld: Use low-smoke, low-emission process.
3. Manufacturers and Products:
   a. Erico Products, Inc.; Cadweld and Cadweld Exolon.
   b. Thermoweld.

B. Compression Type:

1. Compress-deforming type; wrought copper extrusion material.
2. Single indentation for conductors 6 AWG and smaller.
3. Double indentation with extended barrel for conductors 4 AWG and larger.
4. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.
5. Manufacturers and Products:
   a. Burndy Corp.; Hyground Irreversible Compression.
   b. Thomas and Betts Co.
   c. ILSCO.

C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

1. Manufacturers:
   a. Burndy Corp.
   b. Thomas and Betts Co.

PART 3 EXECUTION

3.01 GENERAL

A. Grounding: In compliance with NFPA 70 and IEEE C2.

B. Ground electrical service neutral at service entrance equipment with grounding electrode conductor to grounding electrode system.

C. Ground each separately derived system neutral with common grounding electrode conductor to grounding electrode system.

D. Bond together all grounding electrodes that are present at each building or structure served to form one common grounding electrode system.

E. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

F. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

G. Shielded Instrumentation Cables:

1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
3. Do not ground instrumentation cable shield at more than one point.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

I. Metallic Equipment Enclosures: Use furnished ground lug; if none furnished, tap equipment housing and install solderless terminal connected to box with machine screw. For circuits greater than 20 amps use minimum 5/16-inch diameter bolt.

3.03 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Motors Less Than 10 hp: Use furnished ground lug in motor connection box. If none furnished, provide compression, spade-type terminal connected to conduit box mounting screw.

D. Circuits 20 Amps or Above: Tap motor frame or equipment housing. Install solderless terminal with minimum 5/16-inch diameter bolt.

3.04 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

C. Space multiple ground rods by one rod length.

D. Install to 8 feet below local frost depth.

3.05 CONNECTIONS

A. General:

1. Abovegrade Connections: Install exothermic weld, mechanical, or compression-type connectors; or brazing.
2. Belowgrade Connections: Install exothermic weld or compression type connectors.
3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
4. Notify Engineer prior to backfilling ground connections.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.

2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
3. Avoid using badly worn molds.
4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:

1. Install in accordance with connector manufacturer's recommendations.
2. Install connectors of proper size for grounding conductors and ground rods specified.
3. Install using connector manufacturer's compression tool having proper sized dies and operate per manufacturer's instructions.

D. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

3.06 METAL STRUCTURE GROUNDING

A. Bond metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.07 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network and to any additional indicated grounding electrodes.

B. Bond neutrals of pad-mounted transformers to locally driven ground rods and buried ground wire encircling transformer and system ground network.

3.08 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

END OF SECTION

SECTION 26 05 33
RACEWAY AND BOXES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): HB, Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
   a. A123/123M, Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
   b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   e. D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
3. National Electrical Contractor's Association, Inc. (NECA): Installation standards.
4. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. C80.1, Electrical Rigid Steel Conduit (ERSC).
   c. C80.3, Steel Electrical Metallic Tubing (EMT).
   d. C80.6, Electrical Intermediate Metal Conduit (EIMC).
   e. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   f. TC 2, Electrical Polyvinyl Chloride (PVC) Conduit.
   g. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   h. TC 6, Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.
5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
6. Telecommunications Industry Association (TIA): 569B, Commercial Building Standard for Telecommunications Pathways and Spaces.

7. UL:
    a. 1, Standard for Safety for Flexible Metal Conduit.
    b. 5, Standard for Safety for Surface Metal Raceways and Fittings.
    c. 6, Standard for Safety for Electrical Rigid Metal Conduit – Steel.
    d. 360, Standard for Safety for Liquid-Tight Flexible Steel Conduit.
    e. 514B, Standard for Safety for Conduit, Tubing, and Cable Fittings.
    f. 651, Standard for Safety for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
    g. 651A, Standard for Safety for Type EB and A Rigid PVC Conduit and HDPE Conduit.
    h. 870, Standard for Safety for Wireways, Auxiliary Gutters, and Associated Fittings.
    i. 1242, Standard for Safety for Electrical Intermediate Metal Conduit – Steel.
    j. 1660, Standard for Safety for Liquid-Tight Flexible Nonmetallic Conduit.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's Literature:
    a. Conduit.
    b. Conduit fittings.
    c. Device boxes.
    d. Junction and pull boxes used at or belowgrade.
    e. Terminal junction boxes.
2. Precast Manholes and Handholes:
    a. Dimensional drawings and descriptive literature.
    b. Traffic loading calculations.
    c. Accessory information.
3. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
3. Manufacturer's certification of training for PVC-coated rigid galvanized steel conduit installer.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark.

B. PVC-Coated, Rigid Galvanized Steel Conduit Installer: Certified by conduit manufacturer as having received minimum 2 hours of training on installation procedures.

PART 2 PRODUCTS

2.01 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit (RGS):

1. Meet requirements of NEMA C80.1 and UL 6.
2. Material: Hot-dip galvanized with chromated protective layer.

B. PVC Schedule 40 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

C. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of NEMA RN 1.
2. Material:
   a. Meet requirements of NEMA C80.1 and UL 6.
   b. Exterior Finish: PVC coating, 40-mil nominal thickness; bond to metal shall have tensile strength greater than PVC.
   c. Interior finish: Urethane coating, 2-mil nominal thickness.
3. Threads: Hot-dipped galvanized and factory coated with urethane.
4. Bendable without damage to interior or exterior coating.

D. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel with extruded PVC jacket.

E. Flexible Metal, Nonliquid-Tight Conduit:

1. Meet requirements of UL 1.
2. Material: Galvanized steel.

F. Flexible, Nonmetallic, Liquid-Tight Conduit:

1. Material: PVC core with fused flexible PVC jacket.
2. UL 1660 listed for:
   a. Dry Conditions: 80 degrees C insulated conductors.
   b. Wet Conditions: 60 degrees C insulated conductors.
3. Manufacturers and Products:
   a. Carlon; Carflex or X-Flex.
   b. T & B; Xtraflex LTC or EFC.

2.02 FITTINGS

A. Rigid Galvanized Steel and Intermediate Metal Conduit:

1. General:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized. Set screw and threadless compression fittings not permitted.
2. Bushing:
   a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
   b. Manufacturers and Products:
      1) Appleton; Series BU-I.
      2) O-Z/Gedney; Type HB.
3. Grounding Bushing:
   a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.
   b. Manufacturers and Products:
      1) Appleton; Series GIB.
      2) O-Z/Gedney; Type HBLG.
4. Conduit Hub:
   a. Material: Malleable iron with insulated throat with bonding screw.
   b. UL listed for use in wet locations.
   c. Manufacturers and Products:
      1) Appleton, Series HUB-B.

2) O-Z/Gedney; Series CH.
3) Meyers; ST Series.

5. Conduit Bodies:
   a. Sized as required by NFPA 70.
   b. Manufacturers and Products (for Normal Conditions):
      1) Appleton; Form 35 threaded unilets.
      2) Crouse-Hinds; Form 7 or Form 8 threaded condulets.
      3) Killark; Series O electrolets.
      4) Thomas & Betts; Form 7 or Form 8.
   c. Manufacturers (for Hazardous Locations):
      1) Appleton.
      2) Crouse-Hinds.
      3) Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Unions:
   a. Concrete tight, hot-dip galvanized malleable iron.
   b. Manufacturers and Products:
      1) Appleton; Series SCC bolt-on coupling or Series EC three-piece union.
      2) O-Z/Gedney; Type SSP split coupling or Type 4 Series, three-piece coupling.
8. Conduit Sealing Fitting:
   a. Manufacturers and Products:
      1) Appleton; Type EYF, EYM, or ESU.
      2) Crouse-Hinds; Type EYS or EZS.
      3) Killark; Type EY or Type EYS.
9. Drain Seal:
   a. Manufacturers and Products:
      1) Appleton; Type EYD.
      2) Crouse-Hinds; Type EYD or Type EZD.
10. Drain/Breather Fitting:
    a. Manufacturers and Products:
       1) Appleton; Type ECDB.
       2) Crouse-Hinds; ECD.
11. Expansion Fitting:
    a. Manufacturers and Products:
       1) Deflection/Expansion Movement:
          a) Appleton; Type DF.
          b) Crouse-Hinds; Type XD.
       2) Expansion Movement Only:
          a) Appleton; Type XJ.
          b) Crouse-Hinds; Type XJ.
          c) Thomas & Betts; XJG-TP.

12. Cable Sealing Fitting:
    a. To form watertight nonslip cord or cable connection to conduit.
    b. For Conductors with OD of 1/2 Inch or Less: Neoprene bushing at connector entry.
    c. Manufacturers and Products:
        1) Appleton; CG-S.
        2) Crouse-Hinds; CGBS.

B. PVC Conduit and Tubing:

1. Meet requirements of NEMA TC 3.
2. Type: PVC, slip-on.

C. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of UL 514B.
2. Fittings: Rigid galvanized steel type, PVC coated by conduit manufacturer.
3. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC coated by conduit manufacturer.
4. Finish: 40-mil PVC exterior, 2-mil urethane interior.
5. Overlapping pressure-sealing sleeves.
6. Conduit Hangers, Attachments, and Accessories: PVC-coated.
7. Manufacturers:
    a. Robroy Industries.
    b. Ocal.
8. Expansion Fitting:
    a. Manufacturer and Product: Ocal; OCAL-BLUE XJG.

D. Flexible Metal, Liquid-Tight Conduit:

1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
2. Insulated throat and sealing O-rings.
3. Manufacturers and Products:
    a. Thomas & Betts; Series 5331.
    b. O-Z/Gedney; Series 4Q.

E. Flexible Metal, Nonliquid-Tight Conduit:

1. Meet requirements of UL 514B.
2. Body: Galvanized steel.
3. Throat: Nylon insulated.
4. 1-1/4-Inch Conduit and Smaller: One screw body.

5. 1-1/2-Inch Conduit and Larger: Two screw body.
6. Manufacturer and Product: Appleton; Series 7400.

F. Flexible, Nonmetallic, Liquid-Tight Conduit:

1. Meet requirements of UL 514B.
2. Type: High strength plastic body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.
3. Body/compression nut (gland) design to ensure high mechanical pullout strength and watertight seal.
4. Manufacturers and Products:
   a. Carlon; Type LT.
   b. O-Z/Gedney; Type 4Q-P.
   c. Thomas & Betts; Series 6300.

G. Watertight Entrance Seal Device:

1. New Construction:
   a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
   b. Manufacturer and Product: O-Z/Gedney; Type FSK or Type WSK, as required.
2. Cored-Hole Application:
   a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
   b. Manufacturer and Product: O-Z/Gedney; Series CSM.

2.03 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc-plated or cadmium-plated.

B. Cast Metal:

1. Box: Cast ferrous metal.
2. Cover: Gasketed, weatherproof, malleable iron, or cast ferrous metal, with stainless steel screws.
3. Hubs: Threaded.
4. Lugs: Cast Mounting.
5. Manufacturers and Products, Nonhazardous Locations:
   a. Crouse-Hinds; Type FS or Type FD.
   b. Appleton; Type FS or Type FD.
   c. Killark.
6. Manufacturers and Products, Hazardous Locations:
   a. Crouse-Hinds; Type GUA or Type EAJ.
   b. Appleton; Type GR.

C. PVC-Coated Cast Metal:

1. Type: One-piece.
2. Material: Malleable iron, cast ferrous metal, or cast aluminum.
3. Coating:
   a. Exterior Surfaces: 40-mil PVC.
   b. Interior Surfaces: 2-mil urethane.
4. Manufacturers:
   a. Robroy Industries.
   b. Ocal.

D. Nonmetallic:

1. Box: PVC.
2. Cover: PVC, weatherproof, with stainless steel screws.
3. Manufacturer and Product: Carlon; Type FS or Type FD, with Type E98 or Type E96 covers.

2.04 JUNCTION AND PULL BOXES

A. Outlet Box Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.

B. Conduit Bodies Used as Junction Boxes: As specified under Article Fittings.

C. Large Sheet Steel Box:

1. NEMA 250, Type 1.
2. Box: Code-gauge, galvanized steel.
3. Cover: Full access, screw type.
4. Machine Screws: Corrosion-resistant.

D. Large Cast Metal Box:

1. NEMA 250, Type 4.
2. Box: Cast malleable iron, or ferrous metal, electrogalvanized finished, with drilled and tapped conduit entrances and exterior mounting lugs.
3. Cover: Hinged with clamps.
4. Gasket: Neoprene.
5. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
6. Manufacturers and Products, Surface Mounted Nonhinged Type:
   a. Crouse-Hinds; Series W.
   b. O-Z/Gedney; Series Y.
7. Manufacturer and Product, Surface Mounted, Hinged Type: O-Z/Gedney; Series YW.

8. Manufacturers and Products, Recessed Type:
    a. Crouse-Hinds; Type WJBF.
    b. O-Z/Gedney; Series YR.

E. Large Stainless Steel Box:

1. NEMA 250 Type 4X.
2. Box: 14-gauge, ASTM A240/A240M, Type 304 stainless steel.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers:
    a. Hoffman Engineering Co.
    b. Robroy Industries.
    c. Wiegman.

F. Large Steel Box:

1. NEMA 250 Type 12, or as noted.
2. Box: 12-gauge steel, with white enamel painted interior and gray primed exterior, over phosphated surfaces. Provide gray finish as approved by Engineer.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers:
    a. Hoffman Engineering Co.
    b. Robroy Industries.
    c. Wiegman.

G. Large Nonmetallic Box:

1. NEMA 250 Type 4X.
2. Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Conduit hubs and mounting lugs.
6. Manufacturers and Products:
    a. Crouse-Hinds; Type NJB.
    b. Carlon; Series N, C, or H.
    c. Robroy Industries.

H. Concrete Box, Nontraffic Areas:

1. Box: Reinforced, cast concrete with extension.
2. Cover: Steel diamond plate with locking bolts.

3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
4. Size: 10 inches by 17 inches, minimum.
5. Manufacturers and Products:
   a. Utility Vault Co.; Series 36-1017.
   b. Christy, Concrete Products, Inc.; N9.

I. Concrete Box, Traffic Areas:

1. Box: Reinforced, cast concrete with extension and bottom slab.
2. Cover: Steel checked plate; H/20 loading with screw down.
3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
4. Manufacturers and Products:
   a. Christy, Concrete Products, Inc.; B1017BOX.
   b. Utility Vault Co.; 3030 SB.

2.05 TERMINAL JUNCTION BOX

A. Cover: Hinged, unless otherwise shown.

B. Interior Finish: Paint with white enamel or lacquer.

C. Terminal Blocks:

1. Separate connection point for each conductor entering or leaving box.
2. Spare Terminal Points: 25 percent, minimum.

2.06 METAL WIREWAYS

A. Meet requirements of UL 870.

B. Type: Steel-enclosed, lay-in type.

C. Cover: Hinged with friction latch.

D. Rating: Indoor.

E. Finish: Rust inhibiting phosphatizing primer and gray baked enamel.

F. Hardware: Plated to prevent corrosion; screws installed toward the inside protected by spring nuts or otherwise guarded to prevent wire insulation damage.

G. Knockouts: Without knockouts, unless otherwise indicated.

H. Manufacturers:

1. Circle AW.
2. Hoffman.
3. Square D.

2.07 NONMETALLIC WIREWAY

A. Rating: Outdoor, corrosion resistant, raintight, NEMA Type 12 and Type 3R.

B. Type: Fiberglass-enclosed, with removable cover.

C. Captivated, corrosion-resistant cover screws.

D. Oil-resistant gaskets.

E. Meet UL cold impact test to minus 35 degrees C.

F. Manufacturer: Hoffman.

2.08 PRECAST MANHOLES AND HANDHOLES

A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

B. Loading: AASHTO, H-20 in accordance with ASTM C857.

C. Access: Provide cast concrete 6-inch or 12-inch risers and access hole adapters between top of manhole and finished grade at required elevations.

D. Drainage:

1. Slope floors toward drain points, leaving no pockets or other nondraining areas.
2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and a minimum 4-inch outlet and outlet pipe.

E. Raceway Entrances:

1. Provide on all four sides.
2. Provide knockout panels or precast individual raceway openings.
3. At entrances where raceways are to be installed by others, provide minimum 12-inch-high by 24-inch-wide knockout panels for future raceway installation.

F. Embedded Pulling Iron:

1. Material: 3/4-inch-diameter stock, fastened to overall steel reinforcement before concrete is placed.
2. Location:
   a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
   b. Floor: Centered below manhole or handhole cover.

G. Cable Racks:

1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.
2. Wall Attachment:
   a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
   b. Insert Spacing: Maximum 3 feet on center for inside perimeter of manhole.
   c. Arrange in order that spare raceway ends are clear for future cable installation.

H. Manhole Frames and Covers:

1. Material: Machined cast iron.
2. Diameter: 36-1/2 inch.
3. Cover Type: Indented, solid top design, with two drop handles each.
4. Cover Loading: AASHTO H-20.
5. Cover Designation:
   a. Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
      1) Above 600 Volts: ELECTRIC HV.
      2) 600 Volts and Below: ELECTRIC LV.
      3) TELEPHONE.

I. Handhole Frames and Covers:

1. Material: Steel, hot-dipped galvanized.
2. Cover Type: Solid, bolt-on, hinged, of nonskid design.
3. Cover Loading: AASHTO H-20.
4. Cover Designation:
   a. Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:
      1) 600 Volts and Below: ELECTRIC LV.
      2) TELEPHONE.

J. Hardware: Steel, hot-dip galvanized.

K. Furnish knockout for ground rod in each handhole and manhole.

L. Manufacturers:

1. Utility Vault Co.
2. Penn-Cast Products, Inc.
3. Concrete Conduit Co.
4. Associated Concrete Products, Inc.
5. Pipe, Inc.

2.09 ACCESSORIES

A. Duct Bank Spacers:

1. Modular Type:
   a. Nonmetallic, interlocking, for multiple conduit sizes.
   b. Suitable for all types of conduit.
   c. Manufacturers:
      1) Underground Device, Inc.
      2) Carlon.
2. Template Type:
   a. Nonmetallic, custom made one-piece spacers.
   b. Suitable for all types of conduit.
   c. Material: HDPE or polypropylene, 1/2-inch minimum thickness.
   d. Conduit openings cut 1 inch larger than conduit outside diameter.
   e. Additional openings for stake-down, rebar, and concrete flow through as required.
   f. Manufacturer and Product: SP Products; Quik Duct.

B. Identification Devices:

1. Raceway Tags:
   a. Material: Permanent, nonferrous metal.
   b. Shape: Round.
   c. Raceway Designation: Pressure stamped, embossed, or engraved.
   d. Tags relying on adhesives or taped-on markers not permitted.
2. Warning Tape:
   a. Material: Polyethylene, 4-mil gauge with detectable strip.
   b. Color: Red.
   c. Width: Minimum 3 inches.
   d. Designation: Warning on tape that electric circuit is located below tape.

e. Identifying Letters: Minimum 1-inch-high permanent black lettering imprinted continuously over entire length.
f. Manufacturers and Products:
1) Panduit; Type HTDU.
2) Reef Industries; Terra Tape.

3. Buried Raceway Marker:
a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.
b. Designation: Engrave to depth of 3/32 inch; ELECTRIC CABLES, in letters 1/4-inch-high.
c. Minimum Dimension: 1/4-inch-thick, 10 inches long, and 3/4-inch-wide.

C. Raceway Coating: Clean and paint in accordance with Section 09 90 00, Painting and Coating.

D. Heat Shrinkable Tubing:

1. Material: Heat-shrinkable, cross-linked polyolefin.
2. Semi-flexible with meltable adhesive inner liner.
3. Color: Black.
4. Manufacturers:
a. Raychem.
b. 3M.

PART 3 EXECUTION

3.01 GENERAL

A. Conduit and tubing sizes shown are based on use of copper conductors. Reference Section 26 05 05, Conductors, concerning conduit sizing for aluminum conductors.

B. Comply with NECA Installation Standards.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

G. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

H. Group raceways installed in same area.

I. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

J. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

K. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

L. Block Walls: Do not install raceways in same horizontal course or vertical cell with reinforcing steel.

M. Install watertight fittings in outdoor, underground, or wet locations.

N. Paint threads and cut ends, before assembly of fittings, galvanized conduit, PVC-coated galvanized conduit, or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

O. Metal conduit shall be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

P. Do not install raceways in concrete equipment pads, foundations, or beams without Engineer approval.

Q. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

R. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

S. Install conduits for fiber optic cables, telephone cables, and Category 6 data cables in strict conformance with the requirements of TIA 569B.

3.02 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch.

B. Exterior, Exposed and Wet Locations: Rigid galvanized steel.

C. Interior, Exposed Locations:

1. Rigid galvanized steel for indoor dry.
2. PVC coated rigid galvanized steel for indoor wet corrosive.

D. Ductbanks: PVC Schedule 40 for ac circuits, PVC-coated rigid galvanized steel for dc circuits.

E. Transition from Underground or Concrete Embedded to Exposed: PVC-coated rigid steel conduit.

F. Under Equipment Mounting Pads: PVC-coated rigid steel conduit, unless otherwise stated.

G. Exterior Light Pole Foundations: PVC Schedule 80 conduit.

3.03 FLEXIBLE CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other locations approved by Engineer where flexible connection is required to minimize vibration:

1. Conduit Size 4 Inches or Less: Flexible, liquid-tight conduit.
2. Conduit Size Over 4 Inches: Nonflexible.
3. Wet or Corrosive Areas: Flexible, nonmetallic liquid-tight.
4. Dry Areas: Flexible, metallic liquid-tight.

B. Suspended Lighting Fixtures in Dry Areas: Flexible steel, nonliquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Flexible Conduit Length: 18 inches minimum, 60 inches maximum; sufficient to allow movement or adjustment of equipment.

3.04 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Firestop openings around penetrations to maintain fire-resistance rating as specified in Section 26 05 04, Basic Electrical Materials and Methods.

D. Apply heat shrinkable tubing to metallic conduit protruding through concrete floor slabs to a point 2 inches above and 2 inches below concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.

F. Entering Structures:

1. General: Seal raceway at first box or outlet with oakum or expandable plastic compound to prevent entrance of gases or liquids from one area to another.
2. Concrete Roof or Membrane Waterproofed Wall or Floor:
    a. Provide a watertight seal.
    b. Without Concrete Encasement: Install watertight entrance seal device on each side.
    c. With Concrete Encasement: Install watertight entrance seal device on accessible side.
    d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
    e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.
3. Heating, Ventilating, and Air Conditioning Equipment:
    a. Penetrate equipment in area established by manufacturer.
    b. Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
    c. Seal penetration with Type 5 sealant.
4. Corrosive-Sensitive Areas:
    a. Seal conduit passing through chlorine and ammonia room walls.
    b. Seal conduit entering equipment panel boards and field panels containing electronic equipment.
    c. Seal penetration with Type 5 sealant.
5. Manholes and Handholes:
    a. Metallic Raceways: Provide insulated grounding bushings.
    b. Nonmetallic Raceways: Provide bell ends flush with wall.
    c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.05 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements. Do not exceed 8 feet in any application. Do not support from piping, pipe supports, or other raceways.

B. Application/Type of Conduit Strap:

1. Rigid Steel or EMT Conduit: Zinc coated steel, pregalvanized steel or malleable iron.
2. PVC-Coated Rigid Steel Conduit: PVC-coated metal.
3. Nonmetallic Conduit: Nonmetallic or PVC-coated metal.

C. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

1. Wood: Wood screws.
2. Hollow Masonry Units: Toggle bolts.
3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
4. Steelwork: Machine screws.
5. Location/Type of Hardware:
   a. Dry, Noncorrosive Areas: Galvanized.
   b. Wet, Noncorrosive Areas: Stainless steel.
   c. Corrosive Areas: Stainless steel.

D. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

E. Support aluminum conduit on concrete surfaces with stainless steel or nonmetallic spacers, or aluminum or nonmetallic framing channel.

3.06 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:

1. Bends 30 Degrees and Larger: Provide factory-made elbows.
2. 90-Degree Bends: Provide rigid steel elbows, PVC-coated where direct buried.
3. Use manufacturer's recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.07 PVC CONDUIT

A. Solvent Welding:

1. Apply manufacturer recommended solvent to joints.
2. Install in order that joint is watertight.

B. Adapters:

1. PVC to Metallic Fittings: PVC terminal type.
2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.

C. Belled-End Conduit: Bevel unbelled end of joint prior to joining.

3.08 PVC-COATED RIGID STEEL AND RIGID ALUMINUM CONDUIT

A. Install in accordance with manufacturer's instructions.

B. Tools and equipment used in cutting, bending, threading and installation of PVC-coated rigid conduit shall be designed to limit damage to PVC coating.

C. Provide PVC boot to cover exposed threading.

3.09 WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

C. Applications:

1. Metal wireway in indoor dry locations.
2. Nonmetallic wireway in indoor wet, outdoor, and corrosive locations.

3.10 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Install manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Nonmetallic, Cabinets, and Enclosures:

1. Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
2. Metallic Conduit: Provide ground terminal for connection to maintain continuity of ground system.

C. Sheet Metal Boxes, Cabinets, and Enclosures:

1. General:
   a. Install insulated bushing on ends of conduit where grounding is not required.
   b. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
   c. Utilize sealing locknuts or threaded hubs on sides and bottom of NEMA 3R and NEMA 12 enclosures.
   d. Terminate conduits at threaded hubs at the tops of NEMA 3R and NEMA 12 boxes and enclosures.
   e. Terminate conduits at threaded conduit hubs at NEMA 4 and NEMA 4X boxes and enclosures.
2. Rigid Galvanized Conduit:
   a. Provide one lock nut each on inside and outside of enclosure.
   b. Install grounding bushing at source enclosure.
   c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad.
3. Electric Metallic Tubing: Provide gland compression, insulated connectors.

4. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
5. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.
6. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
7. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut, except where threaded hubs required above.

D. Free-Standing Enclosures:

1. Terminate metal conduit entering bottom with grounding bushing; provide grounding jumper extending to equipment ground bus or grounding pad.
2. Terminate PVC conduit entering bottom with bell end fittings.

3.11 UNDERGROUND RACEWAYS

A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

B. Cover: Maintain minimum 2-foot cover above conduit and concrete encasement, unless otherwise shown.

C. Make routing changes as necessary to avoid obstructions or conflicts.

D. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.

E. Union type fittings not permitted.

F. Spacers:

1. Provide preformed, nonmetallic spacers designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

H. Transition from Underground to Exposed: PVC-coated rigid steel conduit.

I. Installation with Other Piping Systems:

1. Crossings: Maintain minimum 12-inch vertical separation.
2. Parallel Runs: Maintain minimum 12-inch separation.
3. Installation over valves or couplings not permitted.

J. Metallic Raceway Coating: At couplings and joints, clean and paint in accordance with Section 09 90 00, Painting and Coating.

K. Provide expansion fittings that allow minimum of 4 inches of movement in vertical conduit runs from underground where exposed conduit will be fastened to or will enter building or structure.

L. Provide expansion/deflection fittings in conduit runs that exit building or structure belowgrade. Conduit from building wall to fitting shall be PVC-coated rigid steel.

M. Concrete Encasement:

1. As specified in Section 03 30 10, Structural Reinforced Concrete.
2. Concrete Color: Red.

N. Backfill:

1. As specified in Section 31 00 00, Earthwork.
2. Do not backfill until inspected by Engineer.

3.12 UNDER SLAB RACEWAYS

A. Make routing changes as necessary to avoid obstructions or conflicts.

B. Support raceways so as to prevent bending or displacement during backfilling or concrete placement.

C. Install raceways with no part embedded within slab and with no interference with slab on grade construction.

D. Raceway spacing, in a single layer or multiple layers:

1. 3 inches clear between adjacent 2-inch or larger raceway.
2. 2 inches clear between adjacent 1-1/2-inch or smaller raceway.

E. Multiple Layers of Raceways: Install under slab on grade in trench below backfill zone, as specified in Section 31 00 00, Earthwork.

F. Individual Raceways and Single Layer Multiple Raceways: Install at lowest elevation of backfill zone with spacing as specified herein. Where conduits cross at perpendicular orientation, installation of conduits shall not interfere with placement of under slab fill that meets compaction and void limitations of earthwork specifications.

G. Under slab raceways that emerge from below slab to top of slab as exposed, shall be located to avoid conflicts with structural slab rebar. Coordinate raceway stub ups with location of structural rebar.

H. Fittings:

1. Union type fittings are not permitted.
2. Provide expansion/deflection fittings in raceway runs that exit building or structure below slab. Locate fittings 18 inches, maximum, beyond exterior wall. Raceway type between building exterior wall to fitting shall be PVC-coated rigid steel.
3. Couplings: In multiple raceway runs, stagger so couplings in adjacent runs are not in same traverse line.

3.13 OUTLET AND DEVICE BOXES

A. General:

1. Install plumb and level.
2. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.
3. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.
4. Install galvanized mounting hardware in industrial areas.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
   a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
2. Ceiling Outlet: Minimum 4-inch octagonal device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch device box.

C. Locations:

1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by Engineer.
3. Light Fixture: Install in symmetrical pattern according to room layout, unless otherwise shown.

D. Mounting Height:

1. General:
   a. Dimensions given to centerline of box.
   b. Where specified heights do not suit building construction or finish, adjust up or down to avoid interference.
   c. Do not straddle CMU block or other construction joints.
2. Light Switch:
   a. 48 inches above floor.
   b. When located next to door, install on lock side of door.
3. Thermostat: 54 inches above floor.
4. Telephone Outlet:
   a. 15 inches above floor.
   b. 6 inches above counter tops.
   c. Wall Mounted: 52 inches above floor.
5. Convenience Receptacle:
   a. General Interior Areas: 15 inches above floor.
   b. General Interior Areas (Counter Tops): Install device plate bottom or side flush with top of backsplash, or 6 inches above counter tops without backsplash.
   c. Industrial Areas, Workshops: 48 inches above floor.
   d. Outdoor Areas: 24 inches above finished grade.
6. Special-Purpose Receptacle: 48 inches above floor or as shown.
7. Switch, Motor Starting: 48 inches above floor, unless otherwise indicated on Drawings.

E. Flush Mounted:

1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
3. Holes in surrounding surface shall be no larger than required to receive box.

F. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
   a. Wood: Wood screws.
   b. Concrete or Brick: Bolts and expansion shields.
   c. Hollow Masonry Units: Toggle bolts.
   d. Steelwork: Machine screws.
3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Provide plaster rings where necessary.
5. Boxes embedded in concrete or masonry need not be additionally supported.

G. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.

H. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

3.14 JUNCTION AND PULL BOXES

A. General:

1. Install plumb and level.
2. Installed boxes shall be accessible.
3. Do not install on finished surfaces.
4. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.
5. Use conduit bodies as junction and pull boxes where no splices are required and allowed by applicable codes.
6. Install pull boxes where necessary in raceway system to facilitate conductor installation.
7. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
8. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

B. Flush Mounted:

1. Install with concealed conduit.
2. Holes in surrounding surface shall be no larger than required to receive box.

3. Make edges of boxes flush with final surface.

C. Mounting Hardware:

1. Noncorrosive Dry Areas: Galvanized.
2. Noncorrosive Wet Areas: Stainless steel.
3. Corrosive Areas: Stainless steel.

D. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
   a. Wood: Wood screws.
   b. Concrete or Brick: Bolts and expansion shields.
   c. Hollow Masonry Units: Toggle bolts.
   d. Steelwork: Machine screws.
3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Boxes embedded in concrete or masonry need not be additionally supported.

E. At or Belowgrade:

1. Install boxes for belowgrade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Obtain Owner's written acceptance prior to installation in paved areas, roadways, or walkways.
4. Use boxes and covers suitable to support anticipated weights.

F. Install drain/breather fittings in NEMA 250 Type 4 and Type 4X enclosures.

3.15 MANHOLES AND HANDHOLES

A. Excavate, shore, brace, backfill, and final grade in accordance with Section 31 00 00, Earthwork.

B. Do not install until final raceway grading has been determined.

C. Install such that raceway enters at nearly right angle and as near as possible to end of wall, unless otherwise shown.

D. Grounding: As specified in Section 26 05 26, Grounding and Bonding for Electrical Systems.

E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be 1-inch minimum height.

3.16 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.17 IDENTIFICATION DEVICES

A. Raceway Tags:

1. Identify origin and destination.
2. For exposed raceways, install tags at each terminus, near midpoint, and at minimum intervals of every 50 feet, whether in ceiling space or surface mounted.
3. Install tags at each terminus for concealed raceways.
4. Provide nylon strap for attachment.

B. Warning Tape: Install approximately 18 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of run.

C. Buried Raceway Marker:

1. Install at grade to indicate direction of underground raceway.
2. Install at bends and at intervals not exceeding 100 feet in straight runs.
3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

3.18 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

D. Touch up coating damage to PVC-coated conduit with patching compound approved by manufacturer. Compound shall be kept refrigerated according to manufacturers' instructions until time of use.

END OF SECTION

SECTION 26 05 70
ELECTRICAL SYSTEMS ANALYSIS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI).
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
   b. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
   c. 399, Recommended Practice for Industrial and Commercial Power System Analysis.
   d. 1584, Guide for Performing Arc Flash Hazard Calculations.
3. National Electrical Manufacturers Association (NEMA): Z535.4, Product Safety Signs and Labels.
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70E, Standard for Electrical Safety in the Workplace.
5. Occupational Safety and Health Standards (OSHA): 29 CFR, Part 1910 Subpart S, Electrical.

1.02 SUBMITTALS

A. Action Submittals:

1. Short circuit study.
2. Arc Flash Study: Submit final study prior to equipment energization.
3. Arc flash warning labels; submit with Arc Flash Study.
4. Electronic files of final studies including all engineering software input files, output reports, and libraries.

1.03 QUALITY ASSURANCE

A. Short circuit and arc flash studies shall be prepared by manufacturer furnishing equipment for incoming service or a professional electrical engineer registered in the State of Washington.

1.04 SEQUENCING AND SCHEDULING

A. Initial complete short circuit study shall be submitted and reviewed before Engineer will review Shop Drawings for equipment for incoming service equipment.

B. Initial arc flash studies shall be submitted within 90 days after approval of initial short circuit study.

C. Initial complete arc flash study shall be submitted and accepted prior to energization of the electrical equipment.

D. Revised short circuit and arc flash studies, and arc flash labels shall be submitted 10 days before energizing electrical equipment.

E. Final short circuit and arc flash studies shall be completed prior to Project Substantial Completion. Final version of study shall include as-installed equipment, materials, and parameter data or settings entered into equipment based on study.

F. Submit final arc flash labels described herein and in compliance with NEMA Z535.4 prior to Project Substantial Completion.

1.05 GENERAL STUDY REQUIREMENTS

A. Equipment and component titles used in the studies shall be identical to equipment and component titles shown on Drawings.

B. Perform studies using one of the following electrical engineering software packages:

1. SKM Power Tools for Windows.
2. ETAP.
3. Paladin.
4. Easy Power.

C. Perform complete fault calculations for each proposed and ultimate source combination.

1. Source combination may include present and future power company supply circuits, large motors, or generators.

D. Utilize proposed load data for study provided by Engineer.

1.06 SHORT CIRCUIT STUDY

A. General:

1. Prepare in accordance with IEEE 399.
2. Use cable impedances based on copper conductors, except where aluminum conductors are specified or shown.
3. Use bus impedances based on copper bus bars, except where aluminum bus bars are specified or shown.
4. Use cable and bus resistances calculated at 25 degrees C.
5. Use 600-volt cable reactances based on use of typical dimensions of THHN/THWN conductors.
6. Use transformer impedances 92.5 percent of "nominal" impedance based on tolerances specified in IEEE C57.12.00.

B. Provide:

1. Calculation methods and assumptions.
2. Typical calculation.
3. Tabulations of calculated quantities.
4. Results, conclusions, and recommendations.
5. Selected base per unit quantities.
6. One-line diagrams.
7. Source impedance data, including electric utility system and motor fault contribution characteristics.
8. Impedance diagrams.
9. Zero-sequence impedance diagrams.

C. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault at each:

1. Electric utility's supply termination point.
2. Main panelboard.
3. Branch circuit panelboards.
4. Packaged control panels that include starters or variable frequency drives.
5. Future load contributions as shown on one-line diagram.

D. Provide bolted line-to-ground fault current study for areas as defined for three-phase bolted fault short circuit study.

E. Verify:

1. Equipment and protective devices are applied within their ratings.

2. Adequacy of bus bars to withstand short circuit stresses.
3. Adequacy of transformer windings to withstand short circuit stresses.
4. Cable and busway sizes for ability to withstand short circuit heating, in addition to normal load currents.

F. Tabulations:

1. General Data:
   a. Short circuit reactances of rotating machines.
   b. Cable and conduit material data.
   c. Bus data.
   d. Transformer data.
   e. Circuit resistance and reactance values.
2. Short Circuit Data:
   a. Fault impedances.
   b. X to R ratios.
   c. Asymmetry factors.
   d. Motor contributions.
   e. Short circuit kVA.
   f. Symmetrical and asymmetrical fault currents.
3. Equipment Evaluation:
   a. Equipment bus bracing, equipment short circuit rating, transformer, cable, busway.
   b. Maximum fault current available.

G. Written Summary:

1. Scope of studies performed.
2. Explanation of bus and branch numbering system.
3. Prevailing conditions.
4. Selected equipment deficiencies.
5. Results of short circuit study.
6. Comments or suggestions.

H. Suggest changes and additions to equipment rating and/or characteristics.

I. Notify Engineer in writing of existing circuit protective devices improperly rated for new fault conditions.

J. Revise data for “as-installed” condition.

1.07 ARC FLASH STUDY

A. Perform arc flash hazard study after short circuit and protective device coordination study has been completed, reviewed and accepted.

B. Perform arc flash study in accordance with NFPA 70E, OSHA 29 CFR, Part 1910 Subpart S, and IEEE 1584.

C. Base Calculation:

1. For each major part of electrical power system, determine the following:
   a. Flash hazard protection boundary.
   b. Limited approach boundary.
   c. Restricted approach boundary.
   d. Incident energy level.
   e. Glove class required.

D. Produce arc flash warning labels that list items in Paragraph Base Calculation and the following additional items.

1. Bus name.
2. Bus voltage.

E. Produce bus detail sheets that list items in Paragraph Base Calculation and the following additional items:

1. Bus name.
2. Upstream protective device name, type, and settings.
3. Bus line-to-line voltage.

F. Produce arc flash evaluation summary sheet listing the following additional items:

1. Bus name.
2. Upstream protective device name, type, settings.
3. Bus line-to-line voltage.
4. Bus bolted fault.
5. Protective device bolted fault current.
6. Arcing fault current.
7. Protective device trip/delay time.
8. Breaker opening time.
9. Solidly grounded column.
10. Equipment type.
11. Gap.

12. Arc flash boundary.
13. Working distance.
14. Incident energy.

G. Analyze short circuit and arc flash calculations and highlight equipment that is determined to be underrated or causes incident energy values greater than 8 cal/cm2. Propose approaches to reduce energy levels.

H. Prepare report summarizing arc flash study with conclusions and recommendations which may affect integrity of electric power distribution system. As a minimum, include the following:

1. Equipment manufacturer's information used to prepare study.
2. Assumptions made during study.
3. Reduced copy of one-line drawing; 11 inches by 17 inches maximum.
4. Arc flash evaluations summary spreadsheet.
5. Bus detail sheets.
6. Arc flash warning labels printed in color on thermally bonded adhesive backed UV and weather-resistant labels.

PART 2 PRODUCTS

2.01 ARC FLASH WARNING LABELS

A. Arc flash warning labels printed in color on thermally bonded adhesive backed, UV- and weather-resistant labels. An example label is located following end of section in Figure 1.

PART 3 EXECUTION

3.01 GENERAL

A. Notify Engineer in writing of required major equipment modifications.

B. Provide arc flash warning labels on equipment as specified in this section.

3.02 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this Specification:

1. Figure 1: Example Arc Flash Label.

END OF SECTION

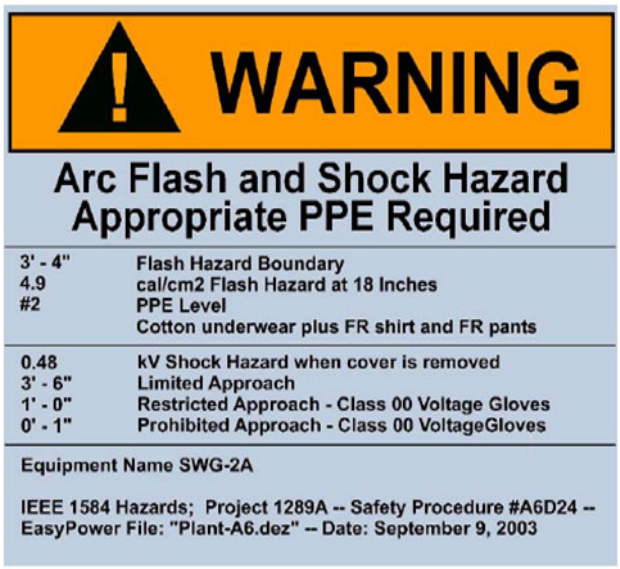


Figure 1
Example Arc Flash Label

SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. D877/D877M, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
   b. D923, Standard Practices for Sampling Electrical Insulating Liquids.
   c. D924, Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
   d. D971, Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
   e. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
   f. D1298, Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
   g. D1500, Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
   h. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Liquids in the Field.
   i. D1533, Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
   j. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43, Recommended Practice for Testing Insulation Resistance of Electric Machinery.
   b. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminators Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV.
   c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
   d. 95, Recommended Practice for Insulation Testing of AC Electric Machinery (2300V and Above) with High Direct Voltage.

e. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
f. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above.
g. 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
h. C2, National Electrical Safety Code.
i. C37.20.1, Standard for Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear.
j. C37.20.2, Standard for Metal-Clad Switchgear.
k. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear.
l. C37.23, Standard for Metal-Enclosed Bus.
m. C62.33, Standard Test Methods and Performance Values for Metal-Oxide Varistor Surge Protective Components.

3. Insulated Cable Engineers Association (ICEA):
   a. S-93-639, 5-46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electric Energy.
   b. S-94-649, Concentric Neutral Cables Rated 5 through 46 kV.
   c. S-97-682, Standard for Utility Shielded Power Cables Rated 5 through 46 kV.
4. InterNational Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
5. National Electrical Manufacturers Association (NEMA):
   a. AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
   b. PB 2, Deadfront Distribution Switchboards.
   c. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70B, Recommended Practice for Electrical Equipment Maintenance.
   c. 70E, Standard for Electrical Safety in the Workplace.
   d. 101, Life Safety Code.
7. National Institute for Certification in Engineering Technologies (NICET).
8. Occupational Safety and Health Administration (OSHA): CFR 29, Part 1910, Occupational Safety and Health Standards.

1.02 SUBMITTALS

A. Informational Submittals:

1. Submit 30 days prior to performing inspections or tests:
   a. Testing firm qualifications.
   b. Schedule for performing inspection and tests.
   c. List of references to be used for each test.
   d. Sample copy of equipment and materials inspection form(s).
   e. Sample copy of individual device test form.
   f. Sample copy of individual system test form.
2. Energization Plan:
   a. Prior to initial energization of electrical distribution equipment; include the following:
      1) Owner's representative sign-off form for complete and accurate arc flash labeling and proper protective device settings for equipment to be energized.
      2) Staged sequence of initial energization of electrical equipment.
      3) Lock-Out-Tag-Out plan for each stage of the progressive energization.
      4) Barricading, signage, and communication plan notifying personnel of newly energized equipment.
3. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test:
4. Operation and Maintenance Data:
   a. In accordance with Section 01 78 23, Operation and Maintenance Data.
   b. After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in Operation and Maintenance Manual.
5. Programmable Settings:
   a. At completion of Performance Demonstration Test, submit final hardcopy printout and electronic files on compact disc of as-left setpoints, programs, and device configuration files for:
      1) Protective relays.
      2) Intelligent overload relays.
      3) Adjustable frequency drives.
      4) Power metering devices.
      5) Uninterruptible power supplies.
      6) Electrical communications modules.

1.03 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years' testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to Project at ratio not to exceed two certified to one noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive Project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.

B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.

C. Test Instrument Calibration: In accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment listed herein has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

1. Scheduled with Owner prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

C. Notify Owner at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Tests and inspections shall establish:

1. Electrical equipment is operational within industry and manufacturer's tolerances and standards.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.

B. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

C. Set, test, and calibrate protective relays, circuit breakers, fuses, and other applicable devices in accordance with values established by short circuit, coordination, and harmonics studies as specified in Section 26 05 70, Electrical Systems Analysis.

D. Adjust mechanisms and moving parts of equipment for free mechanical movement.

E. Adjust and set electromechanical electronic relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

F. Verify nameplate data for conformance to Contract Documents and approved Submittals.

G. Realign equipment not properly aligned and correct unlevelness.

H. Properly anchor electrical equipment found to be inadequately anchored.

I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screw driver to manufacturer's recommendations, or as otherwise specified in NETA ATS.

J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

K. Provide proper lubrication of applicable moving parts.

L. Inform Engineer of working clearances not in accordance with NFPA 70.

M. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

N. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by Engineer door and panel sections having dented surfaces.
5. Repair or replace, as determined by Engineer poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
   a. Provide matching paint and touch up scratches and mars.
   b. If required because of extensive damage, as determined by Engineer, refinish entire assembly.

O. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals.

P. Replace transformer insulating oil not in compliance with ASTM D923.

3.02 CHECKOUT AND STARTUP

A. Voltage Field Test:

1. Check voltage at point of termination of power company supply system to Project when installation is essentially complete and is in operation.
2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
3. Unbalance Corrections:
   a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
   b. Obtain written certification from responsible power company official that voltage variations and unbalance are within their normal standards if corrections are not made.

B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
3. If phase current for a piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

3.03 PANELBOARDS AND MINI-POWER CENTERS

A. Visual and Mechanical Inspection:

1. Include the following inspections and related work:
   a. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
   b. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
   c. Check panelboard or mini-power center mounting, area clearances, and alignment and fit of components.
   d. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
   e. Perform visual and mechanical inspection for overcurrent protective devices.

B. Electrical Tests:

1. Include the following items performed in accordance with manufacturer's instruction:
   a. Insulation Resistance Tests:
      1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
      2) Each phase of each bus section.
      3) Phase-to-phase and phase-to-ground for 1 minute.
      4) With breakers open.
      5) With breakers closed.
      6) Control wiring except that connected to solid state components.
      7) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   b. Ground continuity test ground bus to system ground.

3.04 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Removal of shipping brackets, fixtures, or bracing.
7. Free and properly installed resilient mounts.
8. Cleanliness and improper blockage of ventilation passages.
9. Verify tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
   c. Results temperature corrected in accordance with NETA ATS, Table 100.14.
   d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.05 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed power cable No. 4 and larger for:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.
   c. Cable bends not in conformance with manufacturer’s minimum allowable bending radius where applicable.

d. Color coding conformance with specification.
e. Proper circuit identification.

2. Mechanical Connections for:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables for:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.
4. Control Cables for:
   a. Proper termination.
   b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 4 and Larger:

1. Insulation Resistance Tests:
   a. Utilize 1,000V dc megohmmeter for 600-volt insulated conductors.
   b. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
   c. Evaluate ohmic values by comparison with conductors of same length and type.
   d. Investigate values less than 50 megohms.
2. Continuity test by ohmmeter method to ensure proper cable connections.

C. Low-voltage cable tests may be performed by installer in lieu of independent testing firm.

3.06 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.
2. Proper operation of switch operating handle.
3. Adequate mechanical support for each fuse.
4. Proper contact-to-contact tightness between fuse clip and fuse.
5. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Proper phase barrier material and installation.

7. Verify fuse sizes and types correspond to one-line diagram or approved Submittals.
8. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
   c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each switch blade and fuse holder.
   b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.07 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 100 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.
3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Operate breaker to verify smooth operation.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000V dc megohmmeter for 480-volt and 600-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.

c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
d. Test values to comply with NETA ATS, Table 100.1.

2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.
   e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   f. Trip times shall be within limits established by NEMA AB 4, Table 5-3. Alternatively, use NETA ATS, Table 100.7.
   g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4. Alternatively, use NETA ATS, Table 100.8.

3.08 LOW VOLTAGE POWER CIRCUIT BREAKERS

A. Visual and Mechanical Inspection:

1. Proper mounting, cell fit, and element alignment.
2. Proper operation of racking interlocks.
3. Check for damaged arc chutes.
4. Proper contact condition.
5. Bolt torque level in accordance with NETA ATS, Table 100.12.
6. Perform mechanical operational and contact alignment tests in accordance with manufacturer's instructions.
7. Check operation of closing and tripping functions of trip devices by activating ground fault relays, undervoltage shunt relays, and other auxiliary protective devices.
8. Verify primary and secondary contact wipe, gap setting, and other dimensions vital to breaker operation are correct.
9. Check charging motor, motor brushes, associated mechanism, and limit switches for proper operation and condition.
10. Check operation of electrically operated breakers in accordance with manufacturer's instructions.
11. Check for adequate lubrication on contact, moving, and sliding surfaces.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480-volt and 600-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 100.1.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.
   e. Trip characteristic when adjusted to setting sheet parameters shall be within manufacturer's published time-current tolerance band.

3.09 PROTECTIVE RELAYS

A. Visual and Mechanical Inspection:

1. Visually check each relay for:
   a. Tight cover gasket and proper seal.
   b. Unbroken cover glass.
   c. Condition of spiral spring and contacts.
   d. Disc clearance.
   e. Condition of case shorting contacts if present.
2. Mechanically check each relay for:
   a. Freedom of movement.
   b. Proper travel and alignment.
3. Verify each relay:
   a. Complies with Contract Documents, approved Submittal, and application.
   b. Is set in accordance with recommended settings from Coordination Study.

B. Electrical Tests:

1. Insulation resistance test on each circuit to frame, except for solid state devices.
2. Test on nominal recommended setting for:
   a. Pickup parameters on each operating element.
   b. Timing at three points on time-current curve.
   c. Pickup target and seal-in units.
   d. Special tests as required to check operation of restraint, directional, and other elements in accordance with manufacturer's instruction manual.
3. Phase angle and magnitude contribution tests on differential and directional relays after energization to vectorially verify proper polarity and connections.
4. Current Injection Tests:
   a. For entire current circuit in each section.
   b. Secondary injection for current flow of 1 ampere.
   c. Test current at each device.

3.10 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually check current, potential, and control transformers for:
   a. Cracked insulation.
   b. Broken leads or defective wiring.
   c. Proper connections.
   d. Adequate clearances between primary and secondary circuit wiring.
2. Verify Mechanically:
   a. Grounding and shorting connections have good contact.
   b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
3. Verify proper primary and secondary fuse sizes for potential transformers.

B. Electrical Tests:

1. Current Transformer Tests:
   a. Insulation resistance test of transformer and wiring-to-ground at 1,000V dc for 30 seconds.
   b. Polarity test.
   c. Ratio and accuracy test.

2. Potential Transformer Tests:
   a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 100.9, for 1 minute on:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.
   c. Ratio and accuracy test.
3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 100.5.

3.11 METERING

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify meter types and scales conform to Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

3.12 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in panelboard assemblies for proper connection and tightness.
2. Ground bus connections in panelboard assemblies for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

1. Fall-of-Potential Test:
   a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system’s resistance.
   b. Main ground electrode system resistance to ground to be no greater than 5 ohm(s).

2. Two-Point Direct Method Test:
   a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
   b. Equipment ground resistance shall not exceed main ground system resistance by 0.25 ohm.
3. Neutral Bus Isolation:
   a. Test each neutral bus individually with neutral bonding jumper removed at service entrance or separately derived system.
   b. Evaluate ohmic values by measuring resistance between ground bus and neutral bus.
   c. Investigate values less than 50 megohms.

3.13 GROUND FAULT SYSTEMS

A. Inspection and testing limited to:

1. Zero sequence grounding systems.
2. Residual ground fault systems.

B. Visual and Manual Inspection:

1. Neutral main bonding connection to ensure:
   a. Zero sequence sensing system is grounded ahead of neutral disconnect link.
   b. Ground strap sensing system is grounded through sensing device.
   c. Neutral ground conductor is solidly grounded.
2. Verify control power has adequate capacity for system.
3. Manually operate monitor panels for:
   a. Trip test.
   b. No trip test.
   c. Nonautomatic rest.
4. Zero sequence system for symmetrical alignment of core balance transformers about current carrying conductors.
5. Relay check for pickup and time under simulated ground fault conditions.
6. Verify nameplate identification by device operation.

C. Electrical Tests:

1. Test system neutral insulation resistance with neutral ground link removed; minimum 1 megohm.
2. Determine relay pickup by primary current injection at the sensor. Relay pickup current within plus or minus 10 percent of device dial or fixed setting.

3. Test relay timing by injecting 300 percent of pick-up current or as specified by manufacturer. Relay operating time in accordance with manufacturer's time-current characteristic curves.
4. Test system operation at 55 percent rated control voltage, if applicable.
5. Test zone interlock system by simultaneous sensor current injection and monitoring zone blocking functions.

3.14 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 1 horsepower and larger.

B. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Operate motor and check for:
   a. Excessive mechanical and electrical noise.
   b. Overheating.
   c. Correct rotation.
   d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
   e. Excessive vibration, in excess of values in NETA ATS, Table 100.10.
5. Check operation of space heaters.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 100.1 for:
      1) Motors above 200 horsepower for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
      2) Motors 200 horsepower and less for 1-minute duration with resistances tabulated at 30 seconds and 60 seconds.
   b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
2. Calculate polarization index ratios for motors above 200 horsepower. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.

4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.

3.15 LOW-VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.
2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air-cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.
7. Check door and device interlocking system by:
    a. Closure attempt of device when door is in OFF or OPEN position.
    b. Opening attempt of door when device is in ON or CLOSED position.
8. Check key interlocking systems for:
    a. Key captivity when device is in ON or CLOSED position.
    b. Key removal when device is in OFF or OPEN position.
    c. Closure attempt of device when key has been removed.
    d. Correct number of keys in relationship to number of lock cylinders.
    e. Existence of other keys capable of operating lock cylinders; destroy duplicate sets of keys.
9. Check nameplates for proper identification of:
    a. Equipment title and tag number with latest one-line diagram.
    b. Pushbuttons.
    c. Control switches.
    d. Pilot lights.
    e. Control relays.
    f. Circuit breakers.
10. Verify fuse and circuit breaker sizes and types conform to Contract Documents.
11. Verify current and potential transformer ratios conform to Contract Documents.
12. Check bus connections for high resistance by low-resistance ohmmeter and calibrated torque wrench applied to bolted joints.
13. Ohmic value to be zero.
    a. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
14. Check operation and sequencing of electrical and mechanical interlock systems by:
    a. Closure attempt for locked open devices.

b. Opening attempt for locked closed devices.
c. Key exchange to operate devices in OFF-NORMAL positions.

15. Verify performance of each control device and feature furnished as part of motor control center.
16. Control Wiring:
    a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
    b. Check for proper conductor lacing and bundling.
    c. Check for proper conductor identification.
    d. Check for proper conductor lugs and connections.
17. Exercise active components.
18. Inspect contactors for:
    a. Correct mechanical operations.
    b. Correct contact gap, wipe, alignment, and pressure.
    c. Correct torque of connections.
19. Compare overload heater rating with full-load current for proper size.
20. Compare motor protector and circuit breaker with motor characteristics for proper size.
21. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:
    a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
    b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
    c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.
    d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
    e. Test values to comply with NETA ATS, Table 100.1.
2. Current Injection through Overload Unit at 300 Percent of Motor Full-Load Current and Monitor Trip Time:
    a. Trip time in accordance with manufacturer’s published data.
    b. Investigate values in excess of 120 seconds.
3. Control Wiring Tests:
    a. Apply secondary voltage to control power and potential circuits.
    b. Check voltage levels at each point on terminal board and each device terminal.
    c. Insulation resistance test at 1,000 volts dc on control wiring, except that connected to solid state components; 1 megohm minimum insulation resistance.

4. Operational test by initiating control devices to affect proper operation.

3.16 LOW VOLTAGE SURGE ARRESTORS

A. Visual and Mechanical Inspection:

1. Adequate clearances between arrestors and enclosures.
2. Ground connections to ground electrode.

B. Electrical Tests:

1. Varistor Type Arrestors:
   a. Clamping voltage test.
   b. Rated RMS voltage test.
   c. Rated dc voltage test.
   d. Varistor arrestor test values in accordance with IEEE C62.33, Section 4.4 and Section 4.9.

END OF SECTION

SECTION 26 20 00
LOW-VOLTAGE AC INDUCTION MOTORS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. This section applies to low-voltage AC induction motors, whether or not referenced by a motor-driven equipment specification. If equipment specification section deviates from this section in requirements, such as application, horsepower, enclosure type, mounting, shaft type, or synchronous speed, then those listed requirements shall take precedence over this section.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Bearing Manufacturers Association (ABMA):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Ratings and Fatigue Life for Roller Bearings.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   b. 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines.
   c. 841, Standard for Petroleum and Chemical Industry—Premium Efficiency Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW (500 hp).
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C50.41, Polyphase Induction Motors for Power Generating Stations.
   c. MG 1, Motors and Generators.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL:
   a. 83, Standard for Safety for Thermoplastic-Insulated Wire and Cables.
   b. 674, Standard for Safety for Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.
   c. 2111, Standard for Safety for Overheating Protection for Motors.

1.03 DEFINITIONS

A. DIP: Dust-ignition-proof enclosure.

B. Inverter Duty Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.

C. Inverter Ready Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Part 31.4.4.2.

D. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

E. ODP: Open drip-proof enclosure.

F. TEFC: Totally enclosed, fan-cooled enclosure.

G. TENV: Totally enclosed, nonventilated enclosure.

1.04 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Nameplate data in accordance with NEMA MG 1.
3. Additional Rating Information:
    a. Service factor.
    b. Locked rotor current.
    c. No load current.
    d. Adjustable frequency drive motor load classification (for example, variable torque) and minimum allowable motor speed for that load classification.
    e. Guaranteed minimum full load efficiency and power factor.
4. Enclosure type and mounting (such as, horizontal, vertical).
5. Dimensions and total weight.
6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
7. Bearing type.
8. Motor sound power level in accordance with NEMA MG 1.
9. Maximum brake horsepower required by the equipment driven by the motor.
10. Anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Factory test reports.
3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
4. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. General Electric.
2. MagneTek.
3. Siemens Energy and Automation, Inc., Motors and Drives Division.
4. Baldor.
5. U.S. Electrical Motors.
6. TECO-Westinghouse Motor Co.
7. Toshiba International Corp., Industrial Division.
8. WEG Electric Motors Corp.

2.02 GENERAL

A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.

B. In order to obtain single source responsibility, use a single supplier to provide drive motor, its driven equipment, and specified motor accessories.

C. Meet requirements of NEMA MG 1.

D. Provide motors specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.

E. Lifting lugs on motors weighing 100 pounds or more.

F. Operating Conditions:

1. Maximum ambient temperature not greater than 40 degrees C.

2. Provide motors suitable for operating conditions without reduction in nameplate rated horsepower or exceeding rated temperature rise.
3. Overspeed in either direction in accordance with NEMA MG 1.

2.03 HORSEPOWER RATING

A. As designated in motor-driven equipment specification.

B. Constant Speed Applications: Brake horsepower of driven equipment at any operating condition not to exceed motor nameplate horsepower rating, excluding service factor.

C. Adjustable Frequency and Adjustable Speed Applications (Inverter Duty Motor, Inverter Ready Motor): Driven equipment brake horsepower at any operating condition not to exceed motor nameplate horsepower rating, excluding service factor.

2.04 SERVICE FACTOR

A. Inverter-Duty Motors: 1.0 at rated ambient temperature, unless otherwise noted.

B. Other Motors: 1.15 minimum at rated ambient temperature, unless otherwise noted.

2.05 VOLTAGE AND FREQUENCY RATING

A. System Frequency: 60 Hz.

B. Voltage Rating: As indicated on Drawings.

C. Suitable for full voltage starting.

D. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.06 EFFICIENCY AND POWER FACTOR

A. For all motors except single-phase, under 1 hp, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:

1. Efficiency:
   a. Tested in accordance with NEMA MG 1, Paragraph 12.59.
   b. Guaranteed minimum at full load in accordance with NEMA MG 1 A: Table 12-12, Full-load Efficiencies for NEMA

Premium Efficiency Electric Motors Rated 600 Volts or Less (Random Wound), or as indicated in motor-driven equipment specification.

2. Power Factor: Guaranteed minimum at full load shall be manufacturer's standard or as indicated in motor-driven equipment specification.

2.07 LOCKED ROTOR RATINGS

A. Locked rotor kVA Code G or lower, if motor horsepower not covered by NEMA MG 1 tables.

B. Safe Stall Time: 12 seconds or greater.

2.08 INSULATION SYSTEMS

A. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.

B. Motors Rated Over 600 Volts: VPI windings in accordance with NEMA MG 1.

C. Three-phase and Integral Horsepower Motors: Unless otherwise indicated in motor-driven equipment specification, Class B or Class F at nameplate horsepower and designated operating conditions.

2.09 ENCLOSURES

A. Conform to NEMA MG 1.

B. TEFC and TENV: Furnish with drain hole with porous drain/weather plug.

C. Submersible: In accordance with Article Special Motors.

2.10 TERMINAL (CONDUIT) BOXES

A. Oversize main terminal boxes for motors.

B. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.

C. Except ODP, furnish gaskets between box halves and between box and motor frame.

D. Terminal for connection of equipment grounding wire in each terminal box.

E. Coordinate motor terminal box conduit entries versus size and quantity of conduits shown on Drawings.

2.11 BEARINGS AND LUBRICATION

A. Horizontal Motors:

1. 3/4 hp and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
2. 1 hp through 400 hp: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
3. For Direct Drive Equipment: Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.
4. For Belt Driven Equipment: Minimum 30,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.

B. Vertical Motors:

1. Thrust Bearings:
   a. Antifriction bearing.
   b. Manufacturer’s standard lubrication.
   c. Minimum 50,000 hours L-10 bearing life.
2. Guide Bearings:
   a. Manufacturer’s standard bearing type.
   b. Manufacturer’s standard lubrication 200 hp and smaller.
   c. Minimum 100,000 hours L-10 bearing life.

C. Regreasable Antifriction Bearings:

1. Readily accessible, grease injection fittings.
2. Readily accessible, removable grease relief plugs.

D. Oil Lubrication Systems:

1. Oil reservoirs with sight level gauge.
2. Oil fill and drain openings with opening plugs.
3. Provisions for necessary oil circulation and cooling.

2.12 NOISE

A. Measured in accordance with NEMA MG 1.

B. Maximum Sound Level for Motors Controlled by Adjustable Frequency Drive Systems: 3 dBA higher than NEMA MG 1.

2.13 BALANCE AND VIBRATION CONTROL

A. In accordance with NEMA MG 1, Part 7.

2.14 EQUIPMENT FINISH

A. External Finish: Prime and finish coat manufacturer's standard.

B. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 SPECIAL FEATURES AND ACCESSORIES

A. Screen Over Air Openings: Corrosion-resistant on motors with ODP, WPI, and WPII enclosures meeting requirements for guarded machine in NEMA MG 1, and attached with stainless steel screws.

B. Nameplates:

1. Raised or stamped letters on stainless steel or aluminum.
2. Display motor data required by NEMA MG 1, Paragraph 10.39 and Paragraph 10.40 in addition to bearing numbers for both bearings.
3. Premium efficiency motor nameplates to display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

C. Anchor Bolts: Provide meeting manufacturer's recommendations and of sufficient size and number for specified seismic condition.

2.16 SPECIAL MOTORS

A. Requirements in this article take precedence over conflicting features specified elsewhere in this section.

B. Inverter Duty Motor:

1. Motor Supplied Power by Adjustable Voltage and Adjustable Frequency Drives: Inverter duty rated in accordance with NEMA Parts 30 and 31.
2. Provide winding insulation rated 1,600 peak volts, minimum.
3. Meet or exceed NEMA MG 1 corona inception voltage rating.
4. Suitable for operation over entire speed range indicated.
5. Provide forced ventilation where speed ratio is greater than published range for motor provided.

C. Submersible Pump Motor:

1. Manufacturers:
   a. Goulds.
   b. Reliance Electric.
   c. Xylem Flygt Corp.
   d. ITT Goulds Pumps.
2. At 100 Percent Load:
   a. Motors with Speeds Less than 1,200 rpm: Manufacturer's standard.
   b. Motors with Speeds 1,200 rpm and Greater:

Submersible Pump Motors		
Horsepower	**Guaranteed Minimum Efficiency**	**Guaranteed Minimum Power Factor**
5 through 10	80	82
10.1 through 50	85	82
50.1 through 100	87	82
Over 100	89	82

3. Insulation System: Manufacturer's standard Class B or Class F.
4. Motor capable of running dry continuously.
5. Enclosure:
   a. Hermetically sealed, watertight, for continuous submergence up to 65-foot depth.
   b. Listed to meet UL 674 and NFPA 70 requirements for Class I, Division 1, Group D hazardous atmosphere.
   c. Seals: Tandem mechanical.
6. Bearing and Lubrication:
   a. Permanently sealed and lubricated, replaceable antifriction guide and thrust bearings.
   b. Minimum 15,000 hours L-10 bearing life.
7. Inrush kVA/horsepower no greater than NEMA MG 1 and NFPA 70, Code F.
8. Connecting Cables:
   a. One cable containing power, control, and grounding conductors.
   b. Each cable suitable for hard service, submersible duty with watertight seal where cable enters motor.
   c. Length: As required.
   d. UL 83 listed and sized in accordance with NFPA 70.

2.17 FACTORY TESTING

A. Tests:

1. In accordance with IEEE 112 for polyphase motors.
2. Routine (production) tests in accordance with NEMA MG 1. Test multispeed motors at all speeds.
3. For energy efficient motors, test efficiency and power factor at 50 percent, 75 percent, and 100 percent of rated horsepower:
   a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, Paragraph 12.59. and Paragraph 12.60.
4. Provide test reports for polyphase motors 100 hp and larger.

B. Test Report Forms:

1. Routine Tests: IEEE 112, Form A-1.
2. Efficiency and power factor by Test Method B, IEEE 112, Form A-2, and NEMA MG 1, Table 12-11.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's instructions and recommendations.

B. Align motor carefully and properly with driven equipment.

C. Secure equipment to mounting surface with anchor bolts.

3.02 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection, equipment testing, and startup assistance for motors larger than 100 hp.

END OF SECTION

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Code of Federal Regulations (CFR): 10 CFR Part 431, DOE 2016 efficiency.
2. Institute of Electrical and Electronics Engineers (IEEE): C57.96, Guide for Loading Dry Type Transformers.
3. National Electrical Contractor's Association (NECA): 409, Recommended Practice for Installing and Maintaining Dry-Type Transformers.
4. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. ST 20, Dry-Type Transformers for General Applications.
5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
6. UL:
   a. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   b. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   c. 1561, Standard for Dry-Type, General Purpose, and Power Transformers.

1.02 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Dimensions and weight.
3. Transformer nameplate data, including efficiency.
4. Schematic and connection diagrams.
5. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.

PART 2 PRODUCTS

2.01 GENERAL

A. UL 1561, NEMA ST 20, unless otherwise indicated.

B. Dry-type, self-cooled, two-winding, with copper windings.

C. Units larger than 5 kVA suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Efficiency: Meet or exceed DOE 2016 efficiency requirements.

E. Maximum Sound Level per NEMA ST 20:

1. 40 decibels for 0 kVA to 9 kVA.
2. 45 decibels for 10 kVA to 50 kVA.
3. 50 decibels for 51 kVA to 150 kVA.
4. 55 decibels for 151 kVA to 300 kVA.
5. 60 decibels for 301 kVA to 500 kVA.

F. Overload Capability: Short-term overload per IEEE C57.96.

G. Wall Bracket: For single-phase units, 15 kVA to 37-1/2 kVA, and for three-phase units, 15 kVA to 30 kVA.

H. Vibration Isolators:

1. Rated for transformer’s weight.
2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
3. Less than 30 kVA: Isolate entire unit from structure with external vibration isolators.
4. 30 kVA and Above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.

I. Manufacturers:

1. General Electric Co.
2. Square D Co.
3. Eaton/Cutler-Hammer.

2.02 MINI-POWER CENTER (MPC)

A. General: Transformer, primary, and secondary main circuit breakers, and secondary panelboard section enclosed in NEMA 250, Type 3R enclosure.

B. Transformer:

1. Insulation Class and Temperature Rise: Manufacturer's standard.
2. Efficiency: Manufacturer's standard (DOE 2016 efficiency).
3. Core and Coil: Encapsulated.
4. Full capacity, 5 percent voltage taps, two below normal voltage.
5. Primary Voltage: 480, single-phase.
6. Secondary Voltage: 240/120 volts, single-phase, three-wire.

C. Panelboard: Full, UL 489, short-circuit current rated.

1. Type: Thermal-magnetic, quick-make, quick-break, indicating, with noninterchangeable molded case circuit breakers.
2. Number and Breaker Ampere Ratings: Refer to Panel Schedule.

2.03 GENERAL PURPOSE TRANSFORMER

A. Insulation Class and Temperature Rise: Manufacturer's standard.

B. Core and Coil:

1. Encapsulated for single-phase units 1/2 kVA to 25 kVA and for three-phase units 3 kVA to 15 kVA.
2. Thermosetting varnish impregnated for single-phase units 37.5 kVA and above, and for three-phase units 30 kVA and above.

C. Enclosure:

1. Single-Phase, 3 kVA to 25 kVA: NEMA 250, Type 3R, nonventilated.
2. Single-Phase, 37-1/2 kVA and Above: NEMA 250, Type 2, ventilated.
3. Three-Phase, 3 kVA to 15 kVA: NEMA 250, Type 3R, nonventilated.
4. Three-Phase, 30 kVA and Above: NEMA 250, Type 2, ventilated.
5. Outdoor Locations: NEMA 250, Type 3R.
6. Corrosive Locations: NEMA 250, Type 3R stainless steel.

D. Voltage Taps:

1. Single-Phase, 3 kVA to 10 kVA: Two 5 percent, full capacity, below normal voltage rating.

2. Single-Phase, 15 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
3. Three-Phase, 3 kVA to 15 kVA: Two 5 percent, full capacity, below normal voltage rating.
4. Three-Phase, 30 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

E. Impedance: 1.9 percent minimum on units 75 kVA and larger.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with NECA and manufacturer's instructions.

B. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

C. Provide moisture-proof, flexible conduit for electrical connections.

D. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

E. Provide wall brackets for single-phase units, 15 kVA to 167-1/2 kVA, and three-phase units, 15 kVA to 30 kVA.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. National Electrical Contractor's Association (NECA): 407, Recommended Practice for Installing and Maintaining Panelboards.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. 289, Application Guide for Ground Fault Circuit Interrupters.
   c. KS 1, Enclosed Switches.
   d. PB 1, Panelboards.
   e. PB 1.1, General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
4. UL:
   a. 67, Standard for Panelboards.
   b. 98, Standard for Enclosed and Dead-Front Switches.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   d. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   e. 508, Standard for Industrial Control Equipment.
   f. 870, Wireways, Auxiliary Gutters and Associated Fittings.
   g. 943, Ground-Fault Circuit-Interrupters.
   h. 1699, Standard for Arc-Fault Circuit-Interrupters.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's data sheets for each type of panelboard, protective device, accessory item, and component.
2. Manufacturer's shop drawings including dimensioned plan, section, and elevation for each panelboard type, enclosure, and general arrangement.
3. Tabulation of features for each panelboard to include the following:
   a. Protective devices with factory settings.
   b. Provisions for future protective devices.
   c. Space for future protective devices.

d. Voltage, frequency, and phase ratings.
e. Enclosure type.
f. Bus and terminal bar configurations and current ratings.
g. Provisions for circuit terminations with wire range.
h. Short circuit current rating of assembled panelboard at system voltage.
i. Features, characteristics, ratings, and factory settings of auxiliary components.
j. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's recommended installation instructions.
3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.

1.03 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this section that are listed and labeled as defined in NEC Article 100.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Eaton/Cutler-Hammer.
2. General Electric Co.
3. Square D Co.
4. Siemens.

2.02 GENERAL

A. Provide low voltage panelboards for application at 600V or less in accordance with this section.

B. Provide equipment in accordance with NEMA PB 1, NFPA 70, and UL 67.

C. Wire Terminations:

1. Provide panelboard assemblies, including protective devices, suitable for use with 75 degrees C or greater wire insulation systems at NFPA 70, 75 degrees C conductor ampacity, and in accordance with UL 486E.
2. Lugs for termination of conductors shall comply with Section 26 05 05, Conductors.
3. Lugs for termination of copper feeder phase and neutral conductors shall be replaceable, bolted mechanical or crimp compression type.

D. Load Current Ratings:

1. Unless otherwise indicated, load current ratings for panelboard assemblies, including bus and circuit breakers, are noncontinuous as defined by NEC. Continuous ratings shall be 80 percent of noncontinuous rating.
2. Where indicated “continuous” or “100 percent”, selected components and protective devices shall be rated for continuous load current at value shown.

E. Short Circuit Current Rating (SCCR): Integrated equipment short circuit rating for each panelboard assembly shall be no less than the fault current available as shown at point of application in distribution system or as indicated SCCR.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Overcurrent Device Mounting and Arrangement: Design panelboards to accommodate device installation and replacement without disturbing adjacent devices and without removing main bus.

B. Overcurrent Protective Devices: In accordance with NEMA KS 1, UL 98, and UL 489. Protective devices shall be adapted to panelboard installation.

C. Provisions for Future Overcurrent Device:

1. Provide space, mountings and bus connections such that like device may be installed without additional hardware.
2. Panel openings shall be closed with individual removable cover for each provision for future device.
3. Unless otherwise indicated, “spaces” in panelboards shall be fully equipped provision for future like devices.
4. Provisions for future devices shall be suitable devices rated no less than 60 amperes.

D. Protective Device Locking: Furnish provisions for handle padlocking for main, subfeed, and branch devices where indicated.

E. Branch Protective Devices:

1. Provide Wire Lug Load Connections: Mechanical or crimp compression type, removable/replaceable, and suitable for 75 degrees C rated conductors without derating switch nor conductor ampacity.
2. Provide a nameplate for each circuit, blanks for spares.

2.04 CIRCUIT BREAKERS

A. General: Thermal-magnetic unless otherwise indicated, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle. Circuit breakers shall comply with Section 26 05 04, Basic Electrical Materials and Methods.

B. Bus Connection: Bolt-on circuit breakers in all panelboards.

C. Trip Mechanism:

1. Individual permanent thermal and magnetic trip elements in each pole.
2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
3. Two and three pole, common trip.
4. Automatically opens all poles when overcurrent occurs on one pole.
5. Test button on cover.
6. Calibrated for 40 degrees C ambient, unless shown otherwise.

D. Unacceptable Substitution:

1. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.
2. Do not use tandem or dual circuit breakers in normal single-pole spaces.

E. Specialty Breakers:

1. Where indicated, provide breakers with the following features:
   a. Ground Fault Circuit Interrupter (GFCI): Rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel). Ground fault sensor shall be rated same as circuit breaker. Breaker shall include push-to-test and reset buttons.

b. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker with ground fault sensor and rated to trip on 30-mA ground fault (UL listed for equipment ground fault protection).
c. Heating and Air Conditioning Rated (HACR): Where indicated, provide breaker UL listed for the protection of such equipment.

F. Solid State Trip Units: Where indicated, equip breakers with solid state trip units.

1. Long (Time) Short (Time) Instantaneous (LSI): Electronic trip unit with fixed long-time trip, adjustable short-time trip and delay, and adjustable instantaneous trip settings.
2. Long (Time) Short (Time) Instantaneous Ground (Fault) (LSIG): Electronic trip unit as above and also with adjustable ground fault trip and delay settings.

G. Fused Switch:

1. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.
2. UL 98 listed for use and location of installation and comply with NEMA KS 1.
3. Fuse Provisions:
   a. 30-amp to 600-amp rated shall incorporate rejection feature to reject all fuses except Class R.
   b. 601-amp rated and greater shall accept Class L fuses, unless otherwise shown.
4. Interlock fuse cover and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.
5. Fuses: Provide for each ungrounded circuit conductor as specified in Section 26 05 04, Basic Electrical Material and Methods.

2.05 ENCLOSURES

A. General:

1. Provide as specified in Section 26 05 04, Basic Electrical Materials and Methods.
2. Type 1, Type 3R, and Type 3S material code-gauge, hot-dip galvanized sheet steel with reinforced steel frame.
3. Provide surface-mount panelboard from trim with same dimensions as box front.

B. Finish: Rust inhibitor prime followed by manufacturer’s standard gray baked enamel or lacquer.

C. NEMA 250 Type 1 Branch Panelboard Enclosure:

1. Secure front trim to box with concealed trim clamps.
2. Overlap flush panelboards front trims with box nominal 3/4 inch on all sides.
3. Provide door in panelboard front trim, with concealed hinges, to access protective device operating handles.
4. Provide multi-point latching for doors over 30 inches in height.
5. Door Lock: Secure with flush catch and tumbler lock; all panelboards keyed alike, with two milled keys each lock.
6. Circuit Directory: Metal frame with transparent plastic face and enclosed card, mounted inside each panel door.

2.06 BUSSING AND TERMINAL BARS

A. Bus:

1. Material: Tin-plated copper full sized throughout length.
2. Provide for mounting of future protective devices along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.

B. Equipment Ground Terminal Bus: Copper with suitably sized provisions for termination of ground conductors, and bonded to box.

1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
2. Provide individual termination points for all other grounding conductors such as feeder, grounding electrode, etc.
3. Termination points shall be bolted crimp compression lugs for conductors 6 AWG and larger.

C. Neutral Terminal Bus: Copper with suitably sized provisions for termination of neutral conductors, and isolated from box.

1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
2. Provide individual termination points for all other neutral conductors.
3. Termination Points: Bolted crimp compression lugs for conductors 6 AWG and larger.

D. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances for future protective device ampere ratings indicated.

2.07 SPECIAL FEATURES

A. General: Where indicated on Drawings or schedules, provide special features as specified.

B. Service Equipment Approval: Listed for use as service equipment for panelboards having service disconnecting means.

C. Subfeed: Protective device or lugs indicated, with additional terminals on neutral and ground bus to accommodate feeder.

D. Surge Protection Device:

1. Comply with Section 26 43 00, Surge Protective Devices.
2. Provide protective device within panelboard as disconnecting means and short circuit protection per manufacturer's recommendation.
3. Provide factory mounting within panelboard utilizing UL-recognized mounting device.

PART 3 EXECUTION

3.01 GENERAL

A. Install in accordance with NECA 407, NEMA PB 1.1, and manufacturers' written installation instructions.

B. Install securely, plumb, in-line and square with walls.

C. Install top of cabinet trim 78 inches above floor, unless otherwise shown. Install cabinet so tops of protective device operating handles are no more than 78 inches above the floor.

D. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289.

E. Install filler plates in unused spaces.

F. Wiring in Panel Gutters: Train conductors neatly in groups; bundle and wrap with nylon wire ties.

G. Mount flush panels uniformly flush with wall finish.

H. Provide typewritten circuit directory for each panelboard.

I. Provide engraved identification for each protective device.

END OF SECTION

SECTION 26 24 19
LOW-VOLTAGE MOTOR CONTROL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which shall be followed for this section:

1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
2. National Electrical Contractors Association (NECA): 402, Standard for Installing and Maintaining Motor Control Centers.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
   b. ICS 1, Industrial Control and Systems: General Requirements.
   c. ICS 2, Controllers, Contactors, and Overload Relays Rated 600 Volts.
   d. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL:
   a. 98, Enclosed and Dead-Front Switches.
   b. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.

1.02 DEFINITIONS

A. LCD: Liquid Crystal Display.

B. N.C.: Normally Closed.

C. N.O.: Normally Open.

D. SPD: Surge Protection Device.

1.03 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Itemized Bill of Material.
3. Dimensional drawings.

4. Front Panel Elevations.
5. Conduit entrance locations.
6. Bus data.
7. Protective Devices: Copies of time-current characteristics.
8. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
9. Anchoring instructions and details.
10. Anchoring instructions and details.
11. Typed Tabulation:
    a. Motor name; tag (equipment) numbers as shown on Drawings.
    b. Motor horsepower.
    c. Nameplate full load current.
    d. Measured load current and voltage.
    e. Overload model number and setting.
    f. Protective device trip settings.
    g. Attach above typed, tabulated data to a copy of starter manufacturer's overload relay or setting selection tables for starters provided.
12. Control diagrams.
13. One-line diagrams.
14. Schematic (elementary) diagrams.
15. Outline diagrams.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's installation instructions.
3. Factory test reports, certified.
4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.04 QUALITY ASSURANCE

A. Provide products manufactured within scope of UL that conform to UL Standards and have applied UL Listing Mark.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide materials, equipment, and accessories specified in this section manufactured by:

1. Eaton Electrical/Cutler-Hammer.

2. GE Industrial Systems.
3. Schneider Electric/Square D Services.
4. Allen-Bradley.
5. Siemens.

2.02 GENERAL

A. Like Items of Equipment: End product of one manufacturer.

B. Make adjustments necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.

C. Controllers: NEMA ICS 1, NEMA ICS 2, Class A.

D. Control Transformer:

1. Two winding, 120-volt secondary, primary voltage to suit.
2. Two current-limiting fuses for primary circuit.
3. One fuse in secondary circuit.
4. Mount within starter unit.

E. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

F. Lifting lugs on equipment and devices weighing over 100 pounds.

G. Anchor Bolts.

H. Seismic Zone and Importance Factor: As specified in Section 01 61 00, Common Product Requirements.

I. Operating Conditions:

1. Ambient Temperature: Maximum 40 degrees C.
2. Equipment to be fully rated.

J. Enclosures: In accordance with NEMA 250.

K. Equipment Finish:

1. Electrocoating process applied over rust-inhibiting phosphated base coating.
2. Exterior Color: Manufacturer’s standard.

2.03 SEPARATELY MOUNTED MOTOR CONTROL

A. Combination Full-Voltage, Magnetic Starter:

1. Rating: Horsepower rated at 600 volts, UL labeled for 65,000 amperes at 480 volts short circuit capacity with overload protection.
2. Three-phase, nonreversing, full voltage.
3. Control: As shown on Drawings.
4. Disconnect Type: Nonfused.
5. Padlockable operating handle, capable of up to three locks.

B. Thermal Motor Overload Protection:

1. Inverse-time-limit characteristic.
2. Heater: Bimetallic overload, adjustable trip, or directly heated melting alloy, ratchet principle type element.
3. Relay Trip: Quick, Class 10.
4. Manual reset.
5. Provide in each ungrounded phase.
6. Mount within starter unit.

2.04 SOURCE QUALITY CONTROL

A. Factory Testing:

1. Applicable Standards: NEMA ICS 18, UL 845, and NEC Article 430, Part VIII.
2. Perform standard factory inspection and tests in accordance with NEMA requirements to verify components have been designed to Specification, assembled in accordance with applicable standards, and each unit functions in accordance with electrical diagrams.
3. Actual operation shall be performed wherever possible. Otherwise, inspect and perform continuity checks.
4. Verify component devices operated correctly in circuits as shown on diagrams or as called for in Specification.
5. Control Circuits and Devices:
   a. Energize circuit at rated voltage.
   b. Operate control devices.
   c. Perform continuity check.
6. Verify equipment passed tests and inspection.
7. Provide standard factory inspection and test checklists, and final certified and signed test report.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install equipment in accordance with NEMA ICS 2.3, IEEE C2, NECA 402, Submittals, and manufacturer's written instructions and recommendations.
2. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.
3. Install equipment plumb and in longitudinal alignment with pad or wall.
4. Coordinate terminal connections with installation of secondary feeders.
5. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.
6. Motor Data:
   a. Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:
      1) Motor served by tag number and equipment name.
      2) Nameplate horsepower.
      3) Motor code letter.
      4) Full load amperes.
      5) Service factor.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM): A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. Federal Specifications (FS):
   a. W-C-596G, General Specification for Connector, Electrical, Power.
   b. W-S-896F, Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
3. Institute of Electrical and Electronic Engineers, Inc. (IEEE):
   a. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits.
   b. C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and less) AC Power Circuits.
4. National Electrical Contractors Association (NECA): 1, Standard Practice of Good Workmanship in Electrical Contracting.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. FB 11, Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
   c. WD 1, General Color Requirements for Wiring Devices.
   d. WD 6, Wiring Devices – Dimensional Specifications.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. UL:
   a. 498, Standard for Safety for Attachment Plugs and Receptacles.
   b. 508, Standard for Safety for Industrial Control Equipment.
   c. 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
   d. 1010, Standard for Safety for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
   e. 1436, Standard for Safety for Outlet Circuit Testers and Similar Indicating Devices.
   f. 1449, Standard for Safety for Surge Protective Devices (SPD).

1.02 SUBMITTALS

A. Action Submittals: Manufacturer's product data for wiring devices.

PART 2 PRODUCTS

2.01 SWITCHES

A. Switch, General Purpose:

1. NEMA WD 1 and FS W-S-896F.
2. Totally enclosed, ac type, with quiet tumbler switch and screw terminal.
3. Rivetless one-piece brass or copper alloy contact arm with silver alloy contact.
4. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
5. Rating: 15 amps, 120/277 volts.
6. Automatic grounding clip and integral grounding terminal on mounting strap.
7. Special Features:
   a. Provide the following features in comparable devices where indicated:
      1) Three-way and four-way.
      2) Tamper resistant.
      3) Three-position, maintained contact, center off.
8. Manufacturers and Products, Industrial Grade:
   a. Cooper Arrow Hart; AH1200 Series.
   b. Bryant; 4801 Series.
   c. Hubbell; 1201 Series.
   d. Leviton; 1201 Series.

B. Switch, Motor Rated:

1. Type: Two-pole or three-pole, manual motor starting/disconnect switch without overload protection.
2. UL 508 listed.
3. Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts.
4. Minimum General Purpose Rating: 30 amperes, 600V ac.
5. Minimum Motor Ratings:
   a. 2 hp for 120V ac, single-phase, two-pole.
   b. 3 hp for 240V ac, single-phase, two-pole.
   c. 15 hp for 480V ac, three-phase, three-pole.
6. Screw-type terminal.

7. Manufacturers and Products:
    a. Cooper Arrow Hart.
    b. Hubbell Bryant; HBL78 Series.
    c. Leviton.

2.02 RECEPTACLES

A. Receptacle, General Purpose:

1. NEMA WD 1 and FS W-C-596G.
2. Duplex, two-pole, three-wire grounding type with screw type wire terminals.
3. Impact resistant nylon cover and body, with finder grooves in face, unless otherwise indicated.
4. One-piece mounting strap with integral ground contact (rivetless construction).
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-15R, 15 amps, unless otherwise indicated.
7. Size: For 2-inch by 4-inch outlet box.
8. Special Features:
    a. Provide the following features in comparable devices where indicated:
        1) Listed weather-resistant per NEC 406.8 for installation in damp or wet locations.
9. Industrial Grade Manufacturers and Products:
    a. Cooper Arrow Hart; 5362 Series.
    b. Hubbell Bryant; HBL5362 Series.
    c. Leviton; 5362 Series.

B. Receptacle, Ground Fault Circuit Interrupter:

1. Meet requirements of general-purpose receptacle.
2. Listed Class A to UL 943, tripping at 5 mA.
3. Rectangular smooth face with push-to-test and reset buttons.
4. Listed weather-resistant per NEC 406.8 for installation in damp or wet locations.
5. Feed-through Capability: 20 amps.
6. Manufacturers and Products:
    a. Hubbell Bryant; GFTR20 Series.
    b. Cooper Arrow Hart; WRVGF20 Series.
    c. Leviton; 7899 Series.

C. Receptacle, Corrosion-Resistant:

1. Meet requirements of general-purpose receptacle.
2. Nickel coated metal parts.
3. Manufacturers and Products:
   a. Hubbell Bryant; HBL53CM62 Series.
   b. Leviton; 53CM-62 Series.
   c. Cooper Arrow Hart; 5362CR Series.

D. Receptacle, Special-Purpose:

1. Rating and number of poles as indicated or required for anticipated purpose.
2. Where indicated provide matching plug with cord-grip features for each special-purpose receptacle.

2.03 DEVICE PLATES

A. Sectional type plate not permitted.

B. Stainless Steel:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

C. Cast Metal:

1. Material: Malleable ferrous metal with gaskets.
2. Screw: Oval-head stainless steel.

D. Sheet Steel:

1. Finish: Zinc electroplate.
2. Screws: Oval-head stainless steel.
3. Manufacturers:
   a. Appleton.
   b. Crouse-Hinds.

E. Weatherproof:

1. Receptacle, Weatherproof:
   a. UL listed for wet location while in use.
   b. Polycarbonate cover.

c. Manufacturer and Product: TayMac; Type Multi-Mac.

2. Switch:
   a. Gasketed, cast-metal or cast-aluminum, incorporating external operator for internal switch.
   b. Mounting Screw: Stainless steel.
   c. Manufacturers and Products:
      1) Crouse-Hinds; DS-181 or DS-185.
      2) Appleton; FSK-1VTS or FSK-1VS.

F. Raised Sheet Steel: 1/2-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel box.

2.04 FINISHES

A. Wiring device catalog numbers specified in this section do not designate device color. Unless otherwise indicated, or required by code, provide colors as specified below.

B. Wiring Device: Ivory.

C. Special purpose devices may be manufacturer's standard color (black).

D. Corrosion-resistant receptacle may be manufacturer's standard color (yellow).

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Comply with NECA 1.

B. Coordination with Other Trades:

1. Ensure device and its box are protected. Do not place wall finish materials over device box and do not cut holes for box with router that is guided by riding against outside of box.
2. Keep outlet box free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate raceway system, conductors, and cables.
3. Install device box in brick or block wall such that cover plate does not cross a joint, unless otherwise indicated. Where indicated or directed to cross joint, trowel joint flush with face of wall.
4. Install wiring device after wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. Length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction or that show signs they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (150 mm) in length.
5. Use torque screwdriver when a torque is recommended or required by manufacturer.
6. When conductors larger than 12 AWG are installed on 15-amp or 20-amp circuits, splice 12 AWG pigtails for device connections.
7. Tighten unused terminal screws on device.
8. Device Plates:
   a. Do not use oversized or extra deep plate.
   b. Repair wall finishes and remount outlet box when standard device plate does not fit flush or does not cover rough wall opening.

3.02 SWITCH INSTALLATION

A. Switch, General Purpose:

1. Mounting Height: See Section 26 05 33, Raceway and Boxes.
2. Install with switch operation in vertical position.

3. Install single-pole, two-way switch such that toggle is in up position when switch is on.

B. Switch, Motor Rated:

1. Mounting Height: See Section 26 05 33, Raceway and Boxes.
2. Install with switch operation in vertical position such that toggle is in up position when ON.
3. Install within sight of motor when used as disconnect switch.

3.03 RECEPTACLE INSTALLATION

A. Duplex Receptacle:

1. Install with grounding slot down, except where horizontal mounting is shown, in which case install with neutral slot up.
2. Weatherproof Receptacle:
   a. Install in cast metal box.
   b. Install such that hinge for protective cover is above receptacle opening.
3. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for “downstream” conventional receptacles.
4. Special-Purpose Receptacle: Install in accordance with manufacturer’s instructions.

3.04 DEVICE PLATE INSTALLATION

A. Securely fasten to wiring device; ensure tight fit to box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surface without use of mat or similar material. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box, unless plate has no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Type (Exterior):

1. Switch: Weatherproof.
2. Receptacle in Damp Location: Weatherproof Type 1.
3. Receptacle in Wet Location: Weatherproof Type 2.

F. Type (Interior):

1. Surface Mounted, Metal Box:
   a. General Purpose Areas (Dry, Nonprocess): Sheet steel.
   b. Other Areas: Cast metal.
2. Surface Mounted, Sheet Steel Box: Raised sheet steel.
3. Surface Mounted, Cast Box: Cast.
4. Receptacle Shown as Weatherproof on Drawings: Weatherproof.

3.05 IDENTIFICATION

A. Use tape labels for identification of individual receptacles in dry indoor locations.

1. Degrease and clean device plate surface to receive tape labels.
2. Use 3/16-inch Kroy black letters on white background, unless otherwise indicated.
3. Identify panelboard and circuit number from which item is served on face of plate.

B. Identify conductors with durable wire markers or tags inside outlet boxes.

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections, and prepare test reports.

B. Test Instrument for 125-Volt 20-Amp Receptacle: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

C. Using test plug, verify device and its outlet box are securely mounted.

D. Line Voltage Range: 105 volts to 132 volts.

E. Percent Voltage Drop under 15-Amp Load: Less than 6 percent; 6 percent or higher is not acceptable.

F. Ground Impedance: 2 ohms, maximum.

G. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

H. Tests shall be diagnostic, indicating damaged conductors, high resistance at circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION

SECTION 26 29 23
LOW-VOLTAGE VARIABLE FREQUENCY DRIVE SYSTEM

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Electronic Industries Alliance (EIA): 359-A-1, Special Colors.
2. Hydraulic Institute Standards (HIS).
3. Institute of Electrical and Electronics Engineers (IEEE):
   a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   b. 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
   c. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
4. National Electrical Manufacturer's Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. CP 1, Shunt Capacitors.
   c. MG 1, Motors and Generators.
   d. WC 57, Standard for Control, Thermocouple Extensions, and Instrumentation Cables.
5. National Fire Protection Association (NFPA): 79, Electrical Standard for Industrial Machinery.

1.02 DEFINITIONS

A. Terms that may be used in this section:

1. CMOS: Complementary metal oxide semiconductor.
2. CSI: Current source inverter.
3. EMU: Energy monitoring unit.
4. GTO: Gate turn-off thyristor.
5. MPR: Motor protection relay.
6. MTBF: Mean time between failure.
7. PWM: Pulse width modulation.
8. ROM: Read only memory.
9. RTD: Resistance temperature detector.
10. RTU: Remote Telemetry Unit.
11. Rated Load: Load specified for equipment.

12. Rated Speed: Nominal rated (100 percent) speed specified for equipment.
13. TDD: Total demand distortion.
14. THD: Total harmonic distortion.
15. TTL: Transistor transistor logic.
16. VFD: Variable Frequency Drive.

1.03 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Composite drive/motor efficiency (CE) is defined as ratio of motor shaft kW to drive input kW. VFD system minimum requirements:
   a. At 60-Hz drive output and 100 percent load, CE equals 92 percent.
   b. At 50-Hz drive output and 60 percent load CE equals 89 percent.
   c. At 40-Hz drive output and 30 percent load CE equals 84 percent.
   d. At 30-Hz drive output and 12.5 percent load CE equals 77 percent.
2. Rated Continuous Operation Capacity: Not less than 1.15 times full load current rating of driven motor, as indicated on motor nameplate, and suitable for continuous operation at continuous overload which may be imposed on motor by driven pump operating over specified speed range.
3. Furnish isolating transformers or series reactors, harmonic filters, or other devices necessary for proper system operation. Furnish necessary devices and circuits to prevent operation of one drive from adversely affecting operation of other drives supplied from same transformer or same bus.
4. Furnish DV/DT filters for drive with long distances to motors. See Drawings for these occurrences.

B. Design Requirements:

1. Drive system consisting of adjustable frequency controller, drive motor, auxiliary items, and components necessary for complete operating system.
2. Other equipment is being powered from same bus as adjustable frequency drives. Ensure proper operation of drives and other loads under normal and emergency conditions.
3. Furnish VFDs rated on basis of actual motor full load nameplate current rating times the service factor.

4. Drive System: Convert incoming single-phase, 60-Hz ac power to variable voltage, adjustable frequency output for adjustable speed operation of a standard ac induction squirrel-cage motor, using pulse-width-modulation (PWM) technique to produce adjustable frequency output.
5. System rated for continuous industrial duty and suitable for use with NEMA MG 1, Design B motors.
6. Incoming Line Circuit Breaker: Provide positive means of disconnecting incoming power, and overcurrent protection for drive system.
7. Incoming Line Reactor: Design to minimize harmonic distortion on incoming power feeder.

1.04 SUBMITTALS

A. Action Submittals:

1. Overall drive system operating data, including efficiencies, input currents, and power factors, at driven equipment actual load and rated system input voltage, at 0, 40, 60, 80, 100, and 110 percent of rated speed.
2. VFD output pulse maximum peak voltage, pulse rise time, and pulse rate of rise including justification for proposed deviation from specified values. Include motor manufacturer’s certification motor insulation will withstand long-term over voltages caused at motor terminals due to specified output pulse data or proposed deviation from this data.
3. Data on shelf life of “dc link” capacitor.
4. Complete system rating, including nameplate data, continuous operation load capability throughout speed range of 0 percent to 120 percent of rated speed.
5. Complete adjustable frequency controller rating coordinated with motor full load nameplate current rating; list controller special features being supplied.
6. Controller, reactor, dimensional drawings; information on size and location of space for incoming and outgoing conduit.
7. Maximum heat dissipation from enclosure.
8. Should separate enclosures and equipment be necessary for filter elements provide complete dimensional information including location of space for incoming and outgoing conduit, weight, maximum heat loss, and minimum current carrying capacity and recommended wire size for required interconnecting circuits.
9. Layout of controller face showing pushbuttons, switches, instruments, and indicating lights.

10. Complete system operating description.
11. Complete system schematic (elementary) wiring diagrams.
12. Complete system interconnection diagrams between controller, drive motor, and related components or controls external to system, including wire numbers and terminal board point identification.
13. One-line diagram of system, including component ratings.
14. Description of diagnostic features being provided.
15. Descriptive literature for control devices such as relays and timers.
16. Itemized bill-of-materials listing system components.
17. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Statement of Supplier qualifications.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Factory functional test reports.
6. Certified copy of test report for identical motor tested in accordance with NEMA MG 1-12.53a and IEEE 112, Test Method B, showing rated load, rated speed efficiency meeting or exceeding specified values; motors not as specified will be rejected.
7. Field test reports.
8. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
9. Suggested spare parts list to maintain equipment in service for period of 1 year and 5 years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
10. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
11. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
12. Manufacturer's Certificate of Proper Installation.

1.05 QUALITY ASSURANCE

A. Supplier: Minimum 5 years' experience in furnishing similar size and type adjustable frequency, controlled speed, drive systems.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Components and accessories specified in this section shall be products of:

1. Eaton Cutler Hammer.
2. Allen-Bradley.
3. Yaskawa America, Inc.
4. Danfoss.
5. Siemens Robicon.
6. ABB.
7. Toshiba.
8. Square D.

B. No “or-equal” or substitute products will be considered.

2.02 SERVICE CONDITIONS

A. Ambient Operating Temperature: As specified in Section 01 61 00, Common Product Requirements.

B. Storage Temperature: Minus 40 degrees F to 158 degrees F.

C. Humidity: 0 percent to 95 percent relative (noncondensing).

D. Altitude: As specified in Section 01 61 00, Common Product Requirements.

E. Frequency Stability: Plus or minus 0.1 percent of maximum frequency.

2.03 COMPONENTS

A. Drive Units:

1. Incorporate switching power supply operating from dc bus, to produce PWM output waveform simulating sine wave and providing power loss ride through of 2 milliseconds at full load, full speed.
2. Current-limiting semiconductor fuses for protection of internal power semiconductors.
3. Employ diode bridge rectifier providing constant displacement power factor of 0.95 minimum at all operating speeds and loads.
4. Use transistors for output section, providing a minimum 97 percent drive efficiency at full speed, full load.

5. Employ dc power discharge circuit so that after removal of input power dc link capacitor voltage level will decay below 50V dc within 1 minute after de-energizing following NEMA CP 1 and NFPA 79. Design dc link capacitor for a MTBF of 5 years.
6. Operate with open circuited output.
7. Input Voltage: 240V ac plus or minus 10 percent.
8. Output Voltage: 0V to 240V, single-phase, 0-Hz to 66-Hz, minimum.
9. Maximum peak voltage of PWM VFD output pulse of 1,000 volts, with pulse rise time of not less than 2 microseconds, and maximum rate of rise of 500 volts per microsecond. Maximum frequency of PWM VFD output pulse (carrier) frequency of 3,000-Hz. Should magnitudes of these characteristics be more stressful to motor insulation than specified values, furnish insulation systems on motors suitable for proposed values.
10. Motor Audible Noise Level: When operating throughout speed range of PWM VFD, no more than 3 dBA above that designated in NEMA MG 1 for same motor operated at constant speed with a 60-Hz supply voltage.
11. Short-Time Overload Capacity: 125 percent of rated load in rms current for 1 minute following full load, full speed operation.
12. Equipment Short-Circuit Rating: Suitable for connection to system with maximum source single-phase, bolted fault, short-circuit available of 42,000 amps rms symmetrical at 240V.
13. Furnish drives with output current-limiting reactors mounted within equipment enclosure.
14. Diagnostics:
    a. Comprehensive for drive adjustment and troubleshooting:
        1) Memory battery backup; 100-hour minimum during power loss.
        2) Status messages will not stop drive from running but will prevent it from starting.
        3) Fault Condition Messages and History:
            a) First fault protection function to be activated, ability to store six successive fault occurrences in order. Minimum faults numerically:
                (1) Overcurrent (time and instantaneous).
                (2) Overvoltage.
                (3) Undervoltage (dc and ac).
                (4) Overtemperature (drive, motor windings, motor bearing, pump bearing).
                (5) Serial communication fault.
                (6) Short-circuit/ground fault (motor and drive).
                (7) Motor stalled.
                (8) Semiconductor fault.

(9) Microprocessor fault.
(10) Single-phase voltage condition.

15. Drive Protection:
    a. Fast-acting semiconductor fuses.
    b. Overcurrent, instantaneous overcurrent trip.
    c. Dc undervoltage protection, 70 percent dropout.
    d. Dc overvoltage protection, 130 percent pickup.
    e. Overtemperature, drive, inverter, converter, and dc link components.
    f. Overtemperature, motor, and pump.
    g. Single-phase protection.
    h. Reset overcurrent protection (manual or automatic reset).
    i. Active current limit/torque limit protection.
    j. Semiconductor fault protection.
    k. Short-circuit/ground fault protection.
    l. Serial communication fault protection.
    m. Microprocessor fault.
    n. Surge protection for transient overvoltage (6,000 volts, 80 joule surge, tested per IEEE C62.41).
    o. Visual display of specific fault conditions.
16. Operational Features:
    a. Use manufacturer's standard unless otherwise indicated.
    b. Sustained power loss.
    c. Momentary power loss.
    d. Power interruption.
    e. Power loss ride through (0.1 second).
    f. Start on the fly.
    g. Electronic motor overload protection.
    h. Stall protection.
    i. Slip compensation.
    j. Automatic restart after power return (ability to enable/disable function).
    k. Critical frequency lockout (three selectable points minimum, by 1.5-Hz steps in 10-Hz bands, to prevent resonance of system).
    l. Drive maintenance system software for complete programming and diagnostics.
    m. Ground fault protection, drive, and motor.
    n. Operate with no motor connected to output terminals.

B. Rectifier: Single-phase 4-pulse or 6-pulse full wave diode bridge rectifier to provide constant dc voltage to drive's dc bus.

C. Furnish series choke and capacitors on dc bus to reduce ripple in rectifier output and to reduce harmonic distortion reflected into incoming power feeders.

D. Controller: Microprocessor-controller PWM inverter to convert to dc voltage to variable voltage, adjustable frequency, three-phase ac output. Output voltage shall vary proportionally with frequency to maintain constant ratio of volts to hertz up to 60-Hz; above 60-Hz, voltage shall remain constant with drive operating in constant horsepower output mode.

E. Enclosure:

1. NEMA 250, Type 12 (For Pump Control Room) and NEMA 250, Type 4 (For Wetlands Pump Station), freestanding, enclosure for mounting against wall or stanchion, completely front accessible, and hinged doors. Properly sized to dissipate heat generated by controller within limits of specified operating conditions (including ambient temperature and ambient airflow). Enclosure not to exceed dimensions shown on Drawings.
2. Cable termination compartment door interlocked main circuit breaker, defeatable (lockable in the open position), emergency stop pushbutton, alphanumeric keypad and display, and operator's controls. Components and controls specified in Section 26 05 04, Basic Electrical Materials and Methods.
3. Wire drive from below and above for power and control wiring.
4. Size forced-ventilation for periodic operation to cool each unit with maximum room ambient temperature of 95 degrees F. Furnish redundant fans such that if one fan fails remaining fans furnish adequate ventilation for drive when operating at maximum capacity. Furnish filters on ventilation intakes.
5. Wiring:
    a. Bundle stranded copper wiring neatly with nylon tie wraps or with continuous plastic spiral binding.
    b. Label each terminal for permanent identification of leads.
    c. Identify each wire at each end with imprinted mylar adhesive-back wire markers.
    d. Incorporate in as-installed wiring diagrams for wire and terminal numbers shown.
    e. Wiring across door hinge, use 19-strand, NEMA WC 57 Class C stranding looped for proper twist rather than bending at hinge.
    f. Wire connections internal to panels by crimp-on terminal types.
    g. For multiple enclosure systems, complete interconnection wiring with gasketed enclosure openings for wiring.

h. Multipoint plug receptacles for control wiring crossing equipment shipping splits.

6. Selector switches, indicating lights, potentiometers, instruments, protective devices, and major system components identified by means of mechanically attached, engraved, laminated nameplates.

F. Operator Interface:

1. Controls:
   a. Mount drive local control on front door of enclosure and include control switch and membrane type keypad for the following operator functions:
      1) Start (when in LOCAL mode).
      2) Stop (when in LOCAL mode).
      3) Speed increase (when in LOCAL mode).
      4) Speed decrease (when in LOCAL mode).
      5) Parameter mode selection (recall programmed parameters).
      6) LOCAL/OFF/REMOTE control selection (in REMOTE, furnish for remote RUN command digital input and speed increase/decrease via remote 4 mA to 20 mA analog signal).
      7) Fault reset, manual for faults, except loss of ac voltage, which is automatic upon return.
      8) RUN/preset speed.
      9) Parameter lock, password or key switch lockout of changes to parameters.
      10) Start disable, key switch or programmed code.
2. Control circuit disconnect shall de-energize circuits in units that are not de-energized by main power disconnect device.
3. 120 volts, single-phase, 60-Hz circuits for control power and operator controls from internal control power transformer. Furnish power for motor space heaters rated 120 volts.
4. Arrange component and circuit such that failure of a single component cannot cause cascading failure(s) of other component(s).
5. Alphanumeric Display:
   a. During normal operation and routine test, the following parameters shall be available:
      1) Motor current (percent of drive rated current).
      2) Output frequency (Hertz).
      3) Output voltage.
      4) Running time.
      5) LOCAL/REMOTE indicator.
      6) Status of digital inputs and outputs.
      7) Analog input and output values.

8) Output motor current per leg.
9) All test points.

6. Adjustable Parameters:
   a. Set drive operating parameters and indicate in numeric form. Potentiometers may not be used for parameter adjustment. Minimum setup parameters available:
      1) Frequency range, minimum, maximum.
      2) Adjustable acceleration/deceleration rate.
      3) Volts per Hertz (field weakening point).
      4) Active current limit/torque limit, 0 percent to 140 percent of drive rating.
      5) Adjustable voltage boost (IR compensation).
      6) Preset speed (adjustable, preset operating point).
      7) Provision for adjustment of minimum and maximum pump speed to be furnished as function of 4 mA to 20 mA remote speed signal.

G. Signal Interface:

1. As shown on Drawings.
2. Digital Input: Provide 120V ac digital inputs as shown on the control diagrams on Drawings.
3. Digital Output: Provide 120V ac digital outputs as shown on the control diagrams on Drawings.
4. Analog Input: When LOCAL/OFF/REMOTE switch is in REMOTE, control drive speed from remote 4 mA to 20 mA dc signal.
   a. Make provisions for adjustment of minimum and maximum motor speed which shall result from this signal.
   b. Factory set this adjustment to comply with operating speed range designated in driven equipment specifications.
   c. Frequency resolution shall be 0.1 percent of base speed.
5. Analog Output: Furnish two 4 mA to 20 mA dc signals for actual frequency, actual load.

H. Accessories:

1. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in readily visible location.
2. Lifting Lugs: Equipment weighing over 100 pounds.
3. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer.

2.04 FACTORY FINISHING

A. Enclosure: Manufacturer's standard.

2.05 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all control panels actually furnished.

C. Record test data for report.

D. Functional Test: Perform manufacturer's standard.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

3.02 FIELD QUALITY CONTROL

A. Functional Test:

1. Conduct on each controller.
2. Inspect controller for electrical supply termination connections, interconnections, proper installation, and quiet operation.
3. Vibration Test:
   a. Complete assembly, consisting of motor, load, and flexible shafting, connected and in normal operation shall not develop amplitudes of vibration exceeding limits recommended by HIS.
   b. Where loads and drives are separated by intermediate flexible shafting, measure vibration both at top motor bearing and at two points on top pump bearing, 90 degrees apart.
4. Record test data for report.

B. Performance Test:

1. Conduct on each controller.
2. Perform under actual or approved simulated operating conditions.
3. Test for continuous 12-hour period without malfunction.

4. Demonstrate performance by operating continuous period while varying application load, as input conditions allow, to verify system performance.
5. Record test data for report.

END OF SECTION

SECTION 26 43 00
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI).
2. Department of Defense: MIL-STD-220C, Test Method Standard – Method of Insertion Loss Measurement.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
   b. C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.
   c. C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL:
   a. 497A, Standard for Secondary Protectors for Communications Circuits.
   b. 1283, Standard for Electromagnetic Interference Filters.
   c. 1449, Standard for Surge Protective Devices.

1.02 SUBMITTALS

A. Action Submittals:

1. Product data on each suppressor type, indicating component values, part numbers, and conductor sizes. Include dimensional drawing for each, showing mounting arrangements.
2. Manufacturer’s UL certified test data and nameplate data for each surge protective device (SPD).

1.03 QUALITY ASSURANCE

A. UL Compliance and Labeling:

1. SPDs for Power and Signal Circuits: Comply with UL 1449 and complimentary listed to UL 1283 as an electromagnetic interference filter. Provide units listed and labeled by UL.

B. ANSI Compliance: Use SPD devices in compliance with the recommendations of IEEE C62.41.1, IEEE C62.41.2, and IEEE C62.45.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton; SPD Series.

B. General Electric; Tranquell.

C. Square D; Surelogic.

D. Advanced Protection Technologies, Inc.

E. CITEL; MDS Series.

2.02 GENERAL

A. Unless indicated otherwise, provide direct bus-connected and factory-installed SPDs inside distribution equipment as shown on Drawings.

B. SPD Operating Conditions: Capable of performing at ambient temperatures between minus 40 degrees C and 60 degrees C, at relative humidity ranging from 0 percent to 95 percent, and at altitudes ranging from sea level to 12,000 feet.

C. Connect SPDs through a circuit breaker as selected by manufacturer. Provide overcurrent protection to allow full surge handling capabilities and afford safety protection from thermal overloads and short circuits.

D. SPD Short Circuit Current Rating (SCCR): No less than the SCCR of distribution equipment.

E. Design SPD devices to protect all modes (L-L, L-N, L-G, N-G) of electrical system being used.

F. Provide SPDs with the following monitoring and diagnostics:

1. LED-type indication lights to show normal and failed status of each protected phase.
2. Surge event counter.

G. Voltage Protection Rating (VPR):

Voltage Rating	L-N	N-G	L-G	L-L
208Y/120	800	800	800	1200
480Y/277	1200	1200	1200	2000
240 Δ	--	--	1200	1200
480 Δ	--	--	2000	2000

2.03 PANELBOARD SPD

A. Provide SPD meeting IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category B.

B. Surge Current Capacity:

1. Distribution: 120 kA per phase; 60 kA per mode.
2. Branch: 80 kA per phase; 40 kA per mode.

C. Maximum Continuous Operating Voltage (MCOV): Not less than 125 percent of the nominal system voltage.

D. Nominal Discharge Current (I_N): 10kA.

PART 3 EXECUTION

3.01 APPLICATION REQUIREMENTS

A. Provide SPDs when indicated on Drawings or in the equipment specifications.

B. Provide factory-installed SPDs as integral components to new panelboards. Externally mounted SPDs are not acceptable for new distribution equipment.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Install suppressors according to manufacturer's recommendations.

B. Install suppressors directly to the cabinet which houses the circuit to be protected so that the suppressor leads are straight and short, with conductors laced, running directly to the point of connection within the panel, without loops or bends. If bends are unavoidable, no bend may exceed 90 degrees and bending radius may not be less than 6 inches.

C. Provide connecting wires as short as possible with gently twisted conductors, tied together, to prevent separation.

1. Maximum Length: 24 inches.

D. Field Installed Conductors: As specified for building wire, not smaller than 8 AWG and not larger than 4 AWG. Provide device leads not longer than the maximum length recommended by manufacturer, unless specifically reviewed and approved by manufacturer.

E. Provide dedicated disconnecting means for SPD devices as shown on Drawings. Provide dedicated circuit breakers (size as recommended by the manufacturer) with number of poles as required, as disconnecting means for SPD devices. Provide circuit breakers with interrupting capacity equal to that specified for other breakers at that location.

END OF SECTION

SECTION 26 50 00
LIGHTING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Wood Protection Association (AWPA): M6, Brands Used on Forest Products.
2. ASTM International (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   c. A572/A572A, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
   d. A588/A588M, Standard Specification for High-Strength Low-Alloy Structural Steel, with 50 ksi [345 MPa] Minimum Yield Point to 4-in. [100-mm] Thick.
   e. A595/A595M, Standard Specification for Steel Tubes, Low-Carbon or High-Strength Low-Alloy, Tapered for Structural Use.
   f. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   g. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
   h. D6576, Standard Specification for Flexible Cellular Rubber Chemically Blown.
   i. G154, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.
3. Canadian Standards Association (CSA).
4. Certified Ballast Manufacturer (CBM).
5. Federal Communications Commission (FCC).
6. Illuminating Engineering Society of North America (IESNA).
   a. HB-9, Lighting Handbook.
   b. LM-79, IES Electrical and Photometric Measurements of Solid-State Lighting Products.
   c. LM-80, IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources.
   d. RP (Recommended Practices) Series.

e. TM-21, Projecting Long Term Lumen Maintenance of LED Light Sources.

7. Institute of Electrical and Electronics Engineers (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
8. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ICS 6, Industrial Control and Systems: Enclosures.
9. National Energy Policy Act.
10. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC) – Softbound Version.
11. Rural Utilities Service (RUS): 1728F-700, Specification for Wood Poles, Stubs and Anchor Logs.
12. UL:
    a. 773, UL Standard for Safety Plug-In Locking Type Photocontrols for Use with Area Lighting - Fourth Edition; Reprint with Revisions Through and Including March 08, 2002.
    b. 844, Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.
    c. 924, Emergency Lighting and Power Equipment.
    d. 1598, UL Standard for Safety Luminaires.
    e. 2108, UL Standard for Safety Low Voltage Lighting Systems - First Edition; Reprint with Revisions through and Including February 24, 2014.
    f. 8750, UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products - First Edition; Reprint with Revisions Through and Including April 1, 2015.
13. U.S. Environmental Protection Agency and U.S. Department of Energy: Energy Star.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. General:
      1) Provide catalog data sheets and pictures for all products listed below.
      2) Proposed Luminaire Substitutions (Interior and Exterior): Provide an electronic photometric file in standard '.ies' file format per the Illumination Engineering Society of North America (IESNA) for any proposed luminaire substitution not identified on the project Luminaire Schedule. Obtain file

from the luminaire manufacturer or approved independent photometric testing laboratory. Include the proposed substitute luminaire with all options identified on the project Luminaire Schedule.

b. Interior Luminaires:
   1) Catalog data sheets with pictures.
   2) Luminaire material, finish, dimensions, and metal gauge.
   3) Lens material, pattern, and thickness.
   4) Candle power distribution curves in two or more planes.
   5) Candle power chart 0 degree to 90 degrees.
   6) Lumen output chart.
   7) Average maximum brightness data in foot lamberts.
   8) Coefficients of utilization for zonal cavity calculations.
   9) Mounting or suspension details.

c. Exterior Luminaires:
   1) Catalog data sheets with pictures. Luminaire material, finish, dimensions, and metal gauge.
   2) Lens material, pattern, and thickness. Filters.
   3) IESNA lighting classification (BUG rating).
   4) Isolux diagram.
   5) Lighting distribution data and lighting distribution classification type as defined in IESNA HB 9.
   6) Fastening details to wall, pendant, or pole.
   7) Ballast type, location, and method of fastening.
   8) For light poles, submit catalog sheet, wind loading, pole deflection with fixture attached, total weight, all accessories, complete dimensions, and finish.
   9) Brackets and supports.

d. LED Source Systems:
   1) General:
      a) IESNA LM-80 test reports.
      b) IESNA TM-21 ratings.
      c) Operating temperature range. Data sheet (chart/graph) describing life as a function of temperature.
      d) Warranty: Light engine and driver.
      e) Rated life.
      f) Surge protection.
      g) Thermal control device, heat sink.
      h) Enclosure and wiring information.
      i) Operating voltage range.
   2) Drivers:
      a) Input Current Total Harmonic Distortion.
      b) Power factor.
      c) Sound rating.

e. Photoelectric Switches (Photocells):
   1) Voltage.
   2) Power consumption.
   3) Load capacity (watts).
   4) Contact ratings and configuration.
   5) Time delay.
   6) Light operating level controls.
   7) Enclosure type and dimensions.
   8) Mounting type.
   9) Temperature range.
   10) Features and options.

f. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's printed installation instructions.
3. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, provide material and equipment labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ to provide a basis for approval under NEC.
2. Provide materials and equipment manufactured within the scope of standards published by UL in conformance with those standards and with an applied UL listing mark.

B. Standard Products:

1. Provide materials and equipment of manufacturers regularly engaged in the production of products specified in this section and that are of equal material, design, and workmanship.
2. Provide products that have been in satisfactory commercial or industrial use for 2 years prior to Bid opening in similar applications under similar circumstances and of similar size. Provide products that have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

3. Material and Equipment Manufacturing Date: Do not use products manufactured more than 3 years prior to date of delivery to Site.

PART 2 PRODUCTS

2.01 LUMINAIRES

A. Specific requirements relative to execution of the Work of this section are located on Drawings.

B. Provide luminaires and components tested, listed, and labeled by UL, or other approved testing agency.

C. Provide luminaires with Illumination Engineering Society of North America (IESNA) formatted photometric files, ".ies" format, certified by the luminaire manufacturer for use with lighting software.

D. Luminaire Labels:

1. External label per ANSI C136.15.
2. Internal label per ANSI C136.22.

E. Provide luminaires rated by the manufacturer to start and operate to their full lumen capacity for rated life of the luminaire at the minimum low and maximum high ambient temperatures as defined in the Contract Documents at their installation location.

F. Feed-through type, or separate junction box.

G. Wire Leads: Minimum 18 AWG.

H. Component Access: Accessible and replaceable without removing luminaire from ceiling.

I. Exterior Installations:

1. UL Labeled: SUITABLE FOR WET LOCATIONS.
2. Driver: Removable, prewired.
3. When factory-installed photocells are provided, entire assembly shall have UL label.

J. Illuminated Exit Signs:

1. Body: As indicated on Drawings.

2. Face: Stencil.
   a. Letters:
      1) 6-inch high by 3/4-inch stroke.
      2) Color: Red.
3. Mounting: Universal.
4. Directional Arrows: As indicated on Drawings.

K. Emergency Lighting Units:

1. Power Pack: Self-contained, 120/277-volt transformer, inverter/charger, sealed battery, and indicator switch in accordance with UL 924.
2. Lighted, push-to-test indicator.
3. Capable of providing full illumination for 1-1/2 hours in emergency mode.
4. Capable of full recharge in 24 hours, automatically upon resumption of normal line voltage.
5. Capable of protecting against excess charging and discharging.

2.02 LED SOURCE SYSTEMS

A. General:

1. Provide IESNA LM-80 test reports.
2. Provide Energy Star compliance for solid state luminaires.
3. Listed To: UL 8750 Standard for Safety for Light Emitting Diode (LED) Equipment for use in Lighting Products.
4. Provide RoHS compliant LED light source(s) and driver(s).
5. Rated operating temperature range of 10 degrees C to 40 degrees C.
6. Warranty: 5 years minimum.

B. Drivers:

1. Expected life of 100,000 hours at 25 degrees C.
2. Provide drivers mounted in an all metal can.
3. Operating Voltage Range: 50/60-Hz input source of 120V to 277V with sustained variations of plus or minus 10 percent voltage with no damage to the driver.
4. Input Current Total Harmonic Distortion: Less than 20 percent up to 50 percent of full load rating.
5. Power Factor: Greater than 0.90 for primary application up to 50 percent of full load rating.
6. Sound rating: Class A.
7. Comply with NEMA 410 for inrush current limits.

2.03 LIGHTING CONTROL

A. Photoelectric Switch (Photocell):

1. Automatic Solid State ON/OFF Switching Photo Control:
   a. Dry Contacts:
      1) Configuration: SPST.
      2) Rating: 1,800VA tungsten.
      3) Compatible with connected load device indicated on Drawings.
2. Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.
3. Mounting Type: Twist lock plug.
4. Setting: ON at dusk and OFF at dawn.
5. Time delay feature to prevent false switching.
6. Field adjustable to control operating light levels.
7. Integral surge protection.
8. Manufacturers:
   a. Tork.
   b. Intermatic.
   c. Paragon Electric Company.

2.04 BRACKETS AND SUPPORTS

A. Features:

1. Not less than 1-1/4-inch galvanized steel pipe secured to pole.
2. Slip-fitter or pipe-threaded brackets may be used, but coordinate brackets to luminaires provided. Provide identical brackets for use with one type of luminaire.
3. Select brackets for pole-mounted street lights to correctly position luminaire no lower than mounting height indicated.
4. Mount brackets not less than 24 feet above street.
5. Provide special mountings or brackets as indicated on Drawings fabricated of metal which will not promote galvanic reaction with luminaire head.

2.05 IN-LINE FUSE HOLDER AND FUSE

A. Fuse Holder:

1. General: Waterproof, of corrosion-resistant material.
2. Rating: 600 volts.

B. Fuse:

1. General: Midget, dual element.
2. Rating: 5-amp, voltage as required by application.

C. Manufacturer: Methods Electronics Inc. Network, Buss Div.

2.06 EQUIPMENT IDENTIFICATION

A. Manufacturer's Nameplate: Provide each item of equipment with a nameplate bearing manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; nameplate of distributing agent will not be acceptable.

B. Provide clear markings located to be readily visible to service personnel.

2.07 FACTORY FINISH

A. Provide electrical equipment with factory-applied painting systems that, at minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.01 LUMINAIRES

A. General:

1. Install in accordance with manufacturer's recommendations.
2. Provide proper hangers, pendants, and canopies as necessary for complete installation and meeting specified seismic requirements.
3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building required to safely mount.
4. Install plumb and level.
5. Install each luminaire outlet box with galvanized stud.

B. Mounting:

1. General: Coordinate mounting, fastening, and environmental conditions with Section 26 05 02, Basic Electrical Requirements.
2. Wall Mounted: Measure mounting heights from center of mounting plate to finished floor or finished grade, whichever is applicable.

3. Pendant Mounted:
   a. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.
   b. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48 inches apart.
   c. Provide twin-stem hangers on single luminaires.
   d. Measure mounting heights from bottom of luminaire to finished floor or finished grade, whichever is applicable.

C. Swinging Type: Provide, at each support, safety cable capable of supporting four times vertical load from structure to luminaire.

D. Unfinished Areas: Locate luminaires to avoid conflict with other building systems or blockage of luminaire light output.

1. Fixture Suspension: Provide 1/4-inch threaded steel hanger rods. Scissor type hangers not permitted.
2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.

E. Building Exterior: Flush-mounted back box and concealed conduit, unless otherwise indicated.

3.02 LIGHTING CONTROL

A. Outdoor Luminaires: Photocells switch lights ON at dusk and OFF at dawn.

3.03 EMERGENCY LIGHTING UNIT

A. Install in accordance with manufacturer’s recommendations.

B. Provide permanent circuit connections with conduit and wire.

C. Connect to branch circuit feeding normal lighting in area ahead of all local switches.

D. Provide separate circuit wiring to luminaire.

3.04 FIELD FINISHES

A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Paint as specified in Section 09 90 00, Painting and Coating.

3.05 FIELD QUALITY CONTROL

A. Upon completion of installation, verify equipment is properly installed, connected, and adjusted. Conduct an operating test to show equipment operates in accordance with the requirements of this section.

B. Coordinate lighting and controls installation and testing with commissioning as specified in Section 01 91 14, Equipment Testing and Facility Startup.

3.06 CLEANING

A. Remove labels and markings, except UL listing mark.

B. Wipe luminaires inside and out to remove construction dust.

C. Clean luminaire plastic lenses with antistatic cleaners only.

D. Touch up painted surfaces of luminaires and poles with matching paint ordered from manufacturer.

E. Replace defective lamps at time of Substantial Completion.

END OF SECTION

SECTION 31 00 00
EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Site clearing, stripping, and topsoil excavation and storage, including tree and stump removal.
2. Excavation.
3. Existing asphalt removal and backfill.
4. Subgrade preparation.
5. Backfill and compaction of fill.
6. Protection of Work.
7. Moisture control.
8. Trench excavation and backfill.
9. Finish site grading.
10. Field quality control.
11. Controlled low strength fill.
12. Placing geotextile.
13. Soil cover over liner.

B. Related Sections:

1. Section 03 30 10, Structural Reinforced Concrete.
2. Section 33 47 13.01, Pond and Reservoir Liners—HDPE.
3. Section 33 47 13.07, Pond and Reservoir Liners—Geosynthetic Clay Liner (GCL).

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C33, Standard Specification for Concrete Aggregates.
   b. C117, Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   c. C150, Standard Specification for Portland Cement.
   d. C535, Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

e. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
f. D75, Standard Practice for Sampling Aggregates.
g. D448, Standard Classification for Sizes of Aggregates for Road and Bridge Construction.
h. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600kN-m/m3)).
i. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
j. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
k. D2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
l. D3786, Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method.
m. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
n. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
o. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
p. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
q. D4718, Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles.
r. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
s. D4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
t. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

2. Occupational Safety and Health Administration: OSHA 29 CFR 1926, Safety and Health Regulations for Construction.
3. Washington State Department of Transportation (2020): Standard Specifications for Road, Bridge, and Municipal Construction M 41-10.

1.03 DEFINITIONS

A. Relative Compaction: Ratio in percent of as-compacted field dry density to laboratory maximum dry density as determined by ASTM D1557 as noted in

this Specification. Corrections for oversize material may be applied to either as-compacted field dry density or the maximum dry density as determined by Engineer and as specified in ASTM D4718.

B. Clearing and Grubbing: Removal of interfering or objectionable material lying on or protruding above ground surface, and removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 6 inches below subgrade.

C. Stripping: Removal of top four inches of soil (topsoil) remaining after applicable clearing and grubbing is complete.

D. Optimum Moisture Content: Determine by ASTM standard specified to determine the maximum dry density for relative compaction. Determine field moisture on basis of fraction passing 3/4-inch sieve.

E. Prepared Ground Surface: Ground surface after clearing, grubbing, stripping, excavation, demolition, and scarification and/or compaction.

F. Completed Course: A course or layer ready for next layer or next phase of work.

G. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes. Well-graded does not define any numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters. Well-graded is used to define a material type that when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

H. Influence Area: Area within planes sloped downward and outward at an angle of 60 degrees from horizontal from 1 foot outside the outermost edge at base of foundations or slabs, 1 foot outside outermost edge at surface of roadways or shoulder, or 1/2 foot outside exterior edge at spring line of pipes and culverts.

I. Unclassified Excavation: Nature of materials to be encountered has not been identified or described herein.

J. Structural Fill: Material placed and compacted beneath structures and foundations.

1.04 SUBMITTALS

A. Refer to Submittal Schedule at end of Part 3 for a list of submittal requirements for this section.

B. Quality Control Plan for Earthwork.

C. Quality Control Plan for Material Placement Over Liner: Shall including geotextile, overlying materials, lift thicknesses, equipment, maximum contact pressures on liner, cell access, and timeline. May be included in earthwork QC Plan or provided separately. Coordination with Electrical Leak Detection Survey following initial placement of stone is required.

1.05 EARTHWORK PREPARATION

A. Prior to performing excavation and fill/backfill operations, hold an earthwork pre-activity meeting with Engineer. Topics will include Earthwork QC Plan and applicable earthwork activities. Meetings may be held separately as needed to effectively cover requirements for excavation, asphalt removal and backfill, fill/backfill, trench backfill (including geomembrane liner trench), anti-seep collar backfill, Quality Control testing, Material Placement over Liner, etc.

1.06 QUALITY ASSURANCE

A. Perform work in conformance, except as modified in this section, with current edition of Washington State Department of Transportation Standard Specifications for the Road, Bridge, and Municipal Construction, referred to here as Standard Specification.

PART 2 PRODUCTS

2.01 MATERIALS

A. Mixed Asphalt Fill: Fill obtained by processing existing asphalt in work area to particles no larger than 3 inches and mixed with earthfill such that the mixture contains no greater than 25 percent processed asphalt.

B. Earthfill: Excavated on-site material free from roots, organic matter, trash, debris, rocks larger than 3 inches, and other deleterious materials.

C. Structural Fill: See product data for media gravel.

D. Filter Gravel: See Drawings for details.

E. Media Gravel: See Drawings for details.

F. Drain Gravel: See Drawings for details.

G. Pipe Zone Bedding: Used for backfill in pipe zone as shown on Drawings. Material should contain less than 8 percent fines and be free from clay balls and particle sizes larger than 1.5 inches.

H. Backfill Above the Pipe Zone: For trenches within influence area of existing or proposed structures and under roadways, parking lots, sidewalks, and concrete pads use specified structural fill above pipe zone. For other areas use Earthfill material provided specified compaction can be obtained. If required compaction cannot be obtained use granular fill material as specified herein before.

I. Topsoil: Natural, friable, sandy loam, obtained from stripping or otherwise well-drained areas, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, large roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

J. Controlled Low-Strength Fill:

1. For low strength fill select and proportion ingredients to obtain compressive strength between 50 psi and 150 psi at 28 days in accordance with ASTM D4832. Use the following materials:
   a. Cement: ASTM C150, Type I or Type II.
   b. Aggregate: ASTM C33, Size 7.
   c. Fly Ash (If Used): ASTM C618, Class C.
   d. Water: Clean, potable, containing less than 500 ppm of chlorides.

K. Warning Tape:

1. Tape specifically manufactured for marking and locating underground utilities.
2. Polyethylene film 6 inches wide by 0.004 inch thick and a minimum strength of 1,750 psi and carries continuous inscription naming the specific utility.
3. Color: In accordance with APWA Uniform Color Code.

Color*	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines

Color*	Facility
*As specified in NEMA Z535.1, Safety Color Code.	

4. Provide tape for nonmetallic utility lines with foil backing or wires sufficient for detection by metal detector to a depth of 3 feet. Install tape continuous between manhole, junction boxes, or from start of an underground utility to end. Roll up 3 feet at each end at start and finish to allow Owner to attach a utility locator to aid in finding utility.

L. Water for Compaction: Provide potable water for compaction as required.

M. Nonwoven Geotextile Materials:

1. Pervious sheet of polyester, polyethylene, or polypropylene filaments, oriented to a stable network so that fibers retain their relative positions to each other.
2. Composed of continuous or discontinuous (staple) fibers held together by spun bonding, melt bonding, or needle paneling.
3. Minimum physical property values:

Mass per unit area (ounce/yard^2)	12
Grab tensile strength (pound), ASTM D4632	320
Puncture strength (pound), ASTM D4833	925
Trapezoidal tear strength (pound) ASTM D4533	125
Permittivity (sec^{-1}), ASTM D4491	0.8

4. Finish geotextile so that filaments will retain their relative position with respect to each other. Finish edges of woven fabric to prevent outer material from pulling away from fabric.
5. Provide manufacturer's certificate of compliance attesting that geotextile meets requirements of these Specifications. Provide mill certificates stating length and width of fabric contained on each roll.
6. Materials:
   a. Mirafi 1120N.
   b. GSE NW12.

2.02 EQUIPMENT

A. Compaction Equipment: Use suitable compaction equipment to obtain densities specified. Operate compaction equipment in strict accordance with manufacturer's instructions and recommendations. Maintain equipment in

such condition that it will deliver manufacturer's rated compaction effort. If inadequate densities are obtained, provide larger and/or different types of additional equipment.

B. Moisture Control Equipment: Use equipment for applying water of a type and quality adequate for work, that does not leak, and is equipped with a distributor bar or other approved device to assure uniform application. Use equipment consisting of blades, discs, or other approved equipment for mixing and drying out material.

C. Other Materials and Equipment: Select other materials and equipment not specifically described but required for a complete and proper installation subject to review by the Engineer prior to use.

PART 3 EXECUTION

3.01 SITE CLEARING

A. Clearing and Grubbing: Clear site within areas required for access and execution of work. Remove existing trees, brush, stumps, and waste material on site which are noted for removal as shown on Drawings. Grub out stumps and roots. Prevent damage and disturbance to vegetation and topsoil in areas outside limits as shown on Drawings. Dispose of waste materials offsite in accordance with all federal, state, and local laws relating to such disposal. After completion of clearing and grubbing, get Geotechnical Engineer's acceptance before commencing stripping.

B. Stripping: Prior to beginning any excavation or fill, strip top of existing ground to remove all vegetation, then strip topsoil and stockpile for future use. In general, remove topsoil where structures are to be built, trenches dug, and roads, parking lots, walks, equipment pads, staging areas, and similar improvements are constructed within area presently covered with topsoil. Store topsoil clear of construction area. Take care to prevent topsoil from becoming mixed with subsoil.

C. Asphalt Removal: Remove asphalt in locations shown on Drawings. Process and stockpile asphalt for use as specified herein.

D. Limits: Perform Clearing, Grubbing, Stripping, and Asphalt Removal within 5 feet of the limits of work and borrow areas.

3.02 EXCAVATION

A. General Excavation: Perform excavation of every description, regardless of type, nature, or condition of material encountered, as specified, shown, or required to accomplish construction.

B. Weather Limitations: Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

C. Unclassified Excavation: Excavation is unclassified. Complete excavation regardless of type, nature, or condition of materials encountered. Make own estimate of kind and extent of various materials to be excavated in order to accomplish work.

D. Shoring, Sheeting, Bracing, and Sloping: Design, install and maintain shoring, sheeting, bracing, and sloping necessary to support sides of the excavation, and to prevent movement which may damage adjacent pavements, utilities, or structures, damage or delay work, or endanger life and health. Install and maintain shoring, sheeting, bracing, and sloping as required by OSHA and other applicable governmental regulations and agencies.

E. Structural Excavation for Footings, Retaining Walls, and Related Structures:

1. Excavation is unclassified. Excavate for structures to lines and grades shown or as required to accomplish construction. Perform all excavation regardless of type, nature, or condition of material encountered.
2. Method of excavation used is optional; however, do not operate equipment within 5 feet of existing structures or newly completed structures without prior review by Engineer. Perform with hand tools excavation that cannot be accomplished without endangering present or new structures.

F. Limits of Excavation:

1. Allow for forms, working space, granular base, and finish topsoil as shown or required. Do not carry excavation for footings and slabs deeper than elevation shown.
2. Replace excavations carried below grade lines shown with same fill material as specified for overlying fill or backfill, and compact as required for such overlying fill or backfill. Where overlying area is not to receive fill or backfill, replace overexcavated material and compact to a density required for backfill beneath the applicable structure.
3. Correction of overexcavated areas at Contractor’s sole expense.

3.03 EXISTING ASPHALT REMOVAL AND BACKFILL

A. Removal: Remove existing asphalt in areas where it encroaches the work area footprint.

B. Asphalt Processing: Break up and process the existing asphalt such that no aggregated particles remain greater than 3 inches maximum dimension. Use of onsite equipment such as excavators and dozers is acceptable given breakdown of materials as specified is achieved.

C. Mixed Asphalt Fill: Processed asphalt can be mixed with Earthfill and used as Earthfill and Embankment Fill given the materials are thoroughly mixed, the finished product contains no more than 25 percent asphalt (by weight), and the mixture meets the requirements of the specified fill usage.

3.04 SUBGRADE PREPARATION

A. After completion of stripping, excavation, and/or asphalt removal in areas to provide support for embankment, foundations, and structural fill, inspect for soft surficial soils and proof-roll subgrade surface. Proof-roll with a fully loaded dump truck or similarly heavy-wheeled vehicle to detect soft or loose zones. Notify Engineer prior to commencement of proof-rolling.

B. If soft or loose zones are found, excavate soft or loose material to a depth reviewed in advance by the Engineer, then fill with approved fill for each operation and compact as specified for such fill or subgrade.

C. Compaction:

1. Under Earthfill: Compact upper 12 inches to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.
2. Under Floor Slabs on Grade, Roads, or Structural Fill under Structures: Compact the upper 12 inches to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

D. Moisture Conditioning:

1. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.
2. Wet Subgrade: aerate material by blading, discing, harrowing, or other methods, to hasten drying process.
3. To avoid ponding and saturation of subgrade materials, do not over water in asphalt paving areas.

E. Subgrade Preparation for Geosynthetics: The foundation soil layer surface shall be rolled to a smooth surface, be free of protrusions, surface voids, depressions, or stones that protrude greater than 0.50-inch (12 mm).

3.05 BACKFILL AND COMPACTION OF FILL

A. Compact all materials by mechanical means. Flooding or jetting will not be permitted. If compaction tests indicate that compaction or moisture content is not as specified, terminate material placement and take corrective action prior to continued placement.

B. Do not place fill or backfill if material is frozen or if surface upon which fill or backfill is to be placed is frozen.

C. Fill Under Building Slabs, Building Foundations, and Structures: Place in lifts not to exceed 8 inches loose lift. Compact each lift to not less than 95 percent relative compaction as determined by ASTM D1557.

D. Backfill Around Structures:

1. Remove all form materials and trash from excavation before placing backfill.
2. Place hereinbefore specified structural fill in lifts not less than 8 inches thick prior to compaction and compact each lift to not less than 95 percent relative compaction as determined by ASTM D1557.
3. Do not operate earth-moving equipment within 5 feet of walls of concrete structures for the purpose of depositing or compacting backfill material without prior review by the Engineer. Compact backfill adjacent to concrete walls with hand-operated tampers or similar equipment that will not damage structure.

E. Backfill around concrete structures only after concrete has attained compressive strength in Section 03 30 10, Structural Reinforced Concrete.

F. Structural Fill Beneath Footings and Structures: Place a minimum of 6 inches hereinbefore specified structural fill beneath footings and structures and compact to not less than 95 percent relative compaction as determined by ASTM D1557.

G. Earthfill Under Structures and Around Structures: Place hereinbefore specified earthfill in areas under facilities and around structures where structural fill is not designated. Deposit material from excavation in horizontal lifts to maximum 8-inch uncompacted depth and compact each lift to not less than 95 percent relative compaction as determined by ASTM D1557. Maintain material at optimum moisture content, plus or minus 2 percentage

points. Place backfill material free of roots, organic matter, trash, and rocks larger than 3-inch diameter. Stop backfill at specified grade. Make allowance for topsoil where required.

H. Fill for Earthen Berms and Other Uses Not Under Structures, Pavements or Facilities:

1. Place hereinbefore specified earthfill to lines and grades shown. Place fill material in lifts not greater than 8 inches thick prior to compaction and compact each lift to not less than 95 percent relative compaction as determined by ASTM D1557. Make proper allowance for topsoil where required.
2. Compact full width of embankment. If pipelines or Anti-Seep collars are to be laid in embankment, construct embankment to an elevation 2 feet above top of proposed pipeline/collar prior to trench excavation for pipeline. Moisten fill material as necessary to produce specified compaction. If material is too wet for proper compaction, aerate by blading, discing, or other methods. Dress completed embankment to elevations and slopes shown. Make proper allowance for topsoil where required.

3.06 PROTECTION OF WORK

A. Use all means necessary to prevent erosion of graded areas during construction and until such time as permanent drainage and erosion measures have been installed.

B. Erosion Protection: Take measures to prevent erosion rills and gullies from damaging finished embankment and repair all damage to the standards outlined for that material, including placing and compacting fill in horizontal lifts.

C. Grade top perimeter of excavations to prevent surface water runoff from flowing into excavation.

D. Excavation Safety: Perform excavations in a safe manner. Provide appropriate measures to retain excavation sideslopes and prevent cave-ins and rock falls to ensure that persons working in or near the excavation are protected.

E. For trench excavation exceeding 5 feet in depth, provide adequate safety system meeting requirements for applicable state and local codes, rules, regulations, construction safety orders, and federal requirements.

F. Engineer has not designed or reviewed, is not responsible for, and does not certify any aspect of trench safety systems and/or safety systems for trench

excavation which may be described, shown, or depicted, directly or indirectly, in these plans and specifications.

G. Protect trees, shrubs, lawns, walkways, curbs, vaults, manholes, valve boxes, and other features remaining as a portion of final facilities or landscaping.

H. Protect benchmarks, existing structures, fences, utilities, sidewalks, paving, and curbs from equipment and vehicular traffic.

I. Protect above and below grade utilities that are to remain.

J. Notify Engineer of unexpected subsurface conditions and discontinue work in affected area until notified to resume work.

K. Install erosion control materials or silt fence at toe of fill slopes and around catch basins so as to prevent soil particles from entering the existing adjacent area or the existing storm drain system in accordance with EPA permit on file at Owner's field office.

3.07 MOISTURE CONTROL

A. During all compacting operations, maintain optimum practicable moisture content required for compaction purposes in each lift or fill. Maintain moisture content uniform throughout lift. Supplement, if required, by sprinkling fill. Achieve optimum moisture content of fill, plus or minus 3 percentage points, at time of compaction.

B. Do not attempt to compact fill material that contains excessive moisture. Aerate material by blading, discing, harrowing, or other methods to hasten drying process.

3.08 TRENCH EXCAVATION AND BACKFILL

A. General:

1. Process excavated material to meet specified gradation requirements.
2. Adjust moisture content as necessary to obtain specified compaction.
3. Do not allow backfill to freefall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.
4. Do not use power-driven impact-type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed-rock surfacing, and pavement thickness, wherever applicable.

6. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise shown or specified.

B. Excavation: Excavate for installation of piping, utilities, and appurtenances. Remove obstructions, such as tree roots, stumps, and other material of any type.

C. Trench Excavation: Trench excavation is unclassified. Remove all material regardless of nature, type, or condition of material encountered.

D. Trench Width: Provide minimum width of unsheeted trenches or minimum clear width of sheeted trenches in which pipe is to be laid 18 inches greater than outside diameter of pipe. Sheeting requirements are independent of trench width. The maximum clear width at top of pipe or above pipe will not be limited except in cases where excess width of excavation would cause damage to adjacent structures.

E. Grade: Carry bottom of trench to line and grade shown. Allow for pipe thickness and for pipe base or special bedding when specified. Backfill any part of the trench excavated below grade with pipe base material and compact to not less than 90 percent relative compaction as determined by ASTM D1557.

F. Shoring, Sheeting, and Backing of Trenches: Design, install, maintain, and remove shoring, sheeting, and bracing as required by federal, state, and local laws, codes, and ordinances.

G. Trench Stabilization: If in the opinion of the Design-Builder's designated Geotechnical Engineer, material in bottom of trench is unsuitable for supporting pipe, excavate to remove unsuitable material and backfill to required grade with trench stabilization material as specified. Compact as required by geotechnical engineer. Removal of unsuitable material and replacement fill as specified in this paragraph and as reviewed by the Owner is paid for by an adjustment of the Contract price in accordance with the provisions of additional work.

H. Pipe Zone Backfill:

1. Backfill pipe zone to 12 inches above top of pipe for full width of trench with backfill material conforming to backfill material for pipe zone as specified hereinbefore. Place in horizontal lifts not exceeding 6 inches in uncompacted thickness on both sides of pipe. Thoroughly tamp and supplement by "walking in" material. Use particular attention in placing material on the underside of pipe to provide a solid backing and to prevent lateral movement during final backfilling procedure.

2. Backfill at pipe zone for plastic pipe must receive particular attention and care to prevent damage to pipe. After placing material as specified herein to a point of 12 inches above top outside surface of barrel of pipe, material so placed will be compacted by at least three passes of a vibratory compactor over area generally above sides of pipe. Impact compactors will not be used for compaction of backfill at pipe zone. Impact compactors will not be used until 3 feet of cover has been placed over top of pipe.
3. Marking Tape Installation: Continuously install detectible marking tape as specified along centerline of buried piping, on top of last lift of pipe zone material.

I. Trench Backfill Above the Pipe Zone:

1. In trenches under all structures, sidewalks, roads, parking areas, and similar facilities, except where specifically shown, deposit fill material as specified hereinbefore in horizontal lifts not exceeding 8 inches in uncompacted thickness. Compact as specified for fill in Compaction of Fill, above. Repair subsequent damage caused by settlement of trenches at Contractor's sole expense.
2. In other areas, excavated trench material may be used for backfill. Compact backfill in suitable lifts with mechanical vibratory or impact tampers. Determine type of compaction equipment and amount of compaction required to prevent subsequent settlement. Remove boulders and stones 3 inches in diameter and larger from material used for backfill in upper 12 inches of backfilled trenches. In areas where topsoil conditions exist, replace topsoil in top 4 inches of trench. Compact and rake to match ground surface adjacent to trench. Maintain surface of backfilled trench level with existing grade until entire project is accepted by Owner. Repair promptly, at no cost to Owner, subsequent settlement of finished surface during warranty period, which is considered to be a result of improper or insufficient compaction.

3.09 FINISH SITE GRADING

A. Perform earthwork to lines and grades as shown on Drawings and/or established by the Engineer, with proper allowance for topsoil where specified or shown. Shape, trim, and finish slopes of channels to conform to lines, grades, and cross-section shown. Make slopes free of exposed roots and stones exceeding 3-inch diameter. Round tops of banks to circular curves, in general, not less than a 6-foot radius. Trim rounded surfaces neatly and smoothly. Neatly blend new grading into surrounding existing terrain. Finished site grading will be reviewed by the Engineer.

B. Tolerances: Construct material limits within a tolerance of 0.1 foot except where dimensions or grades are shown or specified as minimum. Perform grading to maintain slopes and drainage as shown on Drawings. No reverse slopes will be permitted.

3.10 FIELD QUALITY CONTROL

A. Design-Builder's Subcontractor shall retain an independent soil testing company to determine in-place density and moisture content as specified.

B. Laboratory Compaction Testing:

1. Obtain a minimum of two samples for each soil unit encountered on site and perform laboratory compaction testing as determined by ASTM D1557. Mixed asphalt fill, if used, shall be considered a separate soil unit.
2. Each laboratory compaction test shall be accompanied by a gradation test ASTM D1557 and Atterberg limits test (ASTM D4318) for accurate soil classification.
3. Provide a combined list of all compaction tests performed that includes testing performed. List shall include at a minimum compaction testing data, gradations, and soil descriptions.

C. Subgrade Testing:

1. In-Place Density Tests: In accordance with ASTM D6938.
   a. Beneath Structures: Minimum one test per every 10,000 square feet on every lift of subgrade, or one test per lift, whichever requires more tests.
   b. Wetland Berm Subgrades: Minimum one test per every 250 linear feet of berm centerline on every lift of subgrade, or one test per lift, whichever requires more tests. Alternate locations of tests across fill width.
   c. For compaction standard, depth, and percentage, reference Article Subgrade Preparation.

D. Fill/Backfill:

1. Embankment Fill: Minimum one test per every 250 linear feet of berm centerline each lift, or one test per lift, whichever requires more tests. Alternate locations of tests across fill width.
2. Granular Fill and Earthfill: Minimum one test per every 10,000 square feet on every lift, or one test per lift, whichever requires more tests.
3. For compaction standard, depth, and percentage, reference Article Backfill and Compaction of Fill.

E. Trench Backfill:

1. Pipe Zone Fill and Pipe Bedding: One test for every 250 feet of backfill each lift; or one test per lift, whichever requires more tests. Alternate sides of pipe and location within trench for testing.
2. Earth Backfill above Pipe Zone: One test every 1,000 cubic yards.
3. For compaction standard, depth, and percentage, reference Article Trench Excavation and Backfill.

3.11 CONTROLLED LOW-STRENGTH FILL

A. Discharge from truck-mounted, drum-type mixer into trench.

B. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.

3.12 PLACING GEOTEXTILE

A. Provide geotextile separation between all materials and Liner. Remove exposed geotextile near the edge of finish-graded material.

B. Prevent exposure of geotextile to light until needed for construction. Place geotextile and subsequently cover with succeeding courses (granular, fill, for example) in such a manner as to limit exposure to light to a maximum period of 48 hours.

C. Lay geotextile loosely, but without creases. Provide at least 2-foot overlap at joints.

D. Do not operate machinery directly on liner or geotextile. When placing material over joints, place in direction from overlying geotextile to underlying geotextile. Prevent puncture, tear, or displacement of geotextile and protect from damage. Replace torn areas and holes by placing an overlay of geotextile having dimensions at least 2 feet greater than tear or hole.

E. Liner shall be protected from damage, and equipment used for media placement above liner shall include low ground pressure equipment, such as skid steers and rubber-tired equipment with ground pressure not to exceed 5 psi.

3.13 SOIL COVER OVER GEOSYNTHETIC CLAY LINER

A. Provide QC Plan submittal and reference methods as indicated in Section 33 47 13.01, Pond and Reservoir Liners—HDPE, Article Field Quality Control and Quality Assurance, Paragraph C.

B. Coordination with Electrical Leak Location Survey Subcontractor to perform leak location survey following initial placement of stone shall be performed.

C. Hold pre-activity meeting as indicated above to review installation plan and methods.

D. Reference Section 33 47 13.01, Pond and Reservoir Liners–HDPE, Article Repairing Geomembrane, for repair requirements for defects found during leak location survey following placement of cushion geotextile and initial stone layer.

3.14 SUBMITTAL SCHEDULE

ITEM NO.	SUBMITTAL REQUIREMENT	AS INDICATED
31 00 00	Quality Control Plan for Earthwork.	Approved a minimum of 2 weeks prior to the start of earthwork.
31 00 00	Quality Control Plan for material placement over liner.	Approved a minimum of 2 weeks prior to start of liner placement.
31 00 00	Certification, test results, source, and samples, if requested, for all imported materials.	Provide the requested information 10 calendar days prior to first use.
31 00 00	Certification and mill certificates for geotextile.	Provide the requested information 10 calendar days prior to shipment.

ITEM NO.	SUBMITTAL REQUIREMENT	AS INDICATED
31 00 00	Catalog and manufacturer's data sheets and samples for warning tape.	Provide the requested information 10 calendar days prior to first use.
31 00 00	Copies of permits obtained for excavation, etc., that are required by state and local governing authorities prior to start of work.	Provide the following within 4 weeks after award or upon receipt from local jurisdiction.
31 00 00	Copies of all Field Quality Control Testing performed as indicated in this specification section.	Provide within 1 week of obtaining tests or as discussed.

END OF SECTION

SECTION 32 92 00
TURF AND GRASSES

PART 1 GENERAL

1.01 DEFINITIONS

A. Maintenance Period: Begin maintenance immediately after each area is planted (seed or sod) and continue for a period of 8 weeks after all planting under this section is completed.

B. Satisfactory Standard:

1. Grass that has:
   a. No bare spots larger than 3 square feet.
   b. Not more than 10 percent of total area with bare spots larger than 1 square foot.
   c. Not more than 15 percent of total area with bare spots larger than 6 square inches.
   d. Finished grass must prevent erosion of the berms during heavy rainfall events.

1.02 SUBMITTALS

A. Action Submittals: Product labels/data sheets.

B. Informational Submittals:

1. Seed:
   a. Certification of seed analysis, germination rate, and inoculation:
      1) Certify that each lot of seed has been tested by a testing laboratory certified in seed testing, within 6 months of date of delivery. Include with certification:
         a) Name and address of laboratory.
         b) Date of test.
         c) Lot number for each seed specified.
         d) Test Results: (i) name, (ii) percentages of purity and of germination, and (iii) weed content for each kind of seed furnished.
   b. Mixtures: Proportions of each kind of seed.
2. Seed Inoculant Certification: Bacteria prepared specifically for legume species to be inoculated.
3. Certification of sod; include source and harvest date of sod, and sod seed mix.

4. Description of required maintenance activities and activity frequency.

1.03 DELIVERY, STORAGE, AND PROTECTION

A. Seed:

1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
2. Keep dry during storage.

B. Sod:

1. Do not harvest if sod is excessively dry or wet to the extent survival may be adversely affected.
2. Harvest and deliver sod only after laying bed is prepared for sodding.
3. Roll or stack to prevent yellowing.
4. Deliver and lay within 24 hours of harvesting.
5. Keep moist and covered to protect from drying from time of harvesting until laid.

C. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.04 WEATHER RESTRICTIONS

A. Perform Work under favorable weather and soil moisture conditions as determined by accepted local practice.

1.05 SEQUENCING AND SCHEDULING

A. Complete Work under this section within 3 days following completion of soil preparation.

B. Notify Engineer at least 5 days in advance of:

1. Each material delivery.
2. Start of planting activity.

C. Planting Season: Those times of year that are normal for such Work as determined by accepted local practice.

1.06 MAINTENANCE SERVICE

A. Contractor:

1. Perform maintenance operations during maintenance period to include:
   a. Watering: Keep surface moist.
   b. Washouts: Repair by filling with topsoil, liming, fertilizing, seeding, and mulching.
   c. Mulch: Replace wherever and whenever washed or blown away.
   d. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.
   e. Reseed/replant entire area if satisfactory stand does not develop by July 1 of the following year.

PART 2 PRODUCTS

2.01 FERTILIZER

A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose.

B. Application Rates: As needed.

C. Fertilizer to be used if deemed necessary by contractor to achieve satisfactory standard.

2.02 SEED

A. Fresh, clean new-crop seed that complies with the tolerance for purity and germination established by Official Seed Analysts of North America.

B. Seeds of Legumes: Inoculated with pure culture of nitrogen-fixing bacteria prepared specifically for legume species in accordance with inoculant manufacturer’s instructions.

C. Provide tall fescue, fine fescue and ryegrass varieties as follows:

Botanical Name Common Name (Variety)	Percentage by Weight of Pure Live Seed (PLS)	Minimum Purity	Minimum Germination
Festuca arundinacea Tall Fescue (3 varieties in equal proportion	60%	97%	85%
Festuca rubra commutata Chewings Fescue (3 varieties in equal proportions)	20%	97%	85%
Festuca ovina Sheep Fescue (2 varieties in equal proportions)	10%	97%	85%
Festuca duriuscula Hard Fescue (2 varieties in equal proportions) Seeding rate 6 pounds per 1,000 square feet for hydroseeding	10%	97%	85%

2.03 SOD

A. Certified turfgrass sod complying with ASPA specifications for machine-cut thickness, size, strength, moisture content, and mowed height, and free of weeds and undesirable grasses. Provide viable sod of uniform density, color, and texture of the following turfgrass species, strongly rooted, and capable of vigorous growth and development when planted.

2.04 STRAW MULCH

A. Threshed straw of oats, wheat, barley, or rye, free from (i) seed of noxious weeds or (ii) clean salt hay.

2.05 HYDROSEEDING MULCH

A. Wood Cellulose Fiber Mulch:

1. Specially processed wood fiber containing no growth or germination inhibiting factors.
2. Dyed a suitable color to facilitate inspection of material placement.
3. Manufactured such that after addition and agitation in slurry tanks with water, the material fibers will become uniformly suspended to form homogenous slurry.
4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

2.06 TOPSOIL

A. Topsoil: ASTM D5268, pH range of 5.5 to 7, 4 percent organic material minimum, free of stones 1 inch or larger in any dimension, and other extraneous materials harmful to plant growth.

PART 3 EXECUTION

3.01 PREPARATION

A. Grade areas to smooth, even surface with loose, uniformly fine texture.

1. Roll and rake, remove ridges, fill depressions to meet finish grades.
2. Limit such Work to areas to be planted within immediate future.
3. Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter.

B. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface to dry off before seeding. Do not create muddy soil.

C. Restore prepared areas to specified condition if eroded or otherwise disturbed after preparation and before planting.

3.02 FERTILIZER

A. Apply evenly over area in accordance with manufacturer’s instructions. Mix into top 2 inches of topsoil, when applied by broad cast method.

B. Application Rate: As necessary to achieve satisfactory standard.

3.03 SEEDING

A. Start within 2 days of preparation completion.

B. Hydroseed slopes steeper than 3H:1V. Flatter slopes may be mechanically seeded.

C. Mechanical: Broadcast seed in two different directions, compact seeded area with cultipacter or roller.

1. Sow seed at uniform rate per manufacturer's recommendations.
2. Use Brillion type seeder.
3. Broadcasting will be allowed only in areas too small to use Brillion type seeder. Where seed is broadcast, increase seeding rate 20.
4. Roll with ring roller to cover seed, and water with fine spray.

D. Hydroseeding:

1. Application Rate: Per manufacturer's recommendation.
2. Apply on moist soil, only after free surface water has drained away.
3. Prevent drift and displacement of mixture into other areas.
4. Upon application, allow absorption and percolation of moisture into ground.
5. Mixtures: Seed and fertilizer may be mixed together, apply within 30 minutes of mixing to prevent fertilizer from burning seed.

E. Cover Crop Seeding: Apply seed at rate of 120 pounds per acre to areas that are bare or incomplete after September 15.

F. Mulching: Apply uniform cover of straw mulch at a rate of 2 tons per acre.

G. Netting: Immediately after mulching, place over mulched areas with slopes steeper than 3:1, in accordance with manufacturer's instructions. Locate strips parallel to slope and completely cover seeded areas.

H. Tackifier: Apply over mulched areas with slopes steeper than 4:1 at rate of 5 gallons per 1,000 square feet in accordance with the manufacturers recommended requirements.

I. Water: Apply with fine spray after mulching to saturate top 4 inches of soil.

3.04 SODDING

A. Do not plant dormant sod, or when ground is frozen.

B. Lay sod to form solid mass with tightly fitted joints; butt ends and sides, do not overlap.

1. Stagger strips to offset joints in adjacent courses.
2. Work from boards to avoid damage to subgrade or sod.
3. Tamp or roll lightly to ensure contact with subgrade; work sifted soil into minor cracks between pieces of sod, remove excess to avoid smothering adjacent grass.
4. Complete sod surface true to finished grade, even, and firm.

C. Fasten sod on slopes to prevent slippage with wooden pins 6 inches long driven through sod into subgrade, until flush with top of sod. Install at sufficiently close intervals to securely hold sod.

D. Water sod with fine spray immediately after planting. During first week, water daily or more frequently to maintain moist soil to depth of 4 inches.

E. Apply top dress fertilizer at recommended rate.

3.05 FIELD QUALITY CONTROL

A. Eight weeks after seeding is complete and on written notice from Contractor, Engineer will, within 15 days of receipt, determine if a satisfactory stand has been established.

B. If a satisfactory stand has not been established, Engineer will make another determination after written notice from Contractor following the next growing season.

END OF SECTION

SECTION 33 05 01.10
HIGH-DENSITY POLYETHYLENE (HDPE) PRESSURE PIPE AND FITTINGS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Society of Mechanical Engineers (ASME):
   a. Boiler and Pressure Vessel Code, Section IX, Article XXI-XXIV.
   b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   c. B18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
   d. B18.2.2, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
2. American Water Works Association (AWWA):
   a. C906, Polyethylene (PE) Pressure Piping and Fittings, 4 in. through 65 in. for Waterworks.
   b. Manual M55, PE Pipe - Design and Installation.
3. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   d. A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.
   e. D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
   f. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
   g. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
   h. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.

i. F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure.
j. F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

4. Code of Federal Regulations (CFR): Title 49 Part 192.285, Plastic Pipe: Qualifying Persons to Make Joints.
5. Plastics Pipe Institute (PPI):
   a. Handbook of PE Pipe.
   b. Technical Note 38, Bolt Torque for Polyethylene Flanged Joints.
   c. TR-33, Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Catalog information confirming pipe, fittings, and other materials conform to requirements of this section.
   b. Drawings of specific connection details.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
2. Infrared temperature gun product data.
3. Experience, training record, and certificates of persons to be fusing HDPE pipe.
4. Information on manufacturer and model of machine to be used for fusion of HDPE pipe.
5. Testing Plan: Submit at least 15 days prior to testing and include the following as a minimum:
   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Method of isolation.
   d. Method of conveying water from source to system being tested.
6. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
7. Test report documentation.

8. Installation Plan following the Plastic Pipe Institute, ASTM F2620, and manufacturer's recommendations. Plan shall include, but not be limited to the following major components:
   a. Pipe and fitting storage.
   b. Pipe and fitting handling equipment.
   c. Proposed means to maintain required temperatures for fusing.
   d. Proposed means to shield fusing area from wind, snow, blowing dust, and rain.
   e. Proposed means to maintain uniform pipe wall temperature prior to fusing.
   f. Temperature Control Plan: Plan shall include means to reduce temperature of pipe to limit stated in Part 3 of this specification.
9. Fusion parameters including recommended limits of criteria recorded by data logger.
10. Fusion report for each joint, including information listed under Article Field Quality Control. Submit joint reports within 24 hours after fusion.
11. Gasket manufacturer's table for recommended bolt torque and tightening pattern.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Pipe Manufacturer: Listed with Plastic Pipe Institute.
2. Experienced in fabricating pipe of similar diameters and wall thickness required for the Work.
3. Successful fabrication of at least 2,000 linear feet of 3-inch diameter or larger pipe within past 5-year period.
4. Persons fusing HDPE pipe shall have a current operator qualification training certificate and wallet card showing operator is qualified to operate machine to be used on the Project.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Shipping: Do not cut, kink, or otherwise damage pipe during transportation.

B. Storage and Handling:

1. Pipe interiors are to be inspected and all debris removed prior to storage.
2. Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes under anticipated temperature conditions.
3. Do not exceed the stacking heights stated in AWWA Manual M55.

4. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.
5. Comply with the requirements of the approved Installation Plan.
6. Keep pipe shaded from direct sunlight prior to fusion and installation in trench.

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe and Fittings:

1. Conform to requirements of ASTM D3035.
2. Resin:
   a. Non-Potable Water Transmission and Distribution Systems: Polyethylene resin shall meet or exceed requirements of ASTM D3350 for:
      1) PE 4710 material manufactured from bimodal resin with cell classification of 445474C, or better. Pressure rating shall be based on hydrostatic design stress of 1,000 psi at 73.4 degrees F.
3. Pressure Rating: 150 psi.
4. Outside Diameter Basis: IPS.
5. Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of a compatible resin mix for the fusion process.
6. Fittings:
   a. Polyethylene fittings shall have same or higher pressure rating as pipe.
   b. Sizes 12 Inches and Smaller: Molded and manufactured to requirements of ASTM D3261.

B. Backup Rings:

1. Convoluted for Flanged Connections:
   a. ASTM A240/A240M, Type 316 stainless steel.
   b. Complete with one-piece, molded polyethylene flange adapters.
   c. Flanged Connections: Same or greater pressure rating as pipe.
2. Gaskets: Material, size, and thickness shall be as recommended by gasket manufacturer and in accordance with PPI Technical Note 38. Gasket manufacturer shall provide a table with recommended bolt torque and tightening pattern.

C. Joints: Thermal butt-fusion or electrofusion, except where connecting to unions, valves, and equipment with flanged or threaded connections that may require future disassembly. Use appropriate transition fitting or adapter for all joints that are not thermal butt-fused or electro-fused.

D. Bolts, Nuts, and Washers:

1. Bolt Materials: Type 316 stainless steel, ASTM A193/A193M, Grade B8M hex-head, carbide solution treated and strained hardened.
2. Bolt Fabrication: In accordance with ASME B18.2.1.
3. Nut Materials: Type 316 stainless steel, ASTM A194/A194M, Grade 8 hex-head.
4. Nut Fabrication: In accordance with ASME B18.2.2.
5. Washers: Type 316 stainless steel. Same material as bolts in accordance with ASME B18.21.1.
6. Thread Lubricant: Provide bolt manufacturer's recommended lubricant on bolt threads, nuts, nut face, and around bolt hole.
7. Corrosion Resistance: When used in submerged brine water applications, bolts, nuts, and washers shall be coated in polytetrafluoroethylene (PTFE) applied by fastener manufacturer.

E. Electrofusion Couplings:

1. Material: HDPE.
2. Method of Attachment: Electrofusion.
3. Designed for coupling HDPE pipe.
4. Manufacturers:
   a. Central Plastics Company.
   b. ISCO Industries.

F. Products that restrain HDPE pipe with wedges or clamps are not acceptable.

2.02 SERVICE CONDITIONS

A. In accordance with Section 01 61 00, Common Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install polyethylene pipe in conformance with AWWA M55, PPI TR-33, ASTM F2620, and pipe manufacturer's recommendations.

2. Follow all requirements of approved Installation Plan where HDPE is to be installed in ambient temperatures less than 50 degrees F, in hot conditions or in windy conditions.
3. Protect and install pipe in accordance with the Temperature Control Plan when contraction of pipe length may cause damage to or pull out from structures.

B. Joining: Butt-fuse pipes and fittings in accordance with pipe manufacturer's recommendations. Depending on Site conditions, perform butt-fusion joining in or outside of excavated trench.

1. If HDPE pipe surface temperature is above 100 degrees F as measured with infrared temperature gun, allow pipe to cool prior to making any connections to flanges, existing pipeline systems, or structures.
2. Connect HDPE pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems with flanged connections as follows:
   a. Polyethylene flange adapter, thermally butt-fused to end of pipe. Flange "stub ends" are not allowed.
   b. Bolt and nut of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard.
   c. Follow requirements of PPI Technical Note 38 including mandatory 4-hour bolt re-torquing.
3. Minimum Long-Term Field Bending Radius: Restricted to limits recommended by AWWA M55, Table 8-2.

C. Placement in Trench:

1. Handle joined pipeline in such a manner that pipe is not damaged by dragging it over sharp and cutting objects.
2. Position slings for handling pipeline away from butt-fused joints.
3. Remove sections of damaged pipe and replace it with undamaged pipe. Damaged pipe is defined as pipe with kinks or gouges exceeding 10 percent of pipe wall thickness.
4. Exercise care when lowering pipe into trench to prevent damage or twisting of pipe.
5. Buried Pipe: Snake pipe from one side of trench to other to allow for thermal and settling movements, and as recommended by pipe manufacturer.

3.02 FIELD QUALITY CONTROL

A. Joint Butt Fusion:

1. Measure and log each joint fusion by an electronic monitoring device (data logger) affixed to fusion machine. Data to be logged shall include the following and shall be capable of being retrieved electronically:
   a. Pipe size, dimensions, and wall thickness.
   b. Machine model and size.
   c. Operator identification.
   d. Job identification number.
   e. Weld number.
   f. Fusion, heating, and drag pressure settings.
   g. Heater plate temperature.
   h. Time stamp showing when weld was performed.
   i. Heating and curing time of weld.
   j. Curing temperature readings and time stamps of readings.
   k. Error messages and warnings for out of range temperature or pressure settings.
2. In addition to logged items above, the following shall be logged or annotated on report:
   a. Location of joint being fused by pipeline station or by reference to pipe Shop Drawing.
   b. Ambient temperature, wind speed, precipitation, and humidity.
   c. If internal bead was removed.
   d. Environmental actions taken (such as, use of tarps, enclosures, and blankets).
   e. Type of HDPE and manufacturer.

B. Joint Weld Inspection: Visually examine each joint in accordance with the guidelines in ASTM F2620. Remove and replace any joints not meeting the standard.

C. Pipeline Hydrostatic Test:

1. General:
   a. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.
   b. Furnish testing equipment and perform tests in manner satisfactory to Engineer. Testing equipment shall provide observable and accurate measurements of initial service leak and allowable make-up water volume under specified conditions.
   c. Test newly installed pipelines.

d. Using water as test medium, pipes shall successfully pass a hydrostatic test prior to acceptance.
e. Conduct field hydrostatic test on buried piping after trench has been completely backfilled.
f. Contractor may, if field conditions permit and as determined by Engineer, partially backfill trench and leave joints open for inspection and conduct initial service leak test. Final field hydrostatic test shall not be conducted until backfilling has been completed as specified above.
g. Dispose of water used in testing in accordance with federal, state, and local requirements.

2. Preparation:
   a. Install temporary thrust blocking or other restraint as necessary to prevent movement of pipe and protect adjacent piping or equipment. Make necessary taps in piping prior to testing.
   b. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
3. Procedure:
   a. Test pressure shall be 150 percent of system operating pressure based on pressure as measured at lowest point in pipeline.
   b. Maximum filling velocity shall not exceed 0.25 feet per second, calculated based on full area of the pipe.
   c. Expel air from pipe system during filling.
   d. Test procedure shall be in accordance with ASTM F2164.
      1) Initial Expansion Phase: Add water as required to maintain test pressure for 4 hours.
      2) Test Phase: Reduce pressure by 10 psi and start pressure test.
      3) Test is successful if pressure says within 5 percent of initial value for 1 hour.
   e. If test is not completed because of leakage, equipment failure, or other reasons, depressurize test section and allow it to relax for at least 8 hours before retesting.
   f. If there is leakage, repair defective pipe section and repeat hydrostatic test.

3.03 MANUFACTURER'S SERVICES

A. Provide pipe manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for assistance during pipe joining operations and pipe installation.

END OF SECTION

SECTION 33 05 13
MANHOLES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): M198, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
2. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Standard Specification for Gray Iron Castings.
   c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   d. A536, Standard Specification for Ductile Iron Castings.
   e. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   f. B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
   g. C14, Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
   h. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   i. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   j. C150/C150M, Standard Specification for Portland Cement.
   k. C192/C192M, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
   l. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   m. C443, Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets.
   n. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
   o. C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
   p. C990, Standard Specification for Joints in Concrete Pipe, Manholes, and Precast Box Sections using Preformed Flexible Joint Sealants.

q. C1311, Standard Specification for Solvent Release Sealants.
r. C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
s. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
t. D4101, Standard Specification for Propylene Injection and Extrusion Materials.
u. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
v. F594, Standard Specification for Stainless Steel Nuts.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings including details of construction, reinforcing and joints, anchors, lifting, erection inserts, and other items cast into members.
2. Product Data:
   a. Concrete mix design.
   b. Rubber gaskets and sealants.

B. Informational Submittals:

1. Experience Record:
   a. Precast concrete production capabilities.
   b. Evidence of current PCI plant certification.
2. Certificate of Compliance: Certify admixtures and concrete do not contain calcium chloride.
3. Manufacturer’s recommended installation instructions.
4. Field quality control report.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Precast Concrete and Precast Prestressed Concrete: Product of manufacturer with 3 years’ experience producing precast concrete products of quality specified.
2. Precast Plant: PCI certified plant with current certification.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials of Construction and Service Conditions:

1. Screws, Bolts, or Nuts: Type 304 stainless steel conforming to ASTM F593 and ASTM F594.
2. Gaskets:
   a. Internal and external seals shall be made of materials that have been proven to be resistant to the following exposures and conditions:
      1) Corrosion or rotting under wet or dry conditions.
      2) Temperature ranges, variations, and gradients in construction area.
      3) Variations in moisture conditions and humidity.
      4) Fatigue failure caused by a minimum of 30 freeze-thaw cycles per year.
      5) Vibrations because of traffic loading.
      6) Fatigue failure because of repeated variations of tensile, compressive and shear stresses, and repeated elongation and compression. Material shall remain flexible allowing repeated movement.
3. Materials shall be compatible with each other and manhole materials.
4. Designed to provide a 20-year service life.

B. Structures shall meet requirements of ASTM C478, this specification and the following:

1. Concrete:
   a. Cement: Meet requirements of ASTM C150/C150M.
   b. Compressive Strength:
      1) Minimum 4,000 psi.
      2) Minimum strength shall be confirmed at 7 days by making two standard cylinders per manhole for testing.
2. Reinforcement: Grade 60, unless otherwise specified.
3. Ring: Custom made with openings to meet indicated pipe alignment conditions and invert elevations.
4. Joint:
   a. Form joint contact services with machined castings.
   b. Surfaces shall be parallel with nominal 1/16-inch clearing and tongue equipped with recess for installation of O-ring rubber gasket.
5. Gasket: Meet requirements of ASTM C443.

2.02 PRECAST MANHOLES

A. Riser Sections:

1. Fabricate in accordance with ASTM C478.
2. Wall Thickness: Minimum 4 inches or 1/12 times inside diameter, whichever is greater.
3. Top and bottom surfaces shall be parallel.
4. Joints: Tongue-and-groove and confined O-ring with rubber gaskets meeting ASTM C443.

B. Base Sections and Base Slab:

1. Base slab integral with sidewalls.
2. Fabricate in accordance with ASTM C478.

C. Manhole Extensions:

1. Concrete grade rings; maximum 6 inches high.
2. Fabricate in accordance with ASTM C478.

D. Joint Seal Manufacturers and Products:

1. Confined Plastic or Rubber O-Ring:
   a. As recommended by precasting manufacturer.
   b. Meet requirements of ASTM C443.

2.03 MANHOLE HATCHES

A. Cover plates and frames shall be rated for HS-20 traffic load, spring assisted, galvanized diamond plate with locking latch.

2.04 MORTAR

A. Standard premixed in accordance with ASTM C387/C387M, or proportion one part Portland cement to two parts clean, well-graded sand that will pass a 1/8-inch screen.

B. Admixtures:

1. May be included; do not exceed the following percentages of weight of cement:
   a. Hydrated Lime: 10 percent.
   b. Diatomaceous Earth or Other Inert Material: 5 percent.

C. Mix Consistency:

1. Tongue-and-Groove Type Joint: Such that mortar will readily adhere to pipe.
2. Confined Groove (Keylock) Joint: Such that excess mortar will be forced out of groove and support is not provided for section being placed.

2.05 PRECAST CONCRETE VAULTS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Oldcastle Precast.
2. Jensen Precast.
3. Hanson Pipe and Precast.

B. Design Requirements:

1. In the event of a conflict between or among standards, the more stringent standard shall govern.
2. Comply with ASTM C858, except as modified herein.
3. Reinforcing Steel:
   a. Deformed Bars: ASTM A615/A615M, Grade 60.
   b. Welded Wire Fabric: ASTM A497/A497M.
4. Nominal Dimensions: As shown on Drawings.
5. Construction: Rigid type and behave monolithically.
6. Design Loads: As determined by ASTM C857.
   a. Live Loads: AASHTO HS-20 truck loading plus impact.
   b. Does not need to be designed to avoid flotation.
7. Design shall accommodate additional stresses or loads that may be imposed during factory precasting, transporting, erection, and placement.
8. Blockouts for penetrations shall be as shown on Drawings.
9. Sealant:
   a. Non-swelling preformed joint sealants to provide a lasting, watertight bond.
   b. Manufacturer and Product: Henry Company; RAM-NEK.

C. Cover plates and frames shall be rated for HS-20 traffic load, spring assisted, galvanized diamond plate with locking latch.

D. ACCESSORIES

1. Insulation:
   a. Cellular polystyrene, 2 inches thick.
   b. Manufacturer and Product: Dow Chemical Co.; Styrofoam.

2.06 BACKFILL AROUND AND UNDER MANHOLE

A. Structural fill as specified in Section 31 00 00, Earthwork.

PART 3 EXECUTION

3.01 GENERAL

A. Prior to installation inspect materials:

1. Sections not meeting requirements of this specification or that are determined to have defects which may affect durability of structure are subject to rejection.
2. Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Owner and Engineer.
3. Remove and replace structure that cannot be repaired.

B. If needed, dewater excavation during construction and testing operations.

3.02 EXCAVATION AND BACKFILL

A. Excavation: As specified in Section 31 00 00, Earthwork.

B. Backfill: As specified in Section 31 00 00, Earthwork.

3.03 INSTALLATION OF PRECAST MANHOLES

A. Concrete Base:

1. Precast:
   a. Place on compacted structural fill.
   b. Properly locate, ensure firm bearing throughout, and plumb first section.

B. Sections:

1. Inspect precast manhole sections to be joined.
2. Clean ends of sections to be joined.
3. Do not use sections with chips or cracks in tongue.

C. Preformed Plastic Gaskets or Rubber O-Ring:

1. Use only pipe primer furnished by gasket manufacturer.
2. Install gasket material in accordance with manufacturer's instructions.
3. Completed Manhole: Rigid and watertight.

3.04 MANHOLE FRAMES AND HATCHES

A. Install concrete grade rings as required to set hatches flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.

3.05 FIELD QUALITY CONTROL

A. Hydrostatic Testing:

1. Procedure: Plug inlets and outlets and fill manhole with water to height determined by Engineer.
2. Manhole may be filled 24 hours prior to time of testing, if desired, to permit normal absorption into pipe walls to take place.
3. Leakage in each manhole shall not exceed 0.1 gallon per hour per foot of head above invert.
4. Repair manholes that do not meet leakage test, or do not meet specified requirements from visual inspection.

END OF SECTION

SECTION 33 47 13.01
POND AND RESERVOIR LINERS—HDPE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service, and other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service, or both.
   c. A276, Standard Specification for Stainless and Steel Bars and Shapes.
   d. B211, Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.
   e. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   f. D570, Standard Test Method for Water Absorption of Plastics.
   g. D638, Standard Test Method for Tensile Properties of Plastics.
   h. D696, Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between Minus 30 Degrees C and 30 Degrees C with Vitreous Silica Dilatometer.
   i. D746, Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   j. D751, Standard Test Methods for Coated Fabrics.
   k. D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   l. D882, Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
   m. D1004, Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
   n. D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique.
   o. D1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
   p. D2240, Standard Test Method for Rubber Property-Durometer Harness.

q. D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
r. D5199, Standard Test Method for Measuring Nominal Thickness of Geosynthetics.
s. D5321, Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
t. D5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
u. D5994, Standard Test Method for Measuring Core Thickness of Textured Geomembrane.
v. D6365, Standard Practice for Nondestructive Testing of Geomembrane Seams Using the Spark Test.
w. D6392, Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
x. D7007, Standard Practices for Electrical Methods for Locating Leaks in Geomembranes Covered with Water or Earthen Materials.
y. D7240, Standard Practice for Electrical Leak Location Using Geomembranes with an Insulating Layer in Intimate Contact with a Conductive Layer via Electrical Capacitance Technique (Conductive-Backed Geomembrane Spark Test).

1.02 DEFINITIONS

A. Boot: Watertight collar fabricated from geomembrane sheet for sealing geomembrane to pipes and other objects that penetrate geomembrane.

B. Construction Quality Assurance (CQA) Officer: The professional representative for the Design-Builder responsible for implementation of the CQA plan.

C. Film Tearing Bond: Failure in ductile mode of one bonded sheet, by testing, prior to complete separation of bonded area.

D. Geomembrane: An essentially impermeable membrane of high-density polyethylene (HDPE) containing 2 percent to 3 percent carbon black or titanium dioxide for ultraviolet light resistance.

E. Installer: Party responsible for handling, transporting, storing, deploying, protecting, sampling, patching (damaged HDPE) and temporary restraining (against wind and thermal/solar expansion) at the construction site.

F. Lot: Group of consecutively numbered rolls from the same manufacturing line.

G. Manufacturer: The party responsible for the production and quality of the geomembrane panels.

H. Panel: Piece of geomembrane composed of two or more sheets seamed together.

I. Sheet: Seamless piece of geomembrane.

J. Owner: Kaiser Mead Custodial Trust.

K. Watertight: Geomembrane installation free of flaws and defects that will allow passage of water and gases, liquids, and solids to be contained under anticipated service conditions.

1.03 SUBMITTALS

A. Product Data (Manufacturer).

B. Qualifications (Installer): Submit the name of Installer, resume of installation supervisor/field Design-Builder to be assigned to the project, and list of projects completed by Installer that involved geomembranes. Reference Article Qualifications.

1. Approved Installers:
   a. D&E Construction, Visalia CA.
   b. International Lining Technology, Reno NV.
   c. Engineer approved alternative.

C. Qualifications (Leak Location Survey): Submit the name of Surveyor, resume of installation supervisor to be assigned to the project, and list of projects completed by Installer that involved performing Leak Location Survey per ASTM D7007 and ASTM D7240.

D. Quality Control Plan and Installation Procedures (Manufacturer) shall be approved a minimum of 2 weeks prior to installation. Plan shall be reviewed by Design-Builder and Owner and shall include:

1. Copy of Manufacturer’s quality control plan including list of quality control tests performed and typical testing frequencies.
2. Recommended installation procedures.
3. Panel layout drawing identifying panels and overlaps.

E. Coordinate with submittal requirement for Quality Control Plan for material placement over liner as described in Section 31 00 00, Earthwork. Include in the plan coordination and timing for the second electrical defect detection survey following initial placement of stone layer.

F. Electrical Defect Detection Survey Plan.

G. Manufacturer’s Certificate of Compliance, stating that the supplied products meet project requirements as outlined in Tables 1 and 2.

H. Geomembrane Installer’s Certificate of Subsurface Acceptability.

I. Testing:

1. Factory QC test results for supplied products.
2. Copy of quality control tests performed as described in Paragraph Product Data (Manufacturer) above.
3. Certified Field seam test results.
4. Laboratory Testing Equipment: Certified calibrations, manufacturer’s product data, and test procedures.

1.04 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty with Owner named as beneficiary, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of Work specified in this Specification section found defective during periods below, commencing on date of Substantial Completion.

1. Guaranty geomembrane against manufacturing defects, deterioration due to ozone, ultraviolet, and exposure to leachate and other elements for period of 20 years on pro rata basis.
2. Guaranty geomembrane against defects in material and factory seams for period of 2 years.
3. Guaranty geomembrane against defects resulting from installation for period of 2 years.

1.05 QUALIFICATIONS

A. Independent Testing Agency: Certified in the State of Washington and 5 years' experience in field of geomembrane testing. Laboratory shall maintain calibrated instruments, equipment, and documented standard procedures for performing specified testing.

B. Installer shall meet the following requirements and include examples in qualifications submittal:

1. Have experience in constructing lining/closure projects using the specified products.
2. Have experience installing the specified product on at least five projects and have installed a minimum of 2,000,000 square feet (200,000 square meters) of specified materials. Review of proposed installation procedures by the project Design-Builder may relieve the Installer experience requirements on a project-specific basis.

C. Electrical Leak Location Survey:

1. Have experience performing and submit qualifications for spark testing per ASTM D7240.
2. Have experience performing and submit qualifications for performing leak location survey testing per ASTM D7007.

1.06 COORDINATION MEETINGS

A. Meet at least once prior to commencing each of the following activities:

1. Submission of submittals.
2. Fabrication of panels and boots.
3. Installation of geomembrane.

B. Attendees:

1. Contractor's designated quality control representative.
2. Design-Builder.
3. Representatives of geomembrane installer.
4. Others requested by Design-Builder.

C. Topics:

1. Specifications and Drawings.
2. Submittal requirements and procedures.
3. Schedule for beginning and completing geomembrane installation.

4. Training for installation personnel.
5. Installation crew size.
6. Establishing geomembrane marking system, to include sheet identification, defects, and satisfactory repairs, to be used throughout Work.

D. Seam Installation and Testing Demonstration: Performed by geomembrane installer, for each type of seam required.

1.07 QUALITY ASSURANCE

A. The Design-Builder will engage a Construction Quality Assurance (CQA) officer in charge of CQA and a laboratory for monitoring the quality and installation of the Geomembrane and GCL.

B. If necessary, the Installer shall aid the CQA officer in the product sampling by providing personnel and equipment necessary to move, cut and protect geosynthetic rolls and panels.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Geomembrane:

1. Individually package each sheet and protect from damage during shipment.
2. Mark each package with identification of material type, size, and weight.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Do not install geomembrane or perform seaming under the following conditions, unless it can be demonstrated to satisfaction of Engineer that performance requirements can be met under these conditions:

1. Air temperature is less than 35 degrees F or more than 90 degrees F.
2. Relative humidity is more than 90 percent.
3. Raining, snowing, frost is in ground, or wind is excessive.

B. Do not place granular materials on geomembrane when ambient temperature is less than 35 degrees F, unless it can be demonstrated to satisfaction of Engineer that materials can be placed without damage.

1.10 SEQUENCING AND SCHEDULING

A. Before placing geomembrane on soil surfaces, prepare subgrade as specified in Section 31 00 00, Earthwork.

B. Do not attach geomembrane to new concrete surfaces until after concrete has attained two-thirds of design compressive strength.

C. Do not place geomembrane over concrete surfaces until finish of concrete surfaces.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Geomembrane: AGRU America, Georgetown, SC.

2.02 GEOMEMBRANE

A. Composition:

1. High density polyethylene (HDPE) containing no plasticizers, fillers, extenders, reclaimed polymers, or chemical additives, except following:
   a. Approximately 2 percent by weight of carbon black to resin for ultraviolet resistance.
   b. Antioxidants and heat stabilizers, not to exceed 1.5 percent total by weight, may be added as required for manufacturing.

B. Furnish in rolled single-ply continuous sheets with no factory seams.

C. Sheet Thickness: Minimum values determined in accordance with ASTM D5199 and shall not include ridges of rough-surfaced HDPE geomembrane.

D. Sheet Width: Minimum 23 feet.

E. Roll Length: Longest that will be manageable and reduce field seams.

F. Rough-Surfaced Conductive HDPE Geomembrane: Manufactured so that surface irregularities that produce specified friction are adequately fused into sheet or are extruded with sheet, on both sides of sheet. Texture is to be in addition to base thickness specified for sheet. Geomembrane shall be conductive to allow electronic leak location testing per this specification.

G. Meet manufacturer's most recent published specifications and required minimum HDPE geomembrane values in this table.

Minimum Physical Properties for Conductive HDPE Geomembrane –		
Property	**Required Value**	**Test Method**
Specific Gravity	0.940 to 0.936, g/cc; not more than 15% greater than base resin density	ASTM D792, Method A-1 or ASTM D1505
Rough-Surfaced, HDPE Minimum Properties, Each Direction		
Thickness, min., for thinner areas of textured sheet [1.]	54 mil	ASTM D5994
Tensile Stress at Yield	132 lb/in width	ASTM D6693,Type IV
Elongation at Yield	13% (GL =1.3in)	ASTM D6693,Type IV
Puncture Resistance	120 lbs	ASTM D4833
Tear Resistance	45 lbs	ASTM D1004
Stress Crack Resistance	500 hours	ASTM D5397 Appendix

Notes:

1. Commercially available micrometers may be used that have a 60-degree taper to a point with a radius of 1/32 inch. Engineer shall make enough measurements of thinner areas of textured sheet to develop statistical basis for thickness.

H. Extrudate for Fusion Welding of HDPE Geomembranes: Formulated from the same resin as geomembrane and shall meet applicable physical property requirements.

2.03 BOOTS

A. Fabricated of same material as geomembrane sheets to fit around penetrations, without folds, stretching, or unsupported areas.

B. Flanges:

1. Angle: Match slope or bottom where penetration passes through liner.
2. Width: Minimum 2 feet, plus dimension of penetration.

2.04 STAINLESS STEEL BANDS

A. As manufactured by Breeze Clamp Products, Saltsburg, PA, or Engineer, approved equal.

2.05 CAST-IN-PLACE HDPE EMBEDMENT

A. Properties:

1. Compatible for attaching geomembrane materials by extrusion welding to provide watertight seal.
2. Width: 5 inches to 6 inches.

B. Manufacturer: AGRU America, Georgetown, SC.

2.06 FACTORY TESTING

A. Per standard factory testing program as approved by Engineer for the application.

PART 3 EXECUTION

3.01 PREPARATION

A. Geomembrane Inspection: During unwrapping visually inspect and mark each imperfection for repair.

B. Do not place geomembrane until condition of subgrade or geosynthetics installed is acceptable to Engineer.

C. Subgrade: Maintain in smooth, uniform, and compacted condition as specified in Section 31 00 00, Earthwork, during installation of geomembrane. The underlying GCL must be free from wrinkles, dirt, or debris prior to placement of the geomembrane."

D. Concrete Surfaces in Contact with Geomembrane:

1. As specified in Section 31 00 00, Earthwork, unless otherwise specified herein.
2. Provide smooth surface, free of projections, rough spots, voids, honeycomb, or other irregularities. Grind uneven concrete surface to which geomembrane is to be attached, flat and smooth. Round edges to minimum 1/2-inch radius.
3. Clean contact surfaces of dirt, dust, oil, curing compounds, and other coatings by sandblasting.

E. Before installation begins, inspect all liner system materials for damage. Materials that cannot be repaired, in Engineer's judgment, shall be rejected and removed from site. Areas that can be repaired shall be marked and done so in conformance with this specification.

3.02 WELDING UNITS

A. Single or double hot-wedge fusion seam welding.

B. Extrusion welding systems.

C. Hot-air welding is not acceptable.

3.03 GEOMEMBRANE INSTALLATION

A. Prepare subgrade as specified in Section 31 00 00, Earthwork.

B. Do not install geomembrane or seam unless Contractor can demonstrate successful performance and test results showing seams meet strength specifications.

C. Protection:

1. Do not use geomembrane surfaces as work area for preparing patches, storing tools and supplies, or other uses. Use protective cover as work surface, if necessary.
2. Instruct workers about requirements for protection of geomembrane, such as, handling geomembrane material in high winds, handling of equipment, and walking on geomembrane surfaces. Shoes of personnel walking on geomembrane shall be smooth bonded sole or be covered with smooth type of overboot. Prohibit smoking, eating, or drinking in vicinity of geomembrane, placing heated equipment directly on geomembrane, or other activities that may damage geomembrane.
3. Do not operate equipment without spark arrestors in vicinity of geomembrane material nor place generators or containers of flammable liquid on geomembranes.
4. Protect from vehicle traffic and other hazards.
5. Keep free of debris during placement.
6. Prevent uplift, displacement, and damage by wind.
7. Only small rubber-tired equipment, with maximum tire inflation pressure of 5 pounds per square inch, shall be allowed directly on geomembrane, unless otherwise approved by Engineer. Demonstrate that equipment can be operated without damaging geomembrane.

D. Placement:

1. Miscellaneous products required for completion of geomembrane installation shall be in accordance with this specification and geomembrane manufacturer's recommendations.
2. Reduce field seaming to the minimum amount possible. Horizontal seams on slopes will not be acceptable. Seams parallel to toe shall be at least 5 feet from toe. Align rough-sided sheets in manner that maximizes their frictional capabilities along slope.
3. Prevent wrinkles, folds, or other distress that can result in damage or prevent satisfactory alignment or seaming. Provide for factors such as expansion, contraction, overlap at seams, anchorage requirements, seaming progress, and drainage.
4. Temporarily weight sheets with sandbags to anchor or hold them in position during installation. Use continuous holddowns along edges to prevent wind flow under sheet.
    a. Bag Fabric: Sufficiently close knit to preclude fines from working through bags.
    b. Bags: Contain not less than 40 pounds nor more than 60 pounds of sand having 100 percent passing No. 8 screen and shall be securely closed after filling to prevent sand loss.
    c. Do not use tires or paper bags, whether or not lined with plastic. Burlap bags, if used, shall be lined with plastic.
    d. Immediately remove damaged or improperly sealed bags from work area, and clean up spills.
5. Anchor perimeter of geomembrane as shown or as otherwise approved by Engineer. Anchor and seal geomembrane to structures, pipes, and other types of penetrations as shown.
6. Place overlying geotextile or soil cover as shown on Drawings immediately following completion of geomembrane installation and field testing as acceptable to Engineer.

E. Field Seams:

1. Wipe sheet contact surfaces clean to remove dirt, dust, moisture, and other foreign materials and prepare contact surfaces in accordance with seaming method accepted by Engineer.
2. Lap sheet edges to form seams. Adjust edges to be seamed and temporarily anchor to prevent wrinkling and shrinkage.
3. Seams shall not go through a boot. Locate seams minimum of 2 feet from boot.
4. Avoid seam intersections involving more than three thicknesses of geomembrane material. Offset seam intersections at least 2 feet. Extend seams through anchor trench to sheet edges.

5. Seal seam “T” intersections by removing excess material and extrusion welding lap joint.
6. Seam sheets together, using fusion-extrusion or hot-wedge welding system, equipment, and techniques.
7. Capping of Field Seams: Use 8-inch wide (minimum) cover strip of same thickness as geomembrane (and from same roll, if available). Position strip over center of field seam and weld to geomembrane using fillet weld each side, including copper wire as described above for spark testing.

F. HDPE Embedments:

1. Coordinate with Section 03 30 10, Structural Reinforced Concrete, and supplier.
2. Attach to forms by nailing strip every 18 inches to ensure flat surface is tight against form.
3. Allow 1/4-inch to 3/8-inch spacing between butt joints to allow for thermal expansion before welding joints.
4. Allow 6-inch spacing from walls or edges of concrete.
5. Chamfer ends of butt joints or intersection joints to allow for extrusion welding seal of strip.
6. On sloped or horizontal surfaces, embedments with air release holes may be pushed into poured concrete.
7. Seal nail and air holes with extrudate prior to installing membrane.
8. Make full perimeter weld of geomembrane to embedment to ensure maximum watertightness.

G. Penetrations:

1. Construct penetrations through the geomembrane as shown on Drawings.
2. No wrinkles shall exist in the geomembrane at the location of clamps, penetrations, or other locations.
3. Tighten steel clamping bands until neoprene rubber pads are compressed 12 percent to 15 percent of total pad thickness.
4. Anchors and seals of the geomembrane to pipe and round penetrations shall be of the compression flange type or of the boot type.
5. Boot Seals: Place tightly fitting factory fabricated boots without folds around the penetrations. Seal the boot to the geomembrane in accordance with procedures for a field seam using extrusion welding methods. Seal the boot to the penetration using adhesives, rubber pads, and stainless steel clamping bands as shown on Drawings.
6. The cast-in-place embedment assembly shall be installed in accordance with manufacturer’s recommendations, providing a water-tight seal.

H. Boot Seals:

1. Preparation: Thoroughly clean contact surfaces.
2. Place boot around penetrations so flange is supported everywhere in full contact with subgrade, and is free of wrinkles.
3. Seal boot to surrounding geomembrane as specified for field seams using extrusion-welding methods.
4. Tighten steel clamping bands until neoprene rubber pads are compressed 12 percent to 15 percent of total pad thickness.

3.04 PLACING PRODUCTS OVER GEOMEMBRANE

A. Refer to Section 31 00 00, Earthwork.

3.05 REPAIRING GEOMEMBRANE

A. Any geomembrane surface showing injury because of scuffing, penetration by foreign objects, or distress from rough subgrade shall be replaced or covered and sealed with an additional layer of geomembrane material of proper size.

B. Repair damage or rejected seams with pieces of flat and unwrinkled geomembrane material free from defects and seams. Patches shall be tightly bonded on completion of repair Work.

C. Patch shall be neat in appearance and of size 18 inches larger in all directions than area to be repaired. Round corners of patch to minimum 1-inch radius.

D. Prepare contact surfaces and seam patch in accordance with Paragraph Field Seams.

1. Pull and hold flat receiving surface in area to be patched.
2. Seal each patch by extrusion welding continuous bead along edge, with no free edge remaining.
   a. Vacuum box test each patch on completion.

3.06 FIELD QUALITY CONTROL

A. General:

1. Field construction quality control (CQC) is the responsibility of the Installer. The Installer must document that the installation proceeds in accordance with the requirements of this Specification Section. CQC consists of all seam testing (destructive and non-destructive), laboratory testing, and record keeping.

2. Field construction quality assurance (CQA) is the responsibility of the Design-Builder. CQA may consist of inspections, field-testing, laboratory testing, and record keeping, and shall be assisted by the Installer as requested by the Design-Build CQA team.
3. All seams must be welded and tested to provide a water-tight seal across the entire installed area.
4. All seams shall be welded and tested. Seam panels using double wedge fusion welds. Other welds shall be extrusion welded.
5. Seam testing is the sole responsibility of the Installer.

B. During Installation, the Installer is responsible for the following:

1. Material Storage and Handling: Verify that the material is carefully unloaded and protected against moisture, rainfall, and other damaging conditions. Material should be stored and handled in accordance with ASTM D5888. Rolls should be stored in a well-drained area and covered with a tarpaulin or equivalent until the time of deployment.

C. Prior to starting geomembrane installation and daily thereafter for installation on subgrade, geomembrane installer shall certify in duplicate that surface upon which geomembrane shall be installed is acceptable, on form located at end of section.

D. Identify each test by date of sample, date of test, sample location, name of individual who performed test, standard test method used, list of departures from standard test methods, at minimum.

E. In-Place Observation and Testing:

1. Visually inspect geomembrane sheets, seams, anchors, seals, and repairs for defects as installation progresses and again on completion.
2. Depending on seam welding equipment used, test each seam and repair using vacuum testing device, spark testing device, or air channel pressure test for double wedge welded seams.
3. Perform testing in presence of Engineer.

F. Field Testing Equipment:

1. Tensiometer:
   a. Motor driven portable tensile tester with jaws capable of traveling at measured rate of 2 inches per minute (for HDPE).
   b. Equip with gauge which measures force in unit pounds exerted between jaws.
   c. Minimum capacity of 500 pounds.

2. Vacuum Box: Conform to ASTM D5641.
   a. Holiday Detector for spark testing for extrusion welds per ASTM D6365.
   b. Leak Location Survey Equipment that will allow spark testing per ASTM D7007.
   c. High Voltage Spark Test Detector that will allow spark testing per ASTM D7240.

G. Field Seam Sampling:

1. Verify that seaming equipment and operators are performing adequately. Produce test seam samples at beginning of each shift for each seaming crew. In addition, if seaming has been suspended for more than 1/2 hour, or if breakdown of seaming equipment occurs, produce test seam samples prior to resuming seaming.
   a. Sample Size: 12 inches wide plus seam width, and 30 inches long.
   b. Nondestructive Sampling:
      1) For boots and seams that cannot be otherwise tested, insert copper wire for spark test at edge of overlapping sheet in extrudate of weld prior to filet welding. Position to within 1/8 inch of sheet edge.
      2) Frequency: Minimum one Sample per 500 feet of field seam or portion thereof, and minimum one Sample per seaming crew per 4-hour work period.
      3) Produce Samples using same materials, equipment, personnel, and procedures as field seams made at time of work in progress and under same conditions.
   c. Destructive Sampling:
      1) Frequency: Minimum of one sample per 40,000 square feet (4,000 square meters), or more as requested by Engineer.
      2) Remove Samples from field seams at locations selected by Engineer.
      3) Repair field seams in accordance with repair procedures specified in these Specifications.
   d. Sample Identification:
      1) Number, date, and identify each sample as to personnel making seam and location of sample or location of field seam.
      2) Work in progress at time Sample is made. Mark location of Sample, or location of field seam in progress at time sample is made, on panel/sheet layout drawing.

2. Installer shall conform to the following testing requirements for nondestructive and destructive seam tests used to define quality of field seams:
   a. Perform shear and peel testing on portion of sample as specified using approved field tensiometer.
   b. Send portion of sample by overnight service to approved Independent Testing Agency for verification of field test results.
   c. Archive a portion of sample for potential verification testing later.
   d. Independent Testing Agency shall provide preliminary test results no later than 24 hours after Samples have been received from Contractor, unless otherwise approved by Engineer. Certified test results shall be provided no more than 7 days after samples have been received from Contractor.
   e. Conform to ASTM D6392 and this specification.
   f. Seam testing for geomembrane includes strength tests, vacuum box testing, high voltage spark tests, air channel pressure tests, and probing.
3. Field Seam Strength Sample Testing:
   a. General:
      1) Test each sample for seam peel and tensile strength.
      2) Save test samples, including specimens tested, until notified by Engineer relative to their disposal.
      3) Each sample that fails under test shall be shipped immediately by express delivery to Engineer for determination of corrective measures required.
      4) Field Seam Acceptance Criteria: Seam strength equal to 90 percent of that of parent material. Parent material shall be tested in accordance with ASTM D638.
      5) Bonded Shear Strength of HDPE:
         a) In Shear: Minimum 2 pounds per inch width per mil thickness as determined in accordance with ASTM D6392.
         b) In Peel: Minimum 1.2 pounds per inch width per mil thickness as determined in accordance with ASTM D6392.
   b. Test Failure:
      1) If sample fails, entire field seam from which it was taken shall be considered a failure and shall be rejected as a result of nonconformance with specification requirements. Comply with following corrective measures:
         a) Nondestructive Sample Failure: Rerun field weld test using same sample. If that test passes, Engineer may assume error was made in first test and accept field seam. If second test fails, cap each field seam

represented by failed sample and submit new test Sample made during capping procedure.

b) Destructive Sample Failure: Rerun field weld test using new sample from same seam. If that test passes, Engineer may assume error was made in first test and accept field seam. If second test fails, either cap field seam between two previous passed seam test locations that include failed seam or take another sample on each side of failed seam location (10 feet minimum), and test both. If both pass, cap field seam between two locations. If either fails, repeat process of taking samples for test. Each field seam shall be bounded by two passed test locations prior to acceptance.

4. Air Channel Pressure Testing of Double Hot-Wedge Seam:
   a. Insert a needle with gauge in air space between welds. Pump air into space to 30 psi and hold for 5 minutes.
   b. At end of 5 minutes, depressurize seam by placing needle hole in air space between welds at opposite end of seam and observe gauge.
   c. Seam is acceptable if seam maintains at least 27 psi during 5-minute hold and pressure drops within 30-second of depressurization.
   d. Seam is acceptable if seam maintains a minimum of 27 psi. If pressure drops below 27 psi during test period, or does not drop during 30-second depressurization period, repair needle holes and retest seam by same procedure or vacuum box test along entire length of seam.
   e. Vacuum box test entire length of seam if second air pressure test fails.
      1) If no bubbles appear in vacuum box, lower weld will be considered defective and upper seam is acceptable.
      2) If bubbles appear in vacuum box, repair each defective area by extrusion welding and test again by vacuum box.
   f. As alternative to vacuum box testing, apply soap solution to exposed seam edge while maintaining required air channel test pressure.
      1) If bubbles appear, mark, trim unbonded edge, and extrusion weld defective areas.
      2) If no bubbles appear and test pressure cannot be maintained, leak is judged to be in bottom or second seam.
   g. If leak is judged to be in bottom seam, cap strip length of seam tested will be accepted.
   h. Mark and repair needle holes.

5. Vacuum Box Testing of Geomembrane Welds:
   a. Vacuum box test each of these types of welds: Fillet, extrusion lap, and single hot-wedge fusion lap.
   b. Testing Procedures: Conforming to ASTM D5641.
6. High Voltage Spark Tests of Extrusion Welds:
   a. Provide each seam to be tested with copper wires properly embedded in seam and with provisions for electrical grounding to test equipment. A conductive geomembrane can be used in lieu of a wire if installer can show proficiency detecting leaks with this method.
   b. Pass spark tester along length of seam containing copper wire.
   c. Presence of a visible spark along tested seam shall be evidence of a faulty seam.
   d. Mark faulty areas for repair and retesting.
7. Repairs and Patches: Verify that the installed material is not damaged. For isolated areas where the geomembrane backing is punctured or torn, or where the bentonite coating has been dislodged during installation, the area should be patched. Patches should be placed over the damaged area with the bentonite coating directly against the damaged area. Patches should extend a minimum 1-foot (300 mm) outward around the perimeter of the damage area. Extrusion weld and test around entire perimeter of all patches.
8. Debris in the Overlapped Seams: Verify that no stones or other debris migrates into overlap seams, or between bentonite and the overlying geomembrane in an encapsulated mode.
9. Material Wrinkles and Fishmouths: Verify that the deployed liner does not contain wrinkles or fishmouths. Wrinkles that cannot be pulled out manually should be (1) patched or (2) cut out and the area subsequently patched. Patches are made from the same base material with the same specified overlap distances extending around the affected area(s).
10. Attachment to Structures: Verify the material is attached to pipe penetration structures in accordance with the manufacturer's recommendations.
11. Material Anchorage at Slopes: Verify the material is properly anchored adjacent to slopes in accordance with the project design details.

H. During soil cover operations, the Installer and Design-Builder's subcontractor for installing material above geomembrane and geosynthetic clay liner, will verify inspection of the following. Design-Builder's CQA representative shall also oversee CQC activities to verify.

   1. Material Inspection: The Installer and Design-Builder's CQA representatives shall inspect each panel placement area before the GCL is covered.

2. General Soil Cover Operations: Verify that geomembrane is covered with soil 1) in a timely manner, 2) carefully and in a manner consistent with the contractor's approved QC Plan, and 3) with adequate soil thickness greater than or equal to 1 foot unless otherwise specified.
3. Subgrade Moisture Conditions:
    a. The following general recommendations are provided for moisture characteristics of soils, the intent being to cover the geomembrane before bentonite migration/displacement due to construction would cause concern. These are general recommendations, but in no condition should placement be allowed to occur more than 10 days following initial placement of the product:
        1) If the subgrade is relatively dry (approaching the "wilting point" moisture content that makes it difficult for vegetation to grow), coverage is recommended within 5 days.
        2) If the subgrade is damp to moist (approaching the "field capacity" moisture content that allows lush vegetation), coverage is recommended within 2 days to 3 days.
        3) If the subgrade is moist to wet (approaching saturation), it is advisable to cover by the end of the following day.
4. Subcontractor CQC Observation of Soil Cover Operations: The contractor performing soil covering shall verify all operations are in accordance with the specifications. Subcontractor should provide a ground person in front of the spreading activities at all times. The primary responsibility of the ground person is (a) to establish and maintain adequate grade control of the cover soil layer, (b) to manually reduce or flatten wrinkles in the installed liner in advance of soil spreading, and (c) to identify and caution against any potential damage to the lining system.

I. The Installer shall aid the Design-Builder's authorized CQA representatives in collecting samples for testing as follows:

1. According to the requirements of the CQA Plan.
2. Each conformance sample shall be a minimum of 2 feet (600 mm) long and run the entire width of the roll.
3. Under direction of the Design-Builder's authorized CQA representatives, the Installer shall mark the roll number and machine direction on each sample.

J. Electrical Leak Detection Survey:

1. Perform two electronic leak location surveys as follows:
   a. Prior to placing protective geotextile and initial gravel layer, perform exposed electrical leak survey with spark tester per ASTM D7240.
   b. After placing protective geotextile and initial gravel layer, perform dipole leak location survey per ASTM D7007. Test can be performed after initial 1-foot layer of gravel is installed unless layer thickness is 0.75-foot, in which case can be performed after 0.75-foot layer. Test shall not be performed at a material thickness greater than 2 feet from the liner.
2. Repair all defects found during leak location surveys. Defects found following placement of cushion geotextile and stone placement shall be exposed and rebuilt at the expense of the Contractor responsible for stone placement.

K. Documentation:

1. Record Documents, include the following:
   a. Panel and sheet numbers.
   b. Seaming equipment and operator identification.
   c. Temperature and speed setting of equipment.
   d. Date seamed.
   e. Identity and location of each repair, cap strip, penetration, boot and sample taken from installed geomembrane for testing.

3.07 MANUFACTURER'S SERVICES

A. Provide authorized representative of geomembrane manufacturer onsite for technical supervision and assistance during the following:

1. Preparation and inspection of surfaces on which geomembrane is to be placed.
2. Inspection of geomembrane prior to installation.
3. Installation of geomembrane.
4. Placement of cover over installed geomembrane.
5. Certification of Proper Installation.

3.08 CLEANUP

A. Clean up work area as the Work proceeds. Take particular care to ensure that no trash, tools, and other unwanted materials are trapped beneath geomembrane and that scraps of geomembrane material are removed from the work area prior to completion of installation.

3.09 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this Specification.

1. Geomembrane Installer's Certification of Subsurface Acceptability.

END OF SECTION

GEOMEMBRANE INSTALLER'S CERTIFICATION
OF
SUBSURFACE ACCEPTABILITY

Geomembrane installer, _____
for Kaiser Mead Groundwater Remediation Interim Action, hereby certify that supporting surfaces are acceptable for installation of geomembrane, undersigned having personally inspected condition of constructed surfaces. This certification is for areas shown on Attachment or defined as follows:

_____

_____

_____

_____

Condition of supporting surfaces in defined area meets or exceeds minimum requirements for installation of geomembrane.

Signed: _____
(Representative of Geomembrane Installer)

_____
(Position)

Date: _____

Witness:

SECTION 33 47 13.07
POND AND RESERVOIR LINERS—GEOSYNTHETIC CLAY LINER (GCL)

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. ASTM International (ASTM):
   a. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   b. D4643, Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
   c. D5084, Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
   d. D5199, Standard Test Method for Measuring Nominal Thickness of Geosynthetics.
   e. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
   f. D5321, Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
   g. D5887, Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
   h. D5889, Standard Practice for Quality Control of Geosynthetic Clay Liners.
   i. D5890, Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
   j. D5891, Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.
   k. D5993, Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners.
   l. D6496, Standard Test Method of Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle Punched Geosynthetic Clay Liners.

1.02 DEFINITIONS

A. Bentonite: Clay soils comprised primarily of sodium montmorillonite, characterized by high swelling potential and low hydraulic conductivity.

B. Construction Quality Assurance (CQA) Officer: The professional representative for the Design-Builder responsible for implementation of the CQA plan.

C. Geosynthetic Clay Lining (GCL): Flexible panel made of a layer of domestic, natural, high swelling sodium bentonite clay (montmorillonite) encapsulated between two geotextiles.

D. Geotextile: Woven or nonwoven permeable manmade textile used with geotechnical engineering related materials.

E. Installer: Party responsible for handling, transporting, storing, deploying, protecting, sampling, patching (damaged GCL) and temporary restraining (against wind and thermal/solar expansion) at the construction site.

F. Lot: Group of consecutively numbered rolls from the same manufacturing line.

G. Manufacturer: The party responsible for the production and quality of the GCL panels.

H. Maximum Average Roll Value (MaxARV): Maximum of a series of average roll values representative of product furnished.

I. Minimum Average Roll Value (MinARV): Minimum of a series of average roll values representative of product furnished.

J. Owner: Kaiser Mead Custodial Trust.

K. Overlap: The width of material of a GCL panel in contact with an adjacent GCL panel. The distance measures perpendicular from the overlying edge of one panel to the underlying edge of the other.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data:
      1) Montmorillonite content by weight, typical moisture content, and swell index values.
      2) Recommended sealing compound.
      3) Repair adhesive.

b. Layout and installation drawings, including procedures for carrying out the Work in coordination with deployment of HDPE geomembrane.
c. Panel joining methods.
d. Handling and storage instructions.

2. Samples: On request from Engineer, 2 square yards of material from each shipment.
3. Test Panel: Set up, build, and arrange with the Engineer a GCL test panel to monitor hydration during the project period.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance.
2. Certified factory test results.
3. Mill Certificate or Affidavit:
   a. Signed by legally authorized official from company manufacturing materials.
   b. Attest that geosynthetic materials meet chemical, physical, and manufacturing requirements stated in this Specification.
   c. Mill certificate from GCL manufacturer attesting that GCL materials meet the chemical, physical, and manufacturing requirements stated in this Specification.
   d. Complete description for handling and storage of the GCL and associated products including, but not limited to, methods of unloading, inspection, covered storage on pallets or in an enclosed storage facility, and recording the quantity and lot numbers for each package.
4. Manufacturer's Warranty of GCL Material.

1.04 QUALIFICATIONS

A. Independent Testing Agency: Certified in the State of Washington and 5 years' experience in field of geomembrane testing. Laboratory shall maintain calibrated instruments, equipment, and documented standard procedures for performing specified testing.

B. Installer shall meet the following requirements and include examples in qualifications submittal:

1. Have experience in constructing lining/closure projects using the specified products.
2. Have experience installing the specified product on at least five projects and have installed a minimum of 2,000,000 square feet (200,000 square meters) of GCL materials. Review of proposed installation procedures

by the project Design-Builder may relieve the Installer experience requirements on a project-specific basis.

1.05 QUALITY ASSURANCE

A. Prior to packaging the finished product, manufacturer shall inspect surface of each roll by using strong light source on one side of panel and observing other side for zones of inadequate bentonite distribution or by using other reliable methods, such as physical measurements or sampling, to detect deficiencies in uniformity of bentonite distribution. Deficient rolls shall be rejected.

B. Label each roll with length, width, and weight, along with lot number and date of manufacture.

C. The Design-Builder will engage a Construction Quality Assurance (CQA) officer in charge of CQA and a laboratory for monitoring the quality and installation of the Geomembrane and GCL.

D. If necessary the Installer shall aid the CQA officer in the product sampling by providing personnel and equipment necessary to move, cut and protect GCL rolls and panels.

1.06 DELIVERY, STORAGE, AND HANDLING

A. General: Conform to the Manufacturer’s requirements and ASTM D5888 unless otherwise specified.

B. Delivery:

1. Deliver material to the site only after the CQA team accepts required submittals.
2. Material shall be covered with a waterproof, tightly-fitting, plastic covering resistant to ultraviolet degradation.
3. Ship less than one month prior to scheduled installation.
4. Each roll shall be marked with the following information:
    a. Manufacturer’s name.
    b. Product identification.
    c. Lot or batch number.
    d. Roll number.
    e. Roll dimensions.

C. Storage:

1. Store rolls in space allocated by Design-Builder. Space should be at high ground level or elevated aboveground surface.

2. Stack no more than three rolls high.
3. Protect rolls from precipitation, other sources of moisture, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.
4. Preserve integrity and readability of roll labels.

D. Handling:

1. Use appropriate handling equipment to Manufacturer's recommendations to load, move, or deploy GCL rolls.
2. Handling of rolls shall be done in a competent manner such that damage does not occur to the product or to its protective wrapping. Follow handling procedures outlined in ASTM D5888.
3. Damage to protective covering due to mishandling or sampling must be repaired immediately. Repairs shall be such that the GCL roll is protected from moisture or other deleterious conditions.
4. Installer is responsible for off-loading, storage, and transporting material form storage area to installation site.

PART 2 PRODUCTS

2.01 MANUFACTURERS AND PRODUCTS

A. Needle-Punched GCL Products: Colloid Environmental Technologies Co. (CETCO), Arlington Heights, IL; Bentomat ST.

2.02 GENERAL PROPERTIES

A. The GCL and its components shall exhibit properties and testing that meet or exceed the minimum applicable required values shown in Table below.

B. No GCL shall be installed until approval of Design-Builder has been obtained.

C. Overlap (minimum 6-inch [15 cm]): overlap guideline shall be imprinted on edges of the component of the GCL to be placed upward in the field as a means for providing quality assurance of the overlap dimension. Lines shall be printed in easily visible, nontoxic ink.

2.03 GEOSYNTHETIC CLAY LINING

A. Panels of bentonite and encapsulating geotextiles manufactured shall perform as continuous lining. Panels shall contain a Min ARV of 0.75 pound per square foot of high-swelling granular sodium bentonite clay at 0 percent moisture content, or equivalent weight at other moisture content using ASTM D5993.

B. Bentonite Properties:

1. High quality natural sodium bentonite without chemical resistance enhancers or polymers.
2. 90 percent typical montmorillonite content by weight.
3. Minimum Bentonite Swell Index of 24 mL/2g when tested pursuant to ASTM D5890.
4. Maximum fluid loss of 18 mL when based on ASTM D5891 test standard.

C. GCL shall be manufactured so the bentonite component is continuously contained throughout GCL and to support geotextile so that no displacement of the bentonite occurs when material is unrolled, moved, cut, torn, or punctured. To contain granular bentonite, GCL materials shall be stabilized by process of needle punching through top and bottom layers of geotextile and bentonite.

D. Encapsulating geotextile materials shall protect the bentonite component and be sufficiently porous to allow bentonite flow-through to create a positive bentonite-to-bentonite seal at seams. The geotextile shall be polypropylene, "or-equal," consisting of two nonwoven geotextile components which are needle-punched together. The nonwoven geotextile shall have minimum mass per area of 6 ounces per square yard.

E. Prior to packaging the finished product, the manufacturer shall inspect each roll over the entire surface area by using a strong light source on one side of the panel and observing the other side for zones of inadequate bentonite distribution or by using other reliable methods to detect deficiencies in the uniformity of the bentonite distribution. Deficient rolls shall be rejected.

F. Each roll shall be labeled with the length, width, and weight, along with the lot number and date of manufacture.

G. The GCL shall be BENTOMAT® ST as manufactured by Colloid Environmental Technologies Co. (CETCO), "or-equal," and shall meet the following requirements:

GCL Material Properties		
Property	**Requirement**	**Test Method**
Geomembrane Thickness, MinARV (applies only to geomembrane component)	N/A	ASTM D5199

GCL Material Properties		
Property	**Requirement**	**Test Method**
Bentonite Content, lb/sq ft at 0% moisture content, MinARV	0.75	ASTM D5993
Clay Moisture Content, %, max.	12	ASTM D4643
Woven Carrier Geotextile Weight oz/sq yd, MinARV	3.1	ASTM D5261
Nonwoven Cover Geotextile Weight oz/sq yd, MinARV	12.0	ASTM D5261
Grab Strength, lbs-width, Tested Dry, MinARV	30	ASTM D6768
Peel Strength, lbs-inch width, Tested Dry, MinARV	3.5	ASTM D6496
Hydraulic Conductivity cm/sec max	$5x10^{-9}$	ASTM D5887
Index Flux, $m^3/m^2/sec$, max	$1x10^{-8}$	ASTM D5887
Finished GCL Roll Width, Feet, MinARV	15	Linear Measurement
Finished GCL Roll Length, Feet, MinARV	300	Linear Measurement

2.04 BENTONITE SEALING COMPOUND

A. Bentonite sealing compound in powder or granular form shall be same product used in manufacture of GCL materials.

B. Sealing compound shall be applied to seal around penetrations and structures shown on Drawings. Use manufacturer's recommended minimum amount of sealing compound to use in each instance in order to affect adequate seal.

C. The sealing compound shall be furnished by the manufacturer of the GCL product furnished for Project.

2.05 REPAIR ADHESIVE

A. Repair adhesive for securing GCL patches shall be nontoxic adhesive as recommended by GCL manufacturer.

2.06 SOURCE QUALITY CONTROL

A. Perform tests in accordance with ASTM D5889, unless otherwise specified herein.

B. Factory test for specified physical material properties per manufacturer's QC Plan, and those listed in table under Article Geosynthetic Clay Lining. Tests shall be representative of materials used on Project.

PART 3 EXECUTION

3.01 GENERAL

A. Conform to ASTM D5889 and the following requirements:

1. Inspect GCL materials delivered to Site for damage. Inventory by quantity, lot number, panel size, and weight. Provide copy of inventory to Engineer.
2. Store GCL in a dry, protected area or building on pallets off the ground and covered with a heavy, water-proof membrane which allows free flow of air between membrane and the product.
3. Remove only quantity of material from storage that is to be installed during current work day.

3.02 SUBGRADE PREPARATION

A. Surface on which GCL is to be installed shall be prepared in accordance with Section 31 00 00, Earthwork and as indicated on Drawings.

B. Maintain surface on which GCL is to be placed in firm, clean, dry, and smooth condition during GCL installation.

3.03 GCL TEST PANEL

A. The purpose of the GCL Test Panel is to monitor the amount of hydration that is occurring in the GCL without the confining pressure of the overlying drain sand. This will set the maximum time the Contractor has before overlying material layers needs to be placed after deployment of the GCL and overlying HDPE geomembrane liner (see below for maximum permitted GCL moisture content).

B. Build a test panel near the area on subgrade that matches the foundation layer soil conditions of the Project. The test pad shall be no smaller than 5 feet by 5 feet (25 square feet). Coordinate with Engineer for locating the test pad.

Test pad shall be installed before or at the same time as the first fall production GCL panel is installed.

C. Monitor the test panel daily for visual signs of hydration. If hydration is observed, test the panel by collecting samples and sending to an approved laboratory for testing. Testing shall be done by measuring the change in weight from the virgin GCL material. The manufacturer's quality control (MQC) published testing results will provide the mass per unit weight and amount of hydration of the virgin GCL material. Test laboratory shall sample and confirm this for comparisons. The amount of hydration (by weight) shall not exceed 50 percent for the deployed GCL panels before the full thickness of the drainage sand layer is placed over the liner.

3.04 PLACEMENT OF GEOSYNTHETIC CLAY LINING

A. Only those GCL panels that can be anchored and covered in the same day shall be unwrapped and placed in position.

B. Place GCL surface on underlying soil with surface of GCL in contact with soil as recommended by manufacturer.

C. GCL panels shall not be dragged over surface, except for slight adjustments as may be necessary for obtaining correct overlap of panels. Rolled-up panels shall not be allowed to unroll unrestrained down slope.

D. Anchorage for GCL (anchor trench, runout area, etc.) shall be prepared as shown on Drawings before installation of GCL begins.

E. Panels shall be placed to provide overlap of 6 inches to 9 inches on longitudinal seams and 24 inches on transverse seams. No lap seams parallel to slope shall be allowed on slopes steeper than 7H:1V, unless otherwise approved by Engineer. Such approval will be dependent upon demonstration by Installer that sufficient additional overlap will be provided to anchor GCL and prevent it from moving downslope during and after placement of overlying materials.

F. GCL panels shall not be installed in standing water, while it is raining, or when rain may begin before panels can be covered with geomembrane or temporary plastic cover and protected. GCL shall be "dry" when installed and "dry" when geomembrane is installed over it.

G. GCL shall be laid smooth without creases or wrinkles and without stretching material to fit area. GCL shall be free of tension or stress upon completion of installation.

H. Cover GCL with required geomembrane cover as soon as practicable after it is installed. Exposed GCL is to be completely covered and protected by soil, geomembrane, or other approved cover material at end of each shift or workday. Installer shall limit amount of exposed GCL to the amount which can be immediately covered in event of rain.

I. Leading edge and panels of GCL left uncovered shall be protected with heavy, waterproof membrane or tarp that is adequately secured and protected with sandbags or other ballast.

3.05 SEAMING GCL PANELS

A. Mark overlaps 6 inches and 9 inches from panel edge longitudinally on GCL to assist in obtaining proper overlap.

B. Prior to lapping, remove dirt, gravel, or other debris from overlap area. Apply 1/4 pound of sealing compound per lineal foot of seam, or as otherwise recommended by manufacturer, whichever represents greatest amount of bentonite. Where soil and sand encroaches lap areas after initial application of bentonite sealant, additional bentonite sealant in amount of 1/4 pound per lineal foot evenly shall be spread across longitudinal seam area.

C. Alternative seaming methods may be used upon successful demonstration to Engineer that alternative method will result in a seam equivalent to seam specified above. Installer shall strictly adhere to manufacturer's recommendations and conditions of approval for these alternative seams.

D. Seam overlap on slopes shall be shingled so direction of flow is from top panel onto bottom panel. Overlaps shall be as hereinbefore specified.

E. Hot Weather Installation:

1. Provide compensation for shrinkage when ambient temperatures are greater than 85 degrees F. At minimum, longitudinal overlap should be increased to 12 inches and transverse overlap should be increased to 36 inches.
2. Dimensions to use for overlapping during temperatures greater than 85 degrees F shall be approved by Engineer.

3.06 PATCHING AND REPAIRS

A. Irregular shapes, cuts, or tears in GCL shall be overlapped minimum of 12 inches in all directions from defect with additional layer of GCL material.

B. Patch seams parallel to slope and secure with repair adhesive recommended by manufacturer.

C. Patches and repairs shall not be allowed on slopes greater than 7H:1V.

D. Complete panels shall be removed and replaced with undamaged panels when damage is extensive as determined by Engineer.

3.07 PROTECTION

A. Installer shall have sole responsibility for protection of the GCL. Any damage to the GCL shall be repaired at Contractor's expense.

B. Installer shall ensure that moisture and surface water runoff collected on completed sections of the HDPE geomembrane liner or draining from other areas does not drain or seep under the HDPE geomembrane liner and expose the GCL to moisture at any time. Any GCL exposed to moisture, as determined by Engineer, either covered with HDPE or not, shall be removed and replaced at Contractor's expense.

C. Any leading edge of panels of GCL left uncovered shall be protected with a heavy, waterproof membrane or tarp that is adequately secured and protected with sandbags or other ballast against uplift from wind and saturation/ hydration. Installer shall protect exposed GCL to the satisfaction of Engineer at all times during execution of the Work.

3.08 PLACEMENT OF OVERLYING MATERIALS

A. Equipment shall not operate directly on GCL, except to minimum extent necessary to deploy specified geosynthetic materials on GCL. Deploy geosynthetic materials with equipment and by methods approved by Engineer.

B. Soil, sand, and aggregate over geosynthetic material shall be install in accordance with cover installation requirements in Section 33 47 13.01, Pond and Reservoir Liners—HDPE.

C. Backfill material shall be placed over the GCL and HDPE geomembrane as specified in Section 31 00 00, Earthwork, and Section 33 47 13.01, Pond and Reservoir Liners—HDPE. Backfill material shall be placed over the completed portions of the geomembrane/GCL cover within 10 calendar days of GCL installation. Engineer reserves the right to shorten this time period if premature hydration of the GCL appears to be occurring. Additionally, this time period may be extended if the test results from the test panel indicate that the GCL is not hydrating above 50 percent during this 10-day period.

3.09 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this Specification:

1. GCL Installer's Certification of Subsurface Acceptability.

END OF SECTION

**GCL INSTALLER'S CERTIFICATION
OF
SUBSURFACE ACCEPTABILITY**

GCL installer, _____
for Kaiser Mead Groundwater Remediation Interim Action hereby certify that supporting surfaces are acceptable for installation of geomembrane, undersigned having personally inspected condition of constructed surfaces. This certification is for areas shown on Attachment or defined as follows:

_____

_____

_____

_____

Condition of supporting surfaces in defined area meets or exceeds minimum requirements for installation of geomembrane.

Signed: _____
(Representative of Geomembrane Installer)

_____
(Position)

Date: _____

Witness: _____

SECTION 40 27 00
PROCESS PIPING—GENERAL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. Air Force: A-A-58092, Tape, Antiseize, Polytetrafluorethylene.
2. American Society of Mechanical Engineers (ASME):
   a. B1.20.1, Pipe Threads, General Purpose (Inch).
   b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
   c. B16.3, Malleable Iron Threaded Fittings Classes 150 and 300.
   d. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
   e. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   f. B31.3, Process Piping.
3. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   d. A276, Standard Specification for Stainless Steel Bars and Shapes.
   e. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   f. A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
   g. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
   h. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
   i. D413, Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.

j. D543, Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
k. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
l. D1330, Standard Specification for Rubber Sheet Gaskets.
m. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
n. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
o. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
p. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
q. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
r. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
s. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
t. D4894, Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials.
u. D4895, Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion.
v. F436, Standard Specification for Hardened Steel Washers.
w. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
x. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

4. FM Global (FM).
5. National Electrical Manufacturers Association (NEMA): LI 1, Industrial Laminating Thermosetting Products.

1.02 DEFINITIONS

A. Submerged or Wetted:

1. Zone below elevation of:
   a. Liquid surface or within 2 feet above top of liquid surface.
   b. Top of tank wall or under tank/wet well cover.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Fabricated Piping:
   a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
   b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
2. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer's Certification of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
   a. Pipe and fittings.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Flanged Pipe and Fittings: Manufacturer's product data sheets for gaskets including torqueing requirements and bolt tightening procedures.
4. Test logs.
5. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Independent Inspection and Testing Agency:
   a. Ten years' experience in field of welding and welded pipe and fittings' testing required for this Project.
   b. Calibrated instruments and equipment, and documented standard procedures for performing specified testing.
   c. Certified in accordance with ASNT SNT-TC-1A for testing procedures required for this Project.
   d. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.
   e. Verification Welding Inspector: AWS QC1 Certified.
2. Welding Procedures: In accordance with ASME BPVC SEC IX (Forms QW-482 and QW-483) or AWS D1.1/D1.1M (Annex N Forms).

3. Welder Qualifications: In accordance ASME BPVC SEC IX (Form QW-484) or AWS D1.1/D1.1M (Annex N Forms).

1.05 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
3. Linings and Coatings: Prevent excessive drying.
4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.01 PIPING

A. As specified on Drawings.

B. Diameters Shown:

1. Standardized Products: Nominal size.

2.02 JOINTS

A. Flanged Joints:

1. Flat-faced, carbon steel, or alloy flanges when mating with flat-faced cast or ductile iron flanges.

B. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.

C. Mechanical connections of high-density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through-flanged connections consisting of the following:

1. Polyethylene stub end thermally butt-fused to end of pipe.
2. ASTM A240/A240M, Type 304 stainless steel backing flange, 125-pound, ASME B16.1 standard. Use insulating flanges where shown.
3. Bolts and nuts of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer’s standard. Retorque nuts after 4 hours.

4. Gaskets as specified on Data Sheet.

2.03 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe manufacturer and no substitute or "or-equal" will be allowed.

2.04 VENT AND DRAIN VALVES

A. Pipeline 2-Inch Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.

B. Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.

B. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

3.02 INSTALLATION—GENERAL

A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
6. Flange fillers are to be avoided, but if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.

7. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.
8. Manufacturer: Same as pipe manufacturer.

D. PVC and CPVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
3. Do not thread Schedule 40 pipe.

E. High-Density Polyethylene Piping:

1. Join pipes, fittings, and flange connections by means of thermal butt-fusion.
2. Perform butt-fusion in accordance with pipe manufacturer's recommendations as to equipment and technique.
3. Special Precautions at Flanges: Polyethylene pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

3.03 INSTALLATION—EXPOSED PIPING

A. Piping Runs:

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: Where shown on Drawings and as necessary.

C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

F. Piping clearance, unless otherwise shown:

1. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
2. From Adjacent Work: Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
3. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
4. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.04 INSTALLATION—BURIED PIPE

A. Placement:

1. Keep trench dry until pipe laying and joining are completed.
2. Pipe Base and Pipe Zone: As specified in Section 31 00 00, Earthwork.
3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
4. Measure for grade at pipe invert, not at top of pipe.
5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.
7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day’s work.
8. Lay pipe upgrade with bell ends pointing in direction of laying.
9. After joint has been made, check pipe alignment and grade.
10. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
11. Prevent uplift and floating of pipe prior to backfilling.

B. PVC or HDPE Pipe Placement:

1. Lay pipe snaking from one side of trench to other.
2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
3. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

C. Tolerances:

1. Deflection from Horizontal Line, Except PVC, CPVC, or HDPE: Maximum 2 inches.
2. Deflection from Vertical Grade: Maximum 1/4 inch.
3. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.05 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Application and Installation: As shown on Drawings.

3.06 VENTS AND DRAINS

A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines at all low and high point locations.

3.07 PIPE IDENTIFICATION

A. Label all exposed piping with process stream identifier and directional arrow.

3.08 FIELD QUALITY CONTROL

A. Pressure Leakage Testing:

1. As specified herein:
   a. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.
   b. Pressure Piping:
      1) Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
      2) Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

3.09 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.

3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure continuously for 30 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.
7. Empty pipe of water prior to final cleaning or disinfection.

C. Buried Piping:

1. Test after backfilling has been completed.
2. Expel air from piping system during filling.
3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
6. Maximum Allowable Leakage:

$$L = \frac{SD(P)^{1/2}}{148{,}000}$$

where:

L = Allowable leakage, in gallons per hour.
S = Length of pipe tested, in feet.
D = Nominal diameter of pipe, in inches.
P = Test pressure during leakage test, in pounds per square inch.

7. Correct leakage greater than allowable, and retest as specified.

3.10 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallon(s) per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Gravity Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping.

D. Exfiltration Test:

1. Hydrostatic Head:
   a. At least 6 feet above maximum estimated groundwater level in section being tested.
   b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

E. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

F. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

G. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.11 CLEANING

A. Following assembly and testing, and prior to final acceptance, flush pipelines, except as stated below, with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

C. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

END OF SECTION

SECTION 40 90 00
INSTRUMENTATION AND CONTROL
FOR PROCESS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for Process Instrumentation and Control (PIC). The following PIC subsections expand on requirements of this section:

1. Section 40 91 00, Instrumentation and Control Components.

B. Major Work Items: Includes but is not limited to engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and training for complete PIC.

1. Process instrumentation including primary elements, transmitters, control devices, and control panels.
2. Programmable controllers.
3. Computers and networks for Human Machine Interface (HMI).
4. Applications Software:
    a. Provided by Engineer for PLCs, and HMI. Work related to supporting this activity includes:
        1) Early delivery of programming equipment to Engineer's office.
        2) Setup and demonstration testing of programming equipment at Engineer's office.
        3) Delivery of PLCs and HMI equipment to Jacobs Bellevue Office.
        4) Demonstration testing at Jacobs Bellevue Office.
        5) Retrieval of programming equipment from Jacobs Bellevue Office.
        6) Assistance with onsite checkout of applications software.
        7) For additional related requirements refer to:
            a) Article Sequencing and Scheduling in this section.
            b) Sections that cover the equipment for which Engineer will provide applications software.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section and other PIC subsections:

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
   c. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   d. B32, Standard Specification for Solder Metal.
   e. B88, Standard Specification for Seamless Copper Water Tube.
3. Deutsche Industrie-Norm (DIN): VDE 0611, Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.
4. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
5. International Conference on Energy Conversion and Application (ICECA).
6. International Society of Automation (ISA):
   a. RP12.06.01, Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety.
   b. S5.1, Instrumentation Symbols and Identification.
   c. S5.4, Instrument Loop Diagrams.
   d. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
   e. TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.
7. National Electrical Code (NEC).
8. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ICS 1, Industrial Control and Systems General Requirements.
9. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
10. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.

b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

11. UL: 508A, Standard for Safety, Industrial Control Panels.

1.03 DEFINITIONS

A. Abbreviations:

1. DCU: Distributed Control Unit.
2. FDT: Factory Demonstration Test.
3. HMI: Human-Machine Interface.
4. HVAC: Heating, Ventilating, and Air Conditioning.
5. I&C: Instrumentation and Control.
6. I/O: Input and Output.
7. O&M: Operation and Maintenance.
8. P&ID: Process and Instrument Diagram.
9. PC: Personal Computer.
10. PIC: Process Instrumentation and Control.
11. PLC: Programmable Logic Controller.
12. RTU: Remote Terminal Unit.
13. SCADA: Supervisory Control and Data Acquisition.
14. SLDC: Single Loop Digital Controller.
15. SSDT: Staging Site Demonstration Test.

B. Enclosure: Control panel, console, cabinet, or instrument housing.

C. Instructor Day: Eight hours of actual instruction time.

D. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, supervisory control, and data acquisition (SCADA) software.

1. System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, programming languages (C, C++, Visual C++, BASIC, Visual Basic, etc.); Office Suites (word processor, spreadsheet, database, etc.); e-mail; security (firewall, antivirus; spam, spyware, etc.) debugging aids; and diagnostics.
2. SCADA Software: Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing configuring and run-time capability for, data acquisition (I/O driver, OPC servers, etc.), monitoring, alarming, human-machine

interface, supervisory control, data collection, data retrieval, trending, report generation, control, and diagnostics.

3. Controller Programming Software: Software packages for the configuring of PLCs, RTUs, DCUs, SLDC, and fieldbus devices.

E. Application Software:

1. Software to provide functions unique to this Project and that are not provided by standard software alone, including but not limited to:
   a. Configuring databases, tables, displays, historians, reports, parameter lists, ladder logic, function block, and control strategies required to implement functions unique to this Project.
   b. Programming in any programming or scripting language.

F. Rising/Falling: Define action of discrete devices about their setpoint.

1. Rising: Contacts close when an increasing process variable rises through setpoint.
2. Falling: Contacts close when a decreasing process variable falls through setpoint.

G. Signal Types:

1. Analog Signal, Current Type:
   a. 4 mA dc to 20 mA dc signals conforming to ISA S50.1.
   b. Unless otherwise indicated for specific PIC subsection components, use the following ISA S50.1 options.
      1) Transmitter Type: Number 2, two-wire.
      2) Transmitter Load Resistance Capacity: Class L.
      3) Fully isolated transmitters and receivers.
2. Analog Signal, Voltage Type: 1V dc to 5V dc within panel where common high precision dropping resistor is used.
3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
4. Pulse Frequency Signals:
   a. Direct-current pulses whose repetition rate is linearly proportional to process variable.
   b. Pulses generated by contact closures or solid state switches.
   c. Power source less than 30V dc.
5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

1. Complete detailed design of PIC components and PIC drawings.
2. Provide consistent hardware and software functions for PIC. For example, provide functions in control logic, sequence controls, and display layouts in same or similar manner.
3. PIC design as shown and specified includes:
   a. Functional requirements, performance requirements, and component specifications.
   b. P&IDs, block diagrams, and network diagrams.

B. Use a qualified PIC System Integrator for at least the following work:

1. For PIC Equipment and Ancillaries:
   a. Completing detail design.
   b. Submittals.
   c. Equipment, enclosures, and ancillaries.
   d. Instructions, details, and recommendations to, and coordination with Contractor for Certificate of Proper Installation.
   e. Verify readiness for operation.
   f. Verify correctness of final power and signal connections (lugging and connecting).
   g. Adjusting and calibrating.
   h. Starting up.
   i. Testing and coordination of testing.
   j. Training.
   k. Assist Engineer with Functional Test Part 2 as defined in Article Field Quality Control.
2. Verify following Work not by PIC System Integrator is provided:
   a. Correct type, size, and number of signal wires with their raceways.
   b. Correct electrical power circuits and raceways.
   c. Correct size, type, and number of PIC-related pipes, valves, fittings, and tubes.
   d. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.
3. NonPIC Equipment Directly Connected to PIC Equipment:
   a. Obtain from Contractor, manufacturers' information on installation, interface, function, and adjustment.
   b. Coordinate with Contractor to allow required interface and operation with PIC.

c. For operation and control, verify installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer's recommendations.
d. Test to demonstrate required interface and operation with PIC.
e. Examples of items in this category, but not limited to the following:
    1) Valve operators, position switches, and controls.
    2) Chemical feed pump and feeder speed/stroke controls.
    3) Automatic samplers.
    4) Motor control centers.
    5) Adjustable speed and adjustable frequency drive systems.
f. Examples of items not in this category:
    1) Internal portions of equipment provided under Division 26, Electrical, that are not directly connected to PIC equipment.
    2) Internal portions of package system instrumentation and controls that are not directly connected to PIC equipment.

1.05 SUBMITTALS

A. General:

1. Submit proposed Submittal breakdown consisting of sequencing and packaging of information in accordance with Project Schedule.
2. Partial Submittals not in accordance with Project Schedule will not be accepted.
3. Submittal Format:
    a. Hard Copy: Required for all submittals.
    b. Electronic Copies: Required, unless otherwise noted for specific items.
        1) Manufacturers' Standard Documents: Adobe Acrobat PDF.
        2) Documents created specifically for Project:
            a) Text and Graphics: Microsoft Word.
            b) Lists: Microsoft Excel, unless otherwise noted for specific items.
            c) Drawings: AutoCAD.
4. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
5. Legends and Abbreviation Lists:
    a. Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.

b. Use identical abbreviations in PIC subsections.
c. Submit updated versions as they occur.

6. Activity Completion:
   a. Action Submittals: Completed when reviewed and approved.
   b. Informational Submittals: Completed when reviewed and found to meet conditions of the Contract.

B. Action Submittals:

1. Bill of Materials: List of required equipment.
   a. Group equipment items by enclosure and field, and within an enclosure, as follows:
      1) PIC Components: By component identification code.
      2) Other Equipment: By equipment type.
   b. Data Included:
      1) Equipment tag number.
      2) Description.
      3) Manufacturer, complete model number and all options not defined by model number.
      4) Quantity supplied.
      5) Component identification code where applicable.
      6) For panels, include panel reference number and name plate inscription.
   c. Formats: Hard copy and Microsoft Excel.
2. Catalog Cuts:
   a. I&C components, electrical devices, and mechanical devices:
      1) Catalog information, marked to identify proposed items and options.
      2) Descriptive literature.
      3) External power and signal connections.
      4) Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
3. Instrument List:
   a. Engineer will provide an initial Instrument List in Microsoft Excel. Data from this may be used as starting point for creating final Instrument List and Component Data Sheets.

b. Applicable fields to be completed include, but are not limited to:

Instrument List Characteristics	
Item	**Initially Completed By**
Tag Number	Engineer
Loop Number	Engineer
Description	Engineer
Manufacturer and complete model number	Contractor
Size and scale range	Engineer
Setpoints	Engineer
Reference P&IDs, Electrical, Mechanical	Engineer
Instrument detail number	Engineer

c. Submit updated version of Instrument List.
d. Electronic Copies: Microsoft Excel.

4. Component Data Sheets: Data sheets for I&C components.
   a. Format:
      1) Similar to ISA TR20.00.01.
      2) Microsoft Excel, one component per data sheet.
      3) Submit proposed format for Component Data Sheets before completing data sheets for individual components.
   b. Content:
      1) Specific features and configuration data for each component, including but not limited to:
         a) Tag Number.
         b) Component type identification code and description.
         c) Location or service.
         d) Service conditions.
         e) Manufacturer and complete model number.
         f) Size and scale range.
         g) Setpoints.
         h) Materials of construction.
         i) Options included.
         j) Power requirements.

k) Signal interfaces.
l) Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.

c. Electronic Copies: Microsoft Excel.

5. Sizing and Selection Calculations:
   a. Primary Elements:
      1) Complete calculations plus process data used. Example for Flow Elements:
         a) Minimum and maximum values, permanent head loss, and assumptions made.
   b. Controller, Computing, and Function Generating Modules: Actual scaling factors with units and how they were computed.
   c. Electronic Copies: Microsoft Excel, one file for each group of components with identical sizing calculations.
6. Preliminary Panel Elevation Drawings:
   a. Provide prior to submitting Panel Construction Drawings:
      1) Scale Drawings: Show dimensions and location of front of panel devices.
      2) Panel Legend (Bill of Material): List front of panel devices by tag number. Include nameplate inscriptions, service legends, and annunciator inscriptions.
   b. Submit electronic copies of Drawings.
7. Panel Construction Drawings:
   a. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, louvers, subpanels, internal and external.
   b. Panel Legend (Bill of Material): List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
   c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
   d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
   e. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.
   f. Submit electronic copies of Drawings.
8. Detailed Wiring Diagrams:
   a. Refer to Drawings for Detailed Wiring Diagrams including:
      1) Panel Wiring Diagrams for discrete control and power circuits.

2) Loop Wiring Diagrams showing individual wiring diagram for each analog or pulse frequency loop.
3) Interconnecting Wiring Diagrams showing electrical connections between equipment, consoles, panels, terminal junction boxes, and field-mounted components.

b. Prepare as-built redline markup of detailed wiring diagrams. Show terminal numbers on switch blocks, relays, and internal components.
c. Submit electronic copies of Drawings.

9. Panel Wiring Diagrams:
a. Cover wiring within a panel including, but not limited to, instrumentation, control, power, and communications, and digital networks.
b. Objectives: For use in wiring panels, making panel connections, and future panel trouble shooting.
c. Diagram Type:
1) Ladder Diagrams: Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.
2) Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.
d. Item Identification: Identify each item with attributes listed.
1) Wires: Wire number and color. Cable number if part of multiconductor cable.
2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
3) Components:
a) Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).
b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).
4) I/O Points: PLC, unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.
5) Relay Coils:
a) Tag number and its function.
b) On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
6) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).

7) Communications and Networks: Network type, address or node identification, port or channel number, and type of connector.

e. Show each circuit individually. No “typical” diagrams or “typical” wire lists will be allowed.

f. Ground wires, surge protectors, and connections.

g. Wire and Cable Names: Show names and wire color corresponding to Circuit and Raceway Schedule for circuits entering and leaving a panel. Refer to Division 26, Electrical.

10. Loop Wiring Diagrams: Individual, end-to-end wiring diagram for each analog and discrete or equipment loop.

a. Conform to the minimum requirements of ISA S5.4.

b. Under Paragraph 5.3 of ISA S5.4, include the information listed under Subparagraphs 2 and 6.

c. Show loop components within a panel and identify each component, component terminals, and panel terminals.

d. If a loop connects to panels or devices not provided under this section and its subsections, such as control valves, motor control centers, package system panels, variable speed drives, include the following information:

1) Show the first component connected to within the panel or device that is not provided under this section and its subsections.

2) Identify the component by tag and description.

3) Identify panel and component terminal numbers.

e. Drawing Size: Individual 11-inch by 17-inch sheet for each loop.

f. Divide each loop diagram into areas for panel face, back-of-panel, field and PLC.

g. One Drawing Per Loop: Show each loop individually. No “typical” loop diagrams will be allowed.

h. Show:

1) Terminal numbers, location of dc power supply, and location of common dropping resistors.

2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.

3) Tabular summary on each analog loop diagram:

a) Transmitting Instruments: Output capability.

b) Receiving Instruments: Input impedance.

c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.

d) Total loop impedance.

e) Reserve output capacity.

4) Circuit and raceway schedule names.

11. Communications and Digital Networks Diagrams:
    a. Scope: Includes connections to telephone system, Ethernet network, remote I/O, and fieldbus (for example, Modbus, Profibus, Foundation Fieldbus, Device Net, etc.).
    b. Format: Network schematic diagrams for each different type of network.
    c. Show:
        1) Interconnected devices, both passive and active.
        2) Device names and numbers.
        3) Terminal numbers.
        4) Communication Media: Type of cable.
        5) Connection Type: Type of connector.
        6) Node and device address numbers.
        7) Wire and cable numbers and colors.
12. Panel Power Requirements and Heat Dissipation:
    a. For control panels tabulate and summarize:
        1) Required voltages, currents, and phases(s).
        2) Maximum heat dissipations Btu per hour.
        3) Calculations.
        4) Steady State Temperature Calculations: For nonventilated panels, provide heat load calculations showing the panel estimated internal steady state temperature for ambient air temperatures of 100 degrees F.
13. Panel Plumbing Diagrams:
    a. For each panel containing piping and tubing. Show type and size for:
        1) Pipes and Tubes: Thickness, pressure rating, and materials.
        2) Components: Valves, regulators, and filters.
        3) Connections to panel-mounted devices.
        4) Panel interface connections.
        5) Submit electronic copies of Drawings.
14. Installation Details: Include modifications or further details required and define installation of I&C components.
15. Spares, expendables, and test equipment.
16. Electronic Copies: Microsoft Excel.
17. PLC I/O List: Submit I/O assignment and Rack/Slot/Point.
18. Shop Drawings for Changes Impacting PLC and SLDC Programming:
    a. Submit details of changes required to PLC and SLDC monitoring and control resulting from installation of alternative or upgraded process equipment and instrumentation, and other causes.
    b. Submit changes at 30-day intervals.
19. Color schedule for control panels.

20. Applications Software Documentation:
    a. For equipment for which Engineer does not provide applications software provide:
        1) Complete configuration documentation for microprocessor based programmable devices.
        2) For each device, include program listings and function block diagrams, as appropriate, showing:
            a) Functional blocks or modules used.
            b) Configuration, calibration, and tuning parameters.
            c) Descriptive annotations.
        3) Refer to PIC subsections for additional requirements.

C. Informational Submittals:

1. Statements of Qualification:
    a. PIC System Integrator.
    b. PIC System Integrator's site representative.
    c. Resume for each PIC System Integrator's onsite startup and testing team member (engineers, technicians, and software/ configuring personnel).
2. Operation and Maintenance Data:
    a. In accordance with Section 01 78 23, Operation and Maintenance Data, and in addition the following:
        1) General:
            a) Provide sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for PIC components.
            b) Submittal Format: Both hard copy and electronic copies for all submittals. Refer to Article Submittals, heading Submittal Format.
        2) Final versions of Legend and Abbreviation Lists.
        3) Process and Instrumentation Diagrams: Marked up copy of revised P&ID to reflect as-built PIC design.
        4) Provide the following items as defined under heading Action Submittals:
            a) Bill of materials.
            b) Catalog cuts.
            c) Instrument list.
            d) Component data sheets.
            e) Detailed Wiring Diagrams: As-built drawings.
                (1) Panel wiring diagrams.
                (2) Loop diagrams.
                (3) Interconnecting wiring diagrams.

f) Panel plumbing diagrams.
g) Applications software documentation.

5) Manufacturer's O&M manuals for components, electrical devices, and mechanical devices:
   a) Content for Each O&M Manual:
      (1) Table of Contents.
      (2) Operations procedures.
      (3) Installation requirements and procedures.
      (4) Maintenance requirements and procedures.
      (5) Troubleshooting procedures.
      (6) Calibration procedures.
      (7) Internal schematic and wiring diagrams.
      (8) Component and I/O Module Calibration Sheets from field quality control calibrations.
   b) Provide PDF file will link index to all manuals.
6) List of spares, expendables, test equipment and tools provided.
7) List of additional recommended spares, expendables, test equipment, and tools. Include quantities, unit prices, and total costs.

3. Provide Manufacturer's Certificate of Proper Installation where specified.
4. Testing Related Submittals:
   a. Factory Demonstration Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures:
         a) Proposed test procedures, forms, and checklists.
         b) Capacity, Timing, and Simulation: Describe simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements.
      3) Test Documentation: Copy of signed off test results.
   b. Staging Site Demonstration Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures: Proposed test procedures, forms, and checklists.
      3) Test Documentation: Copy of signed-off test results when tests are completed.
   c. Functional Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.

2) Final Test Procedures: Proposed test procedures, forms, and checklists.
3) Test Documentation:
a) Copy of signed-off test results.
b) Completed component calibration sheets.

d. Performance Test: Site Acceptance Testing documentation provided by Engineer. Filled out and signed-off test forms jointly completed by Engineer and Contractor during commissioning phases.

5. Owner Training Plan: In accordance with Section 01 43 33, Manufacturers' Field Services.
6. Maintenance Service Agreement: Prior to Substantial Completion, submit service agreements signed by Owner and maintenance provider for work required under Article Maintenance Service.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. PIC System Integrator: Minimum of 5 years' experience providing, integrating, installing, and starting up similar systems as required for this Project.
2. PIC System Integrator's Site Representative: Minimum of 5 years' experience installing systems similar to PIC required for this Project.

B. PIC Coordination Meetings:

1. General: Refer to Section 01 31 19, Project Meetings, for PIC coordination meetings.
2. PIC Schedule Coordination Meeting:
a. Timing: Following Engineer review of PIC Schedule.
b. Purpose: Discuss Engineer's comments and resolve scheduling issues.
3. Training Coordination Meeting:
a. Timing: Following Engineer review of preliminary training plan.
b. Purpose:
1) Resolve required changes to proposed training plan.
2) Identify specific Owner personnel to attend training.

1.07 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements.

B. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.

C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

D. Cover panels and other elements that are exposed to dusty construction environments.

1.08 SEQUENCING AND SCHEDULING

A. Refer to Section 01 31 13, Project Coordination, for Contractor's scheduling requirements for applications software testing.

B. Prerequisite Activities and Lead Times: Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied.

1. Shop Drawing Reviews by Engineer:
    a. Prerequisite: Engineer acceptance of Schedule of Values and Progress Schedule.
    b. Schedule: In accordance with completed schedule of Shop Drawing and Sample submittals specified in Section 01 33 00, Submittal Procedures.
2. Test Prerequisite: Associated test procedures Submittals completed.
3. Training Prerequisite: Associated training plan Submittal completed.
4. PLC and HMI Configuring Equipment Delivered to Engineer's Office:
    a. Refer to PIC subsections for a definition of this equipment.
    b. Prerequisite: PLC and HMI Configuration Training Session 1 completed.
5. PLC and HMI Configuring Equipment Demonstration Test Prerequisite: PLC and HMI configuring equipment delivered and installed at Engineer's office.
6. PLC and HMI Applications Software Configuring by Engineer at Engineer's Office.
    a. Prerequisite: PLC and HMI configuring equipment demonstration test.

7. Equipment Delivered to Staging Site: Refer to PIC subsections for a definition of this equipment.
    a. Prerequisites:
        1) PLC and HMI applications software configuring by Engineer at Engineer's office completed.
        2) FDT completed.
8. Staging Site Demonstration Test Prerequisite: PLC and HMI staging equipment delivered to staging site.
9. PLC and HMI Applications Software Configuring and Testing by Engineer:
    a. Prerequisite: Staging site demonstration test completed.
    b. Duration: One week.
10. PLC and HMI Shipment to Site:
    a. General Prerequisites:
        1) Approval of PIC Shop Drawings and preliminary operation and maintenance data.
        2) FDT and SSDT completed.
    b. Additional prerequisite for equipment previously shipped to Engineer's office and staging site: Completion of PLC and HMI application software configuring and testing by Engineer at Staging Site.
11. PLC and HMI Installation Prerequisite: Equipment received at Site.
12. Functional Test Part 1 Prerequisite: PLC and HMI installation complete.
13. Functional Test Part 2 Prerequisite: Functional Test Part 1 completed.
14. Performance Test Prerequisite: Functional Test Part 2 completed, and facility started up.

1.09 MAINTENANCE

A. Maintenance Service Agreement:

1. Duration of 1 year, unless otherwise noted in PIC subsections.
2. Start on date of Substantial Completion.
3. Performed by factory-trained service engineers with experience on PIC systems to be maintained.
4. PIC Systems Covered: PIC components, PLC, HMI, except for Engineer provided applications software.
5. Materials and labor for preventive maintenance and annual PM site visits.
6. Materials and labor for demand maintenance with coverage 8:00 a.m. to 5:00 p.m. Monday through Friday.
7. Response Time: Service engineer shall be onsite within 48 hours of request by Owner.

8. Spare Parts: If not stocked onsite, delivered to Site within 24 hours from time of request.
9. Repair or replace components or software found to be faulty.
10. Replace and restock within 1 month onsite spare parts and expendables used for maintenance. Provide list of items used and replaced.
11. Submit records of inspection, maintenance, calibration, repair, and replacement within 2 weeks after each Site visit.

B. Telephone Support: As specified in PIC subsections.

1.10 EXTRA MATERIALS

A. As specified in PIC subsections.

B. In computing spare parts quantities based on specified percentages, round up to nearest whole number.

C. Spare Parts:

Description	Percent of Each Type and Size Used	No Less Than
Annunciator light bulbs	20	1
Annunciator window module	10	1
dc power supplies	20	1
Fuses	20	5
Indicating light bulb	20	2
Relays	20	3
Terminal Blocks	10	15
Hand Switches and Lights	10	5
120V ac Isolation Transformers	10	2
Surge Suppressors	10	2

Component (Code)	Quantity	Options
Instrumentation, each type used	1	
PLC Processor	1	
I/O Card, each type used	1	
PLC Power Supply	1	

D. Expendables:

1. For following items provide manufacturer's recommended 2-year supply, unless otherwise noted:
   a. Corrosion-inhibiting vapor capsules.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide PIC functions shown on Drawings and required in PIC subsections for each system and loop. Furnish equipment items required in PIC subsections. Furnish materials, equipment, and software (except for Engineer provided applications software), whether indicated or not, necessary to effect required system and loop performance.

B. First Named Manufacturer: PIC design is based on first named manufacturers of equipment, materials, and software.

1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with the General Conditions, Article 6.05 Substitutes and "Or-Equals".
2. If proposed item requires, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.

C. Like Equipment Items:

1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
2. Implement same or similar functions in same or similar manner. For example control logic, sequence controls, and display layouts.

D. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other

applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 I&C COMPONENTS

A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for I&C components.

B. Components for Each Loop: Major components for each loop are listed in Instrument List referenced in Article Supplements. Furnish equipment that is necessary to achieve required loop performance.

C. Control Panels: Reference Control Panel Schedule in Article Supplements.

2.03 PROGRAMMABLE LOGIC CONTROLLERS

A. Reference PLC Equipment List in Article, Supplements, and PLC components in Section 40 91 00, Instrumentation and Control Components.

2.04 FIELD BUS, NETWORK, AND HMI COMPONENTS

A. Reference PIC subsections.

2.05 SERVICE CONDITIONS

A. Standard Service Conditions:

1. The following defines certain types of environments. PIC subsections refer to these definitions by name to specify the service conditions for individual equipment units. Design equipment for continuous operation in these environments:
   a. Computer Room, Air Conditioned:
      1) Temperature: 60 degrees F to 80 degrees F.
      2) Relative Humidity: 40 percent to 60 percent.
      3) NEC Classification: Nonhazardous.
   b. Inside, Air Conditioned:
      1) Temperature:
         a) Normal: 60 degrees F to 80 degrees F.

b) With Up to 4-Hour HVAC System Interruptions: 40 degrees F to 105 degrees F.

2) Relative Humidity:
   a) Normal: 10 percent (winter) to 70 percent (summer).
   b) With Up to 4-Hour HVAC System Interruption: 10 percent to 100 percent.
3) NEC Classification: Nonhazardous.

c. Inside:
   1) Temperature: 20 degrees F to 104 degrees F.
   2) Relative Humidity: 10 percent to 100 percent.
   3) NEC Classification: Nonhazardous.

d. Inside, Corrosive:
   1) Temperature: 20 degrees F to 104 degrees F.
   2) Relative Humidity: 10 percent to 100 percent.
   3) Corrosive Environment: Per process.
   4) NEC Classification: Nonhazardous.

e. Inside, Hazardous:
   1) Temperature: 20 degrees F to 104 degrees F.
   2) Relative Humidity: 10 percent to 100 percent.
   3) NEC Classification: As shown on Electrical Drawings.

f. Outside:
   1) Temperature: 0 degrees F to 120 degrees F.
   2) Relative Humidity: 10 percent to 100 percent, rain, snow, freezing rain.
   3) NEC Classification: Nonhazardous.

g. Outside, Corrosive:
   1) Temperature: 0 degrees F to 120 degrees F.
   2) Relative Humidity: 0 percent to 100 percent, rain, snow, freezing rain.
   3) Corrosive Environment: Per process.
   4) NEC Classification: Nonhazardous.

h. Outside, Hazardous:
   1) Temperature 0 degrees F to 120 degrees F.
   2) Relative Humidity: 0 percent to 100 percent, rain, snow, freezing rain.
   3) NEC Classification: As shown on Electrical Drawings.

B. Standard Service Conditions for Panels and Consoles:

1. Unless otherwise noted, in Instrument List and Control Panel Schedule located in Article Supplements at End of Section, design equipment for continuous operation in these environments:
   a. Freestanding Panel and Consoles:
      1) Inside, Air Conditioned: NEMA 1.
      2) Inside: NEMA 12.
   b. Smaller Panels and Assemblies (that are not freestanding):
      1) Inside, Air Conditioned: NEMA 12.
      2) All Other Locations: NEMA 4X.
   c. Field Elements: Outside.

C. Special Environmental Requirements: Design following panels for continuous operation in environments listed.

2.06 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on enclosure face.

1. Location and Inscription: Refer to Control Panel Schedule.
2. Materials: Laminated plastic attached to panel with stainless steel screws.
3. Letters: 1/2-inch-high, white on black background, unless otherwise noted.

B. Component Nameplates, Panel Face: Component identification located on panel face under or near component.

1. Location and Inscription: As shown on panel drawing.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

C. Component Nameplates, Back of Panel: Component identification located on or near component inside of enclosure.

1. Inscription: Component tag number.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches.

1. Inscription:
   a. Refer to table under Paragraph Standard Pushbutton Colors and Inscriptions.
   b. Refer to table under Paragraph Standard Light Colors and Inscriptions.
   c. Refer to P&IDs on Drawings.
2. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
3. Letters: Black on gray or white background.

E. Service Legends: Component identification nameplate located on face of component.

1. Inscription: As shown on panel drawing.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

F. Nametags: Component identification for field devices.

1. Inscription: Component tag number.
2. Materials: 16-gauge, Type 304 stainless steel.
3. Letters: 3/16-inch-high, imposed.
4. Mounting: Affix to component with 16-guage or 18-gauge stainless steel wire or stainless steel screws.

2.07 MECHANICAL SYSTEM COMPONENTS

A. Reference Section 40 91 00, Instrumentation and Control Components.

2.08 FUNCTIONAL REQUIREMENTS FOR CONTROL LOOPS

A. Shown on Drawings, in panel control diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on Drawings.

B. Supplemented by Loop Specifications that describe requirements not obvious on P&IDs or panel control diagrams.

C. Supplemented by standard functional requirements in PIC subsections.

2.09 LOOP SPECIFICATIONS

A. See Article Supplements located at End of Section.

B. Organization: By unit process and loop number.

C. Loop Subheadings:

1. Hardwired Special Functions: Clarifies functional performance of loop, including abstract of interlocks for hard wired logic, for example in MCCs and control panels.
2. PLC Special Functions: Specifies nonstandard PLC functions. When required for clarification, additional definition is shown by logic diagrams or sequence diagrams on Drawings.
3. HMI Special Functions: Specifies nonstandard HMI functions.

2.10 ELECTRICAL REQUIREMENTS

A. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.

B. Wiring External to PIC Equipment:

1. Special Control and Communications Cable: Provided by PIC System Integrator as noted in Component Specifications and PIC subsections.
2. Other Wiring and Cable: As specified in Section 26 05 05, Conductors.

C. I&C and electrical components, terminals, wires, and enclosures UL recognized, or UL listed.

D. Wires within Enclosures:

1. ac Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than No. 18 AWG.
2. Analog Signal Circuits:
   a. Type: 600-volt stranded copper, twisted shielded pairs or triad with a 100 percent, aluminum-polyester shield, rated 60 degrees C.
   b. Panels with Circuits Less Than 600 volts: Rated at 600 volts. Belden No. 18 AWG Type 9341, Triad Beldon No. 1121A.
   c. Size: No. 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current carried, but not less than No. 18 AWG.
4. Special Signal Circuits: Use manufacturer’s standard cables.

5. Wire Identification: Numbered and tagged at each termination.
    a. Wire Tags: Machine printed, heat shrink.
    b. Manufacturers:
        1) Brady Perma Sleev.
        2) Tyco Electronics.

E. Terminate and identify wires entering or leaving enclosures as follows:

1. Analog and discrete signal, terminate at numbered terminal blocks.
2. Special signals terminated using manufacturer's standard connectors.
3. Identify wiring in accordance with requirements in Section 26 05 05, Conductors.

F. Terminal Blocks for Enclosures:

1. Quantity:
    a. Accommodate present and spare indicated needs.
    b. Wire spare PLC I/O points to terminal blocks.
    c. One wire per terminal for field wires entering enclosures.
    d. Maximum of two wires per terminal for No. 18 AWG wire for internal enclosure wiring.
    e. Spare Terminals: 20 percent of connected terminals, but not less than 10 per terminal block, unless otherwise shown on Drawings.
2. Terminal Block Types: Reference Section 40 91 00, Instrumentation and Control Components, Article Electrical Components.

G. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground this ground bus at a common signal ground point in accordance with National Electrical Code requirements.
3. Single Point Ground for Each Analog Loop:
    a. Locate signal ground at dc power supply for loop.
    b. Use to ground wire shields for loop.
    c. Group and ground wire shields in following locations:
        1) Control Panels.
4. Ground terminal block rails to ground bus.

H. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.

2. Do not wire in series instruments on different panels, cabinets, or enclosures.

I. Intrinsic Safety System Installation:

1. Comply with NEC Article 504, Intrinsically Safe Systems.
2. Install intrinsically safe circuits in a separate wire way that:
   a. Is separated from nonintrinsically safe circuits as specified by NEC.
   b. Is colored light blue and has message “Intrinsically Safe Circuits Only” on raceway cover every 6 inches.

J. Wiring Interface: Terminate and identify wiring entering or leaving enclosures.

1. Analog and Discrete Signal Wires: Terminate at numbered terminal blocks as shown on the wiring diagrams.
2. Wiring for Special Signals: Terminate communications, digital data, and multiplexed signals using manufacturer’s standard connectors for the device to which the signals terminate.

K. Electrical Transient Protection:

1. General:
   a. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
   b. Surge suppressors are not shown for external analog transmitters. Determine quantity and location, and show on Shop Drawings. Refer to example wiring in installation details on Drawings.
   c. Provide, install, coordinate, and inspect grounding of surge suppressors at:
      1) Connection of ac power to PIC equipment including panels, consoles assembles, and field-mounted analog transmitters and receivers.
      2) At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
2. Surge Suppressor Types: Reference Section 40 91 00, Instrumentation and Control Components, Article Surge Suppressors.

3. Installation and Grounding of Suppressors:
   a. As shown. See Surge Suppressor Installation Details.
   b. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.

2.11 PANEL FABRICATION

A. General:

1. Nominal Panel Dimensions: Refer to Control Panel Schedule in Article Supplements for maximum external dimensions allowed for individual control panels.
2. Panel Component Schedule: Refer to Control Panel Schedule in Article Supplements which provides a list by local control panel of major panel-mounted components for each panel. In case of a conflict between this list and Instrument List, Instrument List takes precedence. In case of a conflict between Panel Component Schedule and P&IDs, P&IDs take precedence.
3. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.
4. Fabricate panels, install instruments and wire, and plumb at PIC System Integrator's facility. No fabrication other than correction of minor defects or minor transit damage permitted onsite.
5. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.
6. Electrical Work: In accordance with the applicable requirements of Division 26, Electrical.

B. Temperature Control:

1. Freestanding Panels:
   a. Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel and on panel.
   b. Ventilated Panels:
      1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel and on panel.
      2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
      3) For panels without backs against wall, furnish louvers on top and bottom of panel back.
      4) Louver Construction: Stamped sheet metal.

5) Ventilation Fans:
a) Furnish where required to provide adequate cooling.
b) Create positive internal pressure within panel.
c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.
6) Air Filters: Washable aluminum, Hoffman Series A-FLT.

c. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation.

2. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel and on panel face.
3. Space Heaters:
a. Thermostatically controlled to maintain internal panel temperatures above dewpoint.
b. Refer to Control Panel Schedule in Article Supplements.

C. Freestanding Panel Construction:

1. Materials:
a. Sheet steel, unless otherwise noted in Control Panel Schedule in Article Supplements.
b. Minimum Thickness: 10-gauge, unless otherwise noted.
2. Panel Front:
a. Fabricated from a single piece of sheet steel, unless otherwise shown on Drawings.
b. No seams or bolt heads visible when viewed from front.
c. Panel Cutouts: Smoothly finished with rounded edges.
d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
3. Internal Framework:
a. Structural steel for instrument support and panel bracing.
b. Permit panel lifting without racking or distortion.
4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
5. Adjacent Panels: Securely bolted together so front faces are parallel.
6. Door:
a. Full height, fully gasketed access door where shown on Drawings.
b. Latch: Three-point, Southco Type 44.
c. Handle: “D” ring, foldable type.
d. Hinges: Full-length, continuous, piano-type, steel hinges with stainless steel pins.

e. Rear Access: Extend no further than 24 inches beyond panel when opened to 90-degree position.
f. Front and Side Access Doors: As shown on Drawings.

D. Nonfreestanding Panel Construction:

1. Based on environmental design requirements and referenced in Article Environmental Requirements, provide the following unless otherwise noted in Control Panel Schedule in Article Supplements:
   a. Panels listed as inside, air conditioned:
      1) Enclosure Type: NEMA 12.
      2) Materials: Steel.
   b. Other Panels:
      1) Enclosure Type: NEMA 4X.
      2) Materials: Type 316 stainless steel.
2. Metal Thickness: 14-gauge, minimum.
3. Doors:
   a. Rubber-gasketed with continuous hinge.
   b. Stainless steel lockable quick-release clamps.
4. Manufacturers:
   a. Hoffman Engineering Co.
   b. Rittal.

E. Breather and Drains:

1. Furnish with NEMA 250, Type 4 and Type 4X panels:
   a. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

F. Control Panel Electrical:

1. Power Distribution within Panels:
   a. Feeder Circuits:
      1) One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.
      2) Make provisions for feeder circuit conduit entry.
      3) Furnish terminal block for termination of wires.
   b. Power Panel: Furnish main circuit breaker and circuit breaker on each individual branch circuit distributed from power panel.
      1) Locate to provide clear view of and access to breakers when door is open.

2) Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker, but not trip main breaker.
   a) Branch Circuit Breakers: 15 amps at 250V ac.
3) Breaker Manufacturers and Products: Refer to Division 26, Electrical.

c. Circuit Wiring:
1) P&IDs and Control Diagrams on Drawings show function only. Use following rules for actual circuit wiring:
   a) Devices on Single Circuit: 20, maximum.
   b) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
   c) Branch Circuit Loading: 12 amperes continuous, maximum.
   d) Panel Lighting and Service Outlets: Put on separate 15-amp, 120V ac branch circuit.
   e) Provide 120V ac plugmold for panel components with line cords.

2. Signal Distribution:
   a. Signal Wiring: Separate analog signal cables from power and control within a panel and cross at right angles where necessary.
   b. Within Panels: 4 mA to 20 mA dc signals may be distributed as 1V dc to 5V dc.
   c. Outside Panels: Isolated 4 mA to 20 mA dc only.
   d. Signal Wiring: Twisted shielded pairs.
   e. RTD and Thermocouple Extension Cable:
      1) Continuous field to panel with no intermediate junction boxes or terminations.
      2) RTDs in motor windings are considered a 600-volt circuit.
      3) Terminate thermocouple extension wire directly to loop instrument.
3. Signal Switching:
   a. Use dry circuit type relays or switches.
   b. No interruption of 4 mA to 20 mA loops during switching.
   c. Switching Transients in Associated Signal Circuit:
      1) 4 mA to 20 mA dc Signals: 0.2 mA, maximum.
      2) 1V dc to 5V dc Signals: 0.05V, maximum.
4. Relay Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.
5. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.

6. Internal Panel Lights for Freestanding Panels:
   a. Type: Switched 100-watt incandescent back-of-panel lights.
   b. Quantity: One light for every 4 feet of panel width.
   c. Mounting: Inside and in the top of back-of-panel area.
   d. Protective metal shield for lights.
7. Service Outlets for Freestanding Panels:
   a. Type: Three-wire, 120-volt, 15-ampere, GFCI GFCI duplex receptacles.
   b. Quantity:
      1) Panels 4 Feet Wide and Smaller: One.
      2) Panels Larger than 4 Feet Wide: One for every 4 feet of panel width, two minimum per panel.
   c. Mounting: Evenly spaced along back-of-panel area.
8. Internal Panel Lights and Service Outlets for Smaller Panels:
   a. Internal Panel Light: Switched 100-watt incandescent light.
   b. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI GFCI duplex receptacle.
   c. Required for panels. Refer to Control Panel Schedule in Article Supplements.
9. Standard Pushbutton Colors and Inscriptions:
   a. Use following unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black

Tag Function	Inscription(s)	Color
EMERGENCY STOP	EMERGENCY STOP	Red

b. Lettering Color:
   1) Black on white and yellow buttons.
   2) White on black, red, and green buttons.

10. Standard Light Colors and Inscriptions:
    a. Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

    b. Lettering Color:
       1) Black on white and amber lenses.
       2) White on red and green lenses.

G. PIC Enclosure Internal Wiring:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
4. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.

5. Connections to Screw Type Terminals:
   a. Locking-fork-tongue lugs.
   b. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
   c. Wires terminated in a crimp lug, maximum of one.
   d. Lugs installed on a screw terminal, maximum of two.
6. Connections to Compression Clamp Type Terminals:
   a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
   b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
7. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
8. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
9. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
11. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.
12. Conductors Carrying Foreign Voltages within a Panel:
    a. Route foreign voltage conductors into panel and land on a circuit blade disconnect type terminal block.
    b. Use wire with pink insulation to identify foreign voltage circuits within panel from terminal block on. Do not use wires with pink insulation for any other purpose.
13. Harness Wiring:
    a. 120V ac: No. 14 AWG, MTW.
    b. 24V dc: No. 16 AWG, MTW where individual conductors are used and Type TC shielded tray cable where shielded wire is used.
14. Panelwork:
    a. No exposed connections.
    b. Allow adjustments to equipment to be made without exposing these terminals.
    c. For power and control wiring operating above 80V ac or dc use covered channels or EMT raceways separate from low voltage signal circuits.
15. Plastic Wire Ducts Color:
    a. 120V ac: White.
    b. 24V dc: Gray.
    c. Communications Cables and Fiber Optic Jumpers: Orange.

16. Provide a communications plastic wire duct for communications cables and fiber optic cables between the communications devices in control panel and communications raceways. Design plastic wire duct design to take into account the minimum bending radius of the communications cable.
17. Make plastic wire ducts the same depth.
18. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.

H. Control Relay Arrangement: Install control relays associated with specific loops in same panel section as corresponding terminal blocks or side panels. Provide 20 percent space for future relays. Locate spare space in same sections as spare terminal blocks.

I. Factory Finishing:

1. Furnish materials and equipment with manufacturer's standard finish system in accordance with Section 09 90 00, Painting and Coating.
2. Use specific color if indicated. Otherwise use manufacturer's standard finish color, or light gray if manufacturer has no standard color.
3. Stainless Steel and Aluminum: Not painted.
4. Nonmetallic Panels: Not painted.
5. Steel Panels:
   a. Sand panel and remove mill scale, rust, grease, and oil.
   b. Fill imperfections and sand smooth.
   c. Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
   d. Sand surfaces lightly between coats.
   e. Dry Film Thickness: 3 mils, minimum.
   f. Color: Manufacturer's standard.

2.12 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsules:

1. Areas Where Required: Refer to Part 3, Article Protection.
2. Manufacturers and Products:
   a. Northern Instruments; Model Zerust VC.
   b. Hoffmann Engineering; Model A-HCI.

2.13 SOURCE QUALITY CONTROL

A. General:

1. Engineer may actively participate in many of the tests.
2. Engineer reserves right to test or retest specified functions.
3. Engineer's decision will be final regarding acceptability and completeness of testing.
4. Procedures, Forms, and Checklists:
   a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
   b. Describe each test item to be performed.
   c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
5. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Contractor.
6. Conducting Tests:
   a. Provide special testing materials and equipment.
   b. Wherever possible, perform tests using actual process variables, equipment, and data.
   c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
   d. Define simulation techniques in test procedures.
   e. Test Format: Cause and effect.
      1) Person conducting test initiates an input (cause).
      2) Specific test requirement is satisfied if correct result (effect), occurs.
   f. For PIC systems for which Engineer provides applications software, provide sufficient temporary software configuring to allow FDT and SSDT testing of these subsystems.

B. Unwitnessed Factory Test:

1. Scope: Inspect and test PIC to ensure it is operational, ready for FDT.
2. Location: PIC System Integrator's facility.
3. Integrated Test:
   a. Interconnect and test PIC, except for primary elements and smaller panels.
   b. Exercise and test functions.
   c. Provide stand-alone testing of smaller panels.
   d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.

C. Factory Demonstration Tests (FDT):

1. Notify Engineer of test schedule 4 weeks prior to start of test.
2. Scope:
   a. Test entire PIC, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
   b. Refer to Control Panel Schedule in Article Supplements for list of panels for which FDT is required.
3. Location: PIC System Integrator's facility.
4. Correctness of wiring from panel field terminals to PLC system input/ output points and to panel components.
   a. Simulate each discrete signal at terminal strip.
   b. Simulate correctness of each analog signal using current source.
5. Operation of communications between PLCs and remote I/O and between PLCs and computers.
6. Operation of communications between the PLC system, single loop controllers (SLC).
7. Nonloop-Specific Functions:
   a. Capacity: Demonstrate that PIC systems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
   b. Timing: Include tests for timing requirements.
   c. Diagnostics: Demonstrate online and offline diagnostic tests and procedures.
8. Correct deficiencies found and complete prior to shipment to Site.
9. Failed Tests:
   a. Repeat and witnessed by Engineer.
   b. With approval of Engineer, certain tests may be conducted by PIC System Integrator and witnessed by Engineer as part of Functional Test.
10. Make following documentation available to Engineer at test site both before and during FDT:
    a. Drawings, Specifications, Addenda, and Change Orders.
    b. Master copy of FDT procedures.
    c. List of equipment to be tested including make, model, and serial number.
    d. Approved hardware Shop Drawings for equipment being tested.
    e. Approved preliminary software documentation Submittal.
11. Daily Schedule for FDT:
    a. Begin each day with meeting to review day's test schedule.
    b. End each day with each meeting to review day's test results and to review or revise next day's test schedule.

D. Staging Site Demonstration Test (SSDT):

1. Scope: Demonstrate that the specified PIC equipment and standard software has been properly installed at staging site and is ready for applications software development by Engineer.
2. Refer to PIC subsections for additional details.

2.14 MAINTENANCE OF PROGRAMMING EQUIPMENT

A. Provide for maintenance of programming equipment while at Engineer's office. Repair or replace failed equipment within 2 days of notice by Engineer.

PART 3 EXECUTION

3.01 EXAMINATION

A. For equipment not provided by PIC System Integrator, but that directly interfaces with PIC, verify the following conditions:

1. Proper installation.
2. Calibration and adjustment of positioners and I/P transducers.
3. Correct control action.
4. Switch settings and dead bands.
5. Opening and closing speeds and travel stops.
6. Input and output signals.

3.02 INSTALLATION

A. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.

B. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Section 26 05 05, Conductors.

C. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.

D. Mechanical Systems:

1. Copper and Stainless Steel Tubing Support: Continuously supported by aluminum tubing raceway system.
2. Plastic Tubing Support: Except as shown on Drawings, provide continuous support in conduit or by aluminum tubing raceway system.

3. Install conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
4. Tubing and Conduit Bends:
    a. Tool-formed without flattening, and of same radius.
    b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
    c. Slope instrument connection tubing in accordance with installation details.
    d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
    e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
    f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
    g. Blow debris from inside of tubing.
    h. Make up and install fittings in accordance with manufacturer's recommendations. Verify make up of tube fittings with manufacturer's inspection gauge.
    i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.
    j. Run tubing to allow but not limited to, clear access to doors, controls and control panels; and to allow for easy removal of equipment.
    k. Provide separate support for components in tubing runs.
    l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
    m. Keep tubing and conduit runs at least 12 inches from hot pipes.
    n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
    o. Securely attach tubing raceways to building structural members.
5. Enclosure Lifting Rings: Remove rings following installation and plug holes.

E. Field Finishing: Refer to Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. General:

1. Coordinate PIC testing with Owner and affected Subcontractors.
2. Notify Engineer of Performance Test schedule 4 weeks prior to start of test.
3. Engineer may actively participate in tests.
4. Engineer reserves right to test or retest specified functions.
5. Engineer's decision will be final regarding acceptability and completeness of testing.

B. Onsite Supervision:

1. Require PIC System Integrator to observe PIC equipment installation to extent required in order to provide Certificates of Proper Installation.
2. Require PIC site representative to supervise and coordinate onsite PIC activities.
3. Require PIC site representative to be onsite while onsite work covered by this section and PIC subsystems is in progress.

C. Leak Tests: During Functional Test Part 1, conduct leak tests in accordance with Section 40 27 00, Process Piping-General.

D. Testing Sequence:

1. Provide Functional Tests and Performance Tests for facilities as required to support staged construction and startup of plant.
2. Refer to article Sequence of Work under Section 01 31 13, Project Coordination, for a definition of project milestones.
3. Refer to Section 01 91 14, Equipment Testing and Facility Startup, for overall testing requirements.
4. Completion: When tests (except Functional Test) have been completed and required test documentation has been accepted.

E. Testing:

1. Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated PIC equipment is ready for operation. Divide Functional Test for each facility into two parts.
2. Functional Test Part 1: Performed by PIC System Integrator to test and document PIC, excluding Engineer provided applications software, is ready for operation. For PIC Subsystems for which Engineer provides

applications software, provide sufficient temporary software configuring to allow testing of these subsystems.

a. Loop/Component Inspections and Tests:
    1) These inspections and tests will be spot checked by Engineer.
    2) Check PIC for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.
    3) Provide space on forms for signoff by PIC System Integrator.
    4) Use loop status report to organize and track inspection, adjustment, and calibration of each loop and include the following:
        a) Project name.
        b) Loop number.
        c) Tag number for each component.
        d) Checkoffs/Signoffs for Each Component:
            (1) Tag/identification.
            (2) Installation.
            (3) Termination wiring.
            (4) Termination tubing.
            (5) Calibration/adjustment.
        e) Checkoffs/Signoffs for the Loop:
            (1) Panel interface terminations.
            (2) I/O interface terminations with PLCs.
        f) I/O Signals for PLCs are Operational: Received/sent, processed, adjusted.
        g) Total loop operational.
        h) Space for comments.
    5) Component calibration sheet for each active I&C component (except simple hand switches, lights, gauges, and similar items) and each PLCs, I/O module and include the following:
        a) Project name.
        b) Loop number.
        c) Component tag number or I/O module number.
        d) Component code number for I&C elements.
        e) Manufacturer for I&C elements.
        f) Model number/serial number for I&C elements.
        g) Summary of Functional Requirements; For Example:
            (1) Indicators and recorders, scale and chart ranges.
            (2) Transmitters/converters, input and output ranges.

(3) Computing elements' function.
(4) Controllers, action (direct/reverse) and control modes (P, I, D).
(5) Switching elements, unit range, differential (FIXED/ADJUSTABLE), reset (AUTO/ MANUAL).
(6) I/O Modules: Input or output.

h) Calibrations, for example, but not limited to:
(1) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
(2) Discrete Devices: Actual trip points and reset points.
(3) Controllers: Mode settings (P&ID).
(4) I/O Modules: Actual inputs or outputs of 0, 10, 50, and 100 percent of span, rising and falling.
(5) Space for comments.

b. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site, and make them available to Engineer at all times.
c. Engineer reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of Preparation for Testing. Correct deficiencies found.
d. FDT-Repeat:
1) Repeat FDT onsite with installed PIC equipment and software.
2) As listed in PIC subsections, certain portions of FDT may not require retesting.
3) Use FDT test procedures as basis for this test.
4) In general, this test shall not require witnessing. However, portions of this test, as identified by Engineer during original FDT shall be witnessed.
e. Forms: See Loop Status Report, Instrument Calibration Sheet, and I&C Valve Adjustment Sheet referenced in Article Supplements.

3. Functional Test Part 2: Combined effort between Contractor, PIC System Integrator, and Engineer to confirm PIC, including applications software, is ready for operation.
a. Prerequisite: Completion of Functional Test Part 1.
b. Joint test with Engineer. Repeat of Engineer's SSDT application software tests, except using real field sensors and equipment. Plant interlocking and communications with PLCs and HMI tested on loop-by-loop basis.

c. Test procedures provided by Engineer based on Functional Test Part 1 and on SSDT application software tests.
d. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.

4. Functional Test:
   a. Scope: Confirm PIC, including applications software, is ready for operation.
   b. Refer to PIC subsections for additional requirements.
   c. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.
5. Required Test Documentation: Test procedures, forms, and checklists. Signed by Engineer and Contractor except for Functional Test items signed only by Contractor.

F. Performance Test During and After Facility Startup:

1. Once a facility's Functional Test has been completed and that facility has been started up, perform jointly with Engineer a Performance Test on associated PIC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
2. Loop-specific and nonloop-specific tests same as required for FDT except that entire installed PIC tested using actual process variables and functions demonstrated.
3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
5. Make O&M data available to Engineer at Site both before and during testing.
6. Follow daily schedule required for FDT.
7. Determination of Ready for Operation: When Functional Test has been completed.
8. Refer to examples of Performance Test procedures and forms in Article Supplements.

3.04 TRAINING

A. General:

1. Provide an integrated training program for Owner's personnel.
2. Perform training to meet specific needs of Owner's personnel.
3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
4. Provide instruction on one working shift(s) as needed to accommodate the Owner's personnel schedule.
5. Owner reserves the right to reuse videotapes of training sessions.

B. Management Seminar:

1. Length: 2 hours.
2. Location: Owner's facility.
3. Objective: Provide overview for nonoperations and maintenance personnel for understanding the PIC.
4. Attended by management, engineering, and other nonoperations and nonmaintenance personnel.
5. Primary Topics:
    a. PIC Overview: How hardware and software are used for operation and control of facilities.
    b. Block Diagram Presentation of PIC: How and what information flows within system and what is done by each functional unit.
    c. Process/Operator Interface: Explanation and demonstration of how to use HMI PC to access displays, reports, and controls.
    d. Management-oriented explanation of data management displays and printouts.
    e. Walk-through of installed systems.

C. Operations and Maintenance Training:

1. General:
    a. Refer to specific requirements specified in PIC Subsections.
    b. Include review of O&M data and survey of spares, expendables, and test equipment.
    c. Use equipment similar to that provided.
    d. Unless otherwise specified in PIC subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.

2. Operations Training: For Owner's operations personnel on operation of I&C components.
   a. Training Session Duration: 1 instructor day.
   b. Number of Training Sessions: Two.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.
   e. Content: Conduct training on loop-by-loop basis.
      1) Loop Functions: Understanding of loop functions, including interlocks for each loop.
      2) Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
      3) Interfaces with PIC subsystems.
3. Maintenance Training:
   a. Training Session Duration: 1 instructor day.
   b. Number of Training Sessions: Two.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed for routine maintenance of PIC.
   e. Content: Provide training for each type of component and function provided.
      1) Loop Functions: Understanding details of each loop and how they function.
      2) Component calibration.
      3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
      4) Troubleshooting and diagnosis for equipment and software.
      5) Replacing lamps, chart paper, and fuses.
      6) I&C components removal and replacement.
      7) Periodic preventive maintenance.

3.05 CLEANING

A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.06 PROTECTION

A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.

B. Periodically replace capsules based on capsule manufacturer's recommendations.

3.07 SUPPLEMENTS

A. Supplements listed below, follows "End of Section," are part of this Specification.

1. Control Narrative.
2. Instrument List.
3. PLC/HMI Equipment List.
4. PLC Input/Output List.
5. Control Panel Schedule.
6. Preparation for Testing and Functional Test Forms:
   a. Loop Status Report: Each sheet shows status of instruments on a loop. Also, gives functional description for loop.
   b. Instrument Calibration Sheet: Shows details on each instrument (except simple hand switches, lights, and similar items).
   c. I&C Valve Adjustment Sheet: Shows details for installation, adjustment, and calibration of a given valve.
7. Performance Test Sheet: Describe Performance Test for a given loop.
   a. List requirements of the loop.
   b. Briefly describe test.
   c. Cite expected results.
   d. Provide space for checkoff by witness.

END OF SECTION

CONTROL NARRATIVE

CONTROL LOOPS – WELL FIELD

THE FOLLOWING CONTROL NARRATIVE FOR THE WELL FIELD IS FOR GUIDANCE PURPOSES ONLY, AND MAY NOT REFLECT FINAL INSTALLED SYSTEM. SYSTEM IS TO FOLLOW REQUIREMENTS OUTLINED IN THE "VENDOR PACKAGE PERFORMANCE SCOPE FOR THE EXTRACTION PUMPS AND CONTROLS" DOCUMENT, ATTACHMENT D

WELL PUMPS (TYPICAL OF 5)
FLOW CONTROL MODE:
VIA THE HMI, OPERATORS WILL TURN THE PUMP ON AND OFF, AND THE PUMP WILL MODULATE SPEED TO MAINTAIN AN OPERATOR ADJUSTABLE FLOW SET POINT.
MANUAL SPEED CONTROL MODE:
VIA THE HMI, OPERATORS WILL TURN THE PUMP ON AND OFF, AND THE PUMP WILL MAINTAIN SPEED BASED ON AN ADJUSTABLE SET POINT.
ALARMS/INTERLOCKS:
ALL INTERLOCKS WILL REQUIRE FIELD RESET BY OPERATOR BEFORE EQUIPMENT CAN RUN.
IF WELL PUMP IS RUNNING, AND NO WELL FLOW FOR THAT RESPECTIVE PUMP IS DETECTED FOR 60 SECONDS, PUMP WILL SHUT OFF AND ALARM.
IF VFD FAULT ENERGIZES FOR WELL PUMP, THE RESPECTIVE PUMP WILL SHUT OFF AND ALARM.
IF PUMPSAVER RELAY FAULT ENERGIZES, THE RESPECTIVE PUMP WILL SHUT OFF AND ALARM.

WELL FLOW METERS (TYPICAL OF 5)
MEASURES FLOW FOR EACH RESPECTIVE WELL. INSTANTANEOUS FLOWRATE AND TOTALIZED FLOW WILL BE DISPLAYED VIA THE HMI. INCLUDING DAY TOTAL, MONTH TOTAL, AND LIFETIME TOTAL. DAY AND MONTH TOTAL VALUES CAN BE RESENT VIA THE HMI.
ALARMS:
SETPOINT DEVIATION, IF FLOW DEVIATES FROM SETPOINT BY MORE THAN 5 PERCENT WHEN WELL PUMP IS IN FLOW CONTROL MODE.
BAD DATA, FAULT IN SIGNAL FROM FLOW METER TO PLC.

HEADER FLOW METER
MEASURES TOTAL FLOW FROM ALL RUNNING WELLS. INSTANTANEOUS FLOWRATE AND TOTALIZED FLOW WILL BE DISPLAYED VIA THE HMI. INCLUDING DAY TOTAL, MONTH TOTAL, AND LIFETIME TOTAL. DAY AND MONTH TOTAL VALUES CAN BE RESENT VIA THE HMI.

ALARMS:
COMPARE HEADER FLOW TO COMBINED INDIVIDUAL WELL FLOWS. IF HEAD FLOW DEVIATES BY MORE THAN 10% FOR 60 SECONDS, ALL PUMPS WILL SHUT OFF AND ALARM.
BAD DATA, FAULT IN SIGNAL FROM FLOW METER TO PLC.

HEADER PRESSURE METER
MEASURES PRESSURE IN HEADER FROM ALL WELLS. INSTANTANEOUS PRESSURE WILL BE DISPLAYED VIA THE HMI.
ALARMS:
IF WELL PUMP IS RUNNING AND HEADER PRESSURE (PIT-TW) GOES ABOVE OR BELOW OPERATOR ADJUSTABLE SETPOINTS (HIHI AND LOLO RESPECTIVELY) FOR 60 SECONDS, ALL WELL PUMPS WILL SHUT OFF AND ALARM.
HIHI PRESSURE, OPERATOR ADJUSTABLE VIA HMI.
LOLO PRESSURE, OPERATOR ADJUSTABLE VIA HMI.
BAD DATA, FAULT IN SIGNAL FROM FLOW METER TO PLC.

SUMP FLOAT SWITCH
MEASURES PRESENCE OF WATER IN SLAB SUMP.
ALARMS:
LEVEL PRESENT ALL PUMPS WILL SHUT OFF AND ALARM.

CONTROL LOOPS – WETLANDS

PUMP-201 - SUMP PUMP
FLOW CONTROL MODE:
VIA THE HMI, OPERATORS WILL TURN THE PUMP ON AND OFF, AND THE PUMP WILL MODULATE SPEED TO MAINTAIN AN OPERATOR ADJUSTABLE FLOW SET POINT. FLOW CONTROL ONLY APPLICABLE WHEN PUMP IS PUMPING TO WETLAND THROUGH FLOWMETER FIT-210. OPERATOR TO ENSURE VALVING IN CORRECT ORIENTATION FOR SELECTED CONTROL MODE.
MANUAL SPEED CONTROL MODE:
VIA THE HMI, OPERATORS WILL TURN THE PUMP ON AND OFF, AND THE PUMP WILL MAINTAIN SPEED BASED ON AN ADJUSTABLE SET POINT. SPEED CONTROL MODE CAN BE USED EITHER PUMPING TO WETLAND OR EC TREATMENT. OPERATOR TO ENSURE VALVING IN CORRECT ORIENTATION FOR SELECTED CONTROL MODE.
ALARMS/INTERLOCKS:
ALL INTERLOCKS WILL REQUIRE FIELD RESET BY OPERATOR BEFORE EQUIPMENT CAN RUN.
IF SUMP LEVEL GOES TO LOLO LEVEL, PUMP TO TURN OFF AND ALARM.

IF WELL PUMP IS RUNNING IN FLOW CONTROL MODE, AND NO WELL FLOW TO WETLANDS IS DETECTED FOR 60 SECONDS, PUMP WILL SHUT OFF AND ALARM.
IF WELL PUMP IS RUNNING AND PRESSURE SWITCH PSH-210 TRIGGERS FOR 15 SECONDS, PUMPS WILL SHUT OFF AND ALARM.
IF VFD FAULT ENERGIZES FOR PUMP, THE PUMP WILL SHUT OFF AND ALARM.

PUMP-202 - SUMP PUMP
FLOW CONTROL MODE:
N/A – PMP-202 DEDICATED ONLY TO PUMP TO EC TREATMENT. OPERATOR TO ENSURE VALVING IN CORRECT ORIENTATION FOR SELECTED CONTROL MODE.
MANUAL SPEED CONTROL MODE:
VIA THE HMI, OPERATORS WILL TURN THE PUMP ON AND OFF, AND THE PUMP WILL MAINTAIN SPEED BASED ON AN ADJUSTABLE SET POINT. SPEED CONTROL MODE CAN BE USED EITHER PUMPING EC TREATMENT ONLY. OPERATOR TO ENSURE VALVING IN CORRECT ORIENTATION FOR SELECTED CONTROL MODE.
ALARMS/INTERLOCKS:
ALL INTERLOCKS WILL REQUIRE FIELD RESET BY OPERATOR BEFORE EQUIPMENT CAN RUN.
IF SUMP LEVEL GOES TO LOLO LEVEL, PUMP TO TURN OFF AND ALARM.
IF WELL PUMP IS RUNNING AND PRESSURE SWITCH PSH-220 TRIGGERS FOR 15 SECONDS, PUMPS WILL SHUT OFF AND ALARM.
IF VFD FAULT ENERGIZES FOR PUMP, THE PUMP WILL SHUT OFF AND ALARM.

WETLANDS FLOW METER
MEASURES FLOW TO WETLANDS. INSTANTANEOUS FLOWRATE AND TOTALIZED FLOW WILL BE DISPLAYED VIA THE HMI. INCLUDING DAY TOTAL, MONTH TOTAL, AND LIFETIME TOTAL. DAY AND MONTH TOTAL VALUES CAN BE RESENT VIA THE HMI.
ALARMS:
SETPOINT DEVIATION, IF FLOW DEVIATES FROM SETPOINT BY MORE THAN 5 PERCENT WHEN SUMP PUMP IS IN FLOW CONTROL MODE.
BAD DATA, FAULT IN SIGNAL FROM FLOW METER TO PLC.
WETLANDS SUMP LEVEL METER
MEASURES LEVEL OF SUMP TO. INSTANTANEOUS FLOWRATE WILL BE DISPLAYED VIA THE HMI.
ALARMS:
HIHI LEVEL, OPERATOR ADJUSTABLE VIA HMI.
LOLO LOLO, OPERATOR ADJUSTABLE VIA HMI.
BAD DATA, FAULT IN SIGNAL FROM LEVEL METER TO PLC.

INSTRUMENT LIST

Tag Number	Comp Code	Component Title	Options	P&ID	Mech/Elec
FIT-TW-1B*	F4	Well 1 Flow Element and Transmitter, Magnetic Flow		001-I-013	
FIT-TW-2B*	F4	Well 2 Flow Element and Transmitter, Magnetic Flow		001-I-013	
FIT-TW-3B*	F4	Well 3 Flow Element and Transmitter, Magnetic Flow		001-I-013	
FIT-TW-4B*	F4	Well 4 Flow Element and Transmitter, Magnetic Flow		001-I-013	
FIT-TW-5B*	F4	Well 5 Flow Element and Transmitter, Magnetic Flow		001-I-013	
PIT-TW*	P9	Treatment Well Header Pressure Indication Element and Transmitter		001-I-013	
FIT-TW*	F4	Treatment Well Header Flow Element and Transmitter, Magnetic Flow		001-I-013	
LSH-TW*	L2	Treatment Well House Sump High Level Switch		001-I-013	
FIT-210	F4	Sump to Wetland Flow Element and Transmitter, Magnetic Flow		002-I-001	
LIT-210	L15	Wetland Sump Level Element and Transmitter, Ultrasonic		002-I-001	
PSH-210	P8	Wetland Sump to Wetland High Pressure Switch		002-I-001	
PSH-220	P8	Wetland Sump to EC Treatment High Pressure Switch		002-I-001	
UPS-100	Y51	Well Field Control Panel UPS		004-I-001	
UPS-200	Y51	Wetland Sump Control Panel UPS		004-I-001	
*Equipment denoted are outlined for guidance purposed only and may not reflect the final installed system. System is to follow requirements outline in the "Vendor Package Performance Scope for the Extraction Pumps and Controls" document, Attachment D.					

PLC EQUIPMENT LIST

Name	Description	Qty.	Model	Manufacturer	Comments
Well Pump PLC	PROGRAMMABLE CONTROLLER		PLC	SIEMENS	Location – Well Field PLC Control Panel
*	Processor	1	CPU 1513-1 PN	SIEMENS	
*	Memory Card, 24MB	1	6ES7954-8LF03-0AA0		
*	Mounting rail S7-1500, 482 mm, for 19" cabinets	1	6ES7590-1AE80-0AA0	SIEMENS	
*	Power Supply 70W, 120/230 V AC, 24 V DC, 3 A	1	6EP1332-4BA00	SIEMENS	
*	Digital input, DI 16x24VDC HF	2	6ES7521-1BH00-0AB0	SIEMENS	16 Channel
*	Digital output, DQ 16x24VDC/0.5A HF	1	6ES7522-1BH01-0AB0	SIEMENS	16 Channel
*	Analog input, AI 8xU/I HS	2	6ES7531-7NF10-0AB0	SIEMENS	8 Channel
*	Analog output, AQ 8xU/I HS	1	6ES7532-5HF00-0AB0	SIEMENS	8 Channel
*	Front connector, screw-type terminal for 35mm modules, 40-pin	6	6ES7592-1AM00-0XB0	SIEMENS	
Well HMI					
*	HMI Touch Panel	1	6AV2124-0GC13-0AX0	SIEMENS	7” SEMATIC TP700 Comfort Panel - Outdoor
Wetlands PLC	PROGRAMMABLE CONTROLLER		PLC	Allen-Bradley	Part of UV Package System
	Processor	1	CPU 1513-1 PN	SIEMENS	
	Memory Card, 24MB	1	6ES7954-8LF03-0AA0		
	Mounting rail S7-1500, 482 mm, for 19" cabinets	1	6ES7590-1AE80-0AA0	SIEMENS	
	Power Supply 70W, 120/230 V AC, 24 V DC, 3 A	1	6EP1332-4BA00	SIEMENS	

Name	Description	Qty.	Model	Manufacturer	Comments
	Digital input, DI 16x24VDC HF	1	6ES7521-1BH00-0AB0	SIEMENS	16 Channel
	Digital output, DQ 16x24VDC/0.5A HF	1	6ES7522-1BH01-0AB0	SIEMENS	16 Channel
	Analog input, AI 8xU/I HS	1	6ES7531-7NF10-0AB0	SIEMENS	8 Channel
	Analog output, AQ 8xU/I HS	1	6ES7532-5HF00-0AB0	SIEMENS	8 Channel
	Front connector, screw-type terminal for 35mm modules, 40-pin	4	6ES7592-1AM00-0XB0	SIEMENS	
Wetlands HMI	HMI Touch Panel	1	6AV2124-0GC13-0AX0	SIEMENS	7” SEMATIC TP700 Comfort Panel - Outdoor
STANDARD SOFTWARE					
	STEP 7 Prof. im TIA Portal Software Update Service (SUS) Download	1	6ES7822-1AE00-0YY0	SIEMENS	
	SIMATIC STEP 7 Professional V15.1 (Download)	1	6ES7822-1AE05-0YA5	SIEMENS	

Note 1: Where SIEMENS products are listed, they are specified as no substitutions allowed.

*Equipment denoted are outlined for guidance purposed only and may not reflect the final installed system. System is to follow requirements outline in the “Vendor Package Performance Scope for the Extraction Pumps and Controls” document, Attachment D.

PLC I/O LIST

PLC	Point No	Description	P&ID	Function	Type	I/O
Well Field PLC		**Panel No. xxx**				
*	TW-1B FIT	TW-1B Flow	001-I-013	Flow	Status	AI
*	TW-1B SC	TW-1B Speed Command	001-I-013	Speed	Command	AO
*	TW-1B SI	TW-1B Speed Feedback	001-I-013	Speed	Status	AI
*	TW-1B MC	TW-1B Run Command	001-I-013	RUN	Command	DO
*	TW-1B MI	TW-1B Run Feedback	001-I-013	RUN FB	Status	DI
*	TW-1B ALM	TW-1B VFD Fault	001-I-013	Fault	Alarm	DI
*	TW-1B FLT	TW-1B Well Motor Fault	001-I-013	Fault	Alarm	DI
*	TW-1B JAY	TW-1B Fault Reset	001-I-013	Reset	Command	DO
*	TW-1B MI	TW-1B Run Light (GRN)	001-I-013	Indication	Status	DO
*	TW-1B MAI	TW-1B Fault Light (RED)	001-I-013	Indication	Alarm	DO
*	TW-2B FIT	TW-2B Flow	001-I-013	Flow	Status	AI
*	TW-2B SC	TW-2B Speed Command	001-I-013	Speed	Command	AO
*	TW-2B SI	TW-2B Speed Feedback	001-I-013	Speed	Status	AI
*	TW-2B MC	TW-2B Run Command	001-I-013	RUN	Command	DO
*	TW-2B MI	TW-2B Run Feedback	001-I-013	RUN FB	Status	DI
*	TW-2B ALM	TW-2B VFD Fault	001-I-013	Fault	Alarm	DI
*	TW-2B FLT	TW-2B Well Motor Fault	001-I-013	Fault	Alarm	DI
*	TW-2B JAY	TW-2B Fault Reset	001-I-013	Reset	Command	DO
*	TW-2B MI	TW-2B Run Light (GRN)	001-I-013	Indication	Status	DO

PLC	Point No	Description	P&ID	Function	Type	I/O
*	TW-2B MAI	TW-2B Fault Light (RED)	001-I-013	Indication	Alarm	DO
*	TW-3B FIT	TW-3B Flow	001-I-013	Flow	Status	AI
*	TW-3B SC	TW-3B Speed Command	001-I-013	Speed	Command	AO
*	TW-3B SI	TW-3B Speed Feedback	001-I-013	Speed	Status	AI
*	TW-3B MC	TW-3B Run Command	001-I-013	RUN	Command	DO
*	TW-3B MI	TW-3B Run Feedback	001-I-013	RUN FB	Status	DI
*	TW-3B ALM	TW-3B VFD Fault	001-I-013	Fault	Alarm	DI
*	TW-3B FLT	TW-3B Well Motor Fault	001-I-013	Fault	Alarm	DI
*	TW-3B JAY	TW-3B Fault Reset	001-I-013	Reset	Command	DO
*	TW-3B MI	TW-3B Run Light (GRN)	001-I-013	Indication	Status	DO
*	TW-3B MAI	TW-3B Fault Light (RED)	001-I-013	Indication	Alarm	DO
*	TW-4B FIT	TW-4B Flow	001-I-013	Flow	Status	AI
*	TW-4B SC	TW-4B Speed Command	001-I-013	Speed	Command	AO
*	TW-4B SI	TW-4B Speed Feedback	001-I-013	Speed	Status	AI
*	TW-4B MC	TW-4B Run Command	001-I-013	RUN	Command	DO
*	TW-4B MI	TW-4B Run Feedback	001-I-013	RUN FB	Status	DI
*	TW-4B ALM	TW-4B VFD Fault	001-I-013	Fault	Alarm	DI
*	TW-4B FLT	TW-4B Well Motor Fault	001-I-013	Fault	Alarm	DI
*	TW-4B JAY	TW-4B Fault Reset	001-I-013	Reset	Command	DO
*	TW-4B MI	TW-4B Run Light (GRN)	001-I-013	Indication	Status	DO
*	TW-4B MAI	TW-4B Fault Light (RED)	001-I-013	Indication	Alarm	DO
*	TW-5B FIT	TW-5B Flow	001-I-013	Flow	Status	AI

PLC	Point No	Description	P&ID	Function	Type	I/O
*	TW-5B SC	TW-5B Speed Command	001-I-013	Speed	Command	AO
*	TW-5B SI	TW-5B Speed Feedback	001-I-013	Speed	Status	AI
*	TW-5B MC	TW-5B Run Command	001-I-013	RUN	Command	DO
*	TW-5B MI	TW-5B Run Feedback	001-I-013	RUN FB	Status	DI
*	TW-5B ALM	TW-5B VFD Fault	001-I-013	Fault	Alarm	DI
*	TW-5B FLT	TW-5B Well Motor Fault	001-I-013	Fault	Alarm	DI
*	TW-5B JAY	TW-5B Fault Reset	001-I-013	Reset	Command	DO
*	TW-5B MI	TW-5B Run Light (GRN)	001-I-013	Indication	Status	DO
*	TW-5B MAI	TW-5B Fault Light (RED)	001-I-013	Indication	Alarm	DO
*	TW-LSH	High Sump Level	001-I-013	Level	Status	AI
*	TW-PIT	Well Header Pressure	001-I-013	Pressure	Status	AI
*	TW-FIT	Well Header Total Flow	001-I-013	Flow	Status	AI
*Equipment denoted are outlined for guidance purposed only and may not reflect the final installed system. System is to follow requirements outline in the "Vendor Package Performance Scope for the Extraction Pumps and Controls" document, Attachment D.						
Wetlands PLC		**Panel No. xxx**				
	PMP-201 SC	PMP-201 Speed Command	002-I-001	Speed	Command	AO
	PMP-201 SI	PMP-201 Speed Feedback	002-I-001	Speed	Status	AI
	PMP-201 MC	PMP-201 Run Command	002-I-001	RUN	Command	DO
	PMP-201 MI	PMP-201 Run Feedback	002-I-001	RUN FB	Status	DI
	PMP-201 ALM	PMP-201 VFD Fault	002-I-001	Fault	Alarm	DI
	PMP-201 FLT	PMP-201 Well Motor Fault	002-I-001	Fault	Alarm	DI

PLC	Point No	Description	P&ID	Function	Type	I/O
	PMP-201 JAY	PMP-201 Fault Reset	002-I-001	Reset	Command	DO
	PMP-201 MI	PMP-201 Run Light (GRN)	002-I-001	Indication	Status	DO
	PMP-201 MAI	PMP-201 Fault Light (RED)	002-I-001	Indication	Alarm	DO
	PMP-202 SC	PMP-202 Speed Command	002-I-001	Speed	Command	AO
	PMP-202 SI	PMP-202 Speed Feedback	002-I-001	Speed	Status	AI
	PMP-202 MC	PMP-202 Run Command	002-I-001	RUN	Command	DO
	PMP-202 MI	PMP-202 Run Feedback	002-I-001	RUN FB	Status	DI
	PMP-202 ALM	PMP-202 VFD Fault	002-I-001	Fault	Alarm	DI
	PMP-202 FLT	PMP-202 Well Motor Fault	002-I-001	Fault	Alarm	DI
	PMP-202 JAY	PMP-202 Fault Reset	002-I-001	Reset	Command	DO
	PMP-202 MI	PMP-202 Run Light (GRN)	002-I-001	Indication	Status	DO
	PMP-202 MAI	PMP-202 Fault Light (RED)	002-I-001	Indication	Alarm	DO
	FIT-210	Wetlands Flow	002-I-001	Flow	Indication	AI
	PSH-210	Wetlands Pump Outlet Pressure High	002-I-001	Pressure HIGH	Alarm	DI
	PSH-220	EC Pump Outlet Pressure High	002-I-001	Pressure HIGH	Alarm	DI
	PMP-201 TAH	PMP-201 Temperature Alarm High	002-I-001	Temp HIGH	Alarm	DI
	PMP-201 XA	PMP-201 Moisture Alarm	002-I-001	Moisture	Alarm	DI
	PMP-202 TAH	PMP-202 Temperature Alarm High	002-I-001	Temp HIGH	Alarm	DI
	PMP-202 XA	PMP-202 Moisture Alarm	002-I-001	Moisture	Alarm	DI
	GEN ALM	Wetlands General Alarm	002-I-001	System	Alarm	DO
	EC SYS RDY	EC System Ready Signal	002-I-001	Indication	Status	DI

CONTROL PANEL SCHEDULE

Panel No.	Service	Mounting	NEMA	Dimensions H	W	D	FDT	Space Heater	Serv. Lights, Outlets	Environment	SS
	Well Field PLC Control Panel	Wall	4X	46	40	12	Yes		Yes	Inside	Yes
	Wetlands PLC Control Panel	Wall	4X	46	40	12	Yes		Yes	Outside	Yes

Column Descriptions:

FDT: Factory Demonstration test required.
Dimensions: Maximum space available for panel.
SS: Stainless Steel.

JACOBS **LOOP STATUS REPORT—EXAMPLE FORMAT** **Rev.06.05.92**

Project Name: *Newport News WTP*	Project No. *WDC24456.C1*
FUNCTIONAL REQUIREMENTS:	
1. Measure, locally indicate, and transmit RAS flow to LP-10.	
2. At LP-10 indicate flow and provide flow control by modulation of FCV-10-2.	
4. Provide high RAS flow alarm on LP-10.	

COMPONENT STATUS (Check and initial each item when complete)

Tag Number	Delivered	Tag ID Checked	Installation	Termination Wiring	Termination Tubing	Calibration	
FE/FIT-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Feb-7-90 DWM*	*Mar-5-90 DWM*	*N.A.*	*May-6-90 VDA*	
FIC-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-4-90 VDA*	
FSH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FAH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FCV-10-2	*Mar-2-90 DWM*	*Mar-2-90 DWM*	*Apr-20-90 DWM*	*Apr-40-90 DWM*		*May-16-90 VDA*	

REMARKS: None.

Loop Ready for Operation	By: *D.W. Munzer*	Date: *May-18-90*	Loop No.: *10-2*

JACOBS **INSTRUMENT CALIBRATION SHEET—EXAMPLE—ANALYZER/TRANSMITTER** **Rev.06.05.92**

COMPONENT	MANUFACTURER		PROJECT
Code: *A7*	Name: *Leeds & Northrup*		Number: *WDC40715.B2*
Name: *pH Element & Analyzer/Transmitter*	Model: *12429-4-2-1-7*	Serial #: *11554422*	Name: *UOSA AWT PHASE 4*

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N	CONTROL? N
Indicate? Y Record? N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
	Scale:	*1-14*	*pH units*		SWITCH? N Unit Range:
Transmit/ Convert? Y	Input:	*1-14*	*pH units*		Differential: fixed/adjustable
	Output:	*4-20*	*mA dc*		Reset? automatic / manual

ANALOG CALIBRATIONS							DISCRETE CALIBRATIONS					Note No.
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		
Input	Indicated	Output	Increasing Input		Decreasing Input		Number	Trip Point	Reset Pt.	Trip Point	Reset Pt.	
			Indicated	Output	Indicated	Output		(note rising or falling)		(note rising or falling)		
1.0	*1.0*	*4.0*	*1.0*	*4.0*	*1.0*	*4.9*	*1.*	*N.A.*		*N.A.*		
2.4	*2.4*	*5.6*	*2.2*	*5.5*	*2.4*	*5.6*	2.					*1.*
7.5	*7.5*	*12.0*	*7.5*	*11.9*	*7.5*	*12.0*	4.					
12.7	*12.7*	*18.4*	*12.7*	*18.4*	*12.6*	*18.4*	4.					
14.0	*14.0*	*20.0*	*14.0*	*20.0*	*14.0*	*20.0*	5.					
CONTROL MODE SETTINGS:			P: *N.A.*	I:	D:		6.					

#	NOTES:	Component Calibrated and Ready for Start-up
	1. Need to recheck low pH calibration solutions.	By: *J.D. Sewell*
		Date: *Jun-6-92*
		Tag No.: *AIT-12-6*[pH]

JACOBS **I&C VALVE ADJUSTMENT SHEET—EXAMPLE** Rev.06.05.92

PARTS	Project Name: *SFO SEWPCP*	Project Number: *SFO10145.G2*
Body	Type: *Vee-Ball*	Mfr: *Fisher Controls*
	Size: *4-inch*	Model: *1049764-2*
	Line Connection: *159 # ANSI Flanges*	Serial #: *1004220*
Operator	Type: *Pneumatic Diaphragm*	Mfr: *Fisher Controls*
	Action: *Linear – Modulated*	Model: *4060D*
	Travel: *4-inch*	Serial #: *2007440*
Positioner	Input Signal: *4-15 psi*	Mfr: *Fisher Controls*
	Action: *Direct - air to open*	Model: *20472T*
	Cam: *Equal percentage*	Serial #: *102010*
Pilot	Action:	Mfr:
Solenoid	Rating: *None*	Model: Serial #:
I/P	Input: *4-20 mA dc*	Mfr: *Taylor*
Converter	Output: *4-15 psi*	Model: *10-T-576-4*
	Action: *Direct*	Serial #: *1057-440*
Position	Settings: *Closed / Open 5 deg, rising*	Mfr: *National Switch*
Switch	Contacts: *Close / Close*	Model: *1049-67-4*
		Serial #: *156 &157*
Power	Type: *Pneumatic*	Air Set Mfr: *Air Products*
Supply	Potential: *40 psi*	Model: *4210D*
		Serial #: *1107064*

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set	*JDS*	*Jun-06-92*	Valve Action	*JDS*	*Jun-04-92*
Positioner	*JDS*	*Jun-06-92*	Installation	*JDS*	*Jun-04-92*
Position Switches	*JDS*	*Jun-06-92*	Wire Connection	*JDS*	*Jun-04-92*
I/P Converter	*JDS*	*Jun-07-92*	Tube Connection	*JDS*	*Jun-04-92*
Actual Speed	*JDS*	*Jun-07-92*			

REMARKS: *Valve was initially installed backwards.*	**Valve Ready for Start-up**
Observed to be correctly installed May-25-92	By: *J.D. Sewell*
	Date: *Jun-07-92*
	Tag No.: *FCV-10-2-1*

JACOBS PERFORMANCE TEST SHEET - EXAMPLE Rev.06.05.92

Project Name: *SFO SEWPCP Plant Expansion*	Project No.: *SFO12445.C1*

Demonstration test(s): For each functional Requirement of the loop:
(a) List and number the requirement. (b) Briefly describe the demonstration test.
(c) Cite the results that will verify the required performance. (d) Provide space for signoff.

1. MEASURE EFFLUENT FLOW

1.a With no flow, water level over weir should be zero and

FIT indicator should read zero. *Jun-20-92 BDG*

2. FLOW INDICATION AND TRANSMISSION TO LP & CCS

With flow, water level and FIT indicator should be related by expression

*Q(MGD) = 429*H**(2/4) (H = height in inches of water over weir).*

Vary H and observe that following.

2.a Reading of FIT indicator. *Jun-6-92 BDG*

2.b Reading is transmitted to FI on LP-521-1 *Jun-6-92 BDG*

2.c Reading is transmitted and displayed to CCS. *Jun-6-92 BDG*

H(measured)	*0*	*5*	*10*	*15*
Q(computed)	*0*	*47.96*	*145.7*	*251.7*
Q(FIT indicator)	*0*	*48.1*	*147*	*254*
Q(LI on LP-521-1)	*0*	*48.2*	*148*	*254*
Q(display by CCS)	*0*	*48.1*	*146.2*	*252.4*

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report	*J.D. Sewell*	*May-18-92*	By: *J.D. Smith*
Instrument Calibration Sheet	*J.D. Sewell*	*May-18-92*	Date: *Jun-6-92*
I&C Valve Calibration Sheet	*N.A.*		
Performance Test	By	Date	
Performed	*J. Blow MPSDC Co.*	*Jun-6-92*	
Witnessed	*B. DeGlanville*	*Jun-6-92*	Loop No.: *40-12*

SECTION 40 91 00
INSTRUMENTATION AND CONTROL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for instrumentation and control components.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

PART 2 PRODUCTS

2.01 GENERAL

A. Article Mechanical Systems Components covers requirements of mechanical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

B. Article Electrical Components covers requirements for electrical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

C. All other Part 2 articles cover components that are referenced by Instrument Lists or Data Sheets in Section 40 90 00, Instrumentation and Control for Process Systems, or by specific component numbers in other PIC subsections.

D. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the

maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 MECHANICAL SYSTEMS COMPONENTS

A. Flow Element, Rotameter, Purge:

1. For air or water service, unless otherwise noted.
2. Materials: Glass tube, fiberglass body, stainless steel float, nylon ball check valve.
3. Direct-Reading Scale Length: 2-1/2 inches, minimum.
4. Scale Ranges: 0 scfh to 2.5 scfh for air service or 0 gph to 10 gph for water service.
5. Integral inlet needle valves.
6. Integral differential pressure regulators:
   a. For water service.
   b. For air service for level ranges greater than 10 feet of water.
7. Rotameters for water service.
8. Manufacturers and Products:
   a. Fischer & Porter; Series 10A3130.
   b. Brooks; Series DS-1350.

B. Manifold, Three-Valve Equalizing:

1. Type: For isolation and equalization of differential pressure transducers.
2. Materials: Stainless steel.
3. Manufacturers and Products:
   a. Anderson, Greenwood and Co.; Type M1.
   b. Evans.

C. Pressure Gauge: For other than process variable measurement.

1. Dial Size: Nominal 2-inch dial size.
2. Accuracy: 2 percent of span.
3. Scale Range: Such that normal operating pressure lies between 50 percent and 80 percent of scale range.
4. Connection: 1/4-inch NPT through bottom, unless otherwise noted.
5. Manufacturers and Products:
   a. Ashcroft Utility; Gauge Series 1000.
   b. Marsh; Standard Gauge Series.

c. Ametek U.S.; Gauge Series P500.
d. Acculite; Series 2000.

D. Valve, Needle:

1. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
2. Size: 0.020-inch orifice.
3. Manufacturers and Products:
   a. Whitey; Model 21RF2.
   b. Hoke; 3700 Series.

E. ON/OFF Valves:

1. Type: Ball valve.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
   a. Whitey; Series 41 through Series 43.
   b. Hoke; Flomite 7100 Series.

F. Regulating Valves:

1. Type: Needle valves, with regulating stems and screwed bonnets.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
   a. Whitey; Catalog No. RF or No. RS.
   b. Hoke; 3100 through 3300 Series.

G. Valve, Three-Way:

1. Type: Ball valve.
2. Materials: Brass or stainless steel with nylon handle as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
   a. Whitey; Series 41 through Series 43.
   b. Hoke; Selecto-Mite Series.

H. Valve, Four-Way:

1. Type: Four-way, two-position ball valve.
2. Materials:
   a. Body and Stem: Type 316 stainless steel.
   b. Handle: Black nylon.
   c. Packing Gland: Teflon.
3. Ball and stem bed, one-piece assembly.
4. Machined handle stops and directional nameplates.
5. Manufacturers and Products:
   a. Whitey; Series 457.
   b. Hoke; Multi-Mite Series.

I. Spool Valve:

1. Type: Five-port arrangement as shown, two-position, push-to-operate knob attached to the spool stem, and spring return.
2. Materials: Aluminum construction with Teflon impregnated aluminum spool, stainless steel spring, and Buna-N O-rings.
3. Port Connection: 1/4-inch outside diameter tube fittings.
4. Manufacturer and Product: Norgren; T71DAOO-TSO-TKO.

J. Solenoid Valve, Two-Way:

1. Type: Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation.
2. Materials:
   a. Body: Brass or stainless steel globe valves as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
   b. Valve Seat: Buna-N.
3. Size: Normally closed or opened, as noted.
4. Coil: 115V ac, unless noted otherwise.
5. Solenoid Enclosure: NEMA 4.
6. Manufacturer and Product: ASCO; Red Hat Series 8260.

K. Pressure Regulator, Air:

1. Provide air at reduced pressures, as shown, constant to within plus or minus 10 percent for flows from 0 scfh to 300 scfh with 100 psi supply pressure.
2. Setscrew for outlet pressure adjustment.
3. Integral filter and relief valve.

4. Manufacturers and Products:
    a. Masoneilan; Series 77-4.
    b. Fisher; Series 67FR.

L. Pressure Regulator, Water:

1. Materials:
    a. Body: Bronze.
    b. Spring Case: Cast iron.
    c. Seat Rings: Brass.
    d. Valve Disk and Holder: Buna-N and bronze.
    e. Diaphragm: Buna-N diaphragm.
2. Sizing: For maximum of 7 psi offset pressure.
3. Manufacturers and Products:
    a. Fisher; Controls Type 95H or 95L.
    b. Masoneilan; Series 17.

M. Test Tap:

1. Manufacturers and Products:
    a. Imperial-Eastman; quick-disconnect couplings No. 292-P and caps No. 259-P.
    b. Crawford Fitting Co.; Swagelok quick-connects Series QC4 and caps QC4-DC.
    c. Parker; CPI Series precision quick couplings.

N. Copper Tubing and Fittings:

1. Type K hard copper, ASTM B88, with commercially pure wrought copper solder joint fittings. Make joints with 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.
2. Alternatively, Type K, soft temper copper tubing, ASTM B88, with brass compression type fittings may be used where shown on Drawings.
3. Manufacturers:
    a. Parker-Hannifin.
    b. Swagelok tube fittings.

O. Plastic Tubing and Fittings:

1. Tubing:
    a. Polyethylene capable of withstanding 190 psig at 175 degrees F.
    b. Manufacturers and Products:
        1) Dekoron; Type P.
        2) Imperial Eastman; Poly-Flo black instrument tubing.

2. Fittings:
   a. Type: Brass compression.
   b. Manufacturers and Products:
      1) Imperial Eastman; Poly-Flo tube fittings.
      2) Dekoron; E-Z fittings.

P. Stainless Steel Tubing: ASTM A312/A312M, Type 316, 0.065-inch wall, seamless, soft annealed, as shown on Drawings.

Q. Stainless Steel Fittings:

1. Compression Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, flareless.
   b. Manufacturers and Products:
      1) Parker Flodar; BA Series.
      2) Swagelok tube fittings.
      3) Parker CPI tube fittings; Parker A-LOK dual ferrule tube fittings.
2. Socket Weld Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, 3,000 psi maximum working pressure, safety factor 4:1.
   b. Manufacturers:
      1) Cajon.
      2) Swagelok.
      3) Parker WELDLOK.

R. Air Set: Consists of a shutoff valve, pressure regulator, discharge pressure gauge, and interconnecting tubing.

S. Purge Set:

1. Parts: Purge rotameter flow element, pressure regulator, pressure gauge, test tap, shutoff valve, spool valve, and interconnecting tubing as shown on Drawings and as required in this section.
2. Pressure Gauge Scale Range: 150 percent of the process variable.
3. Mounting:
   a. Within consoles, panels, or a separate enclosure as shown.
   b. For separate enclosure mounted purge sets, refer to paragraphs Nonfreestanding Panel Construction and Factory Finishing for enclosure requirements.

T. Tubing Raceways:

1. Cable tray systems complete with tees, elbows, reducers, and covers.
2. Size in accordance with manufacturer's recommendations for intended service.
3. Materials: Galvanized steel or aluminum brass as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
4. Manufacturers:
   a. Globetray.
   b. Cope.

U. Air Supply Sets:

1. Parts: Integrally Mounted:
   a. Pressure Controls: Automatic START/STOP, factory set at 30 psig to 50 psig.
   b. Valves: Manual drain, manual shutoff, pressure relief, and check valve.
   c. Pressure gauge.
   d. Inlet filter muffler.
   e. Power: 120V ac.
   f. Compressor: Oilless, single cylinder, rated for at least 1 scfm at 50 psig.
   g. Manufacturers and Products:
      1) ITT Pneumotive; GH Series.
      2) Gast.
2. Simplex Air Supply Sets:
   a. Air Receiver: 2 gallons.
   b. Compressors: One.
3. Duplex Air Supply Sets:
   a. Air Receiver: 20 gallons.
   b. Compressors: Two.
   c. Automatic Failover Control: Factory set at 20 psig.

2.03 ELECTRICAL COMPONENTS

A. Terminal Blocks for Enclosures:

1. General:
   a. Connection Type: Screw compression clamp.
   b. Compression Clamp:
      1) Complies with DIN-VDE 0611.

2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
3) Guides strands of wire into terminal.

c. Screws: Hardened steel, captive, and self-locking.
d. Current Bar: Copper or treated brass.
e. Insulation:
1) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
2) Two funneled shaped inputs to facilitate wire entry.
f. Mounting:
1) Standard DIN rail.
2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
3) End Stops: Minimum of one at each end of rail.
g. Wire Preparation: Stripping only permitted.
h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
i. Marking System:
1) Terminal number shown on both sides of terminal block.
2) Allow use of preprinted and field marked tags.
3) Terminal strip numbers shown on end stops.
4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
j. Test Plugs: Soldered connections for 18 AWG wire.
1) Pin Diameter: 0.079 inch.
2) Quantity: 10.
3) Manufacturer and Product: Entrelec; Type FC2.

2. Terminal Block, General Purpose:
a. Rated Voltage: 600V ac.
b. Rated Current: 30 amp.
c. Wire Size: 24 AWG to 10 AWG.
d. Rated Wire Size: 10 AWG.
e. Color: Gray body.
f. Spacing: 0.25 inch, maximum.
g. Test Sockets: One screw test socket 0.079-inch diameter.
h. Manufacturer and Product: Entrelec; Type M4/6.T.

3. Terminal Block, Ground:
a. Wire Size: 24 AWG to 10 AWG.
b. Rated Wire Size: 10 AWG.
c. Color: Green and yellow body.

d. Spacing: 0.25 inch, maximum.
e. Grounding: Electrically grounded to mounting rail.
f. Manufacturer and Product: Entrelec; Type M4/6.P.

4. Terminal Block, Blade Disconnect Switch:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 10 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body, orange switch.
   f. Spacing: 0.25 inch, maximum.
   g. Manufacturer and Product: Entrelec; Type M4/6.SNT.
5. Terminal Block Diode:
   a. Rated Voltage: 24V dc.
   b. Rated Current: 30 ma.
   c. Wire Size: 16 AWG.
   d. Manufacturer and Product: Phoenix Contact ST-IN.
6. Terminal Block, Fused, 24V dc:
   a. Rated Voltage: 600V dc.
   b. Rated Current: 25 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Fuse: 0.25 inch by 1.25 inches.
   g. Indication: LED diode 24V dc.
   h. Spacing: 0.512 inch, maximum.
   i. Manufacturer and Product: Entrelec; Type ML10/13.SFD.
7. Terminal Block, Fused, 120V ac:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 25 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Fuse: 0.25 inch by 1.25 inches.
   g. Indication: Neon lamp, 110V ac.
   h. Leakage Current: 1.8 mA, maximum.
   i. Spacing: 0.512 inch, maximum.
   j. Manufacturer and Product: Entrelec; Type ML10/13.SFL.
8. Terminal Block, Fused, 120V ac, High Current:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 35 amps.
   c. Wire Size: 18 AWG to 8 AWG.
   d. Rated Wire Size: 8 AWG.
   e. Color: Gray.

f. Fuse: 13/32 inch by 1.5 inches.
g. Spacing: 0.95 inch, maximum.

9. Manufacturer and Product: Entrelec; Type MB10/24.SF.

B. Relays:

1. General:
   a. Relay Mounting: Plug-in type socket.
   b. Relay Enclosure: Furnish dust cover.
   c. Socket Type: Screw terminal interface with wiring.
   d. Socket Mounting: Rail.
   e. Provide holddown clips.
2. Signal Switching Relay:
   a. Type: Dry circuit.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 5 amps at 28V dc or 120V ac.
   d. Contact Material: Gold or silver.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 0.9 watt (dc), 1.2VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Seal Type: Hermetically sealed case.
   k. Manufacturer and Product: Potter and Brumfield; Series KH/KHA.
3. Control Circuit Switching Relay, Nonlatching:
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac, and 6.6A at 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Push-to-test button.
   k. Manufacturer and Product: Potter and Brumfield; Series KUP.
4. Control Circuit Switching Relay, Latching:
   a. Type: Dual coil mechanical latching relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.

f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
g. Expected Mechanical Life: 500,000 operations.
h. Expected Electrical Life at Rated Load: 50,000 operations.
i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.

5. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 30V dc or 277V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Operating Temperature: Minus 10 degrees C to 55 degrees C.
   g. Repeatability: Plus or minus 2 percent.
   h. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
   i. Time Delay Setpoint: As noted or shown.
   j. Mode of Operation: As noted or shown.
   k. Adjustment Type: Integral potentiometer with knob external to dust cover.
   l. Manufacturer and Products: Potter and Brumfield; Series CB for 0.1-second to 100-minute delay time ranges, Series CK for 0.1-second to 120-second delay time ranges.

C. Surge Suppressors:

1. General:
   a. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
   b. Response: 5 nanoseconds maximum.
   c. Recovery: Automatic.
   d. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
   e. Enclosure Mounted: Encapsulated inflame retardant epoxy.
2. Suppressors on 120V ac Power Supply Connections:
   a. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
   b. First-Stage Clamping Voltage: 350 volts or less.
   c. Second-Stage Clamping Voltage: 210 volts or less.
   d. Power Supplies for Continuous Operation:
      1) Four-Wire Transmitter or Receiver: Minimum5 amps at 130V ac.
      2) All Other Applications: Minimum 30 amps at 130V ac.

3. Suppressors on Analog Signal Lines:
    a. Test Waveform: Linear 8-microsecond rise in current from 0 amps to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
    b. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
        1) dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
        2) dc Clamping Voltage Tolerance: Plus or minus 10 percent.
        3) Maximum Loop Resistance: 18 ohms per conductor.
4. Manufacturers and Products:
    a. Analog Signals Lines: Emerson Edco PC-642 or SRA-64 series.
    b. 120V ac Lines: Emerson Edco HSP-121.
    c. Field Mounted at Two-Wire Instruments:
        1) Encapsulated in stainless steel pipe nipples.
        2) Emerson Edco SS64 series.
    d. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistors on signal lines, all in enclosure.
        1) Enclosure:
            a) NEMA 4X Type 316 stainless steel with door.
            b) Maximum Size: 12 inches by 12 inches by 8 inches deep.
        2) Emerson Edco; SLAC series.

D. Power Supplies:

1. Furnish as required to power instruments requiring external dc power, including two-wire transmitters and dc relays.
2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
3. Provide output over voltage and over current protective devices to:
    a. Protect instruments from damage due to power supply failure.
    b. Protect power supply from damage due to external failure.
4. Enclosures: NEMA 1.
5. Mount such that dissipated heat does not adversely affect other components.
6. Fuses: For each dc supply line to each individual two-wire transmitter.
    a. Type: Indicating.
    b. Mount so fuses can be easily seen and replaced.

E. Intrinsic Safety Barriers:

1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
   a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.
2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
   a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.

2.04 I&C COMPONENTS

A. F4 Flow Element and Transmitter, Electromagnetic:

1. General:
   a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.
   b. Type:
      1) Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
      2) Full bore meter with magnetic field traversing entire flow-tube cross-section.
      3) Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.
   c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.
2. Service:
   a. Stream Fluid:
      1) As noted.
      2) Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.
   b. Flow Stream Descriptions: If and as described below.
3. Operating Temperature:
   a. Element:
      1) Ambient: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.
      2) Process: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.
   b. Transmitter:
      1) Ambient: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.

2) Storage: 15 degrees F to 120 degrees F, typical, unless otherwise noted.

4. Performance:
   a. Flow Range: As noted.
   b. Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 feet to 30 feet per second.
   c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.
5. Features:
   a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
   b. No obstructions to flow.
   c. Very low pressure loss.
   d. Measures bi-directional flow.
6. Process Connection:
   a. Meter Size (diameter inches): As noted.
   b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
   c. Flange Material: Carbon steel, unless otherwise noted.
7. Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.
8. Element:
   a. Meter Tube Material: Type 304 or Type 316 stainless steel, unless otherwise noted.
   b. Liner Material:
      1) Teflon, unless otherwise noted.
      2) For potable water service, must have appropriate approvals.
   c. Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.
   d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
   e. Electrode Material: Type 316 stainless steel or Hastelloy C, unless otherwise noted.
   f. Grounding Ring:
      1) Required, unless otherwise noted.
      2) Quantity: Two, unless otherwise noted.
      3) Material: Type 316 stainless steel, unless otherwise noted.
   g. Enclosure: NEMA 4X, minimum, unless otherwise noted.
   h. Submergence:
      1) Temporary: If noted.
      2) Continuous (up to 10 feet depth), NEMA 6P/IP68: If noted.
   i. Direct Buried (3 feet to 10 feet): If noted.

j. Hazardous Area Certification:
   1) Class 1, Division 2, Groups A, B, C, D: If noted.
   2) Class 1, Division 1, Groups A, B, C, D, and FM approved: If noted.
   3) Class 1, Division 1, Groups C, D, and FM approved: If noted.

9. Transmitter:
   a. Mounting: Surface (wall), unless otherwise noted.
   b. Display: Required, unless otherwise noted.
      1) Digital LCD display, indicating flow rate and total.
      2) Bi-directional Flow Display: Required, unless otherwise noted.
         a) Forward and reverse flow rate.
         b) Forward, reverse and net totalization.
   c. Parameter Adjustments: By keypad or non-intrusive means.
   d. Enclosure: NEMA 4X, minimum, unless otherwise noted.
   e. Empty Pipe Detection:
      1) If noted.
      2) Drives display and outputs to zero when empty pipe detected.
10. Signal Interface (at Transmitter):
   a. Analog Output:
      1) Isolated 4 mA to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
      2) Supports Superimposed Digital HART protocol: If noted.
   b. Discrete Outputs: If noted.
      1) Two discrete outputs, typical, rated for up to 30 volts, typical.
      2) Programmable as noted for the following typical parameters:
         a) Totalizer pulse, high/low flow rates, percent of range, empty pipe zero, fault conditions, forward/reverse, etc.
   c. Discrete Input: If noted.
      1) Contact closure, configured as noted for the following typical parameters: reset totalizer, change range, hold output constant, drive output to zero, and low flow cutoff, etc.
   d. Other: As noted.
11. Cables:
   a. Types: As recommended by manufacturer.
   b. Lengths: As required to accommodate device locations.

12. Built-in Diagnostic System:
    a. Features:
        1) Field programmable electronics.
        2) Self-diagnostics with troubleshooting codes.
        3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
        4) Initial flow tube calibration and subsequent calibration checks.
13. Factory Calibration:
    a. Calibrated in an ISO 9001 and NIST certified factory.
    b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
    c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.
14. Manufacturers:
    a. Endress & Hauser, Inc. Flow Measuring System:
        1) Promag 50/53H (size: 1/12 inches to 4 inches).
        2) Promag 50/53P (size: 1/2 inch to 24 inches).
        3) Promag 50/53W (size: 1 inch to 78 inches).
    b. Emerson Process Management, Rosemount Division:
        1) Model 8705 (flanged) and Model 8711(wafer) flow tubes.
        2) Model 8712 (surface) and Model 8732 (integral) transmitters.

B. L2 Level Element and Switch, Electrode:

1. General:
    a. Function: Activate contact at preset liquid level.
    b. Type: Conductance; solid state relays.
    c. Parts: Electrode, electrode holder, relay, enclosure (if specified), cabling.
2. Performance:
    a. Setpoint: As noted.
    b. Accuracy: Plus or minus 1/16-inch electrode tip length.
    c. Sensitivity: As required for (conductivity of) specific liquid application.
3. Service:
    a. Process Liquid: As noted.
    b. Operating Temperature: As noted.
    c. Operating Pressure: As noted.

4. Electrode Holder:
   a. Type: External pipe threaded, unless otherwise noted.
   b. Material: Type 316 stainless steel, unless otherwise noted.
   c. Mounting: 3-inch NPT, unless otherwise noted.
   d. Service: Watertight, outdoor heavy duty, unless otherwise noted.
5. Electrodes:
   a. Type: Rod or wire suspension, as noted.
   b. Number: As noted.
   c. Length (of electrode or suspension wire, as applicable): As required for noted setpoints.
   d. Material:
      1) Type 316 stainless steel electrodes, unless otherwise noted.
      2) Vinyl insulation on suspension wires.
   e. Insulated Sheaths: PVC, unless otherwise noted.
   f. Spacers:
      1) If noted.
      2) Same material as sheaths.
6. Relays:
   a. Type: Solid state, unless otherwise noted.
   b. Number: One per noted setpoint.
   c. Sensitivity: As required for (conductivity of) specific liquid application.
   d. Power: Suitable for 120V ac or 240V ac, 60 Hz.
   e. Contacts: DPDT, rated at 10 amps continuous at 120V ac.
   f. Enclosure: NEMA 4X fiberglass, unless otherwise noted.
7. Cabling:
   a. Provide interconnecting conductors between electrode holder and relay.
   b. Type: As recommended by manufacturer.
   c. Quantity and Length: As required.
8. Ancillaries:
   a. Furnish for a complete and operating system.
   b. Include such items as wire connectors for wire suspension electrodes.
9. Manufacturer: Ametek APT B/W Controls; Series 6012/6013 electrode and Series 5200 solid state relay.

C. L15 Level Element and Transmitter, Ultrasonic, Two-Wire:

1. General:
   a. Function: Continuous, noncontacting level measurement.
   b. Type: Ultrasonic.
   c. Parts: Element/integral transmitter and accessories as noted.

2. Service:
   a. Application: Sodium hypochlorite storage tank.
   b. Operating Temperature Range:
      1) Outside Ambient: Minus 40 degrees F to plus 176 degrees F.
      2) Transducer (Inside Vessel): Minus 40 degrees F to plus 149 degrees F.
3. Performance:
   a. Process Range: As noted.
      1) When several different range sensors are available, select sensor so that process range is not more than 80 percent of maximum sensor range.
   b. Zero Reference: As noted.
   c. Accuracy: Plus or minus 0.25 percent of maximum range or 6 mm, whichever is greater, typical.
   d. Repeatability: Less than or equal to 3 mm, typical.
   e. Temperature Compensation: Integral.
   f. Blanking Distance:
      1) Sensor dependent.
      2) 12 inches for 20-foot range sensor, typical.
4. Element/Integral Transmitter:
   a. NEMA 4X/IP67 watertight enclosure or NEMA 6/6P submersible.
   b. Transducer Material: Valox 357 (PBT), ETFE, or PVDF, unless otherwise noted.
      1) PVDF: If noted.
   c. Element Beam Angle: 11 degrees inclusive, maximum.
   d. Dimensions: 8 inches high by 5-inch diameter, nominal and typical.
   e. Process Connection:
      1) Sensor and vendor dependent.
      2) Typically 1-1/2-inch and 2-inch NPT for short and medium range sensors.
      3) If flange shown on Drawings/Details, PIC Supplier shall be responsible for and coordinate its procurement.
   f. Integral LCD display.
   g. Two-wire loop powered.
   h. Signal Interface:
      1) Analog: 4 mA to 20 mA dc.
      2) Digital: As noted.
   i. Intrinsically Safe: If noted.

5. Accessories:
   a. Remote Programming Software: If noted.
      1) Allows remote programming via personal computer and echo traces for troubleshooting.
      2) One per lot of units furnished.
   b. Communication Module for Remote Programming Software:
      1) If required for connection of personal computer to communication link; e.g., 4 mA to 20 mA dc Hart, furnish if noted.
      2) One per lot of units furnished.
   c. Others: As noted.
6. Manufacturers and Products:
   a. Siemens; SITRANS Probe LU.
   b. Pulsar; IMP 80 (Standard)/IMP 81 (Intrinsically Safe).
   c. Endress and Hauser; Prosonic M FMU 40/41/42/43/44.

D. P8 Pressure Switch, Fixed Deadband:

1. General:
   a. Function: Monitor pressure.
   b. Type: Diaphragm actuated switch.
2. Performance:
   a. Setpoint:
      1) As noted.
      2) Repeatability: Plus or minus 1 percent.
   b. Range: Noted setpoint shall fall between 20 percent and 80 percent of range.
   c. Overpressure Proof Pressure: At least 400 percent of rated maximum static pressure.
   d. Operating Temperature Range:
      1) Dependent on actuator seal materials.
      2) For Buna-N seal, 0 degree F to 150 degrees F.
3. Features:
   a. Actuator Seal: Buna-N, unless otherwise noted.
   b. Differential (deadband): Fixed.
   c. Reset: Automatic, unless otherwise noted.
   d. Mounting: Surface, unless otherwise noted.
4. Process Connection:
   a. 1/4-inch NPT female connections, unless otherwise noted.
   b. Materials: Nickel-plated brass, unless otherwise noted.
5. Enclosure: NEMA 4X.

6. Signal Interface:
    a. Contact Type:
        1) SPDT, unless otherwise noted.
        2) Rated for 10 amps minimum at 120V ac.
    b. Hermetically Sealed Switch: If noted.
7. Manufacturers and Products:
    a. Ashcroft; Type 400, B Series.
    b. United Electric; 400 Series.

E. P9 Pressure Transmitter:

1. General:
    a. Function: Measure pressure and transmit signal proportional to pressure.
    b. Type:
        1) Electronic variable capacitance or silicon strain gauge.
        2) Two-wire transmitter; “smart electronics”.
    c. Parts: Transmitter and accessories.
2. Performance:
    a. Range: As noted.
        1) Select transmitter’s factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
    b. Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.
    c. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
    d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
    e. Humidity: 0 percent to 100 percent relative humidity.
    f. Hazardous Location Certifications: If and as noted.
3. Features:
    a. Type: Gauge pressure, unless otherwise noted.
    b. Adjustable damping.
    c. LCD indicator, unless otherwise noted.
        1) Display in either percent or engineering units, field configurable.
    d. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
        1) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
    e. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.

f. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
g. Fill Fluid: Silicone, unless otherwise noted.

4. Process Connections:
   a. Line Size: 1/2-inch.
   b. Connection Type: FNPT.
   c. Direct/remote Diaphragm Seal: If and as noted.
5. Signal Interface:
   a. 4 mA to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
      1) Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
   b. FOUNDATION Fieldbus Protocol: If noted.
   c. Profibus: If noted.
6. Enclosure:
   a. Type: NEMA 4X.
   b. Materials: Coated aluminum, unless otherwise noted.
   c. Mounting bracket, unless otherwise noted.
      1) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
7. Accessories: Two-valve (isolate and vent).
8. Stainless Steel Manifold: If noted.
9. Manufacturer and Product:
   a. Gauge Pressure Units: Endress & Hauser, Inc.; Cerabar PMP71.

F. Y51 Uninterruptible Power Supply System:

1. General:
   a. Type: On-line industrial UPS.
   b. Function: Provides isolated, regulated uninterrupted ac output power during a complete or partial interruption of incoming line power.
   c. Major Parts: Inverter, battery charger, sealed battery.
2. Performance:
   a. Capacity: As required such that normal running load demand does not exceed 50 percent of UPS capacity.
   b. Input Power:
      1) 120V ac single-phase, 60-Hz, unless otherwise noted.
      2) Connections: Manufacturer’s standard, unless otherwise noted.

c. Output Power:
   1) 120V ac single-phase, 60-Hz, unless otherwise noted.
   2) Connections: Manufacturer's standard, unless otherwise noted.
d. On-line Efficiency: 85 percent minimum, unless otherwise noted.
e. Backup Runtime:
   1) Full Load: 9 minutes minimum, unless otherwise noted.
   2) Half Load: 20 minutes minimum, unless otherwise noted.
f. Continuous no-break power with no measurable transfer time.
g. Sine-Wave Output Voltage Total Harmonic Distortion (THD): Plus or minus 5 percent or less.
h. Input Voltage Range: Plus 15 percent, minus 20 percent.
i. Output Voltage Regulation: Plus or minus 3 percent nominal.
j. Operating Temperature: Minus 20 to 55 degrees C (minus 4 degrees F to 131 degrees F).
k. Operating Relative Humidity: 10 percent to 95 percent without condensation.
l. Lightning and Surge Protection:
   1) Pass lightning standard IEEE C62.41 Categories A and B tests.
   2) 2000 to 1 attenuation of input spike.

3. Certifications: UL 1778, UL 508, cUL, and CE.
4. Features:
   a. Battery Type: Hot swappable, 12-year rated, maintenance free, sealed VRLA.
   b. Maintenance Bypass Switch: Required.
   c. Options Board: Required for UPS ALARM and for maintenance bypass switch.
   d. Enclosure Type: Tower.
5. Manufacturers and Products:
   a. Falcon, Model SSG Series.
   b. "Or-equal."

PART 3 EXECUTION (NOT USED)

END OF SECTION