SECTION 011100 COORDINATION OF WORK AND PERMITS

A. Description

This section generally describes the project and includes Contractor's use of premises and construction permits.

B. General Nature of Work

The work includes but is not limited to construction of the following:

1. Two wells with wellheads
2. Connecting pipelines.
3. Two well buildings.
4. One utility building, with the following:
    a. Chemical storage and feed equipment.
    b. Booster pumps.
    c. Electrical room.
    d. Engine-generator unit.
    e. Control room.
    f. Laboratory.
    g. Restroom.
5. Reservoir.
6. Electrical services and transformers.
7. Instrumentation and control systems.
8. Site restoration work including paving, landscaping, and irrigation.

C. Location of Project Site

The project site is located at 17825 Yukon Avenue. The site is adjacent to Yukon Elementary School and the 405 Freeway, south of Artesia Boulevard in the City of Torrance in Los Angeles County, California.

D. Contractor's Use of Premises

The project site as delineated on the plans is available for the Contractor’s use. Work in McMaster Park will require coordination with City Parks and Water Departments.

E. Permits

Obtain all necessary permits for proper execution of certain phases of the project. Fill out all forms and furnish all drawings required to obtain the permits. A copy of the permit shall be submitted to the Owner. All fees associated with these permits shall be paid by the Contractor as part of the project. Work shall not commence on any phase of the project requiring a permit until the permit is obtained.

1. The Owner will obtain a De Minimus permit (Order No. 98-67) from the State Water Resources Control Board for discharging wastes associated with construction and testing. The Contractor shall adhere to the requirements of the permit. A copy of the Order is included as Appendix A for reference. Note the reporting requirements. The actual permit will be provided to the Contractor after the project is awarded.

2. The Owner has or will have submitted a Notice of Intent to Discharge, along with appurtenant fee, under the Construction Activities Storm Water Permit (99-08-DWQ).

3. The permits contain requirements which affect the cost of project work. Comply with the permit requirements.

END OF SECTION

SECTION 013300 SUBMITTALS

A. Shop Drawings

1. Submit shop drawings in accordance with the General Provisions.

2. The use of contract drawing reproductions for shop drawings is subject to rejection.

3. Submit six copies of shop drawings. The Owner's Representative will keep four copies and return two copies. If the Contractor desires more than two copies, he shall transfer the Owner's Representative's comments onto additional copies at his own expense. Clearly indicate the specification section, and drawing number to which each shop drawing is referenced.

4. For materials originating outside of the United States for which tests are required, provide recertification and retesting by an independent domestic testing laboratory.

B. Contractor's Jobsite Drawings

Provide and maintain on the jobsite one complete set of prints of all drawings which form a part of the contract. Immediately after each portion of the work is installed, indicate all deviations from the original design shown in the drawings either by additional sketches or ink thereon. Upon completion of the job, deliver this record set to the Owner's Representative.

END OF SECTION

SECTION 014210 GENERAL ABBREVIATIONS

A. General

Interpret abbreviations used in the drawings and in the specifications as tabulated below. If an abbreviation on a drawing is not explained below, it shall be as explained in ANSI Y1.1. The interpretation of abbreviations shall consider the context or discipline in which they are used, for example:

1. FF usually means "finish floor" when referring to a floor slab.

2. FF usually means "flat face" when referring to a pipe flange.

B. List of General Abbreviations

Abbreviation	**Term**
A	
A	Ampere/Area
AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	Architectural Aluminum Manufacturer's Association
AASHTO	American Association of State Highway and Transportation Officials
AB	Anchor Bolt/Aggregate Base
ABAN	Abandoned
ABC	Asphalt Base Course
ABS	Acrylonitrile-Butadiene-Styrene
ABT	About
AC	Acre/Asphaltic Concrete/Alternating Current/Air Conditioning
ACI	American Concrete Institute
ACP	Asbestos-Cement Pipe
ACU	Air Conditioning Unit
AD	Access Door
ADDL	Additional
ADJ	Adjacent

Abbreviation	Term
AE	Architect-Engineer
AF	Air Filter/Ampere Frame
AFBMA	Anti-Friction Bearing Manufacturer's Association
AGA	American Gas Association
AGMA	American Gear Manufacturer's Association
AHD	Ahead
AHU	Air Handling Unit
AI	The Asphalt Institute
AIA	American Institute of Architects
AICS	Amperes Interrupting Capacity, Symmetrical
AIEE	American Institute of Electrical Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AL	Aluminum
ALIGN	Alignment
ALM	Alarm
ALTN	Alternate
AMB	Ambient
AMCA	Air Movement and Control Association
AMP	Ampere
ANCH	Anchor
ANG	Angle
ANSI	American National Standards Institute
API	American Petroleum Institute
APPROX	Approximate
APWA	American Public Works Association
ARCH	Architecture/Architectural
AREA	American Railway Engineering Association
ARI	Air Conditioning and Refrigeration Institute
ARV	Air-Release Valve
ARVV	Air-Release/Vacuum Valve
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers

Abbreviation	Term
ASME	American Society of Mechanical Engineers
ASPH	Asphalt
ASSY	Assembly
ASTM	American Society of Testing and Materials
ATS	Automatic Transfer Switch
AVE	Avenue
AVG	Average
AWG	American Wire Gauge
AWPA	American Wood Preservers Association
AWPB	American Wood Preservers Bureau
AWS	American Welding Society
AWWA	American Water Works Association
B	
BB	Back-to-Back
BC	Beginning of Curve/Back of Curve/Bolt Circle
BCR	Begin Curb Return
BEG	Begin
BEP	Best Efficiency Point
BETW	Between
BF	Blind Flange
BHP	Brake Horsepower
BK	Back/Brake
BKR	Breaker
BL	Base Line
BLDG	Building
BLK	Block
BM	Bench Mark/Beam
BO	Blowoff
BOCA	Building Officials Code Administration International, Inc.
BOD	Biochemical Oxygen Demand
BOT	Bottom
BP	Baseplate
BR	Bronze/Branch
BRG	Bearing

Abbreviation	Term
BTN	Button
BTU	British Thermal Unit
BUR CBL	Buried Cable
BV	Butterfly Valve
BVC	Begin Vertical Curve
BW	Block Wall
C	
C	Conduit/Celsius
CAB	Crushed Aggregate Base
CALTRANS	California Department of Transportation
CANTIL	Cantilevered
CAP	Capacity
CATV	Cable Television
CB	Catch Basin/Circuit Breaker
CBC	California Building Code
CC	Cooling Coil
C-C	Center-to-Center
CCB	Concrete Block
CCP	Concrete Cylinder Pipe
CCS	Central Control Station
CD	Cross Drain/Condensate Drain/Ceiling Diffuser
CEC	California Electrical Code
CEM	Cement
CF	Cubic Feet/Curb Face
CFH	Cubic Feet Per Hour
CFM	Cubic Feet Per Minute
CFS	Cubic Feet Per Second
CG	Ceiling Grill
C & G	Curb and Gutter
CGA	Compressed Gas Association
CH	Chiller
CHG	Change
CHKD PL	Checkered Plate
CI	Cast Iron

Abbreviation	Term
CIP	Cast in Place/Cast-Iron Pipe
CISP	Cast- Iron Soil Pipe
CISPI	Cast-Iron Soil Pipe Institute
CJ	Construction Joint
CL	Centerline/Class/Clearance
CLR	Clear
CMAA	Crane Manufacturer's Association of America
CMC	Cement-Mortar Coated or Coating
CML	Cement-Mortar Lined or Lining
CMLCSP	Cement-Mortar Lined and Coated Steel Pipe
CMP	Corrugated Metal Pipe
CMPA	Corrugated Metal Pipe Arch
CMU	Concrete Masonry Unit
CO	Cleanout/Conduit Only
COL	Column
COMM	Communication
COMP	Composite
COMPL	Complete
CONC	Concrete
CONN	Connection
CONST	Construct or Construction
CONT	Continuous
CONTR	Contractor
COORD	Coordinate/Coordinated
COP	Copper
COR	Corner
CPLG	Coupling
CPU	Central Processing Unit
CRES	Corrosion Resistant Steel
CRSI	Concrete Reinforcing Steel Institute
CS	Carbon Steel/Commercial Standard
CSP	Corrugated Steel Pipe
CT	Center Top/Current Transformer
CTG	Coating

Abbreviation	Term
CTR	Center
CTV	Cable Television
CULV	Culvert
CU YD, CY	Cubic Yard
CYL	Cylinder
D	
D	Degree of Curvature
DB	Direct Buried/Decibel
DBL	Double
DC	Direct Current
DEPT	Department
DET	Detail/Detour
DG	Decomposed Granite
DI	Drop Inlet/Ductile Iron
DIA	Diameter
DIAG	Diagonal
DIM	Dimension
DIMJ	Ductile-Iron Mechanical Joint
DIP	Ductile-Iron Pipe
DIPRA	Ductile-Iron Pipe Research Association
DISCH	Discharge
DIST	Distance
DIV	Divide/Division
DO	Dissolved Oxygen
DMH	Drop Manhole
DN	Down
DP	Differential Pressure
DPI	Differential Pressure Indicator
DPNL	Distribution Panel
DR	Drain/Door
DSL	Diesel
DWG	Drawing
DWY	Driveway

Abbreviation	Term
E	
E	East
EA	Each
EC	End of Curve
ECC	Eccentric
ECR	End of Curb Return
ED	External Distance
EDUC	Eductor
EE	Each End
EF	Each Face/Exhaust Fan
EFF	Efficiency
EFL	Effluent
EG	Existing Grade
EGL	Energy Grade Line
EL	Elevation/Each Layer
E/L	Easement Line
ELEC	Electric
ELEV	Elevation
ELL	Elbow
ELP	Elliptical
EMB	Embankment
ENC	Encasement
ENCL	Enclosure
ENG	Engine
ENGR	Engineer
EOP	Edge of Pavement
EOS	Equivalent Opening Size
EOTW	Edge of Traveled Way
EP	Explosion Proof/Edge of Pavement
EPA	Environmental Protection Agency (Federal)
EPR	Ethylene-Propylene Rubber
EQ	Equation
EQL	Equal
ESMT	Easement

Abbreviation	Term
EST	Estimate or Estimated
ETC	And so Forth
ETM	Elapsed Time Meter
EVAP	Evaporator
EVC	End Vertical Curve
EW	Each Way
EWC	Electric Water Cooler
EXC	Excavate or Excavation
EXP	Expansion
EXST	Existing
EXT	Exterior/Extension
F	
F	Fahrenheit/Floor
FAB	Fabricate
FBEL & C	Fusion-Bonded Epoxy Lined and Coated
FBRBD	Fiberboard
FC	Foot-Candle
FCC	Filter Control Console
FCO	Floor Cleanout
FCV	Flow Control Valve
FD	Floor Drain
FDN	Foundation
FE	Flanged End
FF	Finished Floor/Flat Face
FG	Finished Grade
FHY	Fire Hydrant
F&I	Furnish and Install
FIG	Figure
FIN	Final
FIT	Fitting
FL	Floor/Flow Line
FLEX	Flexible/Flexure
FLG	Flange
FLT	Float

Abbreviation	Term
FLUOR	Fluorescent
FM	Force Main/Factory Mutual
FMH	Flexible Metal Hose
FNSH	Finish
FOC	Face of Concrete
FOS	Face of Stud
FPC	Flexible Pipe Coupling
FPM	Feet Per Minute
FPS	Feet Per Second
FPT	Female Pipe Thread
FRP	Fiberglass-Reinforced Plastic
FS	Finished Surface/Floor Sink/Federal Specifications
FSTNR	Fastener
FT	Feet or Foot
FTG	Footing
FUT	Future
FWY	Freeway
FX	Fire Extinguisher
G	
G	Gas
GA	Gauge
GAL	Gallon
GALV	Galvanized
GAS	Gasoline
GB	Grade Break
GDR	Guard Rail
GE	Grooved End
GEN	Generator
GENL	General
GFI	Ground Fault Interrupter
GM	Gas Main
GMT	Greenwich Mean Time
GND	Ground
GPD	Gallons Per Day

Abbreviation	Term
GPM	Gallons Per Minute
GR	Grade
GRTG	Grating
GSKT	Gasket
GUT	Gutter
GV	Gate Valve
GWB	Gypsum Wallboard
GWBX	Gypsum Wallboard, Fire Rated
GYP	Gypsum
H	
H	Humidistat
HARN	Harness
HB	Hose Bibb
HC	Heating Coil
HD	Heavy Duty
HDPE	High Density Polyethylene
HEPA	High Efficiency Particulate Air
HGL	Hydraulic Grade Line
HGT	Height
HID	High Intensity Discharge
HOA	Hand-Off-Automatic
HOR	Hand-Off-Remote
HORIZ	Horizontal
HP	Horsepower/High Pressure
HPS	High Pressure Sodium
HPT	High Point
HR	Hour/Handrail
HS	High Strength
HTG	Heating
HTR	Heater
HV	Hose Valve
HVAC	Heating, Ventilating, and Air Conditioning
HVY	Heavy
HW	Headwall/Hot Water

Abbreviation	Term
HWL	High Water Level
HWY	Highway
HYDR	Hydraulic
HZ	Hertz (cycles per second)
I	
I	Intersection Angle
ICBO	International Conference of Building Officials
ID	Inside Diameter
IE	Invert Elevation
IEEE	Institute of Electrical and Electronics Engineers
IN	Inches
INCAND	Incandescent
INCL	Include
INL	Inlet
INS	Insulating
INSTL	Install or Installation
INTR	Interior/Intersection
INV	Invert
IP	Iron Pipe
IPS	Iron Pipe Size
IPT	Iron Pipe Thread
IRR	Irrigation
ISA	Instrument Society of America
IX	Ion Exchange
J	
J	Joist
JB	Junction Box
JCT	Junction
JIC	Joint Industrial Council
JN	Join
JT	Joint
K	
KG	Kilogram
KM	Kilometer

Abbreviation	Term
KIPS	Thousands of Pounds
KV	Kilovolt
KVA	Kilovolt-Ampere
KW	Kilowatt
KWH	Kilowatt-Hour
KWHM	Kilowatt-Hour Meter
L	
L	Length of Curve/Long/Left
LATL	Lateral
LAV	Lavatory
LB	Pound
LBR	Lumber
LCL	Local
LF	Linear Foot
LG	Long
LGTH	Length
LI	Level Indicator
LLO	Long Leg Outstanding
LOC	Location/Locate
LONGIT	Longitudinal
LOS	Lockout Stop
LP	Light Pole
LPT	Low Point
LR	Long Radius
LS	Lift Station
LT	Left/Light
LTG	Lighting
LWC	Lightweight Concrete
LWIC	Lightweight Insulating Concrete
LWL	Low Water Level
M	
MA	Milliampere
MAG	Magnet/Magnetic
MATL	Material

Abbreviation	Term
MAX	Maximum
MB	Machine Bolt/Megabyte/Millibars
MBH	Thousand BTU Per Hour
MECH	Mechanical
MC	Metal Channel
MCC	Motor Control Center
MCM	Thousand Circular Mils
MCP	Motor Circuit Protector
MD	Motorized Damper
MFR	Manufacturer
MG	Million Gallons/Milligram
MGD	Million Gallons Per Day
MG/L	Milligrams Per Liter
MH	Manhole
MHZ	Megahertz
MI	Malleable Iron/Mile
MIL	Military Specifications
MIN	Minimum
MISC	Miscellaneous
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
MJ	Mechanical Joint
MMA	Monorail Manufacturer's Association
MO	Motor Operator/Motor Operated/Masonry Opening
MOD	Modification
MON	Monument
MOT	Motor
MPT	Male Pipe Thread
MSL	Mean Sea Level
MSS	Manufacturer's Standardization Society
MTD	Mounted
N	
N	North/Neutral/Nitrogen
NA	Not Applicable

Abbreviation	Term
NAAMM	National Association of Architectural Metal Manufacturers
NBFU	National Board of Fire Underwriters
NBS	National Bureau of Standards
N & C	Nail and Cap
NC	Normally Closed
NDT	Nondestructive Testing
NE	Northeast
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFC	National Fire Code
NH	National Hose
NIC	Not in Contract
NIP	Nipple
NMTBA	National Machine Tool Builders Association
NO	Number/Normally Open
NOM	Nominal
NPT	National Pipe Taper
NRS	Nonrising Stem
NSF	National Sanitation Foundation
NTS	Not to Scale
NTU	Nephelometric Turbidity Unit
NW	Northwest
NWL	Normal Water Level
O	
OA	Overall/Outside Air
OC	On Center/Overcurrent
OD	Outside Diameter
ODP	Open Dripproof
OE	Or Equal
OF	Outside Face
OPER	Operator
OPNG	Opening
OPP	Opposite
ORIG	Original

Abbreviation	Term
OSA	Outside Air
OSHA	Occupational Safety and Health Administration
O TO O	Out to Out
OVFL	Overflow
OVHD	Overhead
P	
P	Pole
PARA	Paragraph
PB	Push Button/Pull Box
PC	Point of Curvature/Programmable Controller
PCA	Portland Cement Association
PCC	Point of Compound Curvature/Portland Cement Concrete
PDI	Plumbing and Drainage Institute
PE	Plain End/Polyethylene/Professional Engineer
PEN	Penetration
PERF	Perforated
PF	Power Factor
PG	Pressure Gauge
PI	Point of Intersection
PJTN	Projection
PKWY	Parkway
PL	Plate/Property Line
PLATF	Platform
PLC	Programmable Logic Controller
PLF	Pounds Per Lineal Foot
PNL	Panel
POB	Point of Beginning
POC	Point of Connection
POJ	Push-On Joint
PP	Power Pole/Polypropylene
PPB	Parts Per Billion
PPM	Parts Per Million
PR	Pair
PRC	Point of Reverse Curve

Abbreviation	Term
PRESS	Pressure
PRL	Parallel
PROV	Provisions
PRPSD	Proposed
PRVC	Point of Reverse Vertical Curve
PSI	Pounds Per Square Inch
PSIG	Pounds Per Square Inch Gauge
PSF	Pounds Per Square Foot
PSHL	Pressure Switch (High/Low)
PSL	Pressure Switch (Low)
PT	Point of Tangency
PV	Plug Valve
PVC	Polyvinyl Chloride
PVMT	Pavement
PWR	Power
Q	
Q	Flow Rate
QTY	Quantity
R	
R	Right/Radius
RAD	Radius/Radial
RAF	Return Air Fan
RAG	Return Air Grille
RC	Reinforced Concrete
RCB	Reinforced Concrete Box
RCP	Reinforced Concrete Pipe
RCPA	Reinforced Concrete Pipe Arch
RD	Road
RDC	Reduce
RDCR	Reducer
RDWY	Roadway
REF	Reference
REINF	Reinforce or Reinforced
RELOC	Relocated

Abbreviation	Term
REQ	Required/Requirement
REQD	Required
REV	Revise/Revision
RF	Raised Face
RH	Relative Humidity
RND	Round
RJ	Restrained Joint
RLG	Railing
RPM	Revolutions Per Minute
RR	Railroad
RST	Reinforcing Steel
RT	Right
RTD	Resistance Temperature Detector
RTU	Remote Terminal Unit
R/W	Right-of-Way
S	
S	South/Slope in Feet Per Foot/Sewer
SAE	Society of Automotive Engineers
SAN	Sanitary
SAR	Supply Air Register
SBCCI	Southern Building Codes Congress International
SC	Seal Coat
SCFM	Standard Cubic Feet Per Minute
SCHED	Schedule
SCR	Silicon-Controlled Rectifier/Selective Catalytic Reduction
SCRN	Screen
SD	Storm Drain
SDG	Siding
SDI	Steel Deck Institute
SDWK	Sidewalk
SE	Southeast
SECT	Section
SF	Square Feet
SGL	Single

Abbreviation	Term
SH	Sheet/Sheeting/Shielded
SIM	Similar
SLP	Slope
SLV	Sleeve
SM	Sheet Metal
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SMAW	Shielded Metal Arc Welding
SOL	Solenoid
SOV	Solenoid-Operated Valve
SP	Space/Steel Pipe/Static Pressure/Spare
SPCG	Spacing
SPEC	Specification
SPLC	Splice
SPRT	Support
SQ	Square
SQ FT	Square Feet
SR	Short Radius
SS	Sanitary Sewer
SSPC	Steel Structures Painting Council
SST	Stainless Steel
ST	Street
STA	Station
STBY	Standby
STC	Sound Transmission Class
STD	Standard
STK	Stake
STL	Steel
STR	Straight
STRL	Structural
STRUCT	Structure
STS	Storm Sewer
STGR	Stringer
STWY	Stairway
SURF	Surface

Abbreviation	Term
SW	Southwest
SWG	Swing
SWI	Steel Window Institute
SYMM	Symmetrical
SYS	System
T	
T	Ton/Tangent Length of Curve/Telephone
TAN	Tangent
T/B	Top of Beam
TB	Top of Bank/Terminal Board
T & B	Top and Bottom
TBG	Tubing
TBM	Temporary Bench Mark
TC	Top of Curb
TD	Time Delay
TDH	Total Dynamic Head
TDS	Total Dissolved Solids
TEFC	Totally Enclosed Fan Cooled
TEL	Telephone
TEMP	Temperature/Temporary
TENV	Totally Enclosed Nonventilated
THB	Thrust Block
THD	Thread or Threaded
THH	Thrust Harness
THK	Thick
TIG	Tungsten Inert Gas
TIR	Total Indicator Reading
TO	Turnout
T/O	Top of
TOC	Top of Concrete
TOS	Top of Slab/Top of Steel
TOT	Total
TP	Telephone Pole
TRD	Tread

Abbreviation	Term
TRA	Tie Rod Assembly
TS	Tube Steel
TV	Television
TYP	Typical
U	
UBC	Uniform Building Code
UD	Underdrain
UG	Underground
UH	Unit Heater
UHMW	Ultra High Molecular Weight
UL	Underwriters' Laboratories, Inc.
ULT	Ultimate
UNO	Unless Noted Otherwise
UPS	Uninterruptible Power Supply
UR	Urinal
USGS	United States Geological Survey
UTC	Underground Telephone Cable
UTR	Up Through Roof
UV	Ultraviolet
V	
V	Vent/Valve/Volt
VAC	Vacuum/Volts, Alternating Current
VC	Vertical Curve
VCP	Vitrified Clay Pipe
VEL	Velocity
VERT	Vertical
VFD	Variable Frequency Drive
VOL	Volume
VPC	Vertical Point of Curve
VPI	Vertical Point of Intersection
VPT	Vertical Point of Tangency
VSS	Volatile Suspended Solids
VTR	Vent Through Roof

Abbreviation	Term
W	
W	West/Watt/Wide/Water
W/	With
WC	Water Closet
WCO	Wall Cleanout
WG	Water Gauge
WH	Wall Hydrant
WL	Waterline
WLD	Welded
WM	Water Meter/Water Main
W/O	Without
WP	Waterproof/Working Point
WRGWB	Water-Resistant Gypsum Wallboard
WSE	Water Surface Elevation
WSP	Water Stop
WT	Weight
WTR	Water
WWF	Welded Wire Fabric (same as WWR)
WWM	Woven Wire Mesh (same as WWR)
WWR	Welded Wire Reinforcement
X	
XFMR	Transformer
XFR	Transfer
Y	
YCO	Yard Cleanout
YD	Yard
YP	Yield Point
YR	Year
YS	Yield Strength
Z	

END OF SECTION

SECTION 015100 CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

A. Construction Water

1. Related Work Specified Elsewhere:

    a. Earthwork: 312300.

    b. Trenching, Backfilling, and Compacting: 312316.

2. The Contractor shall make his own arrangements for developing water sources and supply labor and equipment to collect, load, transport, and apply water as necessary for compaction of materials, concrete construction operations, testing, pipeline disinfection, dust control, and other construction use.

3. Obtain water at no cost from the Owner’s system. Obtain a construction water meter from the Owner; all water shall be metered.

B. Electrical Power-Construction Phase

Provide for the purchase of power or provide portable power for the construction of the project where existing outlets are not available. Provide for the extension of utility lines to the point of usage.

C. Dust Control

Perform dust control operations to prevent construction operations from producing dust in amounts harmful to persons or causing a nuisance to persons living nearby or occupying buildings in the vicinity of the work. Use water or dust preventative to control dust.

D. Fire Danger

Minimize fire danger in the vicinity of and adjacent to the construction site. Provide labor and equipment to protect the surrounding private property from fire damage resulting from construction operations.

E. Construction Staking

Construction staking will be the responsibility of the Contractor.

F. Red Imported Fire Ant Quarantine (Southern California)

1. All of Orange County, portions of Los Angeles County, and portions of Riverside County are under federal and state quarantine for red imported fire ant (Solenopsis invicta). This quarantine affects the following items:

   a. Soil, separately or with other articles, except when commercially packaged. Soil for the purpose of this section shall include all excavated earth, fill material, and growing media.

   b. Baled hay and baled straw stored in direct contact with the ground.

   c. Plants and sod with roots and soil attached.

   d. Excess soil to be removed from the project site.

   e. Fill material and topsoil to be imported to the project site.

   f. Used soil/earth-moving equipment, unless free of all soil.

   g. Debris and excess material resulting from demolition and removal operations (such as concrete rubble, pipe that has been removed from the ground, and other materials that have come in direct contact with the ground), unless free of soil.

2. Under the provisions of this quarantine, it is unlawful to move within or from the quarantine area any commodity covered by the quarantine, except when certified by the County Agricultural Commissioner. Obtain any necessary inspections and certifications from the Orange County Agricultural Commissioner, prior to moving any quarantined product within or from the project area. Certification and inspections shall conform to the requirements of Title 23 California Code of Regulations, Section 3432.

END OF SECTION

SECTION 017410 CLEANING DURING CONSTRUCTION AND FINAL CLEANING

A. General

1. This section includes cleaning during construction and final cleaning on completion of the work.

2. At all times maintain areas covered by the contract and adjacent properties and public access roads free from accumulations of waste, debris, and rubbish caused by construction operations.

3. Conduct cleaning and disposal operations to comply with local ordinances and antipollution laws. Do not burn or bury rubbish or waste materials on project site. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in storm or sanitary drains. Do not dispose of wastes into streams or waterways.

4. Use only cleaning materials recommended by manufacturer of surface to be cleaned.

B. Cleaning During Construction

1. During execution of work, clean site, adjacent properties, and public access roads and dispose of waste materials, debris, and rubbish to assure that buildings, grounds, and public properties are maintained free from accumulations of waste materials and rubbish.

2. Wet down dry materials and rubbish to lay dust and prevent blowing dust.

3. Provide containers for collection and disposal of waste materials, debris, and rubbish.

4. Cover or wet excavated material leaving and arriving at the site to prevent blowing dust. Clean the public access roads to the site of any material falling from the haul trucks.

C. Final Cleaning

1. At the completion of work and immediately prior to final inspection, clean the entire project site as follows.

2. Clean, sweep, wash, and polish all work and equipment including finishes.

3. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces; polish surfaces.

4. Repair, patch, and touch up marred surfaces to match adjacent surfaces.

5. Broom clean paved surfaces; rake clean landscaped areas.

6. Remove from the site temporary structures and materials, equipment, and appurtenances not required as a part of, or appurtenant to, the completed work.

END OF SECTION

SECTION 019310 OPERATION AND MAINTENANCE MANUALS

A. General

Submit six copies of all manufacturer's operation and maintenance manuals and data pertinent to equipment supplied for the project. Prepare and organize the material in three-ring binders with divider tabs and labels. Include a table of contents.

B. Submittals

1. Submittals shall include:

   a. List of equipment furnished for project with name, address, and telephone number of each vendor.

   b. List of serial numbers of equipment furnished.

   c. A copy of shop drawings for mechanical, electrical, and instrument equipment in final form.

   d. Manufacturer's operation and maintenance instructions and parts lists.

   e. Tabulation of motor nameplate horsepower, nameplate current, field-measured current, overload relay setting, and catalog number for polyphase motors.

   f. List of fuses, lamps, seals, and other expendable equipment and devices. Specify size, type, and ordering description. List name, address, e-mail address, fax number, and telephone number of vendor.

2. Provide manuals for each piece of equipment including individual components and subsystems of complete assemblies. Line out nonapplicable text and illustrations. The section of the manual on operation shall describe the functions and limitations of each component and its relationship to the system of which it is a part. Where several models, options, or styles are described, the manual shall identify the items actually provided.

3. Each manual shall contain the following:

   a. Manufacturer's identification, including order number, model, and serial number.

b. Blue line prints or reviewed shop drawings and diagrams of all systems.

c. Certified equipment drawings or reviewed shop drawing data clearly marked for equipment furnished.

d. Complete operating and maintenance instructions for each and every item of equipment, setting forth in detail and step-by-step the procedure for starting, stopping, operating, and maintaining the entire system as installed. Include a schedule of recommended maintenance intervals.

e. Complete parts list of replaceable parts, their part numbers, and the name and address of their nearest vendor.

f. Any special emergency operating instruction and a list of service organizations (including addresses and telephone numbers) capable of rendering emergency service to the various parts of the system.

g. Copy of manufacturer's equipment guarantees and warranties.

4. Brochures shall be loose leaf with durable plastic or fiberboard covers. Each sheet shall be reinforced to prevent tearing from continued use, and each brochure shall have the following information clearly printed on its cover:

    a. Project name, name of Owner, and address.

    b. Name and address of Owner's Representative.

    c. Name and addresses of contractors and subcontractors and department to contact.

    d. Telephone number of contractors, including night and emergency numbers.

    e. Major equipment vendors' names and telephone numbers.

5. Submit complete manuals at least four weeks before the date of the instructions required by the subsections on "Manufacturer's Services" in the various specification sections.

6. Operation and maintenance manuals specified herein are in addition to any operation, maintenance, or installation instructions required by the Contractor to install, test, and start up equipment.

C. Equipment Data Sheets

Provide six sets of equipment data sheets, bound in three-ring binders, summarizing the equipment manufacturer's maintenance instructions and recommendations. A blank data sheet and a sample data sheet are attached.

Preventive Maintenance and Operating Requirement Sheets

<table>
<tr><td colspan="2">Preventive Maintenance Program</td><td colspan="2">Equipment Record Number</td></tr>
<tr><td colspan="2">EQUIPMENT DESCRIPTION</td><td colspan="2">ELECTRICAL OR MECHANICAL DATA</td></tr>
<tr><td colspan="2">Name:</td><td colspan="2">Size:</td></tr>
<tr><td colspan="2">Serial No.:</td><td colspan="2">Model:</td></tr>
<tr><td colspan="2">Vendor:</td><td colspan="2"></td></tr>
<tr><td colspan="2" rowspan="2">Vendor Address:</td><td colspan="2">Type:</td></tr>
<tr><td colspan="2">Mfr.:</td></tr>
<tr><td colspan="2">Vendor Rep:</td><td>Voltage:</td><td>Amps:</td></tr>
<tr><td colspan="2">Phone:</td><td>Phase:</td><td>rpm:</td></tr>
<tr><td colspan="3">Maintenance Work to be Done</td><td>Frequency*</td></tr>
<tr><td colspan="3"></td><td></td></tr>
<tr><td colspan="4">OPERATING REQUIREMENTS AND REFERENCE</td></tr>
</table>

*D - Daily; W - Weekly; B - Biweekly; M - Monthly; Q - Quarterly; S - Semiannually; A - Annually.

SAMPLE

Preventive Maintenance and Operating Requirement Sheets

<table>
<tr><td colspan="2">Preventive Maintenance Program</td><td colspan="2">Equipment Record Number</td></tr>
<tr><td colspan="2">EQUIPMENT DESCRIPTION</td><td colspan="2">ELECTRICAL OR MECHANICAL DATA</td></tr>
<tr><td colspan="2">Name: Influent Pump No. 1
Tag No.: P01-1</td><td colspan="2">Size: 15 hp</td></tr>
<tr><td colspan="2">Serial No.: 123456ABC
Vendor: ABC Pump Co.</td><td colspan="2">Model: 140T Frame
Serial No. 987654ZY
Class F Insulation
W/Space Heater</td></tr>
<tr><td colspan="2" rowspan="2">Vendor Address:
1111 Pump Circle
Newport Beach, CA 92663</td><td colspan="2">Type:</td></tr>
<tr><td colspan="2">Mfr.: DEF Motors, Inc.</td></tr>
<tr><td colspan="2">Vendor Rep: XYZ Equipment, Inc.</td><td>Voltage: 460</td><td>Amps: 20</td></tr>
<tr><td colspan="2">Phone: 714/752-0505</td><td>Phase: 3</td><td>rpm: 1,800</td></tr>
<tr><td colspan="2">Maintenance Work to be Done</td><td></td><td>Frequency*</td></tr>
<tr><td colspan="3">1. Operate all valves and check such things as a) bearing temperature, b) changes in running sound, c) suction and discharge gauge readings, d) pump discharge rate, and e) general condition of the drive equipment.
2. Check packing.
3. Checking pumping unit for any dust, dirt, or debris.
(Continued on attached sheet)</td><td>D
D
W</td></tr>
<tr><td colspan="4">OPERATING REQUIREMENTS AND REFERENCE</td></tr>
<tr><td colspan="4">For manufacturer's instructions regarding installation, operation, maintenance, and trouble shooting of this equipment, see Volume ____, Section ______.</td></tr>
</table>

*D - Daily; W - Weekly; B - Biweekly; M - Monthly; Q - Quarterly; S - Semiannually; A - Annually.

SAMPLE

Preventive Maintenance and Operating Requirement Sheets

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<tr><td>Vendor Rep:</td><td>Voltage:</td><td>Amps:</td></tr>
<tr><td>Phone:</td><td>Phase:</td><td>rpm:</td></tr>
<tr><td>Maintenance Work to be Done</td><td></td><td>Frequency*</td></tr>
<tr><td colspan="2">4. Lubricate bearing frame and motor bearings (consult manufacturer's instructions for type of grease or oil).

5. Disassemble and change or repair the following: a) impeller, b) shafts, c) shaft sleeve, d) rotary seals, and e) sleeve bearings.</td><td>Q

A</td></tr>
<tr><td colspan="3">OPERATING REQUIREMENTS AND REFERENCE</td></tr>
<tr><td colspan="3"></td></tr>
</table>

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END OF SECTION

SECTION 020120 PROTECTING EXISTING UNDERGROUND UTILITIES

PART 1 - GENERAL

A. Description

This section includes materials and procedures for protecting existing underground utilities.

B. Related Work Specified Elsewhere

Trenching, Backfilling, and Compacting: 312316.

PART 2 - MATERIALS

A. Replacement in Kind

Except as indicated below or as specifically authorized by the Owner's Representative, reconstruct utilities with new material of the same size, type, and quality as that removed.

B. Vitrified Clay Sewer Pipe and Couplings

For sewer pipe 8 inches and less in diameter, replacement shall consist of plain-end pipe conforming to ASTM C 700. Compression couplings shall conform to ASTM C 594, band seal couplings or equal. Use at least two lengths of pipe in crossing the trench section or as shown on the details in the drawings.

PART 3 - EXECUTION

A. General

1. Replace in kind street improvements, such as curbs and gutters, barricades, traffic islands, signalization, fences, signs, etc., that are cut, removed, damaged, or otherwise disturbed by the construction.

2. Where utilities are parallel to or cross the construction but do not conflict with the permanent work to be constructed, follow the procedures given below and as indicated in the drawings. Notify the utility owner 48 hours in advance of the crossing construction and

coordinate the construction schedule with the utility owner's requirements. For utility crossings not shown in the drawings, refer to the General Provisions and the instructions of the Owner's Representative for guidance.

3. Determine the true location and depth of utilities and service connections which may be affected by or affect the work. Determine the type, material, and condition of these utilities. In order to provide sufficient lead time to resolve unforeseen conflicts, order materials and take appropriate measures to ensure that there is no delay in work.

B. Procedures

1. Protect in Place: Protect utilities in place, unless abandoned, and maintain the utility in service, unless otherwise specified in the drawings or in the specifications.

2. Cut and Plug Ends: Cut abandoned utility lines and plug the ends. Plug storm drains and sewers with an 8-inch wall of brick and mortar. Cap waterlines with a cast-iron cap or install a 3-foot-long concrete plug. Dispose of the cut pipe as unsuitable material.

3. Remove and Reconstruct: Where so indicated in the drawings or as required by the Owner's Representative, remove the utility and, after passage, reconstruct it with new materials. Provide temporary service for the disconnected utility.

C. Compaction

1. Utilities Protected in Place: Backfill and compact under and around the utility so that no voids are left.

2. Utilities Reconstructed: Prior to replacement of the utility, backfill the trench and compact to an elevation 1 foot above the top of the ends of the utility. Excavate a cross trench of the proper width for the utility and lay, backfill, and compact.

3. Alternative Construction--Sand-Cement Slurry: Sand-cement slurry consisting of one sack (94 pounds) of portland cement per cubic yard of sand and sufficient moisture for workability may be substituted for other backfill materials to aid in reducing compaction

difficulties. Submit specific methods and procedures for the review of the Owner's Representative prior to construction.

D. Thrust Blocks on Waterlines

1. The Contractor's attention is called to thrust blocks for waterlines throughout the project whose thrust is in the direction of the new excavation and, therefore, may be affected by the construction. These waterlines are owned and operated by the Owner. Protect thrust blocks in place or shore to resist the thrust by a means approved by the Owner's Representative. If the thrust blocks are exposed or rendered to be ineffective in the opinion of the Owner's Representative, reconstruct them to bear against firm unexcavated or backfill material.

2. Provide firm support by backfilling that portion of the trench for a distance of 2 feet on each side of the thrust block to be reconstructed from the pipe bedding to the pavement subgrade, with either:

    a. Sand-cement slurry (94 pounds of cement per cubic yard).

    b. The native material compacted to a relative compaction of 95%.

3. Then excavate the backfill material for construction of the thrust block.

4. Test compaction of the backfill material before pouring any concrete thrust block. Use Class C concrete per Section 030500 for reconstruction.

END OF SECTION

SECTION 030500 GENERAL CONCRETE CONSTRUCTION

PART 1 - GENERAL

A. Description

This section includes materials, installation, and testing of formwork, reinforcing steel, joints, concrete, and finishing and curing for general concrete construction.

B. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Prepare concrete and mortar mix designs and laboratory 7-day and 28-day compressive tests, or submit test reports of 7- and 28-day compressive tests of the mix where the same mix has been used on two previous projects. Prepare mix designs in accordance with ACI 318, Chapters 4 and 5, except as modified herein. Submit mix design in writing for review by the Owner at least 15 days before placing of any concrete.

3. Submit mill test certificates identifying chemical and physical analyses of each load of reinforcing steel delivered. If mill test reports are unavailable and the quantity of steel for a structure exceeds 5 tons, provide a laboratory test to prove conformance with the specified ASTM standard.

4. Submit reinforcing bending lists and placing drawings for all reinforcing. Placing drawings shall indicate all openings (mechanical, electrical, equipment, and architectural) including additional reinforcing at openings and corner bar arrangements at intersecting beams, walls, and footings indicated in the typical detail and structural drawings. Placing drawings shall be coordinated with the concrete placing schedule. Each bending list and placing drawing submitted shall be complete for each major element of a structure (grade slabs, footings, walls, or floor slabs) including dowels and corner bars. Furnishing such lists shall not be construed that the lists will be reviewed for accuracy. The Contractor shall be wholly and completely responsible for the accuracy of the lists and for

furnishing and placing reinforcing steel in accordance with the details shown in the drawings and as specified. Placing drawings shall be prepared by the Contractor and shall not incorporate photocopies of the contract drawings.

5. Submit six copies of a report from a testing laboratory verifying that aggregate material contains less than 1% asbestos by weight or volume and conforms to the specified gradations or characteristics.

PART 2 - MATERIALS

A. Nondomestic Cement and Additives

1. The use of nondomestic cement and additives in concrete may be permitted only after review of a written request to use such materials. The request to use nondomestic materials shall include a chemical analysis that indicates the material meets the project specifications. Certifications that state the nondomestic materials meet the project requirements will not be accepted.

2. Test reports for concrete materials shall be current to within three months of inclusion into the project and shall be identifiable to the materials supplied.

B. Formwork

1. Design forms according to ACI 347.

2. Class I Forms: Use steel forms, ply form, or smooth-surface plywood 3/4-inch minimum thickness for straight surfaces and 1/2-inch minimum thickness for curved surfaces.

3. Class II Forms: Use plywood in good condition, metal, or smooth-planed boards free from large or loose knots with tongue and groove or ship lap joints.

4. Class II forms may be used for exterior concrete surfaces that are 1 foot or more below finished grade. Use Class I forms for all other surfaces.

5. Coat forms with form release agent.

C. Form Release Agent

1. Form release agent shall effectively prevent absorption of moisture and prevent bond with the concrete. Agent shall be nonstaining and nontoxic after 30 days.

2. For steel forms, release agent shall prevent discoloration of the concrete due to rust.

D. Reinforcing Steel

1. Reinforcement shall conform to ASTM A615 or A706, Grade 60 deformed.

2. Fabricate reinforcing in accordance with the current edition of the Manual of Standard Practice, published by the Concrete Reinforcing Steel Institute. Bend reinforcing steel cold.

3. Deliver reinforcing steel to the site bundled and with identifying tags.

E. Tie Wire

Tie wire shall be 16 gauge minimum, black, soft annealed.

F. Bar Supports

Use concrete supports for reinforcing in concrete placed on grade.

G. Bar Couplers

Reinforcing steel bar splicing couplers shall be a mechanical type as manufactured by Dayton Barsplice Inc. or equal. Use couplers that do not reduce tensile or ultimate strength of bars.

H. Joint Sealant for Concrete Structures

1. Joint sealant shall be a multipart, gray, nonstaining, nonsagging, gun grade polyurethane sealant, which cures at ambient temperature to a firm, flexible, resilient, tear-resistant rubber. Sealant shall comply with ASTM C920, Type M, Grade P, Class 25 for horizontal joints and Grade NS, Class 25 for vertical joints and be recommended by the manufacturer for continuous immersion in water.

Characteristic or Parameter	Technical Requirements
Pot life	1 to 3 hours
Hardness	35 Shore A, ±5, ASTM D2240
Elongation	650%, ASTM D412
Tensile strength	200 psi, ASTM D412
Peel strength on concrete	No adhesion loss at 25 pounds
Temperature service range	40°F to 167°F
Immersion in water	Continuous

2. Sealant shall be Tremco Vulkem 227 or Sikaflex-2CNS (for Grade NS, Class 25), Sikaflex-2CSL of Sika Corporation or Vulkem 245 (for Type M, Grade P, Class 25), or equal. Troweling of sealants into joints will not be permitted.

I. Preformed Control Joint

Preformed control joint shall be a one-piece, flexible, PVC joint former, such as Kold-Seal Zip-Per Strip KSF-150-50-50, manufactured by Vinylex Corp., Knoxville, Tennessee, or a one-piece steel strip with preformed groove, such as Keyed Kold Retained Kap, manufactured by Burke Concrete Accessories, Inc., San Mateo, California, or equal. Provide the preformed control joint material in full-length unspliced pieces.

J. Cement

1. Use domestic portland cement that conforms to ASTM C150, Type II/V.

2. Use only one brand of cement in any individual structure. Use no cement that has become damaged, partially set, lumpy, or caked. Reject the entire contents of the sack or container that contains such cement. Use no salvaged or reclaimed cement.

3. Maximum tricalcium aluminate shall not exceed 8%. The maximum percent alkalies shall not exceed 0.6%.

K. Aggregates

Aggregates shall be natural rock, sand, or crushed natural rock; shall comply with ASTM C33; and shall contain less than 1% asbestos by weight or volume. Aggregates shall be free from any substances that will react with the cement alkalies, as determined by Appendix X-1 of ASTM C33.

L. Water and Ice

Use water and ice that is clean and free from objectionable quantities of organic matter, alkali, salts, and other impurities that might reduce the strength, durability, or otherwise adversely affect the quality of the concrete. Water shall not contain more than 500 mg/L of chlorides or more than 500 mg/L of sulfate.

M. Color Additive for Exterior Electrical Duct Encasement

For exterior electrical duct concrete encasements, use a color additive for identification purposes: brick red "Colorfull" as manufactured by Owl Manufacturing Company, Arcadia, California; coral red "Chromix C-22" as manufactured by L. M. Scofield Company, Los Angeles, California; or equal. Add the color additive while the concrete is being mixed using the quantity per cubic yard of concrete recommended by the manufacturer for the class of concrete indicated.

N. Concrete Admixtures

1. Class A concrete shall contain an air-entraining admixture conforming to ASTM C260. Admixtures shall be Master Builders MB-AE 90, Sika AER, or equal.

2. Class A concrete shall contain a water-reducing admixture conforming to ASTM C494, Type A or D. It shall be compatible with the air-entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's recommendations. Admixture shall be Master Builders Pozzolith polymer-type normal setting, Plastocrete 161 or Plastiment, Sika Chemical Corporation, or equal.

3. Pozzolan Admixture: Where specified, provide concrete containing pozzolan admixture conforming to ASTM C618.

4. Do not use any admixture that contains chlorides or other corrosive elements in any concrete. Admixtures shall be nontoxic after 30 days.

O. Repair Mortar

1. Mortar used for repair of concrete voids shall be made of the same materials as used for concrete, except that the coarse aggregate shall be omitted or the mortar

shall consist of not more than one part cement to two and one-half parts sand by damp loose volume. The quantity of mixing water shall be no more than necessary for handling and placing.

2. Materials for repair of major defects or cracks shall be in accordance with "Repair of Defects and Cracks" specified in Part 3.

P. Bonding Compound

1. Epoxy bonding compound shall be Sikadur 32 Hi-Mod, Sika Chemical Corporation, Lyndhurst, New Jersey; Concresive by BASF; Euco Epoxy 452 by Euclid Chemical Company; or equal.

2. Nonepoxy bonding compound shall be Weldcrete by Larsen Products Corp., Link by Sta-Dry Manufacturing Corp., Euco Weld by Euclid Chemical Co., or equivalent. The compound shall be rewettable for up to two weeks.

Q. Concrete Mix Design

1. Conform to ASTM C94, except as modified by these specifications.

2. Air content as determined by ASTM C231 shall be 4% ±1%.

3. Maximum water-cement ratio for Class A concrete = 0.45 by weight.

4. Use classes of concrete as described in the following table:

Class	Type of Work	28-Day Compressive Strength (in psi)	Minimum Cement Content (in lbs per C.Y.)
A	Concrete for all structures and concrete not otherwise specified. Concrete fill at structure foundations, cradle, supports across pipe trenches.	4,000	564
C	Unreinforced concrete.	2,000	376

5. Measure slump in accordance with ASTM C143. Slump shall be as follows:

Slab on grade or heavy sections wider (in plan view) than 3 feet	3 inches maximum
Footings	4 inches maximum

Proportion and produce the concrete to have a maximum slump as shown. A tolerance of up to 1 inch above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated.

6. Aggregate size shall be 3/4 inch maximum for slabs and sections 8 inches thick and less. Aggregate size shall be 1 inch maximum for slabs and sections greater than 8 inches and less than 17 inches. Aggregate size shall be 1-1/2 inches maximum for all larger slabs and sections.

7. Combined aggregate grading shall be as shown in the following table:

Sieve Sizes	Maximum Aggregate Size		
	1-1/2"	**1"**	**3/4"**
	Percent Passing		
2"	100	---	---
1-1/2"	90 - 100	100	---
1"	50 - 86	90 - 100	100
3/4"	45 - 75	55 - 100	90 - 100
3/8"	38 - 55	45 - 75	60 - 80
No. 4	30 - 45	35 - 60	40 - 60
No. 8	23 - 38	27 - 45	30 - 45
No. 16	17 - 33	20 - 35	20 - 35
No. 30	10 - 22	12 - 25	13 - 23
No. 50	4 - 10	5 - 15	5 - 15
No. 100	1 - 3	1 - 5	0 - 5
No. 200	0 - 2	0 - 2	0 - 2

8. Mix design for pumped concrete shall produce a plastic and workable mix. The percentage of sand in the mix shall be based on the void content of the coarse aggregate.

R. Curing Compound

1. Curing compound shall conform to ASTM C309.

2. Curing compound shall be compatible with required finishes and coatings and shall meet the State of California Clean Air Quality Standards which limit the quantity of volatile organic compounds to 350 grams per liter.

S. Mats, Paper, and Sheeting for Curing

1. Burlap mats shall conform to AASHTO M182.

2. Sisal-kraft paper and polyethylene sheets shall conform to ASTM C171.

T. Reinforcing Dowel Adhesive

Dowel anchor adhesive shall be HIT-RE 500-SD by Hilti; Sikadur 31, Hi-Mod Gel by Sika; or equal.

PART 3 - EXECUTION

A. Form Tolerances

1. Failure of the forms to produce the specified concrete surface and surface tolerance shall be grounds for rejection of the concrete work. Rejected work shall be repaired or replaced at no additional cost to the Owner.

2. The following table indicates tolerances or allowable variations from dimensions or positions of structural concrete work:

	Maximum Tolerance (inch)
Sleeves and inserts	+1/4 -1/4
Projected ends of anchors	+1/4 -0.0
Anchor bolt setting	+1/4 -1/4
Finished concrete, all locations	+1/4 -1/4 in 10 feet
	Max ±1-inch in total length

The planes or axes from which the above tolerances are to be measured shall be as follows:

Sleeves and inserts:	Centerline of sleeve or insert.
Projected ends of anchors:	Plane perpendicular to the end of the anchor as located in the drawings.
Anchor bolt setting:	Centerline of anchor bolt.
Finish concrete:	The concrete surface as defined in the drawings.

Where equipment is to be installed, comply with manufacturer's tolerances if more restrictive than above.

B. Form Surface Preparation

1. Clean form surfaces to be in contact with concrete of foreign material prior to installation.

2. Coat form surfaces in contact with concrete with a release agent prior to form installation.

C. Form Reuse

Reuse only forms that provide a uniform surface texture on exposed concrete surfaces. Apply light sanding or other surface treatment between uses for uniform texture. Plug unused tie rod holes with corks, shave flush, and sand the concrete surface side. Do not patch forms other than filling tie rod holes, except in the case of Class II forms. Do not use metal patching discs on Class I forms.

D. Removal of Forms

1. Forms and shoring for elevated structural slabs or beams shall remain in place until the concrete has reached a compressive strength equal to the specified 28-day compressive strength as determined by test cylinders. Do not remove supports and reshore. The following table indicates the minimum allowable time after the last cast concrete is placed before forms, shoring, or wall bracing may be removed:

Sides of footings and encasements	24 hours

2. Do not remove forms from concrete that has been placed with outside air temperature below 50°F without first determining if the concrete has properly set without regard for time. Do not apply heavy loading on green concrete. Immediately after forms are removed, the surface of the concrete shall be carefully examined and any irregularities in the surface shall be repaired and finished as specified.

E. Formed Openings

Openings shall be of sufficient size to permit final alignment of pipes or other items without deflection or offsets of any kind. Allow space for packing where items pass through the wall to ensure watertightness. Provide openings with continuous keyways and water stops. Provide a slight flare to facilitate grouting and the escape of entrained air during grouting. Provide formed openings with reinforcement as indicated in the typical structural details. Reinforcing shall be at least 2 inches clear from the opening surfaces and encased items.

F. Embedded Items

Set embedded items accurately and hold securely in position until the concrete is placed and set. Check all special castings, channels, or other metal parts that are to be embedded in the concrete prior to and again after concreting. Check nailing blocks, plugs, and strips necessary for the attachment of trim, finish, and similar work prior to concreting.

G. Beveled Edges (Chamfer)

Form 3/4-inch beveled edges on exposed concrete edges and corners and where indicated in the drawings. Reentrant corners in concrete members shall not have fillets, unless otherwise shown in the drawings. The top edges of slabs may be beveled with an edging trowel in lieu of using chamfer strips.

H. Construction Joints

1. Provide construction joints where shown in the drawings.

2. Layout of construction joints shall be as shown in the drawings.

3. After a concrete placement pour has been completed to the construction joint and the concrete has hardened, thoroughly clean the entire surface of the joint of surface laitance, loose or defective concrete, and foreign material. Expose clean aggregate by sandblasting and thoroughly cleaning the surface of construction joints before placing the new concrete. Cover horizontal construction joints with grout bedding. Spread uniformly and work thoroughly into all irregularities of the surface. The consistency of the mortar shall be suitable for placing and working and shall be placed immediately prior to placing new concrete.

4. In case of emergency, place additional construction joints. (An interval of 45 minutes constitutes cause for an emergency construction joint.)

I. Placing Reinforcement

1. Place reinforcing steel in accordance with the current edition of Recommended Practice for Placing Reinforcing

Bars, published by the Concrete Reinforcing Steel Institute.

2. Place reinforcing in accordance with the following, unless otherwise indicated:

   a. Reinforcement indicated in the drawings is continuous through the structure to the farthest extent possible. Terminate bars and hooks 2 inches clear from faces of concrete.

   b. Splicing of reinforcement that is detailed to be continuous in the drawings is not permitted.

3. Reinforcing steel, before being positioned and just prior to placing concrete, shall be free from loose mill and rust scale and from any coatings that may destroy or reduce the bond. Clean reinforcing steel by sandblasting or wire brushing and remove mortar, oil, or dirt to remove materials that may reduce the bond.

4. Do not straighten or rebend reinforcing steel in the field. Do not use reinforcing with bends not shown in the drawings.

5. Position reinforcing steel in accordance with the drawings and secure by using annealed wire ties or clips at intersections and support by concrete or metal supports, spacers, or metal hangers. Do not place metal clips or supports in contact with the forms. Bend tie wires away from the forms to provide the specified concrete coverage. Bars, in addition to those shown in the drawings, which may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position shall be provided by the Contractor at his own expense.

6. Place reinforcement a minimum of 2 inches clear of any metal pipe or fittings.

7. Secure reinforcing dowels in place prior to placing concrete. Do not press dowels into the concrete after the concrete has been placed.

8. Position dowels for masonry walls to occur at reinforced block cells.

J. Site-Mixed Concrete

Conform to ACI 304.

K. Ready-Mixed Concrete

Conform to ASTM C94.

L. Placing Concrete

Conform to ACI 304.

M. Pumping Concrete

Conform to ACI 304.2R-91.

N. Weather Requirements

1. Conform to ACI 305 for placing during hot weather.

2. Conform to ACI 306 for placing during cold weather.

O. Concrete Finishes

1. Complete concrete surfaces in accordance with the following schedule:

Finish Designation	**Area Applied**
F-1	Exterior walls not exposed to view.
F-3	Walls of structures or buildings exposed to view.
S-4	Slabs of structures or buildings exposed to view.
E-1	Exposed edges. EXCEPTION: edges normally covered with earth.
E-2	Top of unformed surfaces.

2. Finish F-1: Repair defective concrete, fill depressions deeper than 1/2 inch, and fill tie holes.

   Finish F-3: In addition to Finish F-1, remove fins, fill depressions 1/4 inch or deeper, fill depressions and airholes with mortar. Dampen surfaces and then spread a slurry consisting of one part cement and one and one-half parts sand by damp loose volume, over the surface with clean burlap pads or sponge rubber floats. Remove any surplus by scraping and then rubbing with clean burlap.

Finish S-4: Steel trowel finish without local depressions or high points and apply a light hair-broom finish. Do not use stiff bristle brooms or brushes. Leave hair-broom lines parallel to the direction of slab drainage.

Finish E-1: Provide chamfer or beveled edges.

Finish E-2: Strike smooth and float to an F-3 or F-4 finish.

P. Curing Concrete

1. Conform to ACI 308.

2. Water cure with burlap mats unless optional curing methods are permitted.

3. It is the responsibility of the Contractor to select the appropriate curing method in response to climatical and/or site conditions occurring at the time of concrete placement. Take appropriate measures as described in ACI 305 and 306 for protecting and curing concrete during hot and cold weather.

Q. Repair of Defects and Cracks

1. Do not repair defects until concrete has been evaluated by the Owner's Representative.

2. Surface Defects:

   a. Repair surface defects that are smaller than 1 foot across in any direction and are less than 1/2 inch in depth.

   b. Repair by removing the honeycombed and other defective concrete down to sound concrete, cut or grind edges perpendicular to the surface and at least 3/8 inch deep, abrasive clean and thoroughly dampen the surface, work into the surface an epoxy bonding agent, and fill the hole with one part cement to one part fine sand. Match the finish on the adjacent concrete, and cure as specified.

3. Severe Defects:

    a. Repair severe defects that are larger than surface defects but do not appear to affect the structural integrity of the structure.

    b. Repair by removing the honeycombed and other defective concrete down to sound concrete, make edges of the repair area perpendicular to the surface, as required above, sandblast the sound concrete surface, coat the exposed surfaces with epoxy bonding compound, place nonshrink grout, match the finish on the adjacent concrete, and cure as specified.

4. Repair minor cracks in concrete structures that are wider than 1/10 inch by cutting out a square edged and uniformly aligned joint 3/8 inch wide by 3/4 inch deep, preparing exposed surfaces of the joint, priming the joint, and applying polyurethane joint sealant.

5. If the cracks are major, the Owner's Representative may require the concrete to be repaired by epoxy injection.

6. Major Defects and Cracks: If the defects affect the structural integrity of the structure or if patching does not satisfactorily restore quality and appearance to the surface, the Owner's Representative may require the concrete to be removed and replaced, complete.

R. Concrete Tests

Concrete quality testing will be performed on the concrete by the Contractor's independent testing laboratory.

1. Frequency of Sampling: Cast four concrete test cylinders from each 50 cubic yards, or fraction thereof, of each class of concrete placed in any one day. Sampling and curing of cylinders shall conform to ASTM C31.

2. Strength Testing: Test cylinders in accordance with ASTM C39. Test one cylinder at 7 days for information; test two cylinders at 28 days for acceptance; and hold one cylinder for verification. Strength acceptance will be based on the average of the strengths of the two cylinders tested at 28 days. If one cylinder of a 28-day test manifests evidence of improper sampling, molding,

or testing, other than low strength, discard it and use the fourth cylinder for the test result.

3. Determine concrete slump by ASTM C143 with each strength test sampling and as required to establish consistency.

4. Determine air content of the concrete using ASTM C231 to verify the percentage of air in the concrete immediately prior to depositing in forms.

5. The average value of concrete strength tests shall be equal to or greater than the specified 28-day strength. No test shall be less than 90% of the specified 28-day strength.

6. If the 28-day strength tests fail to meet the specified minimum compressive strength, the concrete will be assumed to be defective and one set of three cores from each area may be taken as selected by the Owner and in accordance with ASTM C42. If the average compressive strength of the set of three concrete cores fails to equal 85% of the specified minimum compressive strength or if any single core is less than 75% of the minimum compressive strength, the concrete will be considered defective. The Owner may require additional coring, nondestructive load testing, or repair of defective concrete. Costs of coring, testing of cores, load testing, and required repairing pertaining thereto shall be paid by the Contractor at no extra cost to the Owner.

END OF SECTION

SECTION 042223 CONCRETE UNIT MASONRY

PART 1 - GENERAL

A. Description

This section includes materials and installation of hollow block concrete unit masonry.

B. Related Work Specified Elsewhere

General Concrete Construction: 030500.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit manufacturer's catalog data of each type including special shapes required to show range of colors, texture, finishes, and dimensions. If colored, state source of color for coordination with mortar mix.

3. Submit manufacturer's certificate and test results to show that masonry units comply with the cited ASTM specification.

4. Provide statement from concrete products supplier results of ASTM tests and gradations when requested by Owner's Representative.

5. Furnish grout mix design including admixture with laboratory 7- and 28-day compressive tests prior to placing plant-mixed grout on the project.

6. Submit which method of grouting is to be used for masonry work: low-lift or high-lift.

7. Submit six copies of a report from a testing laboratory verifying that aggregate material is asbestos-free and conforms to the specified gradations or characteristics.

8. Submit reinforcing bending lists and placing drawings for all reinforcing. Placing drawings shall indicate all openings (mechanical, electrical, equipment, and architectural) including additional reinforcing at openings and corner bar arrangements at intersecting

walls indicated in the typical detail and structural drawings. Placing drawings shall be coordinated with the sequence of masonry construction. Each bending list and placing drawing submitted shall be complete for each major element of a structure. Furnishing such lists shall not be construed that the lists will be reviewed for accuracy. The Contractor shall be wholly and completely responsible for the accuracy of the lists and for furnishing and placing reinforcing steel in accordance with the details shown in the drawings and as specified. Placing drawings shall include elevation views showing the location of each bar. Placing drawings shall be prepared by the Contractor and shall not incorporate photocopies of the contract drawings.

9. Submit test results of mortar and grout tests conducted by an independent testing agency.

D. Quality Control

Construct in accordance with the CBC, Section 2104, except as specified herein.

PART 2 - MATERIALS

A. Concrete Masonry Units

1. Provide ASTM C90, hollow load-bearing concrete masonry units, medium weight, average compressive strength over net area: 1,900 psi. Nominal face dimensions: 8 inches by 8 inches by 16 inches, unless 4-inch-high units are noted. Color shall be ORCO Block Co. brown for stripe at door heads and Nu-Fad for remainder, unless a specific color is noted otherwise.

2. Units shall be split face for exterior except for the precision stripe at door heads. Units shall be precision face for interior. Units shall be manufactured by ORCO Block Co., Stanton, California or equal.

3. Units shall be modular and shall include all special shapes and sizes to complete the work as shown. Units shall be sound and free from cracks, chipped edges, or other defects that would interfere with their proper setting or impair the strength or durability of the construction. Where used as the finished surface of exposed masonry walls, units shall be free from surface

defects that would be noticeable and objectionable at a distance of 10 feet from the finished wall. Provide special units for bond beams, sills, and half blocks to hold cutting to a minimum.

B. Mortar and Grout

1. Mortar: Provide mortar mix that conforms to the requirements of ASTM C270.

2. Grout: Provide grout that conforms to the requirements of ASTM C476 for fine or coarse grout.

3. Cement: Portland Type I or II, ASTM C150. For mortar, use same cement coloring agent as in colored block manufacture.

4. Sand: Fine granular aggregate; a natural sand passing the No. 4 sieve with 10% to 35% passing the No. 50 and 2% to 15% passing the No. 100; or a manufactured sand, ASTM C144.

5. Coarse Aggregate for Grout: 95% passing the 3/8-inch sieve and no more than 5% passing the No. 8 sieve, ASTM C404. Aggregate shall be asbestos-free.

6. Lime: Hydrated lime, ASTM C207, Type S; lime putty, ASTM C1489; slaked quicklime, ASTM C5.

7. Admixture for Grout: Reduce early water loss and produce an expansive action sufficient to offset initial shrinkage. Products: Sika Grout Aid.

C. Reinforcement

Deformed bars, ASTM A615 or A706, Grade 60. Use annealed tie wires, 16 gauge.

D. Mortar and Grout Mix Proportions and Strengths

Use the following proportions for field mixes and obtain the following strengths of cement mortar with plant mixes:

MORTAR AND GROUT MIX PROPORTIONS AND STRENGTHS					
Type Mix	**Minimum 28-Day Compressive Strength (lbs/sq. in.)**	**Cement**	**Coarse Aggregate**	**Lime Putty or Hydrated Lime**	**Sand (Measure in a Damp, Loose Condition)**
Mortar, Type M	2,000	1	0	1/4 maximum	Not less than two and one-quarter and not more than three times the sum of the volumes of the cement and lime used.
Fine grout	2,000	1	0	0 minimum to 1/10 maximum	Not less than two and one-quarter and not more than three times the sum of the volumes of the cement and lime used.
Coarse grout	2,000	1	Not less than one and not more than two times the sum of the volumes of cement and lime used.	0 minimum to 1/10 maximum	Not less than two and one-quarter and not more than three times the sum of the volumes of cement and lime used.
Grout admixture		In accordance with admixture manufacturer's recommendations.			

E. Control Joint

Control joint shall be PVC conforming to ASTM D2287 Type PVC 654-4 or rubber conforming to ASTM D2000 2AA-805. Shore durometer hardness shall be 80 to 85. Control joint shall be as manufactured by Ty-Wall Accessories (supplier is Dayton Superior), Duro-O-Wal Inc., or equal.

F. Epoxy

Epoxy used for grouting misplaced dowels shall be Sikadur 32 by Sika Corporation, HIT RE 500 by Hilti, or equal.

PART 3 - EXECUTION

A. Product Delivery, Storage, and Handling

1. Store masonry units above ground on level platforms that allow air circulation under stacked units. Cover and protect against wetting prior to use.

2. Deliver units on pallets or flatbed barrows. Do not permit free discharge from conveyor or mortar trays.

B. Mixing and Handling Mortar

Mechanically mix mortar for at least five minutes with the amount of water required to produce the desired workability. Retemper on mortar boards by adding water within a basin formed in the mortar and rework the mortar into the water. Do not dash or pour water over the mortar. Do not retemper harsh, nonplastic mortar. Remove from the work mortar that is unused after one hour of the initial mixing.

C. Mixing and Handling Grout

For block spaces 2 inches or less or if the clear distance between the reinforcing and masonry surface is less than 1/2 inch, use fine grout. For block spaces greater than 2 inches, use coarse grout. Add grout admixture in accordance with the manufacturer's recommendations. Mechanically mix grout for at least five minutes. Completely empty the mixer drum before placing in the succeeding batch of materials. Discard grout that is unused after one hour from initial mixing.

D. Quality Control of Mortar and Grout

Conform to CBC Section 2105. One-half allowable stresses are used for design. Mortar testing is not required.

E. Placement of Reinforcement

1. Use foundation dowels of the same size and spacing as vertical wall reinforcing. When a foundation dowel does not line up with the vertical core to be reinforced, epoxy-grout the misplaced dowel into a core in direct vertical alignment in a cell adjacent to the vertical wall reinforcing. Diameter and depth of hole shall be in accordance with the manufacturer’s recommendations.

2. Where walls are to be low-lift grouted, install vertical reinforcement such that bars are continuous or provide minimum laps of 48 bar diameters. Assure that the cells to be grouted are free from debris and that the vertical reinforcing bars contact the concrete footing or slab.

3. Where high-lift, full-height grouting is employed, clean out opened core and inspect for clearance of reinforcing and mortar debris. Place full-length vertical reinforcing. No splices are permitted in vertical reinforcing, unless indicated in the drawings.

4. Place horizontal reinforcing in special bond beam or other channel units. Lap splices by 50 diameters and securely tie.

F. Laying Masonry Units

1. Do not lay block on concrete footings until concrete has reached a compressive strength of 1,500 psi when tested in accordance with Section 030500.

2. Lay dry block units starting on a full mortar bed over a clean foundation. If the air temperature is below 40°F, heaters are required for curing. If the air temperature is above 95°F, provide shade over the mortar construction.

3. Laying: Lay masonry true to dimensions, plumb, square, and in running bond. All courses shall be level with joints of uniform width.

4. Adjust masonry unit to final position while mortar is soft and plastic. If units are displaced after mortar has stiffened, remove, clean joints and units of mortar, and re-lay with fresh mortar. When joining fresh masonry to set or partially set masonry construction, clean exposed surfaces of set masonry and remove loose mortar prior to laying new masonry.

5. Lay with full mortar coverage on horizontal and vertical faces. Cover webs in all courses of piers, columns and pilasters.

6. Maximum height of masonry laid prior to low-lift grouting shall be 4 feet. Where high-lift grouting is used, masonry may be laid full height of walls.

7. If height of masonry prior to any grouting exceeds 4 feet, provide cleanouts at the bottom of each cell for removing mortar droppings.

8. Set anchor bolts to line and grade with proper projection prior to grouting.

9. Securely hold vertical reinforcement in high-lift grouting at top and bottom and at 192 bar diameters.

10. Accessories: As masonry work progresses, install angles, metal items, flashings, anchors, wall plugs, and other accessories. Spaces around built-in work shall be complete and solidly filled in with masonry.

G. Protection of Work

Protect sills, ledges, and offsets from mortar drippings and other damage during construction. Protect face materials against staining by removing misplaced mortar or grout immediately and by brushing the masonry surface at the end of each day's work.

H. Joints

1. Finish of Horizontal and Vertical Face Joints: Construct uniform 3/8-inch joints. Make vertical joints tight. Strike joints flush for surfaces to be plastered, stuccoed, or covered with other surface-applied finish except paint.

2. Tool joints in surfaces to be painted or to remain exposed with a round jointer as soon as they are thumbprint hard. Joints to receive caulking shall be raked out 3/4 inch and left ready for caulking. Strike flush unexposed joints.

3. Running Bond: Use running bond with vertical joints located at center of masonry units in alternate course below. Bond intersecting masonry walls.

4. Fill collar joints by shoving from the back side or grouting to assure complete filling with mortar.

5. Install control joints where indicated in the drawings. Form control joints with square end masonry units having sash groove and filled with synthetic rubber filler.

Omit mortar from joint. Joint sealant for control joints is specified in Section 030500.

I. Pointing and Cleaning, Wall Completion

1. At final completion of unit masonry work, fill any remaining holes in joints and tool. Do not fill weep holes. Cut out and repoint defective joints. Dry brush masonry surface after mortar has set, at end of each day's work, and after final pointing. Leave work and surrounding surfaces clean and free of mortar spots and droppings.

2. Do not saturate a masonry wall with water for curing, but where the atmosphere is dry, dampen the surfaces with a very light fog spray during a curing period for the mortar of three days.

3. Brace the wall against wind and seismic forces during construction.

J. Grout Placement

1. Before grouting, allow masonry joints to cure at least 18 hours for low-lift grouting and 72 hours for high-lift grouting.

2. After inspection and cleaning out of walls for grouting, place forms over any cleanout and inspection holes and fill cells requiring grout to not over 4 feet in height for low-lift grout placement. Limit high-lift grout pours to lifts of 4 feet maximum. Minimum time period between grout lifts shall be one hour.

3. Fill all cells. Fill cells solid with grout from footings to top of wall. Consolidate by puddling or vibrating.

4. Fill spaces around doorframes and other built-in items.

5. Immediately wash spilled grout from surfaces of masonry units.

END OF SECTION

SECTION 050520 BOLTS, WASHERS, AND ANCHORS

PART 1 - GENERAL

A. Description

This section describes materials and installation of epoxy anchors, connecting bolts, and washers.

B. Related Work Specified Elsewhere

1. General Concrete Construction: 030500.

2. General Piping Requirements: 400500.

C. Design Criteria

Structural Connections: AISC Specification for Structural Steel Buildings (June 1, 1989), except delete the second paragraph of Section A7.1, the last sentence of the first paragraph of Section M5, the last sentence of Section M5.2, and Chapter N in its entirety.

D. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit manufacturer's catalog data and ICBO reports for bolts. Show dimensions and reference materials of construction by ASTM designation and grade.

PART 2 - MATERIALS

A. Anchor Bolts

Anchor bolts shall conform to ASTM A307.

B. Epoxy Anchors

Epoxy anchors in grouted concrete masonry walls shall be Hilti HIT HY-150 adhesive and ASTM A36 threaded rods, hot-dipped galvanized after fabrication.

C. Connection Bolts

Steel connection bolts shall conform to ASTM A325, Type 1 or 2. Connection type shall be N per the AISC handbook.

D. Hardened Steel Washers

Washers for American Standard beams and channels shall be square or rectangular, tapered in thickness, smooth, and conforming to ASTM F436.

E. Plain Unhardened Steel Washers

Washers shall comply with ASTM F844. Provide clipped washers where space limitations necessitate.

PART 3 - EXECUTION

A. Storage of Materials

Store material, either plain or fabricated, above ground on platforms, skids, or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion.

B. Galvanizing

Zinc coating for anchor bolts and threaded parts shall be in accordance with ASTM A153.

C. Installing Connection Bolts

1. Use steel bolts to connect structural steel members.
2. Install ASTM A325 bolts per the AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
3. Install washers per AISC Specification for allowable stress design.
4. Bolt holes in structural members shall be 1/16 inch in diameter larger than bolt size. Measure cast-in-place bolt locations in the field before drilling companion holes in structural steel beam or assembly.

D. Installing Anchors

1. After anchors have been embedded, protect projecting threads by applying grease and having the nuts installed until the time of installation of the equipment or metalwork.

2. Minimum depth of embedment of epoxy anchors shall be as recommended by the manufacturer but no less than that shown in the drawings.

3. Prepare holes for epoxy anchors in accordance with the anchor manufacturer's recommendations prior to installation.

END OF SECTION

SECTION 061110 WOOD FRAMING AND SHEATHING

PART 1 - GENERAL

A. Description

This section includes materials and installation of wood framing and sheathing including lumber, plywood, and rough hardware.

B. Related Work Specified Elsewhere

Prefabricated Wood Trusses: 061753.

C. Submittals

1. Provide submittals in accordance with the General Provisions and Section 013300.

2. Provide supplier's statement of compliance with specified U.S. Federal or other standards.

D. Quality Assurance

Lumber grading rules and wood species shall conform with the Standard Grading and Dressing Rule 17 of the West Coast Lumber Inspection Bureau. Plywood grading shall conform with U.S. Product Standard PS-1.

PART 2 - MATERIALS

A. Lumber

1. Dimensions noted are nominal. Actual dimensions conform to industry standards established by the American Lumber Standards Committee and the rules writing agencies.

2. Provide visible grade stamp on lumber and plywood.

3. Moisture Content: 19% maximum at time of permanent closing in of building or structure, for lumber 2 inches or less nominal thickness. Grade stamp: S-Dry.

4. Surface four sides (S4S).

5. Structural light framing, 2 to 4 inches thick, 2 to 4 inches wide. Grade: Douglas fir No. 2.

6. Structural joists and planks, 2 to 4 inches thick, 6 inches and wider. Grade: Douglas fir No. 1.

B. Plywood

1. Exterior graded plywood where edge or surface is permanently exposed to weather or where ambient moisture content will exceed 18%.

2. Roof Sheathing: Grade: Structural I C-C exterior.

C. Rough Hardware

1. Bolts: ASTM A307.

2. Nuts: Fed. Spec. FF-N-836E or ASTM A307.

3. Lag Screws and Bolts: ASME B18.2.1.

4. Washers: ASTM F844.

5. Nails and Staples: ASTM F1667, Common.

6. Joist Hangers, Bar or Strap Anchors: Obtain from drawings.

7. Ply Clips: Extruded 6063-T6 aluminum alloy.

D. Connectors

1. Structural connectors designated in the drawings are by Simpson Company. Products by Silver Metal Products, Teco, or equal are acceptable. Substitutions to the designated connector must have at least the minimum ICC-recommended strength of the designated connector for the type of installation shown.

2. Use Type 316 stainless steel fasteners with Type 316 stainless steel connectors.

E. Anchor Bolts in Contact With Pressure-Treated Lumber

1. Anchor bolts in contact with pressure-treated lumber shall be ASTM F593, Type 316 stainless steel.

2. Use ASTM F594, Type 316 stainless steel nuts and Type 316 stainless steel washers with stainless steel bolts.

PART 3 - EXECUTION

A. Standards

Conform to provisions of CBC unless otherwise indicated.

B. Condition of Surface

Verify that surfaces to receive rough carpentry materials are prepared to exact grades and dimensions.

C. Pressure-Treated Wood Products

Apply two brush coats of same preservative used in original treatment to sawed or cut surfaces of treated lumber.

D. Nailing

Conform to Table 2304.9.1 of the CBC unless otherwise indicated.

E. Joist Framing

1. Install with crown edge up. Support ends of each member to provide a minimum of 1-1/2 inches of bearing on wood. Support joists at ends with solid blocking, 2 inches thick by depth of joists.

2. Notches: Do not notch in middle third of joist length.

    a. Notches in Top or Bottom of Joists: Maximum of one-sixth depth of member.

    b. Notched Ends: Maximum of one-third depth of member.

3. Bored Holes: Maximum one-third depth of member, 2-inch-minimum distance to top or bottom of joists.

F. Plywood Roof Sheathing

1. Install panels with face grain perpendicular to supports, using panels with continuous end joints over two or more spans staggered between panels and locate over supports. Allow minimum space of 1/16 inch between end joints and 1/8 inch at edge joints for expansion and contraction of panels. Support edge joints by use of wood blocking.

2. Do not use unblocked panels.

3. Minimum nailing is 8d common nails at 6 inches on center along panel edges and 12 inches on center at intermediate supports unless otherwise shown in drawings.

G. Connectors

Install using fasteners indicated in the connector manufacturer's current catalog unless otherwise indicated in the drawings.

END OF SECTION

SECTION 061753 PREFABRICATED WOOD TRUSSES

PART 1 - GENERAL

A. Description

This section includes materials and installation of prefabricated wood trusses.

B. Related Work Specified Elsewhere

Wood Framing and Sheathing: 061110.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit truss shop drawings, erection plans, and calculations of trusses for review prior to fabrication. Calculations shall be prepared and signed by a civil or structural engineer registered in the state of California. Truss load calculations shall include mechanical equipment and piping loads.

3. Show camber of trusses.

4. Show field connection details for truss subassemblies.

D. Standards

1. The design and fabrication of trusses shall conform to CBC Section 2303.4.

2. The design of truss connector plates shall conform to "Design Specifications for Light Metal Plate Connected Wood Trusses," TPI-85 of the Truss Plate Institute.

PART 2 - MATERIALS

A. Lumber

Lumber for truss members shall be Douglas fir. Stress grades shall conform to the grades indicated in the truss calculations submitted by the Contractor. Moisture content of lumber shall be not less than 7% or more than 19%.

B. Truss Connector Plates

Manufacture truss connector plates from galvanized sheet steel of no less than 20-gauge thickness which has a minimum yield strength of 33,000 psi and a minimum ultimate tensile strength of 48,000 psi. Galvanize per ASTM A653, Class G90.

C. Metal Connectors

Metal connectors shall be gang nail connectors and shall be stamped "gang nails." The connectors shall have a series of nail-like projections, which are designed to separate the fibers of the wood into which they are pressed. Provide gang nail hardware on both faces of trusses at every joint.

D. Blocking

Provide blocking of the same material as the trusses, as required by the design calculations.

E. Fabrication

1. Cut truss members to length, angle, and true to line to provide tight joints for finished truss.

2. Place truss members and connector plates in jigs and tightly clamp the members in place until the connector plates have been pressed into the lumber simultaneously on both sides of the joints. Camber trusses for one and one-half times the dead load deflection.

3. Stamp each truss with the name and address of the licensed prefabricated truss fabricator.

F. Design Loads

1. Loads are shown on the roof plan and are given in pounds per square foot.

2. Provide double trusses where shown.

3. Design blocking to meet the requirements above.

PART 3 - EXECUTION

A. Fabrication

Fabricate trusses in accordance with the requirements of CBC Section 2303.4.

B. Handling and Erection

1. Handle fabricated trusses so that they are not damaged. If the trusses are to be stockpiled or stored prior to erection, set them in vertical positions resting upon temporary bearing supports and brace to prevent bending, twisting, and tipping.

2. Trusses shall be plumb and chords held in a straight line. Do not field cut or drill any truss member unless indicated in the shop drawings.

3. Provide temporary bracing to maintain alignment and prevent lateral movement until roof plywood is completely nailed to the trusses and edge blocking.

4. Do not place tile bundles on any areas. During construction, construction loads (roof tiles and live load from erection crew) shall not exceed the loads for which the trusses and other roof members are designed. Nail double trusses together for full load sharing.

END OF SECTION

SECTION 071119 VAPOR BARRIER DAMPPROOFING MEMBRANE

PART 1 - GENERAL

A. Description

This section includes materials and installation of polyethylene film vapor barrier dampproofing membrane.

B. Related Work Specified Elsewhere

1. General Concrete Construction: 030500.

2. Flashing and Sheet Metal: 076000.

3. Architectural Caulking and Sealants: 079200.

C. Submittals

1. Submit shop drawings and samples in accordance with the General Provisions.

2. Submit manufacturer's catalog data, descriptive literature, and samples of the vapor barrier material, tape, and adhesive.

PART 2 - MATERIALS

A. Vapor Barrier Material

1. Polyethylene sheeting, minimum 6 mils thick, clear, conforming to ASTM D4397.

2. Sheets shall be as wide as practicable for application that will result in the least number of laps.

B. Adhesive

Trowel consistency adhesive as recommended by the membrane manufacturer.

C. Tape

Tape for the sealing of laps and joints shall be a pressure-sensitive adhesive tape as recommended by the manufacturer of the vapor barrier material. Tape shall be a minimum of 3 inches wide.

PART 3 - EXECUTION

A. General

Install beneath concrete slab on grade for all buildings of this project.

B. Installation

Lay vapor barrier sheets directly over the compacted subgrade just before sand cushion is placed and concrete is poured. Carefully install to avoid puncture or tear. Patch punctures and tears occurring during subsequent operations. Lap edges not less than 4 inches and lap end joints not less than 6 inches, with all laps continuously sealed with tape. Carry barrier over any pipes laid on the fill and seal in waterproof manner to any pipes or conduits which penetrate the fill. Turn up membrane a minimum of 2 inches at the edges and secure to exterior wall foundations or footings with adhesive. Do not place stakes through vapor barrier membranes for screeding of concrete slabs.

END OF SECTION

SECTION 072100 FIBERGLASS BUILDING INSULATION

PART 1 - GENERAL

A. Description

This section includes materials and installation of fiberglass building insulation in the form of batts or rolls.

B. Related Work Specified Elsewhere

Wood Framing and Sheathing: 061110.

C. Submittals

1. Submit shop drawings and samples in accordance with the General Provisions and Section 013300.
2. Submit manufacturer's catalog data and descriptive literature for the various types of insulation.
3. Indicate location of each type of insulation.

PART 2 - MATERIALS

A. Exposed Ceiling Insulation

Ceiling insulation shall be white-faced fiberglass batts or rolls. Insulation shall be 4 inches thick, in width required for joist spacing, and with an R-value of 11, aged. Install white face toward interior.

PART 3 - EXECUTION

A. Installation

1. Fit insulation snugly between framing.
2. Maintain integrity of insulation over entire area to be insulated.
3. Insulate small areas between closely spaced framing members.

4. Carefully cut and fit insulation around pipes, conduits, and other obstructions.

5. At wood joists/rafters, provide supplementary support using wire ties fastened at 24-inch centers to prevent sagging of insulation.

END OF SECTION

SECTION 073113 ASPHALT SHINGLE ROOFING

PART 1 - GENERAL

A. Description

This section includes materials and installation of fiberglass self-sealing asphalt shingle roofing over wood decks.

B. Related Work Specified Elsewhere

1. Wood Framing and Sheathing: 061110.

2. Flashing and Sheet Metal: 076000.

3. Skylights: 077200.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit manufacturer's catalog data showing full range of styles, materials, colors, and recommended installation procedures.

3. Submit samples of materials to be used on project.

4. Submit shop drawings of flashing, sheet metal, curbs, and other items that will penetrate the roof. Submit these at the same time the shingle shop drawings are submitted.

5. Submit two samples of each shingle style and two pieces (12 inches by 12 inches) of felt underlayment.

PART 2 - MATERIALS

A. Fiberglass Self-Sealing Asphalt Roofing Shingles

1. "Timberline 40," weathered wood blend manufactured by GAF.

2. “Oakridge 40” manufactured by Owens-Corning.

3. "Chaparral" manufactured by Owens-Corning.

4. Or equal Class A UL rated shingles.

B. Felt Underlayment

According to manufacturer's recommendations and UBC.

C. Hip and Ridge Shingles

Precut manufacturer's standard.

D. Nails

Hot-dipped galvanized or aluminum 11 or 12 gauge, barbed shank, 3/8-inch head, sharp pointed conventional, of sufficient length to penetrate at least 3/4 inch into solid decking or to penetrate through plywood sheathing.

E. Staples

Zinc coated, 16 gauge minimum with minimum crown width 15/16 inch, and sufficient length to penetrate 3/4 inch into solid decking or through plywood sheathing.

F. Bituminous Plastic Cement

According to manufacturer's recommendations.

PART 3 - EXECUTION

A. Delivery, Storage, and Handling of Materials

1. Deliver materials with manufacturer's label still intact and legible.

2. Deliver materials in sealed packages with UL labels.

3. Store materials on raised platforms and protect with coverings at outdoor locations.

4. Do not stack bundles of shingles more than 4 feet high.

5. Store rolled goods on end.

B. General

1. Provide uniform, smooth, sound, clean, dry surfaces, free of irregularities, to which shingles are to be applied.

2. Cover roof insulation with minimum 1/2-inch exterior-glue plywood to receive underlayment felt and shingles.

3. Do not apply shingles when air temperature is below 40°F.

4. Remove and replace damaged shingles.

5. Remove excess shingles not part of extra stock and debris from project site.

6. Verify that installation of metal flashings has been completed.

7. Verify that work of other trades that penetrates roof deck has been completed.

C. Installation

1. Underlayment:

a. Decks With Slope 4 Inches in 12 Inches or Greater:

(1) Fasten metal drip edge along the bottom edge (eaves) before felt is laid and to the sides (rakes) after the felt is laid.

(2) Lay one layer of underlayment horizontally over entire roof, lapping each course over lower course 2 inches minimum at horizontal joints and 4-inch side lap at end joints.

(3) Lap underlayment 6 inches from both sides over hips and ridges.

(4) Secure underlayment to deck with sufficient fasteners to hold in place until shingles are applied.

2. Starter Strip:

a. Apply 9-inch-minimum wide mineral-surfaced roll roofing even with lower edge of eaves, or

b. Use shingles with tabs cut off as a starter strip. Offset first starter shingle 6 inches so joints of starter do not lay under joints of first course of shingles. Starter strip shingles shall overhang the eaves and rake by 1/2 inch. Fasten starter strip using same spacing as for shingles, and locate fasteners about 3 inches up from the bottom edge.

3. Shingles:

   a. Place fasteners in the fastening line, 1 inch from each side edge, with the remaining four fasteners equally spaced in the fastening line. Avoid fastening where joint in overlaying shingles will occur.

   b. Three Tab Shingles: Place fasteners 5-5/8 inches above shingle butt edge, 1 inch from each side edge, and 1 inch to either side of the two cutouts.

   c. Overlap Tab Shingles: Place fasteners 5/8 inch above the cutout and fasten in center of 4-inch tab and 1 inch to either side of the two cutouts.

   d. Place one spot of shingle tab cement 1 inch in diameter under each tab immediately upon installation.

   e. Maintain constant, equidistant horizontal lines.

D. Spare Shingles

Provide Owner with a minimum of two bundles of extra stock of each shingle style and color.

END OF SECTION

SECTION 076000 FLASHING AND SHEET METAL

PART 1 - GENERAL

A. Description

This section includes materials and installation of flashing and sheet metal.

B. Related Work Specified Elsewhere

1. Skylights: 077200.
2. Painting and Coating: 099000.

C. Design Criteria

Conform to the recommendations of SMACNA’s Architectural Sheet Metal Manual.

D. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.
2. Provide details to show sizes, installation, anchorage, and interface with adjacent work of each metal configuration.
3. Indicate gauge, composition of sheet metal, and compliance with ASTM standards.

PART 2 - MATERIALS

A. Galvanized Steel

Comply with ASTM A653 with Coating Designation G-90. Provide minimum 24-gauge thickness unless noted otherwise.

B. Nails

Use flathead, wire, barbed, slating type, galvanized steel nails, conforming to ASTM F1667, with steel components and sheet. Use flathead, wire, barbed, slating type, aluminum nails, conforming to ASTM F1667 with aluminum components and sheet.

C. <u>Screws</u>

Use self-tapping sheet-metal type, conforming to ASME B18.6.4. Screw material shall be aluminum or stainless steel for use with aluminum flashing and galvanized steel for use with steel flashing.

D. <u>Solder for Galvanized Steel</u>

Comply with ASTM B32, Alloy Grade Sn50.

E. <u>Sealant</u>

Comply with ASTM C920, Type M, Grade P, Class 25 (minimum) for horizontal joints and Grade NS, Class 25 (minimum) for vertical joints.

F. <u>Cleats</u>

Provide with minimum width of 2 inches. Use the same material and thickness as the sheet metal.

G. <u>Fabrication</u>

Fabricate sheet metal with lines, breaks, and angles sharp and true with surfaces free from objectionable wave, warp, or buckle. Fold exposed edges of sheet metal back to form 1/2-inch-wide hem on side concealed from view. Finish work free from water leakage under all weather conditions.

PART 3 - EXECUTION

A. <u>Preparation for Installation</u>

Verify that substrates are smooth and clean to extent needed for sheet metalwork. Verify that reglets, cants, and blocking to receive sheet metal are installed and free of concrete and soil. Verify shapes and dimensions of surface to be covered.

B. <u>Installation</u>

1. Install work watertight, without waves, warps, buckles, fastening stresses, or distortion, allowing for expansion and contraction. Hem exposed edges. Angle bottom edges of exposed vertical surfaces to form drips. Clean and flux metals prior to soldering.

2. Common Lock Seams: 5/8-inch finished width. Four-ply loose lock.

3. Flat-Lock Seams: 3/4-inch finished width. Four-ply flat lock, malleted tight. Sweat full with solder.

4. Single-Corner Seams: 5/8-inch finished width. Three-ply loose lock. Corners lapped and soldered.

5. Lap Seams: 7/8-inch finished width.

6. Spaced Cleats: 2 feet on center. Secure to substrate with fasteners and cover heads with cleat tabs.

7. Continuous Cleats: Secure to substrate with fasteners spaced 1 foot on center.

8. Roof Counterflashing: Overlap base flashing 4 inches minimum. Install bottom edge tight against base flashing. Lap seam vertical joints 3 inches minimum and apply sealant. Miter, lap seam, and close corner joints with solder or sealant. Overlap base flashing with counterflashing 1 inch minimum. Slope storm collar away from penetration.

9. Roof Penetration Flashing: Extend base flashing flange onto roof 6 inches minimum away from penetration. Extend flange upward around penetration to at least 8 inches above roofing felts. Solder lap joints.

10. Fabricate coping to the shapes and dimensions shown in the drawings. Install with continuous cleats and butt-type joints, 10 feet on center joints to allow for expansion and contraction. Miter, seam, and seal all corners.

C. Cleaning

As work progresses, neutralize excess flux with 5% to 10% washing soda solution and thoroughly rinse. Leave work clean and free of stains, scrap, and debris.

D. Painting and Coating

Exposed galvanized steel flashing shall have a coating per Section 099000, System No. 52. Color shall match adjoining roofing color.

END OF SECTION

SECTION 077200 SKYLIGHTS

PART 1 - GENERAL

A. Description

This section includes materials and installation of skylights.

B. Related Work Specified Elsewhere

1. Wood Framing and Sheathing: 061110.
2. Flashing and Sheet Metal: 076000.
3. Architectural Caulking and Sealants: 079200.
4. Painting and Coating: 099000.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.
2. Submit manufacturer's catalog data and descriptive literature.
3. Submit details showing connection to roof deck.

PART 2 - MATERIALS

A. Skylights

1. Skylights shall be curb mounted Bristol Fiberlite Industries Model CM-4848, Naturalite, TriStar, or equal.
2. Dome shall be acrylic, double.
3. Dome color shall be clear.
4. Install gaskets to create a weathertight installation.

PART 3 - EXECUTION

A. Field Measurements and Templates

Secure field measurements required for fabrication and installation. Exact measurements are the Contractor's responsibility. Furnish templates and any setting instructions required for installation work.

B. Installation

Install roof accessories in accordance with the drawings and the manufacturer's specifications, installation instructions, and recommendations. Installation shall be coordinated and integrated with roofing work, flashed, and shall be completely watertight upon completion.

END OF SECTION

SECTION 079200 ARCHITECTURAL CAULKING AND SEALANTS

PART 1 - GENERAL

A. Description

This section includes materials and installation of architectural caulking and sealants for waterproofing buildings and structures.

B. Related Work Specified Elsewhere

1. General Concrete Construction: 030500.

2. Concrete Unit Masonry: 042223.

3. Sound Control Doors and Frames: 083473.

4. Painting and Coating: 099000.

C. Submittals

1. Submit shop drawings in accordance with General Provisions and Section 013300.

2. Submit manufacturer's catalog data and descriptive literature.

PART 2 - MATERIALS

A. Caulking and Sealant Compounds

1. Exterior Applications: One-part, nonsag, moisture-curing polyurethane joint sealant conforming to ASTM C 920, Type S, Grade NS, Class 25. Use Pecora Corporation "Dynatrol I," Bostik's "Chem-Caulk 900," Sonneborn's "Sonolastic NP-1," or equal. Color of caulking and sealant shall match color of adjacent work.

2. Interior Applications: Butyl-based compound, smooth-flowing, single component, architectural grade, synthetic, general purpose caulking compound, composed of 80% to 100% solids, butyl, nonoily, nonhardening, curing to a tack-free surface, paintable, in gun grade consistency. Use "DAP Butyl-Flex Caulking Compound," A.C. Horn's Vulcatex" Elastic Caulking Compound, acrylic

latex Pecora Sealants AC-20, or equal. Color of caulking and sealants shall match color of adjacent work.

B. Mastic

Where mastic is shown or noted in drawings, it shall be the general purpose butyl-based caulking compound specified, except that it shall be knife or trowel consistency. Exterior applications exposed to weather shall be the polyurethane sealant hereinbefore specified in knife or trowel consistency.

C. Primers

Primers shall be quick-drying, colorless, nonstaining sealer of type and consistency as recommended by the manufacturer of the caulking material for the particular surfaces to be caulked or sealed.

D. Packing

Sealant backup or packing and packing for caulking compounds shall be nonstaining resilient material, such as glass fiber roving, neoprene, butyl, polyurethane, or other closed-cell foams, compatible with the caulking compound used.

PART 3 - EXECUTION

A. Surface Preparation

1. Clean joints and spaces of dirt, dust, mortar, oil, and other foreign materials that might adversely affect the caulking work. Degrease with solvent or commercial degreasing agent. Surfaces shall be thoroughly dry before application of caulking compounds.

2. If recommended by manufacturer, remove paint or other protective coating from surfaces to be caulked prior to priming and caulking application.

3. Enclose joints on three sides. Where grooves for adequate caulking have not been provided, clean out grooves to the depth required or as indicated in drawings and grind to a minimum width of 1/4 inch without damage to the adjoining work. Do not grind on metal surfaces.

4. Preparation of surfaces to receive caulking compound shall conform to the caulking manufacturer's specifications. Use air pressure or other methods approved by the manufacturer to achieve required results. Use masking tape to keep caulking compound off surfaces that will be exposed in the finished work.

B. Locations

1. Exterior: Caulk and seal around architectural openings in exterior walls and roofs of buildings and structures, including penetrations for piping; conduits; ductwork; window, door, and louver frames; vents; and other locations shown in the drawings or required for waterproofing the building and structure.

2. Interior: Caulk and seal around architectural openings in interior walls, partitions, and ceilings of buildings and structures, including penetrations for piping; conduits; ductwork; window, door, and louver frames; bathroom fixtures; and other locations shown in the drawings.

C. Priming

Prime concrete, masonry, and other porous surfaces and any other surfaces recommended by the manufacturer, before applying caulking and sealants. Apply primer with a brush that will reach all parts of joints to be filled with caulking compound.

D. Packing

Fill joints and spaces deeper than 1/2 inch with packing to within 1/2 inch of the surface. Then fill the joints with caulking compound. Provide a minimum of 3/8 inch of caulking compound in all joints 1/2 inch in depth or deeper.

E. Caulking and Sealant Compounds

Store caulking and sealants at temperatures below 50°F. Do not use compounds when they become too jelled to be discharged in a continuous flow from the gun. Do not modify compounds by addition of liquids, solvents, or powders.

F. Workmanship

Fill voids and joints solid. In caulking around openings, include entire perimeter of each opening, unless shown or specified otherwise. Where the use of a gun is impracticable, use handtools.

G. Finishing

Point caulked and sealed joints on flush surfaces with beading tool and internal corners with eaving tool. Remove excess material. Exposed caulking shall be free of wrinkles and uniformly smooth. Caulking and sealing shall be complete before final coats of paint are applied.

H. Cleaning

Clean surfaces of materials adjoining caulked and sealed joints of any smears of compound or other soiling due to caulking application.

I. Miscellaneous Caulking and Sealing Work

Provide caulking wherever required to prevent light leakage as well as moisture leakage. Refer to drawings for conditions and related parts of the work. Match color of adjoining surfaces.

END OF SECTION

SECTION 083473 SOUND CONTROL DOORS AND FRAMES

PART 1 - GENERAL

A. Description

This section includes materials and installation of sound control doors, frames, and related items.

B. Related Work Specified Elsewhere

1. Door Finish Hardware: 087110.

2. Painting and Coating: 099000.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit manufacturer's descriptive literature and installation instructions.

3. Submit illustrations and schedule of door and frame sizes, types, materials, construction, finishing, anchoring, accessories, and preparation for installing hardware.

4. Submit manufacturer's literature showing compliance with cited ANSI, ASTM, AAMA, and SDI specifications.

5. Sound Transmission Class (STC) Certification: Submit Certification of STC rating for sound control doors and frame assembly.

D. Installer Qualifications

Employ an installing firm approved in writing or licensed by the sound control door and frame manufacturer, with not less than five years’ successful experience with units similar to those indicated and having a recent, documentable background of not less than three installations of comparable size, scope, and acoustical performance to that indicated herein.

E. Manufacturer's Services

Provide door manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

1. One labor day to check the door installation and advise during hardware adjustment and adjustment of doors.

2. One-half labor day to instruct the Owner's personnel in the operation and maintenance of the doors.

PART 2 - MATERIALS

A. Manufacturers

Products shall be from the following manufacturers or equal:

1. Krieger Steel Products Co.

2. Overly Manufacturing Co.

3. Sonicbar by Rysdon Products Co.

4. Jamison Door Co.

5. Security Acoustics Co.

B. Materials for Doors and Frames

Fabricate sound control doors and frames from cold-rolled steel conforming to ASTM A1008.

C. Shop Fabrication and Assembly

Sound control doors and frame shall be shop fabricated and shop assembled. Metal shall be zinc coated and primed for field painting and be reinforced for hardware. Provide temporary stiffeners, spacers, and other accessories necessary to facilitate handling and accurate erection. After fabrication, fill tool marks and other surface imperfections and grind smooth.

D. Hardware

Doors and frames shall be reinforced and drilled or tapped for fully templated mortised hardware and shall be reinforced with plates for surface-mounted hardware, meeting ANSI A115 series requirements. Hardware shall be as specified in Section 087110 and as indicated in the drawings.

E. STC

In the location indicated in the Door Schedule, provide a sound control door and frame installation that, in the erected configuration, shall serve as an effective sound barrier with an STC rating of 52. This rating shall be based on a full-scale laboratory test in accordance with ASTM E90, conducted at a recognized acoustical laboratory that has been accredited by the National Voluntary Laboratory Accreditation Program (NVLAP), initiated by the NBS. As a part of the submittal data, furnish certification of such laboratory tests.

F. Sound Control Doors

1. Sound control doors and frames shall be factory-built, laboratory-tested assemblies, complete with perimeter compression seals and automatic, door-bottom seals at sill.

2. Doors, frame, seals, threshold, and related accessory items shall be the products of a single manufacturer. Doors, frames, seals, thresholds, and related accessory items shall be the same manufacturer's model numbers that were tested as described above.

3. Sound control door and frame assembly shall contain only materials that have a Flame Spread Rating of 25 or less when tested in accordance with ASTM E84.

4. Form doors of not less than 16-gauge, cold-rolled, stretcher-leveled steel face sheets joined with continuously and fully welded seams along the vertical edges.

5. Reinforce and enclose door tops and bottoms with die-formed, 16-gauge steel channels, continuously welded in place. Provide tops of doors with flush, watertight, and weathertight top enclosures.

6. Doors shall be rigid and neat in appearance and shall be free from warpage or buckle. Corner bends shall be true and straight and shall be of not less than the minimum radius for the gauge of metal used.

7. Cores shall consist of an incombustible water-resistant, noncoupling filler.

G. Sound Control Frame Design and Construction

Fabricate frames from 14-gauge steel with the corners mitered, welded, and ground smooth. Hinge hardware reinforcement plates shall be of not less than 3/16-inch-thick steel, welded in place. Strike reinforcements shall be not less than 10-gauge steel.

H. Perimeter Seals

Construct perimeter seals of vinyl with a magnetic tape insert in a fully adjustable retainer assembly. Construct the hinge to avoid pinching or other distortion of the seal from opening and closing of the doors.

I. Automatic Door Bottoms

Automatic door bottoms shall be fully mortised, automatic type and adjustable, with an extruded neoprene insert designed to fully close the gap between the door and the sill, along the entire width of the door. The seal insert shall be 50 to 60 durometer neoprene, and the actuating mechanism shall compress or retract the seal properly when the outer face of the door is within 2 inches of the strike jamb.

J. Threshold

Threshold shall be satin finish, solid stainless steel, furnished by the manufacturer as a part of the sound control door and frame assembly.

K. Frame Anchors

1. Floor Anchors: Weld floor anchors inside each frame jamb head. Provide holes for floor anchorage. Minimum thickness of floor anchors shall be 14 gauge.

2. Anchors for Concrete Installations: Provide frames for installation in concrete walls with adjustable jamb anchors of the T-strap, stirrup and strap, or wire type. The number of anchors per frame jamb and head shall be as follows:

    Frames up to 8 feet 8 inches in height: Four anchors.

PART 3 - EXECUTION

A. Product Delivery, Storage, and Handling

1. Ship and store sound control doors and frame with temporary stiffeners and spacers in place where required to prevent distortion.

2. Deliver sound control doors, frame, and all related components, in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

3. Store sound control doors and frames in an area that is protected from the elements and in a manner that will prevent damage or marring of finish.

B. Frame Installation

1. Set frames plumb and square in a true plane and securely anchor to adjoining construction. Provide steel shims and set tight and rigidly attach between frame anchors and structure. Finish metal frames shall be strong and rigid; neat in appearance; and square, true, and free of defects, warp, or buckle.

2. Molded members, trims, and stops shall be clean cut, straight, and shall be of a uniform profile throughout their lengths.

3. Corner joints shall have contact edges tightly closed with trim faces mitered, welded, and finished smooth.

C. Door Installation

1. Install sound control doors and frames in conformance with the manufacturer's instructions under the advice of the manufacturer's technical representative.

2. Where possible, verify field conditions and dimensions prior to fabrication.

3. Install doors in accordance with ANSI A250.8 except as modified herein.

4. Install doors plumb, square, and level with diagonal distortion of no more than 1/16 inch. Doors shall operate freely but not loosely. They shall be free from rattling while in a closed position.

5. Door clearances shall be +3/32 inch or -1/32 inch and shall not exceed the limits in the manufacturer's printed recommendations.

6. Any door that becomes warped such that its acoustic performance or functionality is compromised shall be replaced.

7. Doors and door finish hardware shall be removed for final paint finishing of the doors and, subsequently, reinstalled as a part of the requirement for painting and as indicated in Section 087110.

D. Finish Hardware

1. Prepare doors and frames to receive mortised and concealed finish hardware in accordance with final finish hardware schedule according to templates furnished by the hardware supplier. Preparation shall be in compliance with applicable requirements of ANSI A115 series specifications for door and frame preparation for hardware.

2. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied finish hardware may be done at the project site.

3. Locate finish hardware as indicated on the final shop drawings or, if not indicated, in accordance with "Recommended Locations for Builder's Hardware," published by the Door and Hardware Institute.

E. Painting and Coating

1. Prime Painting: After fabrication, sound control doors, frame, and seal retainers shall be thoroughly cleaned, galvanized, and factory primed with an appropriate primer. Doors and frame shall be chemically treated to provide paint adhesion.

2. Finish Painting: Doors and frame shall be finish painted in the field after installation. Finish paint coating shall conform to the requirements of Section 099000, System No. 52.

F. Adjust and Clean

1. Finished surfaces of doors, frames, and related accessories shall be free from damage, flaws, blemishes, or other defects detrimental to appearance. Surfaces, joints, and exposed trim shall be in correct position and alignment and be uniform in plane, color, texture, and finish.

2. Check and readjust operating finish hardware items, leaving sound control doors and frame undamaged and in complete and proper operating condition.

END OF SECTION

SECTION 087110 DOOR FINISH HARDWARE

PART 1 - GENERAL

A. Description

This section includes materials and installation of door finish hardware: locksets, latch sets, and fasteners.

B. Related Work Specified Elsewhere

Sound Control Doors and Frames: 083473.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit hardware list including item name, manufacturer's catalog number, type, size, finish, function, quality, and fastening method and locations to be installed.

3. Submit catalog data for locksets.

D. Quality Control

1. All locksets and lockset components for the project of the same manufacturer. Master-key the locks.

2. Hardware shall permit doors to be opened from the interior by only one operation, by turning a lever, without the use of a key or any special knowledge or effort.

3. Hardware shall permit the doors to be opened from the exterior both with and without a key.

4. Furnish templates to the metal door and frame manufacturer.

PART 2 - MATERIALS

A. Fasteners

Provide hexagon-head bolts, machine screws, or wood screws for the type of mounting required. Provide machine screws for hardware furnished in connection with metal doors or jambs.

B. Weatherstripping

Provide weatherstripping for exterior doors.

C. Finish

630 for steel and wood doors. Satin stainless steel, US32D finish.

D. Schedule of Finish Hardware

1. The door schedule in the drawings indicates which hardware set is used with each door.

2. Manufacturer's Code:

GJ	Glynn Johnson
H	Hager
LCN	LCN Closers
P	Pemco
R	Reese
SCH	Schlage
VON	Von Duprin

3. Provide the listed hardware set, or equal, of manufacturer’s catalog items for every door type as follows:

HARDWARE SCHEDULE [modify as necessary, add door schedules]

HW-1			
Each 3’-0” x 8’-6” door to have:			
4	Hinges	BB1199 – 4-1/2" NRP	H
1	Lock	L9453 P	SCH
1	Overhead Holder	GJ100ADJ	GJ
1	Dustproof Strike	DP1	GJ
1	Threshold	See Section 083473	--
1 Set	Seals	See Section 083473	--
1	Automatic Door Bottom	See Section 083473	--

HW-2			
Pair 3’-6” x 8’-6” doors, each door to have:			
8	Hinges	BB1199 – 4-1/2" x 4 NRP	H
1	Lock	L9453-P	SCH
2	Overhead Holders	GJ100ADJ	GJ
2	Flush Bolts	FB6	GJ
1	Dustproof Strike	DP1	GJ
1	Threshold	See Section 083473	--
1	Astragal	See Section 083473	--
1 Set	Seals	See Section 083473	--
2	Automatic Door Bottom	See Section 083473	--

PART 3 - EXECUTION

A. Product Handling

Deliver hardware to the jobsite packaged and distinctly marked, identifying each item for its particular opening or location. Furnish a complete hardware list to the job at the time of hardware delivery.

B. Installation

1. Install finish hardware per manufacturer's recommendations.

2. Locate hardware as follows except for special situations detailed in drawings:

   a. Lock/Latch Sets: Knob/lever 38 inches above floor.

   b. Cylinder Deadlocks: 44 inches above floor.

   c. Panic Hardware: Between 30 and 44 inches above floor, 36 inches standard.

   d. Hinges:

      (1) Top Hinge: Top edge 5 inches below head of frame.

(2) Bottom Hinge: Lower edge 10 inches above floor.

(3) Intermediate Hinge: Equally distant between top and bottom hinges or equally spaced where there is more than one intermediate hinge.

e. Closers: Place closers inside buildings, stairways, and rooms.

C. Inspection

Upon completion of the installation and as a condition of its acceptance, visually inspect all finish hardware furnished under this section and place in optimum working order. Replace units that cannot be adjusted to operate freely and smoothly.

D. Field Testing

Demonstrate to the Owner's Representative that all hardware operates freely without sticking, binding, squeaking, or otherwise malfunctioning by operating each hinge, lockset, closer, or other device through a minimum of two complete cycles. Surrender all keys to the Owner upon acceptance of each lockset.

END OF SECTION

SECTION 089119 FIXED LOUVERS

PART 1 - GENERAL

A. Description

This section describes materials and installation of fixed louvers.

B. Related Work Specified Elsewhere

Architectural Caulking and Sealants: 079200.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit dimensional drawings and manufacturer's catalog data for louvers.

3. Submit manufacturer's specifications; catalog cut sheets; certified test data, where applicable; and installation instructions for required products, including finishes.

4. Submit drawings for fabrication and erection of louver units and accessories. Include plans, elevations, and details of sections and connections to adjoining work. Indicate materials, finishes, fasteners, joinery, and other information to determine compliance with specified requirements. Submit color chart for selection by Owner.

D. Quality Control

1. Performance Requirements: Where louvers are indicated to comply with specific performance requirements, provide units whose performance ratings have been determined to be in compliance with AMCA 500.

2. AMCA Certification: Where indicated, provide louvers with AMCA Certified Ratings Seal. The seal provides evidence the product complies with the above requirement.

3. Comply with SMACNA "Architectural Sheet Metal Manual" recommendations for fabrication, construction details,

and installation procedures, except as otherwise indicated.

4. Field Measurements: Verify size, location, and placement of louver units prior to fabrication.

5. Shop Assembly: Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustment, splicing, mechanical joints, and field assembly of units. Preassemble units in shop to greatest extent possible and disassemble as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

PART 2 - MATERIALS

A. Manufacturers

Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include the following:

1. Industrial Acoustics Co.

2. Ruskin Mfg. Co.

B. Acoustical Wall Louvers

1. Acoustical louvers shall be 8 inches deep, constructed of aluminum Alloy 5005-H34 or 6063-T5 with minimum 16-gauge frames and 22-gauge blades. The louvers shall be NOISHIELD Model R as fabricated by Industrial Acoustics Company of Bronx, N.Y., or equal.

2. Water Penetration: Not more than 0.01 ounce per square foot of free area at the specified intake airflow free area velocity.

3. Set blades at a 45-degree slope spaced at 6 inches on center.

4. Noise Reduction: Free field reduction in decibels.

Hz	**63**	**125**	**250**	**500**	**1K**	**2K**	**4K**	**8K**
dB	11	13	17	18	19	20	18	15

C. Fastenings

Use same materials as items fastened, unless otherwise indicated. Fasteners for exterior applications must be of Type 304 or 316 stainless steel. Provide types, gauges, and lengths to suit unit installation conditions. Use Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

D. Anchors and Inserts

Use Type 316 stainless steel expansion bolt devices for drilled-in-place anchors. Provide inserts to be set into concrete or masonry work.

E. Fabrication

1. Fabricate frames and sills with tolerances for installation, including application of sealants in joints between louvers and adjoining work.

2. Include supports, anchorages, and accessories required for complete assembly.

3. Provide sill extensions and loose sills made of same material as louvers for drainage to exterior.

4. Join frame members to one another and to stationary louver blades by welding, except where indicated otherwise or where field-bolted connections between frame members are made necessary by size of louvers. Maintain equal blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

F. Louver Screens

1. Provide removable insect screens of 18 by 14 mesh bronze for exterior louvers.

2. Fabricate screen frames of same metal and finish as louver units to which secured, unless otherwise indicated.

3. Provide screen mounted in extruded aluminum U-frame placed on interior face of louver with sheet metal screws.

G. Metal Finishes

1. General: Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated. Apply finishes in factory after products are assembled. Protect finishes on exposed surfaces with protective covering prior to shipment. Remove scratches and blemishes that are visible after completing finishing process from exposed surfaces.

2. Aluminum Finishes: Medium matte etched finish with 0.7-mil minimum thick anodic coating, AA-C22-A42 dark bronze anodized.

PART 3 - EXECUTION

A. Preparation

Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

B. Installation

1. Locate and place louver units plumb, level, and in proper alignment with adjacent work.

2. Use concealed anchorages wherever possible. Provide washers fitted to screws to protect metal surfaces and to make a weathertight connection.

3. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers.

4. Repair finishes damaged by cutting, welding, soldering, and grinding operations required for fitting and jointing. Restore finish so there is no evidence of corrective work. Return items which cannot be refinished in field to shop, make alterations, and refinish entire unit or provide new units, at Contractor's option.

C. <u>Painting and Coating</u>

Submit color chart for review by the Owner's Representative prior to ordering the louvers. Coat nonferrous metal surfaces in contact with concrete, masonry, or dissimilar metals per Section 099000, System No. 54.

END OF SECTION

SECTION 099000 PAINTING AND COATING

PART 1 - GENERAL

A. Description

This section includes materials and application of painting and coating systems for the following surfaces:

1. Submerged metal.
2. Exposed metal.
3. Buried metal.
4. Concrete and masonry.
5. Metal in contact with concrete.
6. Exterior architectural coatings and finishes.
7. Interior architectural coatings and finishes.

B. Related Work Specified Elsewhere

1. General Concrete Construction: 030500.
2. Concrete Unit Masonry: 042223.
3. Cold-Applied Wax Tape Coating: 099752.
4. Fusion-Bonded Epoxy Linings and Coatings: 099761.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.
2. Submit manufacturer’s data sheets showing the following information:
    a. Percent solids by volume.
    b. Minimum and maximum recommended dry-film thickness per coat for prime, intermediate, and finish coats.
    c. Recommended surface preparation.

d. Recommended thinners.

e. Statement verifying that the specified prime coat is recommended by the manufacturer for use with the specified intermediate and finish coats.

f. Application instructions including recommended equipment and temperature limitations.

g. Curing requirements and instructions.

3. Submit color swatches.

4. Submit certificate identifying the type and gradation of abrasives used for surface preparation.

5. Submit material safety data sheets for each coating.

PART 2 - MATERIALS

A. Painting and Coating Systems

The following index lists the various painting and coating systems by service and generic type:

PAINT COATINGS SYSTEM INDEX

No.	Title	Generic Coating
	Submerged Metal Coating System	
7.	Submerged Metal, Potable or Nonpotable Water	Epoxy
	Exposed Metal Coating System	
10.	Exposed Metal, Corrosive Environment	High-build epoxy (two-coat system) with polyurethane topcoat
	Buried Metal Coating Systems	
21.	Buried Metal	Epoxy
24.	Buried Metal	Corrosion-resisting grease

No.	Title	Generic Coating
25.	Buried Metal Piping and Tubing	Coal-tar, wax, and polyethylene tape wrap or extruded polyethylene
	Coating Systems for Nonferrous Metals	
52.	Exposed Metal, Galvanized Steel	Synthetic resin
54.	Aluminum Insulation from Concrete and Carbon Steel	Epoxy
	Exterior and Interior Architectural Coatings and Finishes	
73.	Clear Sealer on Exterior and Interior Concrete and Masonry	Silane
74	Semi-Transparent Stain Finish	Aldyd/oil

These systems are specified in detail in the following paragraphs. For each coating, the required surface preparation, prime coat, intermediate coat (if required), topcoat, and coating thicknesses are described. Mil thicknesses shown are minimum dry-film thicknesses.

B. Submerged Metal Coating System

1. System No. 7--Submerged Metal, Potable or Nonpotable Water:

   a. Type: Epoxy.

   b. Service Conditions: For use with structures, valves, piping, or equipment immersed in potable or nonpotable water.

   c. Surface Preparation: SSPC SP-10.

   d. Coating System: Apply the manufacturer’s recommended number of coats to attain the specified minimum coating thickness. Products: Devoe Bar-Rust 233V, Sherwin-Williams Duraplate UHS B62-210 series, Tnemec L140F, or equal; 16 mils total. Color of topcoat: white. Each coat shall be different color than the one preceding it.

C. <u>Exposed Metal Coating System</u>

1. System No. 10--Exposed Metal, Corrosive Environment:

   a. Type: High-build epoxy intermediate coat having a minimum volume solids of 60%, with an inorganic zinc prime coat and a pigmented polyurethane finish coat having a minimum volume solids of 52%.

   b. Service Conditions: For use with metal structures or pipes subjected to water condensation; chemical fumes, such as hydrogen sulfide; salt spray; and chemical contact.

   c. Surface Preparation: SSPC SP-10.

   d. Prime Coat: Self-curing, two-component inorganic zinc-rich coating recommended by the manufacturer for overcoating with a high-build epoxy finish coat. Minimum zinc content shall be 12 pounds per gallon. Apply to a thickness of 3 mils. Products: Tnemec 90-97 (shop application) or 94-H2O (field application), Devoe Catha-Coat 302V, Sherwin-Williams Zinc-Clad III B69 series, or equal.

   e. Intermediate Coat: Tnemec L69F, ICI Devoe Devran 224HS or 231, Sherwin-Williams Macropoxy 646 B58-620, or equal; 5 mils.

   f. Finish Coat: Two-component pigmented acrylic or aliphatic polyurethane recommended by the manufacturer for overcoating a high-build epoxy coating. Apply to a thickness of at least 3 mils. Products: Tnemec Series 1081, ICI Devoe Devthane 379H, Sherwin-Williams Hi-Solids Polyurethane B65-625, or equal.

D. <u>Buried Metal Coating Systems</u>

1. System No. 21--Buried Metal:

   a. Type: High solids epoxy or phenolic epoxy having a minimum volume solids of 80% (ASTM D2697).

   b. Service Conditions: Buried metal, such as valves, flanges, bolts, nuts, structural steel, and fittings.

   c. Surface Preparation: SSPC SP-10.

d. Coating System: Apply three or more coats of Tnemec L69F, ICI Devoe Bar-Rust 233V, Sherwin-Williams Duraplate UHS B62 series, or equal; 30 mils total. Maximum thickness of an individual coating shall not exceed the manufacturer's recommendation.

e. System No. 22 may be substituted for System No. 21.

2. System No. 24--Buried Metal:

   a. Type: Corrosion-resisting grease.

   b. Service Conditions: Buried metal, such as bolts, bolt threads, tie rods and nuts.

   c. Surface Preparation: SSPC-SP-3 or SP-6.

   d. Coating: NO-OX-ID GG-2 as manufactured by Sanchem, Inc. Apply to a minimum thickness of 1/4 inch.

3. System No. 25--Buried Metal Piping and Tubing:

   a. Type: Cold-applied coal-tar tape, hot-applied coal-tar tape, or cold-applied wax tape.

   b. Service Conditions: Buried ferrous and nonferrous piping and tubing.

   c. Coat with one of the following systems:

      (1) Wrap with cold-applied coal-tar tape conforming to AWWA C209. Minimum thickness of tape shall be 35 mils. Apply tape with manufacturer's prime coat. Tape shall be Tapecoat CT, Protecto-Wrap 200, or equal.

      (2) Wrap with hot-applied coal-tar tape conforming to AWWA C203, Section 4.6. Minimum thickness of tape shall be 50 mils. Apply tape with manufacturer's recommended prime coat. Tape shall be Tapecoat 20, Protecto-Wrap 110, or equal.

      (3) Wrap with cold-applied wax tape per Section 099752.

   d. Use chloride-free primers with the above coatings when applying to stainless steel piping or tubing.

e. Coat field joints of buried piping that has shop-applied coating with primer and tape conforming to AWWA C209. Use Type 1 tape of 35-mil thickness. Products: Protection Engineering Co. Protecto-Wrap 200 GT, TapecoatCT10/40W, Polyken 930-35, or equal.

f. Perform electrical inspection of shop and field coating in accordance with Section 5 of AWWA C209.

g. Install buried pipes with wrapped coatings by extending the wrapping to the first joint after entering a building, penetrating a slab, or 6 inches above finished grade. Wrap joints spirally with a minimum overlap of 50% of the tape width.

E. Coating Systems for Nonferrous Metals

1. System No. 52--Exposed Metal, Galvanized Steel:

a. Type: Synthetic resin or epoxy primer.

b. Service Conditions: Coat galvanized steel surfaces with this system before applying topcoat.

c. Surface Preparation of Galvanized Steel: Surfaces shall be flat with no protrusions. Remove high spots and tears in the galvanizing with hand and power grinders. Comply with ASTM D6386, paragraph 5.2.1. Do not remove the galvanized coating below the specified thickness. Solvent clean galvanized surfaces per ASTM D6386, paragraph 5.3.2. Then sweep blast per ASTM D6386, paragraph 5.4.1. Use one of the abrasive materials that is described in ASTM D6386, paragraph 5.4.1. Surface preparation for weathered and partially weathered galvanized steel shall be in accordance with ASTM D6386, paragraphs 6 and 7. Apply prime coating within one hour of the surface preparation.

d. Prime Coat: Tnemec L69F, ICI Devoe Devran 224HS, Sherwin-Williams Macropoxy 646 B58-620 series, or equal. Apply to a minimum thickness of 4 mils.

e. Intermediate and Finish Coats: Epoxy and polyurethane as described in System No. 10. Do not include the inorganic zinc prime coat described in that system.

2. System No. 54--Aluminum Insulation from Concrete and Carbon Steel:

   a. Type: High solids epoxy or phenolic epoxy having a minimum volume solids of 80% (ASTM D2697).

   b. Service Conditions: Coat areas of aluminum grating, stairs, structural members or aluminum fabrications, in contact with concrete or carbon steel with this system.

   c. Surface Preparation: Solvent or steam cleaning per SSPC SP-1; do not use alkali cleaning. Then dust blast.

   d. Coating System: Apply three or more coats of Tnemec L69F, ICI Devoe Bar-Rust 233V, Sherwin-Williams Macropoxy B58-620, or equal; 30 mils total. Maximum thickness of an individual coating shall not exceed the manufacturer's recommendation.

F. <u>Exterior and Interior Architectural Coatings and Finishes</u>

1. System No. 73--Clear Sealer on Exterior and Interior Concrete and Masonry Vertical and Horizontal Surfaces:

   a. Type: Silane with minimum solids of 22%.

   b. Surface Preparation: In accordance with Part 3.D.

   c. Prime Coat: One coat Monochem Silane 20 Penetrating Sealer or Hydrozo Enviroseal 7, two coats Okon Block Plugger, one coat Rainstopper 140, two coats Carbocrete Sealer WB. Apply at 80 square feet per gallon.

   d. Finish Coat: Two coats Hydrozo Enviroseal 7, one coat Okon W-2, one coat Rainstopper 140, one coat Carbocrete Sealer WB. Apply at 80 square feet per gallon.

   e. Guarantee: Contractor, sealer manufacturer, and applicator shall jointly and severally guarantee that treated surfaces will remain waterproof and free of water intrusion for five years and that they will immediately repair and correct any deficiencies or leakage that may appear in the treated work during the guarantee period at no cost to Owner.

Leaks caused by structural cracking or movement are excepted from the guarantee.

2. System No. 74—-Semi-Transparent Stain:

   a. Type: Water reducible alkyd semi-transparent stain.

   b. Surface Preparation: Remove dirt, loose wood fibers, mildew, grade stamps, pencil marks, or other discolorations.

   c. Prime Coat: Frazee 385 Madera Water Reducible Semi-Transparent Stain; ICI Delux 2610; PPG SUN-PROOF® Deck, Fence Siding Semi-Transparent Acrylic Stain 77-1460; Dunn Edwards OKON Weather Pro (WPT-3); or equal.

   d. Finish Coat: Frazee 385 Madera Water Reducible Semi-Transparent Stain; ICI Delux 2610; PPG SUN-PROOF® Deck, Fence, Siding Semi-Transparent Acrylic Stain 77-1460; Dunn Edwards OKON Weather Pro (WPT-3); or equal. Prime and finish coats shall be wet-on-wet application.

G. <u>Abrasives for Surface Preparation</u>

1. Abrasives used for preparation of ferrous (excluding stainless steel) surfaces shall be one of the following:

   a. 16 to 30 or 16 to 40 mesh silica sand or mineral grit.

   b. 20 to 40 mesh garnet.

   c. Crushed iron slag, 100% retained on No. 80 mesh.

   d. SAE Grade G-40 or G-50 iron or steel grit.

2. Abrasives used for preparation of copper and aluminum surfaces shall be one of the following:

   a. Crushed slag, 80 to 100 mesh.

   b. Very fine silica sand, 80 to 100 mesh.

3. Abrasives used for preparation of concrete and masonry surfaces shall be 16 to 30 or 16 to 40 mesh silica sand. In the above gradations, 100% of the material shall pass

through the first stated sieve size and 100% shall be retained on the second stated sieve size.

PART 3 - EXECUTION

A. Weather Conditions

1. Do not paint in the rain, wind, snow, mist, and fog or when steel or metal surface temperatures are less than 5°F above the dew point.

2. Do not apply paint when the relative humidity is above 85%.

3. Do not paint when temperature of metal to be painted is above 120°F.

4. Do not apply alkyd, inorganic zinc, silicone aluminum, or silicone acrylic paints if air or surface temperature is below 40°F or expected to be below 40°F within 24 hours.

5. Do not apply epoxy, acrylic latex, and polyurethane paints on an exterior or interior surface if air or surface temperature is below 60°F or expected to drop below 60°F in 24 hours.

B. Surface Preparation Procedures

1. Remove oil and grease from metal surfaces in accordance with SSPC SP-1. Use clean cloths and cleaning solvents and wipe dry with clean cloths. Do not leave a film or greasy residue on the cleaned surfaces before abrasive blasting.

2. Remove weld spatter and weld slag from metal surfaces and grind smoothly rough welds, beads, peaked corners, and sharp edges including erection lugs in accordance with SSPC SP-2 and SSPC SP-3. Grind 0.020 inch (minimum) off the weld caps on pipe weld seams. Grind outside sharp corners, such as the outside edges of flanges, to a minimum radius of 1/4 inch.

3. Do not abrasive blast or prepare more surface area in one day than can be coated in one day; prepare surfaces and apply coatings the same day. Remove sharp edges, burrs, and weld spatter.

4. Do not abrasive blast PVC, CPVC, or FRP piping or equipment. Do not abrasive blast epoxy- or enamel-coated pipe that has already been factory coated, except to repair scratched or damaged coatings.

5. For carbon steel, do not touch the surface between the time of abrasive blasting and the time the coating is applied. Apply coatings within two hours of blasting or before any rust bloom forms.

6. Surface preparation shall conform with the SSPC specifications as follows:

Solvent Cleaning	SP-1
Hand Tool Cleaning	SP-2
Power Tool Cleaning	SP-3
White Metal Blast Cleaning	SP-5
Commercial Blast Cleaning	SP-6
Brush-Off Blast Cleaning	SP-7
Pickling	SP-8
Near-White Blast Cleaning	SP-10
Power Tool Cleaning to Bare Metal	SP-11
Surface Preparation and Cleaning of Steel and Other Hard Materials by High- and Ultrahigh-Pressure Water Jetting Prior to Recoating	SP-12
Surface Preparation of Concrete	SP-13

7. Wherever the words “solvent cleaning,” “hand tool cleaning,” “wire brushing,” or “blast cleaning” or similar words are used in these specifications or in paint manufacturer’s specifications, they shall be understood to refer to the applicable SSPC (Steel Structure Painting Council), surface preparation specifications listed above.

8. Dust blasting is defined as cleaning the surface through the use of very fine abrasives, such as siliceous or mineral abrasives, 80 to 100 mesh. Apply a fine etch to the metal surface to clean the surface of any contamination or oxide and to provide a surface profile for the coating.

9. Brush-off blasting of concrete and masonry surfaces is defined as opening subsurface holes and voids and etching the surface for a coating to bond.

10. For carbon steel surfaces, after abrasive blast cleaning, the height of the surface profile shall be 2 to 3 mils. Verify the surface profile by measuring with an impresser tape acceptable to the Owner’s Representative. Perform a minimum of one test per 100 square feet of surface area. Testing shall be witnessed by the Owner’s Representative. The impresser tape used in the test shall be permanently marked with the date, time, and locations where the test was made. Test results shall be promptly presented to the Owner’s Representative.

11. Do not apply any part of a coating system before the Owner’s Representative has reviewed the surface preparation. If coating has been applied without this review, if directed by the Owner’s Representative, remove the applied coating by abrasive blasting and reapply the coat in accordance with this specification.

C. Abrasive Blast Cleaning

1. Use dry abrasive blast cleaning for metal surfaces. Do not use abrasives in automatic equipment that have become contaminated. When shop or field blast cleaning with handheld nozzles, do not recycle or reuse blast particles.

2. After abrasive blast cleaning and prior to application of coating, dry clean surfaces to be coated by dusting, sweeping, and vacuuming to remove residue from blasting. Apply the specified primer or touch-up coating within the period of an eight-hour working day. Do not apply coating over damp or moist surfaces. Reclean prior to application of primer or touch-up coating any blast cleaned surface not coated within said eight-hour period.

3. Keep the area of the work in a clean condition and do not permit blasting particles to accumulate and constitute a nuisance or hazard.

4. During abrasive blast cleaning, prevent damage to adjacent coatings. Schedule blast cleaning and coating such that dust, dirt, blast particles, old coatings,

rust, mill scale, etc., will not damage or fall upon wet or newly coated surfaces.

D. Preparation of Concrete and Masonry Surfaces To Be Coated

1. Surface preparation of concrete and masonry surfaces shall be in accordance with SSPC SP-13 and the following.

2. Do not apply coating until concrete has cured at least 30 days. Finish concrete surfaces per Section 030500. Do not use curing compound on surfaces that are to be coated.

3. Concrete and masonry surfaces on which coatings are to be applied shall be of even color, gray or gray-white. The surface shall have no pits, pockets, holes, or sharp changes of surface elevation. Scrubbing with a stiff-bristle fiber brush shall produce no dusting or dislodging of cement or sand. Sprinkling water on the surface shall produce no water beads or standing droplets. Concrete and masonry shall be free of laitance and slick surfaces.

4. Detergent clean the concrete or masonry surface with trisodium phosphate per ASTM D4258. Then sandblast surfaces (brush-off blast). Floor slabs may be acid etched per ASTM D4260 in lieu of sandblasting. After sandblasting, wash surfaces with water to remove dust and salts, per ASTM D4258 or D 4261. The grain of the concrete surface to touch shall not be rougher than that of No. 10 mesh sand.

5. Acceptance criteria for concrete surfaces (except for those coated with System No. 73) shall be in accordance with SSPC SP-13, Table 1, "Severe Service."

6. Do not apply coatings to concrete when the concrete is outgassing. Apply coatings only when the concrete surface temperature is stable, not rising.

E. Procedures for Items Having Shop-Applied Prime Coats

1. After application of primer to surfaces, allow coating to cure for a minimum of two hours before handling to minimize damage.

2. When loading for shipment to the project site, use spacers and other protective devices to separate items to prevent damaging the shop-primed surfaces during transit and unloading. If wood spacers are used, remove wood splinters and particles from the shop-primed surfaces after separation. Use padded chains or ribbon binders to secure the loaded items and minimize damage to the shop-primed surfaces.

3. Cover shop-primed items 100% with protective coverings or tarpaulins to prevent deposition of road salts, fuel residue, and other contaminants in transit.

4. Handle shop-primed items with care during unloading, installation, and erection operations to minimize damage. Do not place or store shop-primed items on the ground or on top of other work unless ground or work is covered with a protective covering or tarpaulin. Place shop-primed items above the ground upon platforms, skids, or other supports.

F. Field Touch-Up of Shop-Applied Prime Coats

1. Remove oil and grease surface contaminants on metal surfaces in accordance with SSPC SP-1. Use clean rags wetted with a degreasing solution, rinse with clean water, and wipe dry.

2. Remove dust, dirt, salts, moisture, chalking primers, or other surface contaminants that will affect the adhesion or durability of the coating system. Use a high-pressure water blaster or scrub surfaces with a broom or brush wetted with a solution of trisodium phosphate, detergent, and water. Before applying intermediate or finish coats to inorganic zinc primers, remove any soluble zinc salts that have formed by means of scrubbing with a stiff bristle brush. Rinse scrubbed surfaces with clean water.

3. Remove loose or peeling primer and other surface contaminants not easily removed by the previous cleaning methods in accordance with SSPC SP-7. Take care that remaining primers are not damaged by the blast cleaning operation. Remaining primers shall be firmly bonded to the steel surfaces with blast cleaned edges feathered.

4. Remove rust, scaling, or primer damaged by welding or during shipment, storage, and erection in accordance

with SSPC SP-10. Take care that remaining primers are not damaged by the blast cleaning operation. Areas smaller than 1 square inch may be prepared per SSPC SP-11. Remaining primers shall be firmly bonded to the steel surfaces with cleaned edges feathered.

5. Use repair procedures on damaged primer that protects adjacent primer. Blast cleaning may require the use of lower air pressure, smaller nozzles, and abrasive particle sizes, short blast nozzle distance from surface, shielding, and/or masking.

6. After abrasive blast cleaning of damaged and defective areas, remove dust, blast particles, and other debris by dusting, sweeping, and vacuuming; then apply the specified touch-up coating.

7. Surfaces that are shop primed with inorganic zinc primers shall receive a field touch-up of organic zinc primer per System No. 18 to cover scratches or abraded areas.

8. Other surfaces that are shop primed shall receive a field touch-up of the same primer used in the original prime coat.

G. Painting Systems

1. All materials of a specified painting system, including primer, intermediate, and finish coats, shall be produced by the same manufacturer. Thinners, cleaners, driers, and other additives shall be as recommended by the paint manufacturer for the particular coating system.

2. Deliver paints to the jobsite in the original, unopened containers.

H. Paint Storage and Mixing

1. Store and mix materials only in areas designated for that purpose by the Owner’s Representative. The area shall be well-ventilated, with precautionary measures taken to prevent fire hazards. Post “No Smoking” signs. Storage and mixing areas shall be clean and free of rags, waste, and scrapings. Tightly close containers after each use. Store paint at an ambient temperature from 50°F to 100°F.

2. Prepare multiple-component coatings using all of the contents of the container for each component as packaged by the paint manufacturer. Do not use partial batches. Do not use multiple-component coatings that have been mixed beyond their pot life. Provide small quantity kits for touch-up painting and for painting other small areas. Mix only the components specified and furnished by the paint manufacturer. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

I. <u>Procedures for the Application of Coatings</u>

1. Conform to the requirements of SSPC PA-1. Follow the recommendations of the coating manufacturer including the selection of spray equipment, brushes, rollers, cleaners, thinners, mixing, drying time, temperature and humidity of application, and safety precautions.

2. Stir, strain, and keep coating materials at a uniform consistency during application. Power mix components. For multiple component materials, premix each component before combining. Apply each coating evenly, free of brush marks, sags, runs, and other evidence of poor workmanship. Use a different shade or tint on succeeding coating applications to indicate coverage where possible. Finished surfaces shall be free from defects or blemishes.

3. Do not use thinners unless recommended by the coating manufacturer. If thinning is allowed, do not exceed the maximum allowable amount of thinner per gallon of coating material. Stir coating materials at all times when adding thinner. Do not flood the coating material surface with thinner prior to mixing. Do not reduce coating materials more than is absolutely necessary to obtain the proper application characteristics and to obtain the specified dry-film thicknesses.

4. Remove dust, blast particles, and other debris from blast cleaned surfaces by dusting, sweeping, and vacuuming. Allow ventilator fans to clean airborne dust to provide good visibility of working area prior to coating applications. Remove dust from coated surfaces by dusting, sweeping, and vacuuming prior to applying succeeding coats.

5. Apply coating systems to the specified minimum dry-film thicknesses as determined per SSPC PA-2.

6. Apply primer immediately after blast cleaning and before any surface rusting occurs, or any dust, dirt, or any foreign matter has accumulated. Reclean surfaces by blast cleaning that have surface colored or become moist prior to coating application.

7. Apply a brush coat of primer on welds, sharp edges, nuts, bolts, and irregular surfaces prior to the application of the primer and finish coat. Apply the brush coat prior to and in conjunction with the spray coat application. Apply the spray coat over the brush coat.

8. Before applying subsequent coats, allow the primer and intermediate coats to dry for the minimum curing time recommended by the manufacturer. In no case shall the time between coats exceed the manufacturer’s recommendation.

9. Each coat shall cover the surface of the preceding coat completely, and there shall be a visually perceptible difference in applied shade or tint of colors.

10. Applied coating systems shall be cured at 75°F or higher for 48 hours. If temperature is lower than 75°F, curing time shall be in accordance with printed recommendations of the manufacturer, unless otherwise allowed by the Owner’s Representative.

11. Assembled parts shall be disassembled sufficiently before painting or coating to ensure complete coverage by the required coating.

J. Surfaces Not To Be Coated

Do not paint the following surfaces unless otherwise noted in the drawings or in other specification sections. Protect during the painting of adjacent areas:

1. Concrete walkways.

2. Mortar-coated pipe and fittings.

3. Stainless steel.

4. Metal letters.

5. Glass.

6. Roofing.

7. Fencing.

8. Copper tubing, red brass piping, and PVC piping except where such piping occurs in rooms where the walls are painted, or required for color coding.

9. Electrical fixtures except for factory coatings.

10. Nameplates.

11. Grease fittings.

12. Brass and copper, submerged.

13. Buried pipe, unless specifically required in the piping specifications.

14. Fiberglass items, unless specifically required in the FRP specifications.

15. Insulated pipe.

K. <u>Protection of Surfaces Not To Be Painted</u>

Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process. Mask openings in motors to prevent paint and other materials from entering the motors.

L. <u>Surfaces To Be Coated</u>

The exact coating to be applied in any location is not designated by the descriptive phrases in the coating system titles such as “corrosive environment,” “buried metal,” or “submerged metal.” Coat surfaces with the specific coating systems as described below:

1. Coat mechanical equipment, such as pumps, as described in the various mechanical equipment specifications.

Color of finish coat shall match the color of the connecting piping.

2. Coat aboveground and exposed piping as described in the various piping specifications.

3. Coat valves the same as the adjacent piping. Aboveground valves shall match the color of the connecting piping.

4. Coat masonry surfaces of the building and walls. Apply System No. 73 on exposed interior and exterior masonry.

5. Coat aluminum surfaces in contact with concrete per System No. 54.

6. Coat buried flanges, nuts and bolts, valves, flexible pipe couplings, exposed rebar in thrust blocks, and valve boxes as specified in the particular specifications for the above item. Coat buried bolt threads, tie bolt threads, and nuts per System No. 24.

7. Coat aboveground structural steel or structural steel located in vaults and structures as described in Section 051210. Color of finish coat shall be selected by Owner.

8. Coat exposed indoor galvanized electrical conduit per System No. 52. Color of finish coat shall be OSHA Safety Orange.

9. Coat flashing and sheet metal per Section 076000.

10. Coat doors and frames per System No. 52. Color of finish coat shall match the color of the concrete block.

M. <u>Dry-Film Thickness Testing</u>

1. Measure coating thickness specified for carbon steel surfaces with a magnetic-type dry-film thickness gauge in accordance with SSPC PA-2. Provide certification that the gauge has been calibrated by a certified laboratory within the past six months. Provide dry-film thickness gauge as manufactured by Mikrotest or Elcometer.

2. Test the finish coat of metal surfaces (except zinc primer and galvanizing) for holidays and discontinuities with an electrical holiday detector, low-voltage, wet-sponge type. Provide measuring equipment. Provide certification that the gauge has been calibrated by a certified laboratory within the past six months.

Provide detector as manufactured by Tinker and Rasor or K-D Bird Dog.

3. Measure coating thickness specified for concrete or masonry surfaces in accordance with ASTM D4138. Test the finish coat of concrete and masonry surfaces in accordance with NACE RP-0188-90 or ASTM D4787. Patch coatings at the points of thickness measurement or holiday detection.

4. Check each coat for the correct dry-film thickness. Do not measure within eight hours after application of the coating.

5. For metal surfaces, make five separate spot measurements (average of three readings) spaced evenly over each 100 square feet of area (or fraction thereof) to be measured. Make three readings for each spot measurement of either the substrate or the paint. Move the probe or detector a distance of 1 to 3 inches for each new gauge reading. Discard any unusually high or low reading that cannot be repeated consistently. Take the average (mean) of the three readings as the spot measurement. The average of five spot measurements for each such 100-square-foot area shall not be less than the specified thickness. No single spot measurement in any 100-square-foot area shall be less than 80%, nor more than 120%, of the specified thickness. One of three readings which are averaged to produce each spot measurement may underrun by a greater amount as defined by SSPC PA-2.

6. For concrete surfaces, make five separate spot measurements spaced evenly over each 100 square feet of area (or fraction thereof) to be measured. The average of five spot measurements for each such 100-square-foot area shall not be less than the specified thickness. No single spot measurement in any 100-square-foot area shall be less than 80%, nor more than 120%, of the specified thickness.

7. Perform tests in the presence of the Owner’s Representative.

N. Repair of Improperly Coated Surfaces

If the item has an improper finish color or insufficient film thickness, clean and topcoat the surface with the specified paint material to obtain the specified color and coverage. Sandblast or power-sand visible areas of chipped, peeled, or abraded paint, feathering the edges. Then prime and finish coat in accordance with the specifications. Work shall be free of runs, bridges, shiners, laps, or other imperfections.

O. Cleaning

1. During the progress of the work, remove discarded materials, rubbish, cans, and rags at the end of each day’s work.

2. Thoroughly clean brushes and other application equipment at the end of each period of use and when changing to another paint or color.

3. Upon completion of painting work, remove masking tape, tarps, and other protective materials, using care not to damage finished surfaces.

END OF SECTION

SECTION 099752 COLD-APPLIED WAX TAPE COATING

PART 1 - GENERAL

A. Description

This section includes materials and application of a three-part, cold-applied wax tape coating system for buried piping per NACE RP0375-99, Section 4 except as modified herein.

B. Related Work Specified Elsewhere

Polyethylene Sheet Encasement: 099754.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit manufacturer's catalog data sheets and application instructions.

PART 2 - MATERIALS

A. Primer

1. Primer shall be a blend of petrolatums, plasticizers, and corrosion inhibitors having a paste-like consistency. The primer shall have the following properties:

    a. Pour Point: 100°F to 110°F.

    b. Flash Point: 350°F.

    c. Coverage: 1 gallon per 100 square feet.

2. Primer shall be Trenton Wax Tape Primer, Denso Paste Primer, or equal.

B. Wax Tape

1. Wax tape shall consist of a synthetic-fiber felt, saturated with a blend of microcrystalline wax, petrolatums, plasticizers, and corrosion inhibitors, forming a tape coating that is easily formable over

irregular surfaces. The tape shall have the following properties:

a. Saturant Pour Point: 115°F to 120°F.

b. Thickness: 50 to 70 mils.

c. Tape Width: 6 inches.

d. Dielectric Strength: 100 volts per mil.

2. Wax tapes used for pipe soil-to-air transitions shall be UV light stable so as not to degrade in the presence of sunlight.

3. Wax tape shall be Trenton No. 1 Wax Tape, Denso "Densyl Tape," or equal.

C. Plastic Wrapper

1. Wrapper shall be a polyvinylidene chloride plastic with three 50-gauge plies wound together as a single sheet. The wrapper shall have the following properties:

a. Color: Clear.

b. Thickness: 1.5 mils.

c. Tape Width: 6 inches.

2. Plastic wrapper shall be Trenton Poly-Ply, Denso Tape PVC Self-Adhesive, or equal.

D. Polyethylene Sheet Coating

See Section 099754.

PART 3 - EXECUTION

A. Wax Tape Coating Application

1. Surfaces shall be clean and free of dirt, grease, water, and other foreign material prior to the application of the primer and wax tape.

2. Apply primer by hand or brush to fitting surfaces. Work the primer into crevices and completely cover exposed metal surfaces.

3. Apply the wax tape immediately after the primer application. Work the tape into the crevices around fittings. Apply the wax tape by pressing and molding the tape into conformity with the surface so that it does not bridge over irregular surfaces configurations. Begin wrapping approximately 3 inches behind the area to be wrapped. If starting at a straight edge, wrap the tape spirally around the pipe while touching the end edge before starting the angle to begin the spiral. If the previous roll is headed in a downward direction, tuck the next roll under the previous roll. Stretch each roll tight as wrapping continues to avoid air bubbles.

4. Wrap the wax tape spirally around the pipe and across the fitting. Use a minimum overlap of 50% of the tape width. Apply tape to flanges, mechanical and restrained joint bolts, nuts and glands, and grooved-end couplings to 6 inches beyond each side of the item.

5. Work the tape into the crevices and contours of irregularly shaped surfaces and smooth out so that there is a continuous protective layer with no voids or spaces under the tape.

6. After application, seal the overlap seams of the tape by hand by tapering and pressing the seam, attempting to create a continuous surface. There shall be no air pockets underneath the tape. The tape shall have direct intimate contact with the pipe surface.

7. On vertical sections of the piping, such as at pipe-to-soil transitions, wrap the pipe starting from the bottom and proceeding upward so that downward flowing water and backfill do not catch in a seam.

8. Overwrap the completed wax tape installation with the plastic wrapping material. Wrap spirally around the pipe and across the fitting. Use a minimum overlap of 55% of the tape width and apply two layers or applications of overwrap. Secure plastic wrapper to pipe with adhesive tape.

B. Application of Polyethylene Sheet Coating to Buried Piping

Wrap completed wax tape coating system with polyethylene film per Section 099754 and secure around the adjacent pipe circumference with adhesive tape.

END OF SECTION

SECTION 099754 POLYETHYLENE SHEET ENCASEMENT

PART 1 - GENERAL

A. Description

This section includes materials and installation of a polyethylene sheet encasement for buried steel and ductile-iron pipe, fittings, and valves.

B. Related Work Specified Elsewhere

1. Cold-Applied Wax Tape Coating: 099752.

2. Trenching, Backfilling, and Compacting: 312316.

3. General Piping Requirements: 400500.

4. Flexible Pipe Couplings: 400722.

C. Submittals

1. Submit shop drawings in accordance with General Provisions and Section 013300.

2. Submit manufacturer's catalog literature and product data sheets describing the physical, chemical, and electrical properties of the encasement material.

PART 2 - MATERIALS

A. Polyethylene Wrap

1. The encasement shall consist of low-density polyethylene wrap of at least 8-mil thickness conforming to AWWA C105. Color: Black.

2. Polyethylene encasement for ductile-iron pipe shall be supplied as a flat tube meeting the dimensions of Table 1 in AWWA C105 and shall be supplied by the ductile-iron pipe manufacturer.

B. Plastic Adhesive Tape

1. Tape shall consist of polyolefin backing and adhesive which bonds to common pipeline coatings including polyethylene.

2. Minimum Width: 2 inches.

3. Products: Canusa Wrapid Tape, Tapecoat 35, Polyken 934, or equal.

PART 3 - EXECUTION

A. Application of Moldable Mastic Filler to Irregular Adjacent Surfaces

When the adjacent joints are bell-and-spigot or mechanical joints and any associated welding specifications do not require an external full fillet weld, apply a moldable mastic filler (per Section 400500) at the step-down area prior to the application of the sheet encasement and tape.

B. Applying Sheet Coating to Buried Piping and Fittings

1. Apply wrapping per AWWA C105 as modified herein.

2. Apply a single wrapping.

3. Install the polyethylene to completely encase the pipe and fittings to provide a watertight corrosion barrier. Continuously secure overlaps and ends of sheet and tube with polyethylene tape. Make circumferential seams with two complete wraps, with no exposed edges. Tape longitudinal seams and longitudinal overlaps, extending tape beyond and beneath circumferential seams.

4. Wrap bell-spigot interfaces, restrained joint components, and other irregular surfaces with wax tape or moldable sealant prior to placing polyethylene encasement.

5. Minimize voids beneath polyethylene. Place circumferential or spiral wraps of polyethylene tape at 2-foot intervals along the barrel of the pipe to minimize the space between the pipe and the polyethylene.

6. Overlap adjoining polyethylene tube coatings a minimum of 1 foot and wrap prior to placing concrete anchors, collars, supports, or thrust blocks. Hand wrap the polyethylene sheet, apply two complete wraps with no exposed edges to provide a watertight corrosion barrier, and secure in place with 2-inch-wide plastic adhesive tape.

C. Applying Sheet Coating to Buried Valves

1. Wrap flanges and other irregular surfaces with wax tape or moldable sealant. Press tightly into place leaving no voids underneath and a smooth surface under coating for polyethylene sheet.

2. Wrap with a flat sheet of polyethylene. Place the sheet under the valve and the flanges or joints with the connecting pipe and fold in half. Extend the sheet to the valve stem and secure the sheet in place with 2-inch-wide plastic adhesive tape. Apply a second layer and secure with tape. Make two complete wraps, with no exposed edges, to provide a watertight corrosion barrier. Secure the sheets with tape around the valve stem below the operating nut and around the barrel of the connecting pipe to prevent the entrance of water and soil. Place concrete anchor and support blocks after the wrap has been installed.

D. Applying Sheet Coating to Buried Flexible Pipe Couplings

1. Wrap irregular surfaces with wax tape or moldable sealant. Press tightly into place leaving no voids underneath and a smooth surface under coating for polyethylene sheet.

2. Apply two layers or wraps around the coupling. Overlap the adjoining pipe or fitting a minimum of 1 foot and secure in place with tape. Provide sufficient slack in polyethylene to allow backfill to be placed around fitting without tearing polyethylene. Apply tape around the entire circumference of the overlapped section on the adjoining pipe or fitting in two complete wraps, with no exposed edges, to provide a watertight corrosion barrier.

E. Repair of Polyethylene Material

Repair polyethylene material that is damaged during installation. Use polyethylene sheet, place over damaged or torn area, and secure in place with 2-inch-wide plastic adhesive tape.

F. Applying Sheet Coating to Existing Buried Piping

When connecting polyethylene-encased pipe or fittings to existing pipe, expose existing pipe, thoroughly clean the surface, and securely tape the end of the polyethylene to the existing as specified above. When the existing pipe is polyethylene encased, wrap new polyethylene encasement over the existing, with overlap of at least 2 feet. Tape securely as specified above.

G. Backfill for Polyethylene-Wrapped Pipe, Valves, and Fittings

Place sand backfill within 1 foot of the pipe, valves, and fittings wrapped with polyethylene encasement per Section 312316.

H. Repair of Polyethylene at Service Taps

1. Wrap two or three layers of polyethylene adhesive tape completely around the pipe to cover the area where the tapping machine and chain will be mounted.

2. Mount the tapping machine on the pipe area covered by the polyethylene tape. Then make the tap and install the corporation stop directly through the tape and polyethylene.

3. After making the direct service connection, inspect the entire circumferential area for damage and make repairs.

4. To minimize the possibility of dissimilar metal corrosion at service connections, wrap the corporation stop a minimum clear distance of 3 feet of copper service pipes with polyethylene or dielectric tape.

END OF SECTION

SECTION 099761 FUSION-BONDED EPOXY LININGS AND COATINGS

PART 1 - GENERAL

A. Description

This section includes materials, application, and testing of one part, fusion bonded, heat cured, thermosetting, 100% solids epoxy linings and coatings on steel pipe.

B. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit manufacturer's catalog literature and product data sheets, describing the physical and chemical properties of the epoxy coating. Describe application and curing procedure.

3. Submit coating application test records for measuring coating thickness and holiday detection for each item or pipe section and fitting. Describe repair procedures used.

PART 2 - MATERIALS

A. Equipment Surfaces

The Contractor shall require the equipment suppliers to provide equipment that is free of salts, oil, and grease to the coating applicator.

B. Shop-Applied Epoxy Lining and Coating

Lining and coating shall be a 100% solids, thermosetting, fusion-bonded, dry powder epoxy resin: Scotchkote 134 or 206N, Lilly Powder Coatings "Pipeclad 1500 Red," H. B. Fuller 1F-3003, or equal. Epoxy lining and coating shall meet or exceed the following requirements:

Hardness (minimum)	Barcol 17 (ASTM D 2583) Rockwell 50 ("M" scale)
Abrasion resistance (maximum value)	1,000 cycles: 0.05 gram removed
	5,000 cycles: 0.115 gram removed
	ASTM D 1044, Tabor CS 17 wheel, 1,000-gram weight
Adhesion (minimum)	3,000 psi (Elcometer)
Tensile strength	7,300 psi (ASTM D 2370)
Penetration	0 mil (ASTM G 17)
Adhesion overlap shear, 1/8-inch steel panel, 0.010 glue line	4,300 psi, ASTM D 1002
Impact (minimum value)	100 inch-pounds (Gardner 5/8-inch diameter tup)

C. <u>Field-Applied Epoxy Coating for Patching</u>

Use a two-component, 80% solids liquid resin, such as Scotchkote 306.

PART 3 - EXECUTION

A. <u>Shop Application of Fusion-Bonded Epoxy Lining and Coating--General</u>

1. Grind surface irregularities, welds, and weld spatter smooth before applying the epoxy. The allowable grind area shall not exceed 0.25 square foot per location, and the maximum total grind area shall not exceed 1 square foot per item or piece of equipment. Do not use any item, pipe, or piece of equipment in which these requirements cannot be met.

2. Remove surface imperfections, such as slivers, scales, burrs, weld spatter, and gouges. Grind outside sharp corners, such as the outside edges of flanges, to a minimum radius of 1/4 inch.

3. Uniformly preheat the pipe, item, or piece of equipment prior to blast cleaning to remove moisture from the surface. The preheat shall be sufficient to ensure that the surface temperature is at least 5°F above the dew point temperature during blast cleaning and inspection.

4. Sandblast surfaces per SSPC SP-5. Protect beveled pipe ends from the abrasive blast cleaning.

5. After cleaning and surface preparation, test the surface for residual chloride concentration. If the residual chloride concentration exceeds 5 mg/cm^2, then apply a phosphoric acid wash to the pipe, item, or piece of equipment after sandblasting. The average temperature, measured in three different locations, shall be 80°F to 130°F during the acid wash procedure. The acid wash shall be a 5% by weight phosphoric acid solution. The duration in which the acid is in contact with the surface shall be determined by using the average temperature as tabulated below:

Pipe Temperature (°F)	**Contact Time (seconds)**
80	52
85	45
90	36
95	33
100	28
105	24
110	21
130	10

After the acid wash has been completed, remove the acid with demineralized water having a maximum conductivity of 5 micromhos/cm at a minimum nozzle pressure of 2,500 psi.

6. Apply lining and coating by the electrostatic spray or fluidized bed process. Minimum thickness of lining or coating shall be 15 mils. Heat and cure per the epoxy manufacturer's recommendations. The heat source shall not leave a residue or contaminant on the metal surface. Do not allow oxidation of surfaces to occur prior to coating. Do not permit surfaces to flash rust before coating.

B. <u>Shop Application of Fusion-Bonded Epoxy Lining and Coating to Pipe--Additional Requirements</u>

1. Apply lining and coating per AWWA C213 except as modified herein.

2. Grind 0.020 inch (minimum) off the weld caps on the pipe weld seams before beginning the surface preparation and heating of the pipe.

C. Quality of Lining and Coating Applications

The cured lining or coating shall be smooth and glossy, with no graininess or roughness. The lining or coating shall have no blisters, cracks, bubbles, underfilm voids, mechanical damage, discontinuities, or holidays.

D. Factory Testing of Coating--General

1. Test linings and coatings with a low-voltage wet sponge holiday detector. Test pipe linings and coatings per AWWA C213, Section 5.3.3. If the number of holidays or pinholes is fewer than one per 20 square feet of coating surface, repair the holidays and pinholes by applying the coating manufacturer's recommended patching compound to each holiday or pinhole and retest. If the number of pinholes and holidays exceeds one per 20 square feet of coating surface, remove the entire lining or coating and recoat the item or pipe.

2. Measure the coating thickness at three locations on each item or piece of equipment or pipe section using a coating thickness gauge calibrated at least once per eight-hour shift. Record each measured thickness value. Where individual measured thickness values are less than the specified minimum thickness, measure the coating thickness at three additional points around the defective area. The average of these measurements shall exceed the specified minimum thickness value, and no individual thickness value shall be more than 2 mils below or 3 mils above the specified minimum value. If a section of the pipe, item, or piece of equipment does not meet these criteria, remove the entire lining or coating and recoat the entire item or piece of equipment.

E. Factory Testing of Lining and Coating of Pipe--Additional Requirements

Check for coating defects on the weld seam centerlines. There shall be no porous blisters, craters, or pimples lying along the peak of the weld crown.

F. Field Repairs

Patch scratches and damaged areas incurred while installing fusion-bonded epoxy coated items with a two-component, 80% solids (minimum), liquid epoxy resin. Wire brush or sandblast the damaged areas per SSPC SP-10. Lightly abrade or sandblast the coating or lining on the sides of the damaged area before applying the liquid epoxy coating. Apply a two-part epoxy coating to defective linings and coatings to areas smaller than 20 square inches. Patched areas shall overlap the parent or base coating a minimum of 0.5 inch. If a defective area exceeds 20 square inches, remove the entire lining and coating and recoat the entire item or piece of equipment. Apply the liquid epoxy coating to a minimum dry-film thickness of 15 mils.

END OF SECTION

SECTION 104416 FIRE EXTINGUISHERS

PART 1 - GENERAL

A. Description

This section includes materials and installation of fire extinguishers.

B. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit manufacturer's literature including catalog cuts, data sheets, and UL certification and label.

PART 2 - MATERIALS

A. Manufacturers

1. Model numbers included are items manufactured by Potter-Roemer, Inc.

2. Equivalent items of the following manufacturers are acceptable:

   a. J. L. Industries.

   b. Larsen’s Manufacturing Co.

B. Fire Extinguishers--Multipurpose Chemical Type

Fire extinguishers shall be ABC multipurpose dry-chemical type per NFPA 10 and UL 299, red enamel steel shell, stored-pressure type with indicating gauge and UL rating of 20A:120B:C.

PART 3 - EXECUTION

A. Delivery and Storage

Deliver items with manufacturer's tags and labels intact. Handle and store to avoid damage and protect after installation.

B. Installation

1. Install fire extinguishers at the locations indicated in the drawings by the abbreviation "FX" with the top of the unit 48 inches above the floor.

2. Install fire extinguishers having a gross weight not exceeding 40 pounds so that the top of the fire extinguisher is not more than 4 feet above the floor. Install fire extinguishers having a gross weight greater than 40 pounds so that the top of the fire extinguisher is not more than 3-1/2 feet above the floor. The clearance between the bottom of the fire extinguisher and the floor shall not be less than 4 inches.

3. Location of fire extinguishers shall be per NFPA 10 and verified with the fire marshal.

END OF SECTION

SECTION 230933 ELECTRIC HVAC CONTROLS

PART 1 - GENERAL

A. Description

This section includes materials and installation of HVAC equipment controls and instruments. Equipment controls and instruments shall be electric/electronic with independent remote room thermostats. Provide a complete and operable system of automatic temperature control and for each air-handling unit.

B. Related Work Specified Elsewhere

1. Fans: 233410.

2. General Electrical Requirements: 260500.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit manufacturer's catalog data and specifications for control automation devices, including installation instructions and start-up instructions. Submit wiring diagram for each electrical control device.

PART 2 - MATERIALS

A. Manufacturers

Controls shall be as manufactured by Johnson Controls, Honeywell, Siebe, Landis & Gyr, or equal.

B. Room Thermostats

Thermostat shall be line-voltage type, with motor current rated contacts. The single-pole double-throw switch shall be rated at a minimum of 7.4 amperes full load at 120 volts. Switches shall be sealed against corrosion. Front and bottom air slots shall be provided for air circulation over a coiled copper tube sensing element. Thermostat shall be wall mounted, UL listed with a range of 70°F to 140°F, Honeywell Model T631C1020.

PART 3 - EXECUTION

A. Installation

Provide wiring and conduit to connect the electrical control devices, which includes wiring for controls of thermostatically controlled exhaust fans.

B. Field Testing

1. After completion of the installation, check controls for proper operation, per the following sequence of operation. Make adjustments to hardware and software.

2. Thermostat shall energize exhaust fans on a rise of room temperature above the set point.

END OF SECTION

SECTION 233410 FANS

PART 1 - GENERAL

A. Description

This section includes materials and installation of fans used for ventilation service. Fan models, styles, and performance are indicated in the drawings and by the requirements of this section.

B. Related Work Specified Elsewhere

1. Electric HVAC Controls: 230933.

2. Miscellaneous Electrical Devices: 260590.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit manufacturer's catalog data, fan curves, spare parts list, and test reports for performance and noise.

PART 2 - MATERIALS

A. Propeller Direct-Driven Sidewall Fans

1. Fan shall be of the propeller, direct-driven type. Construct the fan panel, wire blade guard, propeller blades, and mounting collar of aluminum or steel coated with a phenolic epoxy resinous coating (Heresite).

2. Supply with motor-side fan guard. Construct the guard of aluminum or steel coated with Heresite.

3. Fan shall bear the AMCA Certified Ratings Seal for Air and Sound Performance.

4. Products: Greenheck SE1, Penn, ACME Model FN, or equal.

B. Thermostats

See Section 230933.

C. Motors

1. Motors shall comply with NEMA MG 1.

2. Motors for applications in hazardous locations shall bear the UL label listing its use in accordance with the NEC.

3. Provide totally enclosed, fan-cooled motors where motors are in the airstream or are not shielded from weather. Provide explosionproof motors suitable for Class I, Division 1, Group D hazardous locations for fans denoted as explosionproof. All other motors shall have open dripproof enclosures.

4. Motor voltage and phases shall be as noted in the drawings.

5. Open dripproof motors shall have a service factor of 1.15, and totally enclosed motors shall have a service factor of 1.0.

6. Motors shall be rated for continuous duty at an ambient temperature of 40°C and an elevation of 3,300 feet.

PART 3 - EXECUTION

A. Thermostat

Set thermostat to 80°F.

B. Start-Up

Install fans in accordance with the manufacturer's instructions.

C. Field Testing

1. Adjust the thermostat set point. Verify operation of fans at set point.

2. Verify operation of fans when activated by wall switch.

END OF SECTION

SECTION 260500 GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

A. Description

This section includes materials, installation, and testing of the electrical system.

B. Related Work Specified Elsewhere

1. One-Year Guarantee: General Provisions.
2. Permits and Licenses: General Provisions.
3. Submittals: 013300.
4. Construction Facilities and Temporary Controls: 015100.
5. Operation and Maintenance Manuals: 019310.
6. Arc-Flash Hazard Analysis: 260573.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.
2. In submitted catalog cuts, cross out items shown that are not pertinent to this project. Where catalog cuts list manufacturer’s standard options, cross out those options not intended to be provided and clearly highlight those options that are to be provided.

D. Regulatory Agencies and Standards

1. See General Provisions.
2. Electrical work shall comply with the NEC as amended by the CEC.

E. Quality Control

Materials, appliances, equipment, and devices shall conform to the applicable UL standards. The label of, or listing by, UL is required for all electrical equipment.

F. Utility Company Requirements and Fees

1. The Contractor shall make application for electric service in the name of the Owner. The Contractor shall pay and the Owner will reimburse Contractor for utility company fees, cable charges, and added facilities charges.

2. The Contractor shall make any service and installation agreements that the utility companies may require.

3. Install electric service entrance equipment in accordance with the serving utility's requirements. Coordinate with the serving utility to ensure timely connection by the utility. Obtain utility company approval of service entrance and metering equipment shop drawings prior to starting fabrication.

G. Electrical Service Changes

1. These specifications and drawings delineate the remodeling of an existing structure and/or the addition to an existing structure. While the existing structure is occupied, keep the present services intact until the new construction, facilities, or equipment is installed.

2. Prior to making revisions to the existing service, make certain that every item is thoroughly prepared. Do the actual work at an off-peak time, or overtime, as arranged with the Owner or as hereinafter specified. Once the work is started, vigorously prosecute it to completion to keep downtime to a minimum. Be prepared to temporarily serve the existing service or discontinue the necessary revisions in the event of an emergency or other condition which makes it impossible to finish the scheduled work on time.

3. Prepare a work procedure for work-interrupting service to the Owner's equipment. Include a step-by-step procedure that will be followed in the performance of this work and the time involved in each step. Submit this procedure to the Owner's Representative for review two weeks in advance of the performance of the work.

H. Power for Construction

Provide for or purchase power for construction in accordance with Section 015100.

I. Operation and Maintenance Manuals

Submit operation and maintenance manuals in accordance with Section 019310.

J. Locations

1. General: Use equipment, materials, and wiring methods suitable for the types of locations in which they are located as defined below.

2. Definitions of Types of Locations:

    a. Dry Locations: Indoor areas which do not fall within the definitions below for wet locations and which are not otherwise designated in the drawings.

    b. Wet Locations: Locations exposed to the weather, whether under a roof or not, unless otherwise designated in the drawings.

PART 2 - MATERIALS

A. General

1. Similar materials and equipment shall be the product of a single manufacturer.

2. Provide only products which are new, undamaged, and in the original cartons or containers.

3. Materials and equipment shall be the standard products of manufacturers regularly engaged in the production of such material and shall be the manufacturer's current design.

4. Materials and equipment shall be suitable for storage, installation, and operation at an ambient temperature of 0°C to 40°C except where more stringent conditions are stated in individual equipment specifications.

5. Electrical equipment and panels shall be factory finished with manufacturer's standard primer and enamel topcoats, unless stated otherwise in the individual equipment specifications. Provide 1 pint of the equipment manufacturer's touchup paint per 500 square feet of painted surface for repair of damaged enamel topcoats.

PART 3 - EXECUTION

A. Installation

1. The drawings indicate connections for typical equipment only. If the equipment furnished is different from what is shown, provide the modifications necessary for a safe and properly operating installation in accordance with the equipment manufacturer's recommendations.

2. The drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Field determine exact location based on physical size and arrangement of equipment, finished elevations, and obstructions.

3. Work or equipment not indicated or specified which is necessary for the complete and proper operation of the electrical systems shall be accomplished without additional cost to the Owner.

4. Accomplish work required to pierce any waterproofing after the part piercing the waterproofing has been set in place. Seal and make watertight the openings made for this purpose.

5. Install equipment and material piercing fire walls and fire-resistant or fire-stopped walls, partitions, ceilings, and floors in a manner so the rating remains equivalent.

6. Seal weathertight equipment or components exposed to the weather.

7. Protect equipment outlets and conduit openings with factory-made plugs or caps whenever work is not in progress at that point.

B. Nameplates

1. Mark each individual panelboard, motor controller, disconnect switch, timer, relay, and contactor to identify each item with its respective service or function.

2. Provide a nameplate inside the door of each panelboard listing its designation, voltage, and feeder circuit number.

3. Provide a nameplate on each transformer listing its designation, voltage, feeder number, and load served.

4. Provide nameplates with engraved lettering not less than 1/4 inch high. Use black-on-white laminated plastic, attached with rivets or sheet metal screws. Do not use embossed plastic adhesive tape.

C. Warning Signs

1. Install markings, identifications, warning, caution, or instruction signs where required by NEC, NFPA 70E, and NFPA 79 paragraph 4.5.1, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect.

2. The design of safety signs and labels shall conform to ANSI Z535.4. Switchgear, panelboards, and motor control center shall be field marked to warn qualified persons of potential electric arc hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment, in conformance with NEC 2005 Article 110.16.

3. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.

D. Emergency Operation Signs

Install engraved laminate signs with white legend on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer.

END OF SECTION

SECTION 260519 WIRES AND CABLES LESS THAN 600 VOLTS

PART 1 - GENERAL

A. Description

This section describes materials and installation of wires and cables rated 600 volts and below.

B. Related Work Specified Elsewhere

1. General Electrical Requirements: 260500.

2. Grounding and Bonding: 260526.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 260500.

2. Submit material list for each conductor type. Indicate insulation material, conductor material, voltage rating, manufacturer and other data pertinent to the specific cable, such as shielding, number of pairs, and applicable standards.

PART 2 - MATERIALS

A. Low-Voltage Building Wire

1. Conductor material shall be copper.

2. Low-voltage building wire for use at 600 volts or less shall be 600-volt insulated, Type XHHW or THWN, and rated for continuous operation at 75°C.

3. Use No. 12 AWG minimum conductor size for power and lighting circuits.

4. Use No. 14 AWG minimum conductor size for control circuits.

5. Conductors for lighting and receptacle circuits that are No. 10 AWG and smaller shall be solid. All other conductors shall be stranded.

B. Twisted-Shielded Cable

Single-pair cables shall be two No. 18 AWG and single triads shall be three No. 18 AWG stranded tinned-copper conductors individually insulated with fully color-coded PVC rated at 600 volts; insulated conductors twisted together and shielded with a spiral-wound metal foil tape overlapped for 100% shielding. Outer jacket shall be PVC.

C. Grounding Conductors--Bare Copper

Refer to Section 260526 for bare copper grounding conductors.

D. Conductor Tags

Provide self-extinguishing heat-shrink individual or sleeved, nonmetallic, snap-on type. Grafoplast, Phoenix Contact, Thomas & Betts sleeve markers, or equal.

E. Plastic Adhesives

Plastic adhesives for color coding shall be 7-mil minimum thick, flame-retardant, weather-resistant tape, resisting abrasion, UL rays, moisture, alkalies, solvents, and acids. Adhesives shall meet the requirements of UL 510 and CSA C22.2.

PART 3 - EXECUTION

A. Low-Voltage Building Wire Installation

1. Install wiring and cable in conduit and terminate unless otherwise noted.

2. To reduce pulling tension in long runs, coat cables with pulling compound recommended by the cable manufacturer before being pulled into conduits.

3. Remove debris and moisture from the conduits, boxes, and cabinets prior to cable installation.

4. Group conductors No. 1/0 and smaller in panelboards, cabinets, pull boxes, motor control centers, and switchboard wireways; tie with plastic ties; and fan out to terminals. Lace conductors No. 2/0 and larger with marline.

B. Identification

1. Color Coding of Low-Voltage Building Wire: Provide color coding throughout the entire network of feeders and circuits as follows:

Phase	**240/120 Volts**	**208/120 Volts**	**240 Volts**	**480/277 Volts**
Phase A	Black	Black	Black	Brown
Phase B	Red	Red	Red	Orange
Phase C	---	Blue	Blue	Yellow
Neutral	White	White	White	Gray
Ground	Green	Green	Green	Green

2. Phase conductors No. 10 AWG and smaller and neutral/ground conductors No. 6 and smaller shall have factory color coding with solid color insulation. Do not use onsite coloring of ends of conductors or apply colored plastic adhesives in lieu of factory color coding. Larger conductors may have onsite application of colored plastic adhesives at ends of conductors and at each splice.

3. Control wires shall have colored insulation. Separate color codes for each wire shall be provided in each conduit that has up to seven wires. Conduits with more than seven wires shall have at least seven types of colored insulation.

4. Tagging of Conductors: Tag control wires and instrument cables in panels, pull boxes, wireways, and at control device. Tag control wires and instrument cables with same wire numbers as on the shop drawing submittals. Tag power wires in pull boxes and wireways where there is more than one circuit. Tag power conductors with motor control center or panelboard number and circuit numbers.

C. Low-Voltage Wire Splices

1. Solid Conductors: Use 3M "Scotchlok," Ideal "Super Nut," Buchanan B-Cap, or equal. Seal splices in underground handholes and pull boxes and in light poles with individual sealing packs of Scotchcast Brand 400 Resin or equal.

2. Stranded Conductors No. 8 and Larger: Use T & B "Locktite" connectors, Burndy Versitaps and heavy-duty connectors, O.Z. solderless connectors, or equal.

3. Stranded Conductors No. 10 and Smaller: Use crimp connectors with tools by same manufacturer and/or UL listed for connectors of all stranded conductors.

4. Retighten bolt-type connectors 24 to 48 hours after initial installation and before taping. Tape connections made with noninsulated-type connectors with rubber-type tape, one and one-half times the thickness of the conductor insulation, then cover with Scotch 33 tape.

D. Low-Voltage Wire Terminations

1. Terminate wires and cables at each end.

2. Provide ring tongue, nylon- or vinyl-insulated copper crimp terminals for termination on screw-type terminals, except for light switches and receptacles. Utilize installation tools recommended by the crimp manufacturer.

3. Terminal lugs shall be electro-tin plated copper compression type or spring compression type with a corrosion protection coating. Provide color-coded system on terminal and die sets to provide the correct number and location of crimps. Permanent die index number shall be embossed on completed crimp for inspection purposes.

4. Tighten screws and bolts to the value recommended by the manufacturer.

E. Field Testing

1. Perform insulation resistance test on all circuits and feeders with No. 10 size conductors and larger. Utilize a 1,000-volt d-c megohmmeter for 600-volt insulated conductors.

2. Test each complete circuit prior to energizing. Insulation resistance between conductors and between each conductor and ground shall not be less than 25 megohms. Repair or replace wires or cables in circuits that do not pass this test and repeat the test.

3. Evaluate ohmic values by comparison with conductors of same length and type.

4. Inspect shielded cables for proper shield grounding, proper terminations, and proper circuit identifications.

5. Inspect control cables for proper termination and proper circuit identification.

6. In cables terminated through window-type CTs, verify that neutrals and grounds are terminated for correct operation of protective devices.

END OF SECTION

SECTION 260526 GROUNDING AND BONDING

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation of electrical grounding.

B. Related Work Specified Elsewhere

1. General Electrical Requirements: 260500.

2. Wires and Cables Less Than 600 Volts: 260519.

3. Gravel and Crushed Rock Base for Structures: 312323.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 260500.

2. Submit material list for all grounding materials and equipment. Indicate size, material, and manufacturer.

3. Submit test results. Indicate overall resistance to ground and resistance of each electrode.

D. Performance Requirements

1. Grounding System Resistance:

   a. Separately Derived Sources (as Defined by NEC 250) Grounding Electrode: 25 ohms.

   b. Grounds Not Covered Above: 25 ohms.

PART 2 - MATERIALS

A. Ground Rods

Ground rods shall be copper-clad steel, 3/4 inch in diameter, minimum 10 feet long, with hardened steel points.

B. Connections

1. Ground Clamps: Clamps for connection of ground wire to ground rod shall be bronze.

2. Exothermic Connections: Provide Cadweld or equal.

C. Conductors

1. Equipment Ground: Conductors shall be low-voltage building-wire type as specified in Section 260519.

2. Bare Copper Conductors: Annealed bare copper, conforming to ASTM B3 and B8.

PART 3 - EXECUTION

A. Ground Electrode

1. Install a bare copper ground loop 3 inches above bottom of concrete footing for new buildings as shown in the drawings. Bring both ends of the loop to the ground bus within the main service switchboard. Buried or concealed joints or terminations are not permitted. Protect wires with a rigid PVC conduit where wires stub up through slab at switchboard.

2. Bond the interior metallic water system to the grounding system in accordance with NEC Article 250-80 and Table 250-95.

3. Bond the rebar in the building floor slab to the grounding system as shown in the drawings.

B. Equipment Grounding

1. Connect the ground buses of lighting panels and motor control centers to the ground bus within the main service switchboard with a grounding conductor.

2. Ground raceways and noncurrent-carrying parts of electrical equipment in accordance with NEC Article 250. Use the metallic conduit system for equipment and enclosure grounding.

3. Additionally, all circuits shall carry one ground conductor for equipment grounding. Ground conductor

shall be in excess of grounding through the metallic conduit system.

C. Ground Test Well

1. Provide a handhole and ground rod as detailed in the drawings to aid in performing ground testing and connecting additional ground rods if required by the test results. Connect ground wire from ground rod to main service switchboard ground bus as detailed in the drawings.

2. Gravel base shown in ground well detail shall comply with Section 312323.

D. Connections

Exothermic weld all underground connections.

E. Tests

Before making connections to the ground electrode, measure the resistance of the electrode to ground using a ground resistance tester specifically designed for ground resistance testing. Perform testing in accordance with test instrument manufacturer's recommendations using fall-of-potential method. Perform the test not less than two days after the most recent rainfall and in the afternoon after any ground condensation (dew) has evaporated. If a resistance less than the performance requirements is not obtained, provide a ground rod driven 6 inches below grade spaced 10 feet away from the ground well and connect to ground test well with No. 4 AWG bare copper wire and repeat the test. If the performance requirements are still not obtained, inform the Owner for resolution.

END OF SECTION

SECTION 260534 CONDUITS, BOXES, AND FITTINGS

PART 1 - GENERAL

A. Description

This section includes material, installation, and testing for conduit, boxes, and fittings.

B. Related Work Specified Elsewhere

1. General Electrical Requirements: 260500.

2. Grounding and Bonding: 260526.

3. Trenching, Backfilling, and Compacting: 312316.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 260500.

2. Submit product data for the following:

   a. Fittings.

   b. Conduit and fittings for each type specified.

   c. Boxes.

D. Quality Control

1. NEMA Compliance: Comply with NEMA standards pertaining to conduits and components.

2. UL Compliance and Labeling: Comply with requirements of UL standards pertaining to electrical conduits and components. Provide conduits and components listed and labeled by UL.

PART 2 - MATERIALS

A. Rigid Steel Conduit and Fittings

1. Rigid Steel Conduit and Fittings: Conform to ANSI C80.1, NEMA RN2, and UL 6, hot-dipped galvanized after

threading. The zinc coating shall be flexible and not crack during bending.

2. Fittings:

   a. Locknuts: Steel or malleable iron.

   b. Bushings: Threaded type, steel or malleable iron, with 105°C rated plastic insulated throat. Plastic bushings with a temperature rating of 105°C may be used for conduits 1 inch and smaller.

   c. Box Connectors for Damp and Wet Locations: Provide a watertight threaded hub on enclosure consisting of sealing fitting with tapered conduit thread, neoprene O-ring, and 105°C rated insulating throat with grounding and bonding lug.

   d. Couplings: Threaded, hot-dipped galvanized after fabrication.

3. Long-Radius Elbows (90 Degrees):

Conduit Size (inches)	**Minimum Radius (inches)**
3/4 through 1-1/4	12
2 and 2-1/2	15
3 and 3-1/2	18
4	30
5	36

B. Rigid Nonmetallic Conduit (PVC) and Fittings

1. Conduit: PVC Schedule 40, 90°C rise rating, conforming to NEMA TC-2 Type EC-40 and UL 651.

2. Long-Radius Elbows (90 Degrees): Rigid PVC-coated conduit of the same dimension as specified for steel conduit.

3. Couplings, Adapters, End Bells, Expansion Couplings, Elbows, and Turns of 30 Degrees: Factory-made in accordance with NEMA TC-2 and TC-3.

4. Joint Cement: As recommended by manufacturer as suitable for the climate, furnished with instructions to achieve watertight joints.

5. Manufacturers: Carlon, Condux, or equal.

C. Liquid-Tight Flexible Metal Conduit and Fittings

1. Conduit: Steel, UL 360 listed, PVC jacketed.

2. Fittings:

a. Conform to ANSI C33.84, UL listed for use with the conduit.

b. In sizes 1-1/4 inches and less, UL listed for grounding.

c. Made of steel or malleable iron, zinc plated, 105°C insulated throat, grounding and bonding lug.

D. Conduit Bodies

1. Provide types, shapes, and sizes to suit individual applications. Provide matching gasketed covers, secured with at least two captive corrosion-resistant screws.

2. Bodies connecting to rigid conduit shall be of the same material and material coating as the conduit, with metal threaded hubs. Provide with threaded covers or gasketed covers secured with at least two corrosion-resistant captive screws.

3. Bodies connecting to nonmetallic conduit shall be nonmetallic conduit bodies conforming to UL 514B.

E. Outlet Boxes

1. Concealed and Flush-Mounted Boxes:

a. Galvanized steel of gang sizes and as required by code. Do not use sectional boxes for multigang applications.

b. Receptacle Device Boxes: 4 by 4 by 1.5 inches with square-cornered tile-type covers with ribs or extensions for casting in concrete.

2. Exposed Boxes:

    a. Cast iron or aluminum, with threaded hubs.

    b. Conduit bodies may be used instead of boxes except where boxes contain devices.

    c. Outlet boxes connecting to PVC-coated rigid conduit shall be of the same material and material coating as the conduit, with metal threaded hubs. Provide with gasketed covers secured with at least two corrosion-resistant capture screws.

F. <u>Junction and Pull Boxes</u>

1. Provide factory-made standard sizes, and shop fabricate when nonstandard size boxes are shown or are required. Comply with UL and NEMA standards.

2. NEMA Type 4X: Type 316 stainless steel with gasketed covers and Type 316 stainless steel bolts or screws.

3. NEMA 4: Code gauge steel, hot-dipped galvanized after fabrication. Provide cover with Type 303 stainless steel bolts.

4. Junction boxes shall be manufactured by Hoffman, Wiegmann, or equal.

G. <u>Conduit Sealant</u>

1. Moisture Barrier Types: Sealant shall be a nontoxic, nonshrink, nonhardening, putty-type hand-applied material providing an effective barrier under submerged conditions.

2. Fire-Retardant Types: Fire stop material shall be a reusable, nontoxic, asbestos-free, expanding, putty-type material with a three-hour rating in accordance with UL 35L4.

PART 3 - EXECUTION

A. <u>Conduit Usage Schedule</u>

Install the following types of conduits and fittings in locations listed, unless otherwise noted in the drawings. Definitions and requirements of NEC apply unless specifically modified below. Refer to Section 260500 for definitions of locations.

1. Exterior, Exposed:

    a. Material: Rigid steel conduit.

    b. Minimum Size: 3/4 inch.

2. Interior, Exposed, Dry, and Wet:

    a. Material: Rigid steel conduit.

    b. Minimum Size: 3/4 inch.

3. Interior, Concealed: Typical for exterior masonry walls:

    a. Material: Rigid steel conduit or intermediate metal conduit.

    b. Minimum Size: 3/4 inch.

4. Embedded in Concrete:

    a. Material: Rigid steel conduit.

    b. Minimum Size: 3/4 inch.

5. In Earth, Below Concrete Slabs or Underground:

    a. Material: Rigid nonmetallic conduit (PVC).

    b. Minimum Size: 3/4 inch.

    c. Conduit Stub-Ups: Provide PVC-coated rigid steel conduit long-radius elbows for stub-ups which connect to underground rigid PVC conduit. Extensions from elbows above grade shall be PVC-coated rigid steel for a minimum of 6 inches above grade. Stub-ups into free-standing electrical gear, such as motor control centers, or switchboards, may be rigid PVC conduit.

6. Final Connections to Motors, Transformers, Vibrating Equipment, or Instruments:

    a. Material: Liquid-tight flexible conduit.

    b. Minimum Size: 3/4 inch.

c. Length of liquid-tight flexible conduit shall be 5 feet or less, unless field conditions require longer lengths.

B. Junction and Pull Boxes--Usage Schedule

Install the following type of boxes in locations listed, unless otherwise noted in the drawings. Refer to Section 260500 for definitions of locations:

1. Exterior: NEMA 4.

2. Interior: NEMA 4.

C. Conduit Fill

For runs that are not sized in drawings, compute the maximum conduit fill using NEC requirements for Type THW conductors (larger if applicable), although the actual wiring may be with types of conductors having smaller cross-sections.

D. Conduit Installation, General

1. Install conduit concealed unless specifically noted otherwise.

2. Run exposed conduits parallel and perpendicular to surface or exposed structural members and follow surface contours as much as practicable to provide a neat appearance.

3. Make right-angle bends in conduit runs with long-radius elbows or conduits bent to radii not less than those specified for long-radius elbows.

4. Make bends and offsets so that the inside diameter of conduit is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

5. Cap all conduits immediately after installation to prevent entrance of foreign matter.

6. Do not use diagonal runs except when specifically noted in the drawings.

7. Route exposed conduit to preserve headroom, access space, and work space.

8. Treat threaded joints of rigid steel conduit with T&B "Kopr-Shield" before installing fittings where conduit is in slabs and other damp or corrosive areas.

9. For PVC-coated rigid conduits, use manufacturer's recommended installation tools and recommendations. The manufacturer shall certify the installer before installation can proceed.

10. Conduit Terminations:

    a. Terminate conduits with locknuts and bushings except where threaded hubs are specified.

    b. Install conduits squarely to the box and provide one locknut outside the box and one locknut and bushing inside the box.

    c. Install locknuts with dished side against the box.

    d. When terminating in threaded hubs, screw the conduit or fitting tight into the hub so that the end bears against the fire protection shoulder.

    e. When chase nipples are used, install conduits and coupling square to the box and tighten the chase nipple leaving no exposed threads.

11. Install exposed, parallel, or banked conduits together. Make bends in parallel or banked runs from the same centerline so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel.

12. Provide expansion fittings for conduits crossing expansion joints in structures and in exposed straight runs exceeding 100 feet.

13. Conduit runs are shown schematically. Supports, pull boxes, junction boxes, and other ancillary equipment are not usually shown in drawings. If not shown, provide as required by NEC except that there shall not be more than the equivalent of three quarter bends (270 degrees) total between underground pull points. Provide additional boxes to permit pulling of wires without damage to the conductors or insulation.

14. Locations of conduit stub-ups shown in the drawings are schematic. Coordinate these locations with conduit entries of actual equipment served.

E. Requirements for Rigid Nonmetallic (PVC) Conduit

1. Comply with the installation provisions of NEMA TC-2, except as modified below.

2. Make cuts with a fine tooth handsaw. For sizes 2 inches and larger, use a miter box or similar saw guide to assure a square cut.

3. Use factory-made couplings for joining conduit.

4. Cementing and joining operation shall not exceed 20 seconds. Do not disturb joint for 5 minutes, longer (up to 10 minutes) at lower temperatures. Make joints watertight. Joining procedure shall conform to the procedures of ASTM D2855.

5. Install expansion fittings. Expansion fittings are required when the conduit is left exposed in trenches for a period of time during which the conduit's temperature can vary more than 2 degrees. Install expansion fittings near the fixed end of the run and 100 feet on center.

6. Where PVC conduit is installed above ground, provide expansion fittings and nylon or Type 316 stainless steel supports at spacings recommended by the raceway manufacturer.

F. Conduit Sealing

Seal conduit entries with conduit sealant where conduits exit buildings and underground structures.

G. Grounding

1. Provide grounding in accordance with Section 260526.

2. Use grounding bushings for all conduits carrying a grounding conductor.

3. Provide a grounding conductor in flexible conduit, size conforming to NEC Article 250.

H. Conduits Embedded in Concrete and Below Slabs

1. Install conduits and sleeves passing through slabs or walls so as not to impair the strength of construction. Secure conduit to prevent sagging or shifting during concrete pour.

2. Conduits larger than 1-1/2 inches in diameter may be embedded in structural concrete only after submittal and review of location and reinforcement details.

3. Conduits and sleeves may be installed without specific permission, provided:

    a. They are 1-1/2 inches or less in diameter, are spaced not less than three diameters on centers, and conform to paragraph b or c below.

    b. Conduits, including fittings, which are embedded within a column, do not displace more than 4% of the cross-sectional area on which structural strength is calculated.

    c. Conduits and sleeves, embedded within a wall or slab are not larger in the outside dimension than one-third the overall thickness of wall or slab in which they are embedded.

    d. There is a minimum of 1-1/2 inches between the conduit and reinforcement for slab and wall penetrations.

4. Install conduits in slabs other than slabs-on-grade as close to the middle of the slabs as practical without disturbing the reinforcement. Outside diameter of the conduit shall not exceed one-third times the slab thickness. Do not space parallel runs of conduit closer than three diameters on centers, except at cabinet and outlet box locations.

5. Conduits shown in or under slab-on-grade construction shall be installed below the floor slab and under curing or dampproofing membranes. An exception may be made for conduit with an outside diameter not larger than 25% of the slab thickness, in which case, standards applying to slabs other than slab-on-grade may be used.

I. Conduits Underground

Where PVC conduit is installed underground in locations other than under concrete slab, provide 24-inch minimum cover. Provide 3-inch minimum sand above and below conduits as specified in Section 312316. Maintain a 12-inch minimum separation between conduit and other systems. Pitch conduit to drain away from buildings.

J. Conduit Supports

1. Support conduit at intervals and at locations as required by the NEC. Do not use perforated strap or plumber's tape for conduit supports.

2. Conduit on Concrete or Masonry: Use one-hole malleable iron clamps with pipe spacers (clamp backs) or preformed galvanized steel channels. Anchor with metallic expansion anchors and screws or from preset inserts. Use preset inserts in prestressed concrete.

3. Conduit on Wood: Use two-hole galvanized steel straps and wood screws.

4. Suspended Conduit: Use malleable iron, factory-made, split-hinged pipe rings with threaded suspension rods sized for the weight to be carried (minimum 3/8 inch diameter); Kin-Line, Grinnell, Elcen, or equal. For grouped conduits, construct racks with threaded rods and tiered angle-iron or preformed channel cross members. Construct channel to limit deflection to 1/200 of span. Clamp each conduit individually to a cross member. Where rods are more than 2 feet long, provide rigid sway bracing.

K. Conduit Penetrations

1. Unless otherwise indicated, dry-pack around conduits which penetrate concrete walls, floors, or ceilings.

2. Conduits passing vertically through concrete slabs shall be sleeved, except where sealing and expansion/deflection fittings are required. Pack sleeves through floors and fire-rated walls with fire-rated packing. Nonrated penetrations may be packed with nonshrink grout.

3. Where underground conduits penetrate a structure through a concrete floor, provide a malleable iron, watertight, entrance sealing device. When there is no raceway concrete encasement, provide the device with sealing assembly at each end with pressure bushings that may be tightened at any time. For concrete-encased raceway penetrations, provide with pressure bushing on the accessible side.

4. Install conduits passing through building sidewalls with expansion/deflection fittings.

5. Maintain the integrity of all damp-proofing and waterproofing membranes that are penetrated by conduits and boxes.

6. Buried conduit shall penetrate surface at right angle.

L. <u>Damaged Conduit</u>

1. Repair or replace conduit damaged during or after installation.

2. Replace crushed or clogged conduit or any conduit whose inner surface is damaged or not smooth.

3. Repair cuts, nicks, or abrasions in the zinc coating of galvanized conduit with galvanizing repair stick, Enterprise Galvanizing "Galvabra" or equal.

M. <u>Empty Conduit</u>

1. Provide 200-pound strength pull cord in all empty conduits or cord of higher strength if so required by the utility for which the conduit is intended.

2. Provide a waterproof label on each end of the pull cords to indicate the destination of the other end.

N. <u>Outlets for General Wiring</u>

1. Use multigang boxes and device plates where several devices are located in the same general area. Obtain back box requirements for systems provided under other sections and provide them per those requirements.

2. Locate switch boxes 4 inches from doorjamb.

3. Rigidly support boxes for wall outlets and finish flush and straight. Front edge shall be within 1/8 inch of finished surface and plumb within 1/8 inch.

4. Install outlets in exposed masonry with square corner boxes or standard boxes with square corner extensions that are sufficiently deep so that conduit offsets are not required. Saw cut openings in exposed masonry with an opening tolerance of 1/8 inch on all sides, placing bottom of box at nearest masonry joint to specified mounting height. Do not activate any outlet unless these installation requirements are met.

5. Install outlets and boxes securely and support them substantially. Anchor boxes into masonry construction with one or more integral flanges.

O. Equipment Supports

Support wall-mounted junction boxes, pull box enclosures, and panels with Type 304 stainless steel preformed channels and Type 304 stainless steel concrete anchors.

P. Adjusting and Cleaning

Upon completion of installation of conduits and boxes, inspect interiors of conduits and boxes; clear blockages; and remove burrs, dirt, and construction debris.

END OF SECTION

SECTION 260548 SEISMIC RESTRAINT FOR ELECTRICAL EQUIPMENT

PART 1 - GENERAL

A. Description

This section describes the requirements for furnishing and installing seismic restraint devices for electrical equipment.

B. Related Work Specified Elsewhere

When it applies, this section is referenced in other sections of the specifications.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 260500.

2. Submit seismic anchoring calculations with equipment and raceway submittals. Calculations shall be performed by a licensed civil or structural engineer employed by the equipment manufacturer and registered in the state of California.

3. Submit equipment anchoring methods. Include anchoring locations, anchor types, and minimum anchor embedment depths. Anchors shall have ICC-approved anchorage values.

PART 2 - MATERIALS

A. Seismic Design of Equipment

Equipment fabricated or assembled at manufacturers' premises shall be designed and constructed in such a manner that all portions, elements, subassemblies, and/or parts of said equipment and the equipment as a whole, including their attachments, shall have the capability of withstanding seismic forces specified under "Seismic Anchoring and Restraints" below.

B. Seismic Anchoring and Restraints

1. Equipment Anchors: Electrical equipment shall be securely anchored. Anchoring shall have the capability of withstanding seismic forces per Sections 13.3 and 13.4 of ASCE 7-05. Use Ip = 1.5, Site Class B.

2. Raceway Supports:

   a. Seismically support raceway (conduit, cable tray, busway, etc.) of 2.5-inch inside diameter and larger and suspend 12 inches or more from the top of the raceway to the bottom of the support for the hanger. Raceway supports shall have the capability of withstanding seismic forces per Sections 13.3 and 13.4 of ASCE 7-05. Use Ip = 1.5, Site Class B.

   b. Provide Kin-Line seismic bracing system, Midland Ross superstrut seismic restraint system, Cooper B-Line Seismic Bracing System, or equal. Install per manufacturer's requirements.

PART 3 - EXECUTION

A. Equipment and Raceways

Install equipment anchors and raceway supports in accordance with the final shop drawing and manufacturer's recommendations. Properly torque all bolts to the required values.

END OF SECTION

SECTION 260573 ARC-FLASH HAZARD ANALYSIS

PART 1 - GENERAL

A. Description

This section describes the requirements for furnishing an arc-flash hazard analysis.

B. Submittals

Submit six copies of the study in accordance with the General Provisions.

PART 2 - MATERIALS

(NOT USED)

PART 3 - EXECUTION

A. Arc-Flash Hazard Analysis

Perform an arc-flash hazard analysis in compliance with the latest edition of NFPA 70E 110.8(B)(1) for the electrical equipment in accordance with Appendix D of NFPA 70E and IEEE 1584, Guide for Performing Arc Flash Hazard Calculations, utilizing commercially available software, to identify:

1. The arc-flash protection boundaries, defined in Article 130.3(A) as "an approach limit at a distance from exposed live parts within which a person could receive a second-degree burn if an electrical arc flash were to occur."

2. The proper personal protective equipment (PPE) and protective clothing necessary, based on the incident energy present at the working distance for the task to be performed, as described in Article 130.3(B) and Article 130.7.

3. Label equipment where applicable with these boundaries.

4. Provide nameplates with engraved lettering not less than 1/4 inch high. Use black-on-white laminated plastic,

attached with rivets or sheet metal screws. Do not use embossed plastic adhesive tape.

END OF SECTION

SECTION 261216 DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

A. Description

This section includes materials and installation of transformers.

B. Related Work Specified Elsewhere

1. General Electrical Requirements: 260500.

2. Low-Voltage Motor Control: 262419.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 260500.

2. Submit ratings and characteristics including voltage, phases, connections, enclosure type and dimensions, and conduit entry restrictions.

PART 2 - MATERIALS

A. General

1. Provide general-purpose, single-phase and three-phase, individually mounted dry-type transformers of the two-winding, self-cooled type. Kva size, voltage, and phase of the transformers are indicated in the drawings.

2. Within motor control center or electric cabinets, provide core and coil, dry-type transformers.

3. Transformers shall have copper windings and shall be UL listed and labeled where listing applies.

4. Transformers shall be rated for continuous operation in a 40°C maximum ambient temperature.

B. Dry-Type Transformers (10 kva and Below)

1. Construct transformers in accordance with ANSI C89.2, NEMA ST-20, and UL listed under the requirements of UL 506.

2. Transformers 5 kva and larger shall have two 5% FCBN taps on the primary side.

3. Transformers rated 2 kva and below shall have 80°C rise, 150°C insulation system. Transformers rated 3 kva through 10 kva shall have 115°C rise, 185°C insulation system.

4. Encapsulate core and coil in an insulating resin of the class equal to the temperature rise and embed in a resin and filler system to attenuate the sound level.

5. Transformer shall be totally enclosed, nonventilated, suitable for indoor or outdoor installation.

6. Transformers shall be Sorgel Electric Division, Square D Company "Quiet Quality"; General Electric Company "QB," "ML," or "QMS"; Cutler-Hammer Type Westinghouse "EP" or "EPT"; or equal.

C. <u>Dry-Type Transformers (15 kva and Above)</u>

1. Transformer shall be in accordance with ANSI C89.2 NEMA TR-27, NEMA ST-20, and UL listed under the requirements of UL 506.

2. Transformers shall have two 2-1/2% FCAN and FCBN taps on the primary side.

3. Transformers shall have 115°C rise, 150°C insulation system.

4. Transformers shall be energy-efficient type complying with NEMA TP-1.

5. Sound levels shall be within the requirements of ANSI C89.1-2.7.2.

6. Transformers shall be ventilated type.

7. Basic impulse level (BIL) shall be 10 kV for transformers less than 300 kva and 30 kV for transformers 300 kva and larger.

8. Transformers shall be Sorgel Electric Division, Square D Company "Quiet Quality," General Electric Company "QL," Cutler-Hammer Type Westinghouse "DS-3" or "DT-3," or equal.

D. Factory Tests

Perform factory tests in accordance with the latest revisions of ANSI C57.12.91 for dry-type transformers.

PART 3 - EXECUTION

A. General

1. Where shown as part of a motor control, install transformer within a section center of the motor control center.

2. Set taps under load conditions for correct voltage.

B. Tests

Transformers shall have insulation resistance tests made on the windings prior to being connected. The measurements shall be from primary and secondary windings to ground and between primary and secondary windings. The minimum value shall be 10 megohms.

END OF SECTION

SECTION 262410 PANELBOARDS

PART 1 - GENERAL

A. Description

This section describes materials, testing, and installation of panelboards.

B. Related Work Specified Elsewhere

General Electrical Requirements: 260500.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 260500.

2. Show ratings and characteristics including voltage ratings, busing arrangement, continuous current ratings, fault current withstand ratings, neutral bus rating, enclosure type, ratings and arrangement of overcurrent protective devices, and mounting provisions.

3. Submit outline and dimensional drawings and conduit entry restrictions.

PART 2 - MATERIALS

A. General

1. Panelboards shall comply with NEMA PB 1 (panelboards) and UL 67 (electric panelboards) requirements.

2. Provide dead-front, safety-type panelboards with ratings as scheduled. Panelboards shall be circuit-breaker type and shall be fully rated for short-circuit capacity indicated in the drawings. Panelboards shall be UL listed and labeled and manufactured by General Electric, Cutler-Hammer, Square D, Siemens, or equal.

B. Breakers

1. Breakers shall be molded-case type and shall comply with NEMA AB3 requirements. Provide quick-make and quick-break toggle mechanism, inverse-time trip

characteristics, and trip-free operation on overload or short circuit. Automatic tripping shall be indicated by a handle position between the manual OFF and ON position. Provide trip ratings as indicated in the panelboard schedules.

2. Single-pole breakers shall be full module size; two poles shall not be installed in a single module. Multiple circuit breakers shall be of the common-trip type having a single operating handle.

C. <u>Breaker Connections</u>

Circuit breaker current-carrying connections to the bus shall be bolted type.

D. <u>Bus Bars</u>

Bus bars shall be copper. Provide a copper ground bus bar installed on the panelboard frame, bonded to the box, and containing a number of terminal screws equal to or greater than the maximum number of branch circuits. For panelboards with neutrals, provide full-size neutral bus bar, unless otherwise noted in the drawings, and suitable lugs to support maximum number of circuits.

E. <u>Space</u>

Where "space" is noted in the panelboard schedules in the drawings, provide connectors and mounting brackets for the future insertion of a 20-ampere, single-pole overcurrent device.

F. <u>Directories</u>

Provide typed circuit directories on the inside face of the door of each panel. Do not provide handwritten directories.

G. <u>Nameplates</u>

Provide nameplates as specified in Section 260500. Designate the identifying nomenclature, voltage, and phase of the panel as shown in the drawings; for example, "PANEL LA, 120/240-volt, single-phase, 3-wire, 100-ampere bus."

PART 3 - EXECUTION

A. Accessibility

Install panelboards so that the top of the highest circuit breaker is not more than 6 feet 6 inches above the floor or working platform.

B. Tests

Operate each circuit breaker and verify that all phases of each load are disconnected.

END OF SECTION

SECTION 262419 LOW-VOLTAGE MOTOR CONTROL

PART 1 - GENERAL

A. Description

This section describes materials, testing, and installation of low-voltage motor control equipment.

B. Related Work Specified Elsewhere

1. General Electrical Requirements: 260500.

2. Seismic Restraint for Electrical Equipment: 260548.

3. Arc-Flash Hazard Analysis: 260573.

4. Dry-Type Transformers: 261216.

5. Panelboards: 262410.

6. Transient Voltage Surge Suppressor (TVSS): 264313.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 260500.

2. Submit manufacturer's descriptive and technical literature.

3. Submit manufacturer's descriptive data including ratings, single-line diagrams, three-line diagrams, control schematic wiring diagrams, dimensional data, weights, conduit entry restrictions, and overload heater ratings.

4. Submit control schematic diagrams in a “ladder diagram” format that satisfy the following minimum requirements:

   a. Show unique rung numbers on left side of each rung. Provide unique wire numbers for all wires between terminals.

   b. Show terminal numbers for all devices, relays, timers, contacts, etc.

c. Where the internal wiring diagrams of subassemblies are furnished on separate sheets, show as a rectangle in the schematic diagram with external points identified and cross-referenced to the separate sheets of the control circuit. Show coils and contacts internal to the subassemblies in the rectangle connected to their terminal points.

d. Use a cross-referencing system in conjunction with each relay coil so that associated contacts may be readily located on the diagram. Where a relay contact appears on a sheet separate from the one on which the coil is shown, describe the purpose of the contact on the same sheet. Show spare contacts.

e. Show symbols of external field devices on the schematic (ladder) diagram with utilities turned off (electric power, oil, water, lubrication, etc.) and with the equipment at its normal starting position. If the equipment is shown in a specific position, identify the position.

f. Show contacts of multiple contact devices, e.g., selector switches, on the line of the schematic diagram where they are connected in a circuit. Indicate a mechanical connection between the multiple contacts by a dotted line or arrow. This does not apply to control relays, starters, or contactors. Use additional charts or diagrams to indicate the position of multiple contact devices.

g. Show the purpose or function of switches adjacent to the symbols. Show the purpose or function of controls such as relays, starters, contactors, solenoids, subassemblies, and timers on the diagram on the right side of the respective rung.

h. The motor control center manufacturer shall review the control schematic diagrams provided in the drawings, shall identify any adjustments that might be required to achieve the intended control features described in the drawings, and shall implement such changes, prior to shipping the equipment. If further adjustments are required, make such adjustments in the field, with the consent of the Owner's Representative.

5. Submit manufacturer’s test report of the factory tests. Describe each circuit, logic function, device, or item tested. Describe results of tests and retests. Describe corrective action taken on defective circuits, logic functions, and devices.

D. Operation and Maintenance Manuals

Submit operation and maintenance manuals in accordance with Section 260500.

E. Manufacturer’s Services

Provide equipment manufacturer’s services at the jobsite for the minimum labor days listed below, travel time excluded:

1. Two labor days for the motor control center to check the installation and advise during start-up, testing, and adjustment.

2. One labor day to instruct the Owner’s personnel in the operation and maintenance of the equipment.

F. Ratings

Motor horsepower ratings and enclosures shown are minimum expected. This does not limit the equipment size. When motors furnished differ from the minimum ratings indicated, make the necessary adjustments to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate the motors actually installed, at no additional cost to the Owner.

PART 2 - MATERIALS

A. Motor Control Centers

1. Motor control centers shall be dead front, dead rear, floor standing, and front accessible NEMA 1 gasketed construction. The voltage and ampere rating and physical dimensions shall be as indicated in the drawings. Wiring shall be NEMA Class II, Type B (with wiring schematics showing field devices and connections). Tag control wiring within 2 inches of termination at each device and terminal board. Schematics shall also show terminal numbers and interior and field wire numbers.

2. Provide channel iron sills and removable lifting angles.

3. Provide a separate vertical wiring compartment for each motor control center section. Provide cable supports and a hinged door separate from the unit starters.

4. Provide vertical bus insulated barriers.

5. Provide hinged pull-apart terminal blocks for control wiring where foreign voltage may be present, in compliance with NEC 430-74.

6. Provide individual compartments separated by steel barriers and with separate hinged doors for each starter, circuit breaker, or other unit. Locate equipment to enable termination of field wiring from front without equipment removal.

7. Mechanically interlock starter and circuit breaker doors so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access while starter or circuit breaker is energized. Make provisions for padlocking external disconnect handles in the OFF position.

8. Motor control center shall have short-circuit current rating equal to or greater than kAIC rating shown in the drawings.

9. Bus bars shall be copper. Provide full horizontal bus rating for entire length of the motor control center. Do not taper the bus.

10. Provide a continuous, front accessible 200-ampere-minimum ground bus extended the full length of the motor control center.

11. Do not mount components or terminals on the sides of cubicles. Only mounting on back panels or front panels is acceptable.

12. Provide rodent barriers at all sections.

13. Mount devices without obstruction, to be readily accessible.

14. Feeder circuit breakers shall be molded-case type. Provide quick-make and quick-break toggle mechanism, inverse-time trip characteristics, and trip-free

operation on overload or short circuit. Automatic tripping shall be indicated by a handle position between the manual off and on positions. Provide trip ratings and number of poles as indicated in the drawings.

15. Combination starters shall be as described in "Combination Magnetic Motor Starters" in this section.

16. Each compartment shall have nameplates as specified in Section 260500.

17. Motor control centers shall comply with applicable NEMA, UL, and ANSI standards for industrial control. Provide UL label on each motor control center section.

18. Exterior finish shall be ANSI 49 gray.

19. The complete assembly, including anchors, shall be capable of withstanding seismic forces per Section 260548.

20. Motor control centers shall be General Electric 8000 line, Cutler-Hammer Freedom 2100, Allen-Bradley Centerline, Siemens Model 95 Plus, or equal.

B. Combination Magnetic Motor Starters

1. Comply with NEMA ICS, Class A, and with NEC Article 430.

2. Combination motor starters shall be circuit-breaker type equipped with adjustable magnetic-trip circuit breakers (motor circuit protectors) as noted in the drawings. The short-circuit rating shall be at least 65,000 amperes symmetrical at 480 volts. Where a higher short-circuit rating is shown in the drawings, provide combination starters with higher short-circuit rating or provide current-limiting type breakers or circuit breakers with current limiters to achieve the short-circuit rating.

3. Provide 120-volt control circuit transformer where indicated. Provide 100-volt-ampere spare capacity that is in addition to contactor load plus other loads specified. Fuse one side of secondary winding and ground other side. Provide primary winding fuses where shown in drawings. Transformer shall be NEMA ST1, machine tool grade with isolated secondary winding.

4. The manufacturer shall verify the motor ratings and coordinate the starter overloads with the actual horsepower ratings of the motors installed.

5. Provide indicating lights, control switches, elapsed time meters, ammeter, etc., as shown in the schematic wiring diagrams and single-line diagrams. Mount on the front panel of the starter.

6. Provide externally operable overload relay reset buttons and disconnect operators.

7. Provide relays, etc., within the starter enclosure as shown in the schematic wiring diagrams.

8. Starters shall have nameplates as specified in Section 260500.

C. Relays

1. Provide relays with the number of contacts shown on the schematic diagrams. Utilize additional contact blocks or relays to satisfy the required number of contacts shown at no additional cost to the Owner.

2. Control relays shall be magnetically held. Control relays shall be UL listed with NEMA A300 rated contacts and coil voltage, number of poles, and pole arrangement as indicated in the drawings. Relays may be plug-in type in which case they shall have retaining clips, check button for test operation, and indicating light for coil power indication. Relays shall be Allen-Bradley Bulletin 700, Cutler-Hammer Type AR, Idec RR Series, or equal.

3. Time-delay relays shall be UL listed with contacts rated 10-ampere noninductive load, 120 volts, with coil voltage, number of poles, pole arrangement, and maximum timing adjustment as indicated in the drawings. Relays shall be plug-in, solid-state type with timing knob adjustment and retaining clip. Provide Potter Brumfield, Syracuse Electronics, ISSC, or equal.

D. Miscellaneous Devices

1. Control switches shall be round, oiltight type, complete with legend plates and quantity of contact blocks required for the control function.

2. Indicating lights shall be oiltight type, complete with color of lens indicated in drawings and legend plate. Lamps shall be 120-volt a-c, 6S6 screw base. Provide self-contained transformer-type lights with 6.3-volt incandescent lamps. Indicating lights shall be push-to-test type.

3. Elapsed time meters shall be synchronous motor driven, 0- to 99,999.9-hour range, nonreset type, suitable for semiflush, panel mounting.

E. Transient Voltage Surge Suppressor (TVSS)

Provide TVSS per Section 264313.

F. Monitoring and Protective Device

1. Provide a microprocessor-based monitoring and protective device where shown in the drawings for electrical metering and system voltage protection. Device shall have the following features:

   a. Continuous metering of the three phases of the electrical system.

   b. It shall be possible to view on the LCD module display the current, voltage, active power, reactive power, power factor, watt-hours, frequency, and demand values.

   c. A multiposition keypad to give full front panel programmability.

   d. Set points shall be stored in EEPROM for permanent storage.

   e. A minimum 32-character liquid crystal display to provide English language description of set points and metered values.

   f. A minimum of four isolated analog current outputs (4 to 20 mA).

   g. An alarm indication via a front panel LED indicator and the change in state of dedicated on-board output relays (a minimum of two relays), with Form C contacts. These contacts shall be used to open and close breakers and/or initiate alarm signals to remote equipment, as shown in the drawings. Provide a third output relay for kwhr pulse initiation.

2. Device shall be Cutler-Hammer IQ4100, GE PQM, or equal.

G. Transformer and Panelboard

1. Provide a dry-type transformer in the motor control center as shown in the drawings and per Section 261216.

2. Provide a panelboard in the motor control center as shown in the drawings and per Section 262410.

H. Factory Tests

Subject the motor control centers to a complete functionality test. Simulate remote inputs and outputs and verify correct operation.

PART 3 - EXECUTION

A. Installation

1. Install starters and controllers in the motor control center.

2. Secure motor control centers rigidly to walls and floors or mounting pads with anchor bolts or Phillips Drill Company concrete anchors. Anchor bolts or concrete anchors shall be Type 316 stainless steel.

B. Field Tests

1. Test the operation of each interlock to verify that the interlock performs its function.

2. Test system for correct execution of control logic. Adjust wiring connections in panel to correct errors.

3. Operate each breaker and verify that all phases of each load are disconnected.

4. Set adjustable trip circuit breakers two settings above the setting that causes the breaker to trip during motor starting. Do not adjust the setting above 1,300% of the motor nameplate current rating.

C. Spare Fuses

Provide six spare fuses for fused disconnect switches of each type and ampere rating installed.

END OF SECTION

SECTION 262650 ELECTRIC MOTORS

PART 1 - GENERAL

A. Description

This section describes materials, installation, and testing of induction motors and applies to motors that are provided as part of equipment specified in other sections. When it applies, this section is referenced in those other sections.

B. Related Work Specified Elsewhere

1. General Electrical Requirements: 260500.

2. Low-Voltage Motor Control: 262419.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 260500.

2. Show complete nameplate data, ratings, characteristics, mounting arrangements, size and location of conduit entry, location and size of grounding lug, and coatings.

3. For high-efficiency motors (Suffix E), provide percent efficiency data at full, 75%, and 50% load.

4. Submit factory test results for each motor larger than 100 horsepower.

D. Factory Tests

For each integral horsepower motor provide routine (short commercial) test data. Tests shall comply with NEMA MG 1-12.55.

E. Quality Control

NEMA Compliance: Unless otherwise indicated, comply with NEMA MG 1.

PART 2 - MATERIALS

A. General Motor Design Requirements

1. Unless otherwise specified or specifically required by the manufacturer of the equipment to be driven, a-c motors shall be single speed, squirrel cage induction type. Small and medium size motors per NEMA MG 1, Section II shall be NEMA Design B. Large size motors per NEMA MG 1, Section III shall be standard torque type. Motors 15 horsepower and larger shall be NEMA Starting Code F or G. Motors smaller than 15 horsepower may have manufacturer's standard starting characteristics.

2. Stator windings shall be copper.

3. If motors are subjected to overhanging loads, they shall be designed for such loads. The magnitude of the overhanging load shall not exceed the recommendations of the motor manufacturer.

4. The connected load (maximum horsepower required) of each motor shall not exceed its nameplate horsepower rating (exclusive of service factor) under any operating condition.

5. Size motors to start and accelerate the design load of the driven equipment without exceeding any of the specified design requirements. Replace or repair any motor failing these requirements with a motor that will meet the specifications and requirements.

6. Connection box shall be cast metal with gaskets between the box and housing and between the box and cover. Provide a grounding terminal in the connection box.

7. Open dripproof and weather-protected motors shall have a service factor of 1.15. Totally enclosed motors shall have a service factor of 1.0, unless a higher service factor is standard for the operating duty.

8. Unless otherwise noted, motors shall be rated for continuous duty at an ambient temperature of 40°C and at an elevation of 3,300 feet.

9. Open dripproof and weather-protected motors 7.5 horsepower and larger shall have stainless steel screens over openings.

10. Motors 7.5 horsepower and larger shall have cast-iron frames. Do not provide aluminum frames.

B. Bearings

1. Horizontal Motors:

a. Bearings for motors up to 1 horsepower shall be sealed, permanently lubricated ball bearings.

b. Bearings for motors 1 horsepower and larger shall be shielded open-type ball bearings installed in labyrinth sealed end bells with pipe plugs, or shielded type. Bearings shall be regreasable and have provisions for purging old grease.

2. Vertical Motors:

a. Design vertical motors for vertical operation and shall have thrust bearings with a rated L-10 life of 20,000 hours as defined by AFBMA.

b. Thrust bearings for motors 75 horsepower and larger shall be oil lubricated. Guide bearings may be antifriction, grease lubricated, or oil lubricated.

c. Equip grease-lubricated bearings with fittings in each bearing housing. Fittings shall be accessible without removal of any covers or guards. Provide drains to prevent overlubrication.

C. Insulation and Temperature Rise

Unless otherwise noted, provide Class B or F insulation with Class B rise requirements, per NEMA MG 1-12.43, at the specified service factor.

D. Coating

1. Do not coat cast aluminum frame motors.

2. Motors housed within equipment enclosures, such as exhaust fans, air-handling units, and air conditioners, may have factory's standard prime and finish coats.

3. Coat cast-iron frame motors. Apply prime coat at the factory which shall be compatible with field-applied finish coat(s).

4. Field apply finish coat(s) specified in the applicable equipment section.

E. Noise Levels

Unless quieter type motors are specified, motors shall have no-load sound power levels not to exceed the values specified in NEMA MG 1, Section I, Part 9.

F. Efficiency

Unless otherwise specified, motors 1 horsepower and larger shall be classified as “Energy Efficient” and shall have minimum guaranteed full load efficiencies in accordance with NEMA MG 1-12.59. The efficiency shall be determined in accordance with NEMA MG 1-12.55.

G. Motor Types

Motor designations consist of type number and suffix letter. The number and letter are intended to be compatible and the motor shall meet the requirements of both.

1. Type 1: Vertical weather-protected Type 1, NEMA WP-1.

2. Suffix E: Motors shall be classified as “Premium Efficient” and shall have minimum guaranteed full load efficiencies in accordance with NEMA MG 1-12.60. The efficiency shall be determined by IEEE 112 Method B using sine wave power for motors up to 300 horsepower and Method F for motors above 300 horsepower. Efficiency shall be listed on the nameplate in accordance with NEMA MG 1-12.58.2.

3. Suffix H: Motor shall have 120-volt heating elements.

4. Suffix N: Provide motor with a guaranteed maximum sound power level of 72 dBA, measured per IEEE 85, when running at no-load connected to sine wave power.

5. Suffix R: Equip motor with a nonreversing ratchet.

6. Suffix T:

    a. Equip motor with thermal protection in accordance with NEMA MG 1. Control leads shall be color-coded, brought out to the motor conduit box or a separate terminal box for connection.

b. Provide three series-connected, normally closed switches, one in each winding.

7. Suffix V: Motor shall be inverter rated in accordance with NEMA MG-1.31 and shall be suitable for use with a pulse width modulated VFD with nonfiltered output. Design the motor to limit temperature rise to within the specified requirement at a 1.0 service factor when powered from the drive. Provide a nameplate on the motor stating that it is rated for VFD applications.

H. Manufacturer

Motors shall be manufactured in the United States by U.S. Motors; no equal.

PART 3 - EXECUTION

A. Storage

1. Protect motors from exposure of elements for which they are not designed. Install and energize temporary electrical service to motors with electrical heaters (Suffix H).

2. Store motors in an air-conditioned, ventilated, or protected environment similar to or better than the environment in their final location.

B. Field Operating Tests

1. Run each motor with its control as nearly as possible under operating conditions to demonstrate correct rotation direction, alignment, wiring size, proper overload relay sizing, speed, and satisfactory operation. Test interlocks and control features to verify correct wiring and operation.

2. Include measured running current of each phase of motors 1/2 horsepower and larger in the maintenance manual. Repair or replace motor or driven equipment if current exceeds motor nameplate value.

END OF SECTION

SECTION 262726 WIRING DEVICES

PART 1 - GENERAL

A. Description

This section describes materials and installation of light switches, receptacles, and other miscellaneous wiring devices.

B. Related Work Specified Elsewhere

General Electrical Requirements: 260500.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 260500.

2. Submit material list for each type of wiring device and cover plate. Indicate type, ratings, material, color, and manufacturer.

D. References

1. NEMA WD 1, General Purpose Wiring Devices.

2. NEMA WD 6, Wiring Device Configurations.

PART 2 - MATERIALS

A. General

Provide wiring devices that are UL listed.

B. Receptacles

1. Duplex Receptacles: Provide NEMA WD 1, molded composition, ivory, specification grade receptacles. Duplex receptacles for 120-volt, single-phase, 3-wire circuit to be rated 20 amperes, 125 volts, NEMA Type 5-20R.

2. Ground Fault Interrupter (GFI) Duplex Receptacles: Receptacles shall be rated 20 amperes and comply with UL 943, Class A. Provide Leviton 6398-HGI, 3M GFI-2701, or equal.

C. Switches

1. Switches shall be NEMA WD 1, molded composition, ivory, specification grade, single pole, three way and four way as shown in the drawings.

2. 120- or 277-Volt Lighting: Provide switches rated 20 amperes, 120/277-volt a-c. Provide quiet operation, toggle-type switches.

D. Cover Plates

Provide ivory plastic plates in all remaining locations. Plates to be smooth style, noncombustible, mar-resistant thermosetting plastic.

PART 3 - EXECUTION

A. Grounding

Provide a bonding jumper between the grounded outlet box and the receptacle ground terminal.

B. Testing

1. Operate each switch and verify that the load is turned on and off.

2. Test each receptacle with a circuit tester that checks voltage, polarity, and grounded conditions. Repair or replace defective receptacles and repeat the test.

3. GFI receptacles shall be tested with the circuits energized. Devices shall be tested with a portable GFI receptacle tester capable of circulating 7.5 mA of current, when plugged in, between the "hot" line and "ground" to produce tripping of the receptacle. Resetting and tripping shall be checked at least twice at each GFI receptacle.

END OF SECTION

SECTION 262913 LOW-VOLTAGE SWITCHBOARDS

PART 1 - GENERAL

A. Description

This section includes materials and installation of low-voltage switchboards.

B. Related Work Specified Elsewhere

1. General Electrical Requirements: 260500.

2. Seismic Restraint for Electrical Equipment: 260548.

3. Arc-Flash Hazard Analysis: 260573.

4. Transient Voltage Surge Suppressors (TVSS): 264313.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 260500.

2. Submit ratings and characteristics including voltage ratings, busing arrangement, continuous current ratings, fault current withstand ratings, enclosure type, ratings and arrangement of all overcurrent protective devices.

3. Submit outline and dimensional drawings, conduit entry restrictions, and weights.

4. Submit ground fault protection system field test results.

D. Operation and Maintenance Manuals

Submit operation and maintenance manuals in accordance with Section 260500.

E. Utility Approval

Shop drawings of service sections shall be approved by the serving utility and reviewed by the Owner's Representative prior to fabrication.

F. Manufacturers

Switchboards shall be manufactured by Allen Bradley, Cutler-Hammer, General Electric, or Siemens; no equal.

PART 2 - MATERIALS

A. General

1. Main service switchboards shall be floor standing, dead front and rear enclosure with front removable devices and load connections, front accessible enabling switchboard to be mounted against a wall.

2. Construct sections with a minimum thickness of 12-USSG formed sheet steel and of overall dimensions that will fit within the space limitation indicated in the drawings.

3. Provide service switchboards with metering and current transformer space, pull sections, and fully removable front covers of the widths, depths, and heights required by the service utility and as necessitated by the physical requirements of the conduits and cables entering the sections.

4. Provide distribution switchboards with circuit breakers, space for controls behind hinged lockable doors (common keyed with panelboards), motor starters, transformers, and other equipment as indicated.

5. Switchboard shall consist of required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on panels. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.

6. Provide switchboard with adequate lifting means.

7. Switchboard shall have short-circuit current rating equal to or greater than kAIC rating shown in the drawings.

8. Switchboards shall comply with NEMA PB-2 and UL 891 and UL 489 standards. Provide UL label on each switchboard section.

B. Busing

1. Provide switchboards with rectangular copper busing. Cross busing shall be full capacity. Vertical busing shall be full height and rated for the load to be carried, but in no case less than one-third the capacity of the main bus. A copper ground bus with a cross section meeting code requirement but not less than 1/4 by 2 inches shall extend the entire length of the distribution sections of the switchboards.

2. Dimensions and arrangement of vertical buses in the service section shall comply with the serving utility company requirements.

3. Connections shall be silver plated. Provide conical spring-type washers at each bolted joint.

4. Provide heavy-duty pressure-type terminal lugs for connections of incoming and outgoing cables. Support cables and internal wiring with bolted cleats.

C. Main Disconnect

1. Main disconnect device shall be as indicated in the drawings. Device shall be capable of being padlocked in the off position.

2. The disconnect shall be permanently marked to identify it as a service disconnecting means, in accordance with NEC Article 230, Part F and shall be 100% rated, capable of carrying continuous loads to 100% of its rating.

D. Molded-Case Circuit Breakers

Branch and main protective devices shall be of the molded-case circuit-breaker type. Provide quick-make and quick-break toggle mechanism, inverse time trip characteristics, and trip-free operation on overload or short circuit. Automatic tripping shall be indicated by a handle position between the manual OFF and ON position. Provide trip ratings and number of poles as indicated in the drawings. Provide provisions for padlocking external disconnect handles in the OFF position.

E. Nameplates

Provide nameplates as specified in Section 260500. Provide a nameplate for each circuit breaker to indicate load served. The main nameplate shall give the switchboard designation in 1/2-inch-high letters. A second line in 1/4-inch-high letters shall indicate the voltage and phases.

F. Transient Voltage Surge Suppressor (TVSS)

Provide TVSS per Section 264313.

G. Seismic Requirements

The complete assembly including anchoring shall be capable of withstanding seismic forces per Section 260548.

PART 3 - EXECUTION

A. Installation

Secure switchboards rigidly to walls and floors or mounting pads with anchor bolts or Phillips Drill Company concrete anchors. Anchor bolts or concrete anchors shall be Type 316 stainless steel.

B. Field Tests

1. Test and calibrate devices and instruments that require testing and calibration for proper operation per manufacturer's instructions.

2. Voltage:

    a. When the installation is essentially complete and the plant is in operation, check the voltage at the point of termination of the power company supply system to the project. Check voltage amplitude and balance between phases for loaded and unloaded conditions.

    b. If the unbalance (as defined by NEMA) exceeds 1%, or if the voltage varies throughout the day and from loaded to unloaded conditions more than ±5% of nominal, make a written request to the power company that the condition be corrected. If corrections are not made, request from a responsible power company official a written statement that the voltage variations and/or unbalance are within their normal standards.

3. Operate each switch and circuit breaker at least three times, demonstrating satisfactory operation each time.

C. Spares

Provide six spare fuses of each type and ampere rating installed.

END OF SECTION

SECTION 262923 VARIABLE FREQUENCY DRIVE (VFD)

PART 1 - GENERAL

A. Description

This section describes materials, testing, and installation of VFDs for pumping applications.

B. Related Work Specified Elsewhere

1. General Electrical Requirements: 260500.

2. Seismic Restraint for Electrical Equipment: 260548.

3. Low-Voltage Motor Control: 262419.

4. Electric Motors: 262650.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 260500.

2. Submit manufacturer's descriptive data including ratings, performance and operational features, dimensional data, conduit entry restrictions, and heat dissipation to ambient.

3. Submit a schematic diagram for each drive showing field devices, wire numbers, terminal numbers, and interface with other panels.

4. Submit harmonic analysis.

5. Submit certified factory test report.

D. Operation and Maintenance Manuals

Submit operation and maintenance manuals in accordance with Section 260500.

E. Manufacturer's Services

Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded, for a certified technical representative:

1. Two labor days to check the installation, calibrate the drive, and advise during start-up and testing of the drive.

2. One labor day to instruct the Owner's personnel in the operation and maintenance of the equipment.

F. Service Organization Qualifications

1. The service organization office shall be located within 100 miles of the jobsite.

2. The service organization must have been an authorized service organization of the equipment manufacturer for the past 12 months. Service engineers or technicians must be factory trained.

3. Maintain a spare parts inventory of 100% of the controller components.

PART 2 - MATERIALS

A. General

1. VFDs shall consist of variable frequency controller, input circuit breaker, harmonic suppression equipment, output isolation contactor, and controls. Each drive shall operate as a simplex unit with no interaction with other drives. Horsepower rating of each drive shall be sufficient to drive the motor as shown in the drawings or the motors actually provided, whichever is larger, under the specified operating conditions.

2. All components shall be integral to the VFD lineup, factory wired, and tested as a complete system.

3. Design equipment to operate under the following operating conditions:

   a. Altitude to 3,300 feet above sea level.

   b. Ambient 0°C to 40°C.

   c. Noncondensing relative humidity to 95%.

   d. A-C line frequency variation of ±3 hertz.

4. VFD shall maintain a 0.95 minimum true power factor throughout the entire speed range.

5. VFD shall be suitable for use with any standard NEMA-B squirrel-cage induction motor having a 1.15 service factor. Provide equipment for proper operation of motor and drive when required due to motor feeder length.

6. Equipment shall comply with the requirements of ANSI, IEEE, and NEMA. The electrical equipment, design, and construction shall comply with the provisions of the NEC. The complete drive shall be UL listed.

7. All drives shall be supplied by one manufacturer.

8. VFDs shall be manufactured by ABB or Cutler-Hammer; no equal.

B. Enclosures

1. Equipment enclosure shall be floor standing, unless otherwise noted in the drawings, completely front accessible, NEMA 12. Enclosures shall be suitable for mounting against a wall or back-to-back with other equipment.

2. Locate output isolation contactors, harmonic suppression equipment, and controls either within the variable frequency controller enclosure or in an adjacent enclosure.

3. Verify that overall equipment dimensions are within the dimensions indicated in the drawings. If larger equipment is required, submit a proposed room layout showing arrangement of electrical equipment. Provide working clearances in accordance with the NEC. Any costs due to rearrangement of equipment shall be borne by the Contractor with no additional expense to the Owner.

4. Provide additional pull sections as required for bottom entry of incoming and/or outgoing cables.

C. Variable Frequency Controllers

1. Controller shall consist of an input rectifier-grade phase-shifting transformer with 18-pulse minimum converter section and output inverter utilizing IGBT technology.

2. Controller shall be pulse width modulated design.

3. Controller shall be variable voltage/variable frequency (constant volts per hertz).

4. The controller shall include the following features:

   a. 460-volt a-c, +10%, -10% (at rated load), 3-phase, 3-wire, 60-hertz input power.

   b. 460-volt a-c, 3-phase, 3-wire, ungrounded output power.

   c. Equipment fault current rating of 65,000 symmetrical amperes fault current.

   d. Input power surge protector.

   e. 20- to 60-hertz continuous operating range.

   f. 115% overload rating for 100 seconds, 100% rated current continuous.

   g. Output current limit, 50% to 110% adjustable. Limits motor inrush current during start-up.

   h. Regulation ±3% of base speed.

   i. Voltage Dip Ride-Through: Controller shall be capable of sustaining continued operation with a 40% dip in nominal line voltage. Output speed may decline only if current limit rating of the controller is exceeded.

   j. Power Loss Ride-Through: Controller shall be capable of a minimum three-cycle power loss ride-through without fault activation.

   k. Separately adjustable acceleration and deceleration rates.

   l. Maximum and minimum speed adjustments.

   m. 120-volt a-c control power for run/stop circuits.

   n. Blower cooled, with thermal switch cutout.

   o. Comprehensive microprocessor-based digital diagnostic system that monitors its own control functions and displays faults and operating conditions in plain English without the use of codes. The digital keypad and display shall be a membrane keypad with integral 24-character minimum LCD display capable of controlling the VFD and setting drive parameters. Include self-test software program to verify proper keypad operations. A fault log shall record, store, display, and print, upon demand, the following for the 15 or more most recent events:

(1) VFD mode (auto/manual).

(2) Elapsed time (since previous fault) or fault time.

(3) Type of fault.

p. The following digital indications shall be possible to be selectively displayed:

(1) Speed called for by incoming process signal in percent of full speed.

(2) Output current in amperes.

(3) Output frequency in hertz.

(4) Input voltage.

(5) Output voltage.

(6) Total 3-phase kilowatts.

(7) Kilowatt-hour.

(8) Elapsed time.

(9) rpm.

(10) D-C bus voltage.

q. Password security shall be available to protect drive parameters from unauthorized personnel.

r. A plain English user menu shall be provided in software in nonvolatile memory as a guide to parameter setting.

s. VFD parameters, fault log, and diagnostic log shall be downloadable via RS-232, RS-422, and RS-485 ports, as well as line-by-line on the keypad display.

5. Minimum controller efficiency shall be 96% at 100% speed and 100% torque and 88% at 50% speed and 25% torque based on nominal 1,800-rpm motor with load horsepower to vary as cube of speed.

6. The controller shall include protective circuitry that initiates an orderly shutdown of the inverter without component failure. The controller shall shut down and require manual reset for the following fault conditions:

   a. Motor inverse time overload.

   b. Instantaneous overcurrent.

   c. Inverter fault.

   d. Overfrequency.

   e. D-C link overvoltage.

   f. Ground fault.

7. The controller shall ride through or shut down for the following fault conditions.

   a. Incorrect phase sequence.

   b. Loss of an input phase.

8. The controller shall shut down for input undervoltage. The controller shall automatically restart upon a cleared fault condition.

9. The controller shall have not less than five restart capabilities. If the drive reaches the limits of restart, the restart circuit shall lock out and shall provide a fault signal.

10. Provide a common failure contact for remote indication of fault conditions previously listed.

11. The power circuit design shall be such that the following fault conditions can occur without damage to the power circuit components:

a. Single-phase fault or 3-phase short circuit on VFD output terminals.

b. Failure to commutate inverter transistor due to severe overload or other conditions.

c. Disconnecting motor during VFD operation.

d. Loss of input power due to opening of VFD input disconnect device or utility power failure during VFD operation.

e. Loss of one phase of input power.

12. VFD shall have integral modbus communication capability.

13. Phase-shift transformers shall be ventilated, dry type with 80°C temperature rise.

14. Provide a critical speed avoidance circuit for selection of a critical speed with a rejection band centered on that speed. The drive shall ignore any speed signals requiring drive operation within the rejection band.

15. The VFD controller shall operate satisfactorily when connected to a bus subject to a total harmonic voltage distortion caused by other sources of up to 10% and commutation notches of up to 36,500 microsecond-volts.

D. <u>Input Circuit Breaker</u>

Circuit breaker shall be molded-case or insulated-case type, mechanically interlocked with the enclosure door to provide positive disconnect of incoming a-c power. The circuit breaker shall be rated for 65,000 AIC.

E. <u>Air Conditioner</u>

Provide a panel-mounted air conditioner to maintain internal VFD temperature to within manufacturer’s requirements with a maximum ambient temperature of 115°F. Provide ducting, cabinet penetrations, and clearances as required for proper operation. Provide custom VFD cabinet enclosure, if required, to comply with this requirement. Provide McLean Midwest air conditioner or equal.

F. Controls

1. Provide control logic and interlocks to interface the bypass starter with the variable frequency controller and the converter output contactor as shown in the schematic diagrams in the drawings.

2. Provide control circuit transformers, indicating lights, selector switches, push buttons, elapsed time meter, analog dial-type speed indicator, digital keypad, and display as indicated in the schematic diagrams shown in the drawings.

3. Mount and wire the devices listed above on the controller cabinet door.

4. Control circuit transformers, indicating lights, selector switches, push buttons, and elapsed time meters shall be as specified in Section 262419.

5. Provide relays with the number of contacts shown on the schematic diagrams. Utilize additional contact blocks or relays to satisfy the number of contacts shown at no additional cost to the Owner. Plug-in relays are acceptable and shall have retaining clips.

G. Harmonic Suppression Equipment

1. VFDs shall meet requirements outlined in the current edition of IEEE 519 for each individual and total harmonic current distortion and as indicated in these specifications, whichever is more stringent. Total demand distortion (TDD) as defined by IEEE 519, caused by the simultaneous operation of the VFDs shall not exceed 5% at the main switchboard bus while operating from the utility source or 5% while operating from standby generator. Provide additional harmonic filters, if required, to meet these requirements.

2. Submit a harmonic analysis showing compliance with the above requirement including all voltages and current harmonics up to the 49th.

3. Base harmonic analysis of the system operating from the utility source on a short-circuit kva available at the main switchboard of 30,000 kva.

H. Factory Testing

Subject the VFDs to a complete functionality test and a full-load operational test prior to shipment. Simulate remote inputs and outputs and verify correct operation. Submit certified factory test report.

I. Spare Parts

Provide six spare fuses of each type and ampere rating installed. Provide two of each type of converter power semiconductor, two of each type of inverter power semiconductor, one keypad assembly, five of each type of panel lamps, and one of each type of control printed circuit board and gate firing boards. Pack spare parts in a wooden box; label with manufacturer's name and representative's name, address, and telephone number; and attach list of material contained within.

PART 3 - EXECUTION

A. Installation

Secure drives rigidly to floors or mounting pads and walls with anchor bolts or concrete anchors in accordance with manufacturer's recommendations and Section 260548.

B. Field Tests

1. Adjust control set points and verify proper operation. Coordinate minimum speed with performance requirements of driven equipment.

2. Test the operation of each interlock to verify that the interlock performs its function.

3. Test the operation of each control feature to verify operation of the controls.

4. Perform dynamic tuning tests with the facility controls.

5. Measure total harmonic distortion with one, two, three, and four drives operating at 100% speed for compliance with harmonic design requirements. Utilize a recording-type harmonic analyzer displaying individual and total harmonic currents and voltages up to the 49th harmonic. Test shall be performed by a NETA-certified independent testing company.

END OF SECTION

SECTION 264313 TRANSIENT VOLTAGE SURGE SUPPRESSORS (TVSS)

PART 1 - GENERAL

A. Description

This section includes materials and installation of TVSS for the protection of electrical and electronic circuits and equipment.

B. Related Work Specified Elsewhere

1. Operation and Maintenance Manuals: 019310.

2. General Electrical Requirements: 260500.

3. Grounding and Bonding: 260526.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 250500.

2. Submit product data on each suppressor type, indicating component values, part numbers, and conductor sizes. Include dimensional drawing for each, showing mounting arrangements.

3. Submit manufacturer's UL certified test data and nameplate data for each TVSS.

4. Submit electrical single-line diagram showing location of each TVSS.

5. Provide copy of extended warranty.

D. Quality Assurance

1. UL Compliance and Labeling: For power and signal circuits, TVSS devices shall comply with UL 1449 and UL 1283 as an electromagnetic interference filter. Provide units that are listed and labeled by UL.

2. ANSI Compliance: Use TVSS devices that comply with ANSI/IEEE C62.41 and ANSI/IEEE C62.33.

3. NEC Compliance: Use TVSS devices that comply with NEC Article 285.

E. Extended Warranty

Provide written warranty, signed by the manufacturer, agreeing to replace any surge suppressor which fails in service within one year following the guarantee period specified in the General Provisions.

PART 2 - MATERIALS

A. General

1. TVSS devices for power circuits shall be the product of a single manufacturer and shall be of modular construction designed for field replacement.

2. TVSS devices shall be capable of performance at ambient temperatures between 40°C and 60°C, at relative humidity ranging from 0% to 95%, and at elevations ranging from sea level to 12,000 feet.

3. TVSS devices shall be fused to disconnect the suppressor from the electrical source should the suppressor fail. The fusing shall allow full surge handling capabilities and afford safety protection from thermal overloads and short circuits.

4. Design TVSS devices for the specific type and voltage of the electrical service. Single-phase and 3-phase wye-configured systems shall have L-N, L-G, and N-G protection. Grounded delta-configured systems shall have L-L and L-G protection.

5. Power Filter: The TVSS shall include a high-frequency extended range power filter and shall be UL 1283 listed as an electromagnetic interference filter. The filter shall provide minimum noise attenuation as follows:

Attenuation Frequency	**100 KHz**	**1 MHz**	**10 MHz**	**100 MHz**
Insertion loss (ratio)	50:1	350:1	500:1	250:1
Insertion loss (dB)	34	51	54	48

B. Manufacturer

TVSS devices shall be products of one of the following manufacturers:

1. Advanced Protection Technologies.

2. Current Technology, Inc.

3. Westinghouse Clipper Power System.

4. United Power Corporation.

5. Atlantic Scientific Corporation, MB or ZMS Series.

6. Leviton Manufacturing Company, Inc., 57000 Series.

C. Main Distribution TVSS

1. Provide TVSS meeting ANSI/IEEE C62.41 Location Category C.

2. Maximum single impulse current rating shall be not less than the following:

   a. L-L Capacity: 200 kA.

   b. L-N Capacity: 200 kA.

   c. L-G Capacity: 150 kA.

   d. N-G Capacity: 100 kA.

3. Suppressor housing shall be in an enclosure that has the same NEMA rating as the panel it protects and painted to match.

4. UL 1449 maximum suppression voltage shall not be more than:

System Voltage	Phase	L-L or L-N Suppression Voltage
480Y/277	3	1,000

D. Short-Circuit Rating

1. Provide TVSS with short-circuit rating permanently marked on the enclosure.

2. Provide TVSS with the same or greater short-circuit rating as the switchboards and/or panelboards with which they are installed.

E. Annunciation

Provide unit or separately mounted LED-type indication lights to show the normal and failed status of each module. Provide one normally open and one normally closed contacts which operate when the unit fails.

F. Surge Counter

Provide each TVSS rated above 100 kA with a counter displaying the number of voltage transients that have occurred on the unit input. The counter shall have battery backup and retain the count through system power outages.

PART 3 - EXECUTION

A. Application Requirements

Install TVSS as indicated in drawings.

B. General Installation Requirements

1. Install suppressors according to manufacturer's recommendations.

2. Install suppressors directly to the cabinet which houses the circuit to be protected so that the suppressor leads are straight and short, with all 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.

3. Provide at least 3 inches of separation between line-side and load-side connecting wires. Do not bundle line-side and load-side conductors together or run them in the same raceway.

4. Field installed conductors shall be the same as specified for building wire, not smaller than No. 8 AWG and not larger than No. 4 AWG. Device leads shall not be longer than the length recommended by the manufacturer, unless specifically reviewed and approved by the manufacturer.

5. Provide dedicated disconnecting means for TVSS devices installed at main service entrance location, in switchboards, and in motor control centers. Provide dedicated 20-ampere circuit breakers, number of poles as required, as disconnecting means for TVSS devices installed in panelboards. The interrupting capacity of the circuit breakers shall be that specified for the other breakers at that location.

C. Spare Parts

1. Provide spare TVSS components as follows:

    a. Six main distribution TVSS suppression elements.

    b. Three subpanel TVSS assemblies.

    c. Twelve indicator light lamps of each color installed.

2. Provide spare TVSS fuses as follows:

    Six fuses of each type and rating installed.

END OF SECTION

SECTION 265000 LIGHTING

PART 1 - GENERAL

A. Description

This section includes materials and installation of lighting fixtures.

B. Related Work Specified Elsewhere

1. General Electrical Requirements: 260500.

2. Seismic Restraint for Electrical Equipment: 260548.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 260500.

2. Submit manufacturer's catalog data including complete catalog number, photometric data, and descriptive literature.

PART 2 - MATERIALS

A. General

1. Furnish lighting fixtures of the type indicated in the drawings, complete with lamps, sockets, wiring, and mounting hardware.

2. The use of a manufacturer's name and model or catalog number in the drawings is for the purpose of establishing the standard of quality, photometrics, and general appearance desired only. Products of other manufacturers will be considered in accordance with the General Provisions, provided they are the cataloged and manufactured products of such manufacturers. Custom designed and/or fabricated fixtures will not be considered.

B. Lamps

1. Fluorescent: 32-watt - F032, T-8, 4,100K, 75 CRI, 2,850 lumen minimum output lamps.

2. Manufacturers: General Electric, Osram Sylvania, Philips, or equal.

C. Ballasts

1. Fluorescent:

   a. Ballasts: Provide solid-state electronic ballasts compatible with the lamps provided. Provide ballasts with 97% minimum power factor, less than 10% THD, instant start, multivolt type, having less than 1.7 current crest factor, with a minimum operating frequency of 20 KHz, Class A sound rating, IEEE 587A (ANSI C62.41) transient protection, FCC Part 18C, Class A EMI filtering, and UL listed.

   b. Provide single-lamp dimming ballasts for fixtures controlled by dimmers. Verify type with dimming system provided.

2. High-Intensity Discharge:

   a. Ballasts shall be single lamp, volts and watts as indicated. At any lamp voltage, from nominal through life, lamp wattage regulation spread at that lamp voltage shall not exceed 5% for ±10% line voltage variation. Ballasts shall have a minimum power factor of 90% and shall be suitable for low-temperature operation.

   b. Indoor ballasts shall have all components, including capacitor and starter where applicable, enclosed in a fluorescent style ballast can. Ballast shall be encased and potted and shall be sound rated.

   c. Outdoor ballasts shall be weatherproof.

3. Manufacturers: Advance, General Electric, Jefferson, Magnetek, Osram Sylvania, or equal.

PART 3 - EXECUTION

A. Installation

1. Install lighting fixtures as close as possible to the locations shown in the drawings, making adjustments only for the purpose of avoiding interferences.

2. Install lighting fixtures plumb and level, with fixture surfaces parallel and perpendicular to walls and other major structures.

3. Install continuous rows of fixtures straight and true and equip with joining straps, couplings, and nipples as recommended by the manufacturer.

4. Support fluorescent lighting fixtures at two points minimum from structural elements that are capable of carrying the total weight. Mount fixtures rigidly with no rocking action.

5. Remove ballasts that are judged by the Owner's Representative to be excessively noisy and replace at no cost to the Owner.

END OF SECTION

SECTION 312300 EARTHWORK

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation of earthwork for excavations and fills for structures and sites.

B. Related Work Specified Elsewhere

1. Protecting Existing Underground Utilities: 020120.

2. Trenching, Backfilling, and Compacting: 312316.

C. Submittals

1. Submit excavation and shoring drawings for worker protection in accordance with the General Provisions and Section 013300.

2. Submit six copies of a report from a testing laboratory verifying that the material conforms to the gradation specified.

D. Testing for Compaction

1. The Contractor will test for compaction and relative density as described below.

2. Determine the density of soil in place by the sand cone method, ASTM D1556 or by nuclear methods, ASTM D2922 and D3017. Compaction tests will be performed for each lift or layer. If nuclear methods are used for in-place density determination, verify the accuracy with one sand cone, and one maximum laboratory dry density, for every five nuclear tests taken if the backfill material is processed fill or visually consistent. More sand cones and densities will be required if the backfill material is visually variable. The minimum depth for the sand cone test hole shall be 12 inches. The minimum size shall be 8 inches, and size 16/30 or 10/20 silica sand shall be used.

3. Determine laboratory moisture-density relations of soils per ASTM D1557. If nuclear methods are used for in-place

density determination, the compaction test results for maximum dry density and optimum water content shall be adjusted in accordance with ASTM D4718. This will be required for determination of percent relative compaction and moisture variation from optimum.

4. Determine the relative density of cohesionless soils per ASTM D4253 and D4254.

5. Sample materials per ASTM D75.

6. "Relative compaction" is the ratio, expressed as a percentage, of the inplace dry density to the laboratory maximum dry density.

7. Compaction shall be deemed to comply with the specifications when no more than one test of any three consecutive tests falls below the specified relative compaction. The one test shall be no more than three percentage points below the specified compaction. The Contractor shall pay the costs of any retesting of work not conforming to the specifications.

E. Disposal of Excess Materials

Excess site excavated or wasted material shall be disposed of offsite by the Contractor at his expense. No prearranged disposal site or related permits have been determined or secured by the Owner.

F. Material Availability

Sufficient earthwork material to complete the work may not be available at the site. Secure source of material and permits to complete the project requirements.

PART 2 - MATERIALS

A. Structural Fill

Structural fill is material that is to be placed beneath structures to the limits indicated in the drawings. Material shall be excavated material that is free from organic matter, roots, debris, and rocks larger than 3 inches in the greatest dimension. Expansion potential shall be less than 20.

B. Structural Backfill

1. Structural backfill is material that is to be placed adjacent to and around piping and structures.

2. Material shall be free from deleterious material and shall have a sand equivalent greater than 30 per ASTM D2419.

3. Excavated material may be used for structural backfill provided it conforms to the above specifications for structural backfill material.

C. Fill

Material that is to be placed in locations that are not to be constructed as structural fill or structural backfill. Material shall be same as structural fill.

D. Sand, Including Imported Sand for Pipe Zone and Pipe Base in Pipe Trenches

1. Granular material free from clay balls, organic matter, and other deleterious substances and conforming to the following gradations:

Sieve Size	Percent Passing By Weight
3/8 inch	100
No. 4	75 - 100
No. 30	12 - 50
No. 100	5 - 20
No. 200	0 - 10

2. Sand shall have a coefficient of permeability greater than 0.014 cm/s measured in accordance with ASTM D2434 or a sand equivalent of 30 per ASTM D2419, and have an expansion potential less than 20.

E. Water for Compaction

Water shall be free of organic materials and shall have a pH of 7.0 to 9.0, a maximum chloride concentration of 500 mg/L, and a maximum sulfate concentration of 500 mg/L. Provide all water needed for earthwork. Provide temporary piping and valves to convey water from the source to the point of use.

Provide any meters if the water is taken from a city, water district, or agency pipeline.

PART 3 - EXECUTION

A. Excavation

1. Excavations shall have sloping, sheeting, shoring, and bracing conforming with 29CFR1926 Subpart P-Excavations, CAL/OSHA requirements, and the Special Provisions.

2. Excavation is unclassified. Perform excavation regardless of the type, nature, or condition of the material encountered to accomplish the construction. Do not operate excavation equipment within 5 feet of existing structures or newly completed construction. Excavate with hand tools in these areas.

3. After the required excavation has been completed, the Owner will observe the exposed subgrade to determine the need for any additional excavation. It is the intent that additional excavation be conducted in all areas within the influence of the structure where unacceptable subgrade materials exist at the exposed subgrade. Overexcavation shall include the removal of all such unacceptable material that exists directly beneath the structure or within a zone outside and below the structure defined by a line sloping at 1-horizontal to 1-vertical from 1 foot outside the edge of the footing. Refill the overexcavated areas with structural backfill material.

4. The Contractor will not receive any additional payment for refill material used for his convenience.

B. Limits of Foundation Excavation

Excavate to the depths and widths needed to accomplish the construction. Allow for forms, working space, structural backfill, and site grading. Unless unacceptable material is encountered and overexcavation is authorized by the Owner, backfill overexcavations with compacted structural backfill material. Correct cuts below grade by trimming adjoining areas and creating a smooth transition. The Contractor shall bear all costs for correcting unauthorized overexcavated areas.

C. <u>Preparation for Placing Fill or Backfill</u>

1. After excavation of existing material or removal of unacceptable material at the exposed subgrade, scarify the final subgrade surface to a depth of 12 inches and compact to 90% relative compaction.

2. Remove foreign materials and trash from the excavation before placing any fill material. Obtain the specified compressive strength and finish of concrete work per Sections 030500 before backfilling.

D. <u>Placing and Compacting Fill and Structural Fill</u>

1. Excavated material may be used for fill and structural fill providing all deleterious materials have been removed from the stockpiled material.

2. Place in maximum 8-inch lifts and compact each lift to 90% relative compaction.

E. <u>Placing and Compacting Structural Backfill</u>

1. Place structural backfill to the lines and grades shown or specified. Do not exceed loose lifts of 8 inches.

2. Compact each lift to 90% relative compaction, unless otherwise shown in the drawings. Stop structural backfill at least 6 inches below finished grade in all areas where topsoil is to be placed.

3. Do not operate earthmoving equipment within 5 feet of walls of concrete structures. Place and compact backfill adjacent to concrete walls with hand-operated tampers or other equipment that will not damage the structure.

F. <u>Moisture Control</u>

During the compacting operations, maintain optimum practicable moisture content required for compaction purposes in each lift of the material. Maintain uniform moisture content throughout the lift. Insofar as practicable, add water to the material at the site of excavation. Supplement by sprinkling the material. At the time of compaction, the water content of the material shall be at optimum water content or within 2 percentage points above optimum. Aerate material containing excessive moisture by blading, discing, or harrowing to hasten the drying process.

G. Site Grading

Perform earthwork to the lines and grades shown in the drawings. Shape, trim, and finish surfaces to conform with the lines, grades, and cross sections as shown. Remove exposed roots and loose rocks exceeding 3 inches in diameter.

END OF SECTION

SECTION 312316 TRENCHING, BACKFILLING, AND COMPACTING

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation for pipeline trench excavation, backfilling, and compacting.

B. Related Work Specified Elsewhere

1. Protecting Existing Underground Utilities: 020120.

2. Earthwork: 312300.

3. Asphalt Concrete Paving: 321216.

C. Submittals

1. Submit six copies of a report from a testing laboratory verifying that material conforms to the specified gradations or characteristics for pea gravel, granular material, imported sand, rock refill for foundation stabilization, and water.

2. Submit method(s) of compaction including removal sequence of shoring where used.

D. Testing for Compaction

The Contractor will test for compaction as described in Section 312300.

E. Pavement Zone

The pavement zone includes the asphalt concrete and aggregate base pavement section placed over the trench backfill.

F. Street Zone

The street zone is the top 30 inches of the trench immediately below the pavement zone in paved areas. Where the depth of cover over the pipe does not permit the full specified thickness of the street zone, construct a thinner street zone, extending from the top of the pipe zone to the bottom of the pavement zone.

G. Trench Zone

The trench zone includes the portion of the trench from the top of the pipe zone to the bottom of the street zone in paved areas or to the existing surface in unpaved areas. If the resulting trench zone is less than 24 inches thick, the street zone shall extend to the top of the pipe zone and there shall be no separate trench zone.

H. Pipe Zone

The pipe zone shall include the full width of trench from the bottom of the pipe or conduit to a horizontal level above the top of the pipe, as specified below. Where multiple pipes or conduits are placed in the same trench, the pipe zone shall extend from the bottom of the lowest pipe to a horizontal level above the top of the highest or topmost pipe. Thickness of pipe zone above the highest top of pipe shall be as follows unless otherwise shown in the drawings or otherwise described in the specifications for the particular type of pipe installed.

Pipe Diameter	**Thickness of Pipe Zone Above Top of Pipe**
6 inches or smaller	6 inches
8 inches and larger	10 inches

I. Pipe Base or Bedding

The pipe base or bedding shall be defined as a layer of material immediately below the bottom of the pipe or conduit and extending over the full trench width in which the pipe is bedded. Thickness of pipe base shall be as follows unless otherwise shown in the drawings or otherwise described in the specifications for the particular type of pipe installed.

Pipe Diameter	**Thickness of Pipe Base**
Smaller than 4 inches	3 inches
4 inches through 16 inches	4 inches
18 inches and larger	6 inches

PART 2 - MATERIALS

A. Native Earth Backfill--Street and Trench Zones

1. Native earth backfill used above the pipe zone shall be excavated fine-grained materials free from roots, debris, rocks larger than 3 inches, asbestos, organic matter, clods, clay balls, broken pavement, and other deleterious materials. Less than 50% shall pass a No. 200 sieve. At least 40% shall pass a No. 4 sieve. The coarser materials shall be well distributed throughout the finer material.

2. Backfill materials that are obtained from trench excavated materials to the extent such material is available shall be either screened directly into the trench or screened during the trenching operation. If screened during trenching, the material shall be maintained free of unscreened material during the handling and backfilling process. Hand selecting of rocks from earth as it is placed into the trench will not be permitted in lieu of the specified screening. Backfill shall be moisture conditioned to within approximately 2% of the optimum moisture content prior to being placed in trench.

B. Imported Sand--Pipe Zone and Pipe Base

See Section 312300.

C. Sand-Cement Slurry--Pipe Zone

Sand-cement slurry backfill shall consist of one sack (94 pounds) of Type I or II portland cement added per cubic yard of imported sand and sufficient water for workability.

D. Water for Compaction

See Section 312300. Water shall be free of organic materials injurious to the pipe coatings.

PART 3 - EXECUTION

A. Sloping, Sheeting, Shoring, and Bracing of Trenches

Trenches shall have sloping, sheeting, shoring, and bracing conforming with 29CFR1926, Subpart P--Excavations, CAL/OSHA requirements, and the Special Provisions.

B. Sidewalk, Pavement, and Curb Removal

Cut bituminous and concrete pavements regardless of the thickness and curbs and sidewalks prior to excavation of the trenches with a pavement saw or pavement cutter. Width of the pavement cut shall be at least equal to the required width of the trench at ground surface. Haul pavement and concrete materials from the site. Do not use for trench backfill.

C. Trench Excavation

1. Excavate the trench to the lines and grades shown in the drawings with allowance for pipe thickness, sheeting and shoring if used, and for pipe base or special bedding. If the trench is excavated below the required grade, refill any part of the trench excavated below the grade at no additional cost to the Owner with granular material. Place the refilling material over the full width of trench in compacted layers not exceeding 6 inches deep to the established grade with allowance for the pipe base or special bedding.

2. Trench widths in the pipe zone shall be as shown in the drawings. If no details are shown, maximum width shall be 18 inches greater than the pipe outside diameter. Comply with 29CFR Part 1926 Subpart P--Excavations. Trench width at the top of the trench will not be limited except where width of excavation would undercut adjacent structures and footings. In such case, width of trench shall be such that there is at least 2 feet between the top edge of the trench and the structure or footing.

3. Construct trenches in rock by removing rock to a minimum of 6 inches below bottom of pipe bedding and backfilling with granular material.

D. Location of Excavated Material

During trench excavation, place the excavated material only within the working area or within the areas shown in the drawings. Do not obstruct any roadways or streets. Do not place trench spoil over pipe, buried utilities, manholes, or vaults. Conform to federal, state, and local codes governing the safe loading of trenches with excavated material.

E. Dewatering

Provide and maintain means and devices to remove and dispose of water entering the trench excavation during the time the trench is being prepared for the pipelaying, during the laying of the pipe, and until the backfill at the pipe zone has been completed. These provisions shall apply during both working and nonworking hours, including lunch time, evenings, weekends, and holidays. Dispose of the water in a manner to prevent damage to adjacent property and in accordance with regulatory agency requirements. Do not drain trench water through the pipeline under construction.

F. Installing Buried Piping

1. Grade the bottom of the trench to the line and grade to which the pipe is to be laid, with allowance for pipe thickness. Remove hard spots that would prevent a uniform thickness of bedding. Place the specified thickness of pipe base material over the full width of trench. Grade the top of the pipe base ahead of the pipelaying to provide firm, continuous, uniform support along the full length of pipe, and compact to the relative compaction specified herein. Before laying each section of the pipe, check the grade and correct any irregularities.

2. Excavate bell holes at each joint to permit proper assembly and inspection of the entire joint. Fill the area excavated for the joints with the bedding material specified or indicated in the drawings for use in the pipe zone. If no bedding material is specified or indicated, use imported sand.

3. Inspect each pipe and fitting before lowering the buried pipe or fitting into the trench. Inspect the interior and exterior protective coatings. Patch damaged areas in the field with material recommended by the protective coating manufacturer. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after installation.

4. Handle pipe in such a manner as to avoid damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.

5. When installing pipe, do not deviate more than 1 inch from line or 1/4 inch from grade. Measure elevation at the pipe invert.

6. After pipe has been bedded, place pipe zone material simultaneously on both sides of the pipe, in maximum 6-inch lifts, keeping the level of backfill the same on each side. If no pipe zone material is specified or indicated, use imported sand. Carefully place the material around the pipe so that the pipe barrel is completely supported and no voids or uncompacted areas are left beneath the pipe. Use particular care in placing material on the underside of the pipe to prevent lateral movement during subsequent backfilling.

7. Compact each lift to the relative compaction specified herein.

8. Push the backfill material carefully onto the backfill previously placed in the pipe zone. If no backfill material is otherwise specified or indicated, use granular material for backfill. Do not permit free-fall of the material until at least 2 feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe. Do not operate heavy equipment or a sheepsfoot wheel mounted on a backhoe over the pipe until at least 3 feet or one-half of the internal diameter, whichever is greater, of backfill has been placed and compacted over the pipe.

9. When the pipelaying is not in progress, including the noon hours, close the open ends of pipe. Do not allow trench water, animals, or foreign material to enter the pipe.

10. Keep the trench dry until the pipelaying and jointing are completed.

G. Backfill Compaction

1. Unless otherwise shown in the drawings or otherwise described in the specifications for the particular type of pipe installed, relative compaction in pipe trenches shall be as follows:

   a. Pipe Zone: 90% relative compaction.

b. Backfill in Trench Zone Not Beneath Paving: 90% relative compaction. Compact backfill within embankment above the pipe zone to the same relative compaction as the adjacent embankment as specified in Section 312300.

c. Backfill in Trench Zone to Street Zone in Paved Areas: 90% relative compaction.

d. Backfill in Street Zone in Paved Areas: 95% relative compaction.

e. Rock Refill for Foundation Stabilization: 80% relative density.

f. Refill for Overexcavation: 80% relative density.

2. Compact trench backfill to the specified relative compaction. Compact by using mechanical compaction, water jetting, or hand tamping. Do not use high-impact hammer-type equipment except where the pipe manufacturer warrants in writing that such use will not damage the pipe.

3. Compact material placed within 12 inches of the outer surface of the pipe by hand tamping only.

4. Do not use any axle-driven or tractor-drawn compaction equipment within 5 feet of building walls, foundations, and other structures.

H. Material Replacement

Remove and replace any trenching and backfilling material that does not meet the specifications, at the Contractor's expense.

END OF SECTION

SECTION 312323 CRUSHED ROCK BASE FOR STRUCTURES

PART 1 - GENERAL

A. Description

This includes materials, testing, and installation of gravel and crushed rock base for vaults, manholes, and ground wells.

B. Related Work Specified Elsewhere

1. General Concrete Construction: 030500.

2. Earthwork: 312300.

3. Grounding and Bonding: 260526.

C. Submittals

Submit six copies of a report from a testing laboratory verifying that material conforms to the specified gradations or characteristics.

D. Testing for Compaction

The Contractor will test for compaction or relative density as described in Section 312300.

PART 2 - MATERIALS

A. Crushed Rock

Crushed rock base shall conform to ASTM C33, coarse aggregate, size number 57. Durability Index shall be at least 40 per ASTM D3744.

PART 3 - EXECUTION

A. Placement of Crushed Rock

1. Place crushed rock or gravel base beneath structures where shown in the drawings, 12 inches thick unless otherwise indicated. Excavate below the required grade for the bottom of the structure and refill with crushed

rock as specified above. The rock base shall extend a minimum of 6 inches beyond the ground well.

2. Compact base to 80% relative density.

3. Place base material in maximum lifts of 8 inches.

END OF SECTION

SECTION 321216 ASPHALT CONCRETE PAVING

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation of asphalt concrete pavement, aggregate base course, herbicide, prime coat, tack coat, seal coat, slurry seal, and restriping.

B. Related Work Specified Elsewhere

1. Earthwork: 312300.
2. Trenching, Backfilling, and Compacting: 312316.

C. Submittals

Submit six copies of a report from a testing laboratory verifying that aggregate material conforms to the specified gradations or characteristics.

D. Testing for Compaction

The Contractor will test for compaction as described in Section 312300.

E. Standard Specifications

Wherever reference is made to the Public Works Specifications such reference shall mean the Standard Specifications for Public Works Construction (SSPWC), 2003 edition.

F. Measurement and Payment

Include allowances for pavement removal in the lump-sum or unit prices bid for the work. No extra compensation will be made should the existing pavement sections vary from the conditions as listed or described.

PART 2 - MATERIALS

A. Asphalt Concrete Paving

Asphalt concrete paving shall conform to III-C2-AR-4000 as listed in Section 400-4 of the Public Works Specifications.

B. Aggregate Base Course

Aggregate base shall be crushed aggregate base as specified in Section 400-2 of the Public Works Specifications.

C. Tack Coat

Tack coat shall conform with Section 302-5.4 of the Public Works Specifications and shall be either AR1000 paving asphalt or Grade SS-1h emulsified asphalt.

D. Asphalt

Asphalt shall be viscosity grade AR 4000 or AR 8000. Asphalt content in the pavement shall be 5.5% to 6.0%.

E. Aggregate for Asphalt Concrete

Aggregate shall be in accordance with Section 400-1 of the Public Works Specifications.

F. Seal Coat

Seal coat shall be "Guardtop" as manufactured by Industrial Asphalt or equal.

G. Herbicide or Weed Killer

Use Gallery (Isoxaben) by Dow AgroSciences, Pre-M (Pendimethalin) by American Cyanamid Co., Surflan (Orizalin) by Dow Chemical, or equal.

H. Slurry Seal

Slurry seal shall be Type II per Section 203.5.3 of the Public Works Specifications.

I. Paint for Traffic and Parking Lot Striping and Marking

Provide rapid-dry or fast-dry paint per Section 210-1.6 of the Public Works Specifications.

PART 3 - EXECUTION

A. Pavement Removal

1. Initially cut asphalt concrete pavement with pneumatic pavement cutter or other equipment at the limits of the excavation and remove the pavement. After backfilling the excavation, saw cut asphalt concrete pavement to a minimum depth of 2 inches at a point not less than 9 inches outside the limits of the excavation or the previous pavement cut, whichever is greater, and remove the additional pavement.

2. Saw cut concrete pavement, including cross gutters, curbs and gutters, sidewalks, and driveways, to a minimum depth of 1-1/2 inches at a point 1 foot beyond the edge of the excavation and remove the pavement. The concrete pavement may initially be cut at the limits of the excavation by other methods prior to removal and the saw cut made after backfilling the excavation. If the saw cut falls within 3 feet of a concrete joint or pavement edge, remove the concrete to the joint or edge.

3. Make arrangements for and dispose of the removed pavement.

4. Final pavement saw cuts shall be straight along both sides of trenches, parallel to the pipeline alignment, and provide clean, solid, vertical faces free from loose material. Saw cut and remove damaged or disturbed adjoining pavement. Saw cuts shall be parallel to the pipeline alignment or the roadway centerline or perpendicular to same.

B. Pavement Replacement

1. Backfill, compaction, and the permanent paving, except for the final asphalt surface course, shall be complete at the conclusion of the project. The final asphalt surface course shall be 1 inch thick. Do not place final surface course until at least three months after traffic has been returned to the pavement. Place temporary striping after the base course of A.C. pavement has been completed in the same configuration as the existing permanent striping so that traffic can be returned to normal patterns. This striping shall be considered temporary and is the Contractor's responsibility to place and maintain.

C. Installation

Producing, hauling, placing, compacting, and finishing of asphalt concrete shall conform to Section 302-5 of the Public Works Specifications. Apply seal coat to all paving except open asphalt concrete.

D. Connections with Existing Pavement

Where new paving joins existing paving, chip the existing surfaces 12 inches back from the joint line so that there will be sufficient depth to provide a minimum of 1 inch of asphalt concrete. Dispose of waste material offsite. Tack chipped areas prior to placing the asphalt concrete. Meet lines shall be straight and the edges vertical. Paint the edges of meet line cuts with liquid asphalt or emulsified asphalt prior to placing asphalt concrete. After placing the asphalt concrete, seal the meet line by painting with a liquid asphalt or emulsified asphalt and then immediately cover with clean, dry sand.

E. Preparation of Subgrade

1. Excavate and shape subgrade to line, grade, and cross section shown in the drawings. The subgrade shall be considered to extend over the full width of the base course.

2. Scarify and cultivate the top 6 inches of subgrade when the subgrade consists of dry soils which are impervious to the penetration of water, soils which contain excessive amounts of moisture which may result in unstable foundations, soils which are nonuniform in character which may result in nonuniform relative compactions and subsequent differential settlements of finished surfaces, or when pavement is to be placed directly on the roadbed material.

3. After rough grading has been completed, when scarifying and cultivating are required, loosen the roadbed to a depth of at least 6 inches. Work the loosened material to a finely divided condition and remove rocks larger than 2 inches in diameter. Bring the moisture content to optimum by the addition of water, by the addition and blending of dry material, or by the drying of existing material. Compact the material to the specified relative compaction.

4. Uniform pervious soils that allow the immediate penetration of water or uniform impervious soils which will allow the penetration of water to a depth of at least 6 inches after the addition of a suitable wetting agent will not require scarifying and cultivating. When scarifying and cultivating are not required, bring the moisture content of the top 6 inches of the subgrade material to optimum by the addition of water at the surface, and compact the material to the specified relative compaction.

5. Remove soft material disclosed by the subgrade preparation, replace with aggregate base course material, and recompact.

6. Compact the top 6 inches of subgrade to 90% relative compaction.

7. The finished subgrade shall be within a tolerance of ±0.08 of a foot of the grade and cross-section shown and shall be smooth and free from irregularities and at the specified relative compaction.

F. Placing Aggregate Base Course

Place aggregate base course to a minimum thickness of 6 inches, unless shown otherwise in the drawings. Compact to 95% relative compaction. Install in accordance with Section 301-2 of the Public Works Specifications.

G. Compaction of Aggregate Base and Leveling Courses

Compaction and rolling shall begin at the outer edges of the surfacing and continue toward the center. Apply water uniformly throughout the material to provide moisture for obtaining the specified compaction. Compact each layer to the specified relative compaction before placing the next layer.

H. Applying Herbicide or Weed Killer

Apply weed killer or herbicide on base prior to placing pavement. Apply at the rate recommended by the manufacturer to control dawny brome grass, puncture vine, and plaintain. Apply from outside of curb to opposite outside of curb and for the full width of roadways and parking areas.

I. Placing Tack Coat

Apply tack coat on surfaces to receive finish pavement per Section 302-5.4 of the Public Works Specifications. Apply tack coat to metal or concrete surfaces that will be in contact with the asphalt concrete paving.

J. Placing Asphalt Paving

Place asphalt paving to a minimum thickness of the existing thickness plus one inch unless otherwise shown in the drawings. Install in accordance with Section 302-5 of the Public Works Specifications.

K. Compaction of Asphalt Concrete Paving

Compact until roller marks are eliminated and a density of 92% minimum to 98% maximum has been attained per ASTM D2041.

L. Applying Seal Coat

Apply fog-type seal coat at the rate of 0.05 to 0.10 gallon per square yard.

M. Surface Tolerance

1. Finished grade shall not deviate more than 0.02 foot in elevation from the grade indicated in the drawings. Slopes shall not vary more than 1/4 inch in 10 feet from the slopes shown in the drawings.

2. After paving has been installed and compacted, spray water over the entire paved area. Correct any areas where water collects and does not drain away.

N. Slurry Seal

Apply slurry seal per Section 302-4 of the Public Works Specifications.

O. Applying Paint for Traffic Striping and Marking

Apply in accordance with Section 310-5.6 of the Public Works Specifications.

END OF SECTION

SECTION 331300 DISINFECTION OF PIPING AND WELL

PART 1 - GENERAL

A. Description

This section includes materials and procedures for disinfection of water mains by the continuous feed method. Disinfect piping in accordance with AWWA C651, except as modified below.

B. Related Work Described Elsewhere

Pressure Testing of Piping: 400515.

C. Job Conditions

1. Discharge of chlorinated water into watercourses or surface waters is regulated by the National Pollutant Discharge Elimination System (NPDES). Disposal of the chlorinated disinfection water and the flushing water is the Contractor's responsibility. Dechlorinate the disinfection water such that the chlorine residual complies with California Regional Water Quality Control Board Order No. MRP R8-2003-0061, NPDES No. CA G998001.

2. Schedule the rate of flow and locations of discharges in advance to permit review and coordination with Owner and cognizant regulatory authorities: Regional Water Quality Control Board and County of San Bernardino. The allowable location of discharges is to the storm drain catch basin on Benson Avenue.

3. Use potable water for chlorination.

4. Submit request for use of water from waterlines of Owner 48 hours in advance.

PART 2 - MATERIALS

A. Liquid Chlorine

Inject with a solution feed chlorinator and a water booster pump. Follow the instructions of the chlorinator manufacturer.

B. Calcium Hypochlorite (Dry)

Dissolve in water to a known concentration in a drum and pump into the pipeline at a metered rate.

C. Sodium Hypochlorite (Solution)

Further dilute in water to desired concentration and pump into the pipeline at a metered rate.

D. Chlorine Residual Test Kit

For measuring chlorine concentration, supply and use a medium range, drop count, DPD drop dilution method kit per AWWA C651, Appendix A. Maintain kits in good working order available for immediate test of residuals at point of sampling.

PART 3 - EXECUTION

A. Continuous Feed Method for Pipelines

Introduce potable water into the pipeline at a constant measured rate. Feed the chlorine solution into the same water at a measured rate. Proportion the two rates so that the chlorine concentration in the pipeline is maintained at a minimum concentration of 50 mg/L. Check the concentration at points downstream during the filling to ascertain that sufficient chlorine is being added.

B. Disinfection of Valves, Blind Flanges, and Appurtenances

During the period that the chlorine solution or slug is in the section of pipeline, open and close valves to obtain a chlorine residual at hydrants and other pipeline appurtenances. Swab exposed faces of valves and blind flanges prior to bolting flanges in place with a 1% sodium hypochlorite solution.

C. Disinfection of Connections to Existing Pipelines

Disinfect isolation valves, pipe, and appurtenances per AWWA C651, Section 4.7. Flush with potable water until discolored water, mud, and debris are eliminated. Swab interior of pipe and fittings with a 1% sodium hypochlorite solution. After disinfection, flush with potable water again until water is free of chlorine odor.

D. Confirmation of Residual

After the chlorine solution applied by the continuous feed method has been retained in the pipeline for 24 hours, confirm that a chlorine residual of 10 mg/L minimum exists along the pipeline by sampling at air valves and other points of access.

E. Pipeline Flushing

After confirming the chlorine residual, flush the excess chlorine solution from the pipeline until the chlorine concentration in the water leaving the pipe is within 0.5 mg/L of the replacement water.

F. Bacteriologic Tests

Collect two sets of samples per AWWA C651, Section 5.1, deliver to a certified laboratory within six hours of obtaining the samples, and obtain a bacteriologic quality test to demonstrate the absence of coliform organisms in each separate section of the pipeline after chlorination and refilling. Collect at least one set of samples from every 1,200 feet of the new water main, plus one set from the end of the line and at least one set from each branch. At each connection to an existing pipeline, take two additional samples.

G. Repetition of Procedure

If the initial chlorination fails to produce required residuals and bacteriologic tests, repeat the chlorination and retesting until satisfactory results are obtained.

H. Test Facility Removal

After satisfactory disinfection, disinfect and replace air valves, restore the pipe coating, and complete the pipeline where temporary disinfection or test facilities were installed.

I. Piping to be Disinfected

Disinfect all piping except sewers and drainage piping.

J. Well Disinfection

Refer to AWWA C654 for procedures for disinfection of the well and pump and for bacteriologic sampling and testing. Treat the full well depth 900 feet below ground surface.

END OF SECTION

SECTION 331620 PRESTRESSED CIRCULAR CONCRETE RESERVOIRS

PART 1 - GENERAL

1.01 DESCRIPTION

This section describes materials and construction of prestressed circular concrete reservoirs. Contractor may select either a concrete roof or aluminum geodesic dome.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. General Concrete Construction: 030500.

B. Leakage Testing of Hydraulic Structures: 030510.

C. Ladders, Stairs, and Stair Nosings: 055100.

D. Handrails and Safety Chains: 055200.

E. Grating, Cover Plates, and Access Hatches: 055300.

F. Painting and Coating: 099000.

G. Aluminum Geodesic Domes: 133310.

1.03 DESIGN INFORMATION

		Data
1.	Nominal capacity	3 MG
2.	Maximum water depth for overflow (above floor at wall)	37 feet, diameter = 118 feet
3.	Free-board below top of wall to high water level	3 feet
4.	Backfill height (above floor at wall)	20 feet (see drawings)
5.	Equivalent liquid backfill pressure (static--at rest)	0 psf at F.G., 60 x H psf at reservoir bottom
6.	Equivalent liquid backfill pressure (dynamic) on wall (add to static pressure)	0 psf at F.G. and bottom 10 x reservoir H applied at 0 H
7.	Downward drag coefficient of backfill on wall	0.30

		Data
8.	Soil bearing capacity (net)	3,000 psf
9.	Seismic: Per AWWA D110, including Section 4	S_s = 1.508 S_1 = 0.605 S_{ds} = 1.005 S_{d1} = 0.605 I = IV

1.04 BID-SUBMITTALS RESPONSIVENESS

The following items shall be included in the bid documents:

A. The Prestressed Concrete Tank shall be constructed by a single Tank Contractor experienced in the construction of circumferentially prestressed cast-in-place concrete tanks utilizing freed neoprene bearing pad connections at the base of the wall, PVC waterstops, seismic cables spanning the wall to footing joint, and a column supported flat slab roof.

B. Written statement that the tank constructor has successfully completed at least three circumferentially strand wrapped prestressed Type 1 concrete tanks 2 MG or larger in the last 10 years. The referenced three tanks shall have Type 1 corewalls. Experience with tank construction having other than what is indicated in the drawings shall not be considered. All tanks listed for the experience requirements must have been built in the tank constructor’s own name or one of its divisions. At least two of the tanks shall have been in successful service for a minimum of five years.

C. The name and address of the tank constructor, if different than the prime bidder or General Contractor.

D. The name of the General Contractor's proposed superintendent who will be in direct charge of the project for the full duration of the contract and the name, of the proposed tank subcontractor's superintendent who will be in direct charge of the reservoir construction.

The proposed tank construction superintendent shall be currently employed by the qualified tank constructor and shall have been the tank construction superintendent on no less than two strand-wrapped prestressed concrete tanks during the last ten years. The tank superintendent shall have been under the direct employment of the tank constructor for both tanks listed and will be required to be on the project site full-time and in responsible charge during all tank concrete construction activities.

E. The tank constructor may subcontract the tank design and tank prestressing operations to a prestress tank designer and prestressor who meets the experience requirements of this section for performing tank design and prestressing operations.

F. The prestress Tank Designer shall have in its employ a professional design engineer who shall have designed a minimum of 5 AWWA D110 Type I prestressed tanks located within a region with a mapped spectral response acceleration, Ss, of 1.0g or greater.

G. The Tank Contractor or Tank constructor’s listed Tank designer and Prestressor shall have successfully completed prestressing activities, as specified herein, on a minimum of 10 prestressed concrete tanks, greater than or equal to 2 million gallons in size, used for potable water storage in the last 10 years. At least 5 of the above tanks shall have been in successful service for a minimum of five years. Experience gained on work not meeting all of the technical requirements of this specification will not be considered for meeting the necessary experience requirements.

H. Descriptive literature of the strand wrapping, vertical prestressing (and/or metal diaphragm), and shotcrete machinery to be used that meets these specifications. Literature shall include actual printouts or other records of applied wrapping force recordings (as well as force elongation diagrams, if available) taken from projects on which the proposed prestressing equipment and systems have been used.

I. A written statement from the tank prestressor indicating that the prestressor has a minimum of two operable strand-wrapping and automated shotcrete machines meeting these specifications.

1.05 SUBMITTALS AFTER AWARD OF CONTRACT

A. Provide submittals in accordance with the General Provisions and Section 013300.

B. Set of reservoir design calculations and drawings indicating the procedures to be used and the ability of the proposed reservoir to resist loads specified. The reservoir design calculations and drawings shall be signed and stamped by a civil or structural engineer registered in the state of California who has at least five years of experience in the design of the type of reservoir specified. Said engineer must be under the full-time employment of the reservoir General Contractor or the subcontractor performing the tendon wrapping and stressing operations. Submit a list of at least three prestressed concrete reservoirs completed in the last five years and stamped and signed by said engineer.

C. Detailed construction drawings prepared by the Contractor shall include:

1. Scaled dimensional drawings.

2. Accessory list with fabrication details.

3. Erection drawings.

4. Catalog cuts and description of standard manufactured items.

5. Location, size, and anchorage of vertical and circumferential prestress reinforcement.

6. Prestress forces including initial, temporary, final, and related losses.

D. Provide documentation relative to concrete reservoir work as may be specified elsewhere in the construction specifications.

E. Concrete that comes in direct contact with potable water shall include the following:

1. Cement and admixtures shall be NSF/ANSE 61 certified.

2. Aggregates shall be tested and approved by one of the following methods:

a. Provide test cylinders using the proposed mix designs for concrete that comes in direct contact with potable water and test as a Barrier Material per Chapter 5of NSF/ANSE 61-

2005. Concrete shall be tested for all CA Title 22 radionuclides listed in Table 64442.

b. Gross alpha radionuclides testing of the dry aggregates using test procedures acceptable to the California Department of Public Health.

3. If NSF/ANSI 61 certified cement and admixtures are not available the following testing procedure shall be required:

a. Provide concrete test cylinders for each mix design that will come in contact direct with potable water to an approved testing laboratory.

b. Concrete specimens shall be soak-tested to verify water quality is in compliance with NSF/ANSI 61-2011 Chapter 5-Barrier Materials. Concrete specimens shall be tested for the items listed in NSF/ANSI 61 Table 3.1-Portland and Hydraulic Cements.

4. Testing shall be conducted by an ANSI or ELAP accredited product certification body for Drinking Water Quality.

F. Mill certificates that prestressing strand comply with these specifications.

G. Stress-strain curves and physical properties of the vertical prestressed reinforcing identified specifically for this project.

H. Submittals for admixtures proposed for use in the concrete reservoir walls.

I. Certificate of compliance with AWWA D110 as modified herein.

J. Submit evidence to the Owner’s Representative, prior to the preparation of shop drawings and installation of vertical tendons, that the proposed tendon anchorage system meets the requirements of these specifications. Should such anchorage systems not meet the specifications, the Owner’s Representative may order anchorage tests to be made. Such testing expenses shall be paid by the Contractor.

1.06 BASIS OF DESIGN

A. The prestressed concrete reservoir shall conform to the dimensions and be equipped with the appurtenances shown in the drawings and shall consist of cast-in-place concrete floor. The cast-in-place concrete core wall shall be post-tensioned vertically with steel rods and circumferentially with wrapped strand and protected with shotcrete and specified coatings.

B. Roof and Roof Supports:

1. Design flat roofs with drop panels in accordance with ACI 318. Roof designs that incorporate post-tensioning, precasting, dome, flat slab without drop panels, or waffle-type structures will not be considered.

2. Concrete roof shall be two-way flat slab poured-in-place reinforced concrete. The roof shall incorporate drop panels and shall be supported by circular spiral-reinforced concrete columns, as indicated in the drawings.

3. The concrete cover over column ties or spiral reinforcing in columns shall be 1.5 inch nominal with a ±1/4-inch construction tolerance.

C. Wall:

1. Walls shall be cast-in-place reinforced concrete. Do not use precast or shotcrete walls.

2. Wall-to-Wall Footing Connection: Support walls by solid neoprene bearing pads allowing free radial movement of the wall relative to the wall footing. Tie the walls circumferentially to the wall footing with seismic cables consisting of hot-dipped galvanized strands encased in closed-cell sponge rubber sleeves permitting a radial free movement of the wall of at least 3/4 inch. Provide a 9-inch by 3/8-inch PVC center bulb water stop connection between wall and wall footing.

3. Wall-to-Roof Connection – Either:

a. Coordinate the aluminum dome roof with the dome roof manufacturer’s anchorage requirements. Provide an elastomeric sealant between wall and roof as indicated in the drawings, or:

b. Support the flat slab roof by solid neoprene bearing pads allowing free radial movement of the wall relative to the roof or vice versa. Provide an elastomeric sealant between wall and roof as indicated in the drawings.

4. Seismic Forces: Calculate forces and moments resulting from water sloshing and seismic accelerations of roof, wall and water loads in accordance with AWWA D110, ASCE 7-05 ACI 350.3.

5. Bearing Pads:

   a. Support reservoir walls around the circumference of the reservoir by neoprene bearing pads of the size and thickness indicated in the submitted drawings. Use neoprene sponge-rubber filler pads to seal the reservoir between the bearing pads.

   b. The minimum pad thickness under reservoir walls shall be 1 inch or as determined per dome roof requirements, or 1/2 inch under a roof slab.

   c. The minimum total neoprene pad width under reservoir walls shall be 3 inches.

   d. Loads transmitted through neoprene pad areas shall account for all vertical and horizontal forces.

   e. Base neoprene pad sections on continuous loading values not to exceed those allowed in the neoprene design manuals.

   f. Fill voids remaining between wall and wall footing and between wall and roof, not filled completely with solid neoprene pads, with closed-cell neoprene sponge-rubber pads and soft mastic to ensure a substantially unrestrained free movement of wall and roof.

6. Minimum final circumferential prestressing force for water load at the bottom of the wall shall be:

   Pcw = 62.5 (R) (H)   (lbs/ft of height)

   in which:

R = inside radius of wall (feet).

H = maximum overload water height (feet).

This force shall taper uniformly to zero at the top of the maximum overflow water height.

7. Minimum final circumferential prestress for differential temperature and dryness bending (Pctd) at any height on the wall, for aboveground wall conditions (per these specifications), shall be 200 psi over the water load and after deduction of all losses. This compression may taper to zero at a distance 6 feet below the minimum backfill height.

8. Minimum Circumferential Backfill Force on Wall (Pcb):

   Pcb = (h) (p) (R + 0.0833 t) (lbs/ft of height)

   in which:

   R = inside radius of wall (feet).

   h = height of soil above wall-footing (feet).

   p = equivalent liquid backfill pressure (lbs/C.F.) under seismic loading.

   t = total wall thickness including cover over prestressing wires (inches).

9. The minimum "final" vertical compression and the vertical prestressing force (Pvtd) for poured-in-place walls, at any point around the reservoir wall, shall be no less than the amounts (Pctd) calculated herein. The total vertical post-tensioning (200 psi x Ag at wall) shall be applied prior to the circumferential prestressing.

10. Maximum final stress in circular and vertical prestress steel (fse) shall not be less than the maximum allowable initial stress of 0.75 minimum ultimate strength (±1.5% MUS) less 25,000-psi stress losses.

11. Minimum initial-to-final stress ratio (I.F. ratio) is the value of the not-to-be-exceeded initial steel stress divided by the value of the final steel stress as defined herein.

D. Maximum Compressive Stress in Concrete Walls: The maximum compressive stress in concrete walls, under any combination of load conditions, at any stage during the construction, and without any allowance for stress losses due to creep of steel and concrete or due to elastic deformation or concrete shall not exceed 0.55 f'c.

1. Minimum Total Overall Wall Thickness: The minimum overall wall thickness shall be no less than the value calculated below:

$$t_{overall} = \frac{[(\text{I.F. Ratio}) \times (Pcw + Pctd)] + Pcb}{(0.55\ f'c) \times (12)}$$

2. Bottom edge restraint reinforcing for cast-in-place walls prestressed vertically with threadbar tendons shall be reinforced on the inside bottom of the reservoir wall with No. 5 bars, having a length not less than 40% of the wall height and spaced 18 inches maximum on centers.

E. Wall Footing:

1. The circumferential wall footing reinforcing shall have a minimum total cross-sectional area no less than 0.5% of the wall footing section excluding any reinforcement requirements for tension forces due to water loads.

2. Tension forces caused by liquids acting on wall footings shall be taken fully by reinforcing steel in the radial and circumferential direction at steel stresses not exceeding 18,000 psi. No value shall be given to radial friction resistance effects of soils on footings.

3. Hinged or fixed wall-to-wall footing connections shall not be considered.

4. Radial and circumferential bar sizes shall not exceed 3/4 inch in diameter.

5. Stagger splices in parallel bars to avoid more than one splice at any point around the circumference of the wall footing.

6. Install water stops (6 inches by 3/8 inch)in radial construction joints in the floor and wall footings and connect and seal to the circumferential water stop

connecting the wall-to-wall footing. The wall footing may be poured monolithically with the floor. Circumferential joint water stop between the floor slab and ringwall footing shall be continuous and connected to radial water stop when the footing is cast over the floor slab or circumferentially adjacent.

7. The minimum width of the wall footing shall be 4 feet. The minimum thickness shall be 18 inches.

F. Floor:

1. The floor shall be no less than 6-1/2 inches thick.

2. The cross-sectional area of steel provided for floor reinforcing in each direction shall be no less than 0.5% of the nominal floor cross-sectional area with a maximum bar spacing of 12 inches. Floor thicknesses in excess of 8 inches shall have two mats of reinforcing with the bottom mat being at least 3 inches clear to subgrade.

3. Do not post-tension floor slab.

G. Column Footings:

1. Column footings shall be cast with or project above the floor slab. The minimum size of column footings shall be 4 feet by 4 feet.

2. Footing reinforcing steel added to the floor reinforcement shall be evenly spaced and staggered to the normal slab reinforcing.

H. Prestressing System:

1. No stressing system will be considered unless it has been successfully used on reservoirs of similar size and capacity.

2. Vertical wall prestressing tendons shall be 1.25-inch or 1.375-inch-diameter thread bars, with screw nut anchors.

3. Circumferential prestressing of reservoir walls shall be done with hot-dipped galvanized strand.

4. Circumferential wrapping forces applied on strand shall be continuously electronically monitored and

permanently recorded while the steel is being wrapped. Die-drawing of prestress reinforcement will not be permitted.

5. Vertical tendon forces and elongations shall be electronically monitored and permanently recorded from beginning to end of each stressing operation.

6. Do not base reservoir wall design on wrapping tolerances greater than what the wrapping machinery can continuously meet based upon electronically recorded data taken from previous projects.

7. Do not space wrapped strands in any vertical layer closer than 2.5 strand diameters or less than 3/8-inch clearance between individual strands, whichever offers the greatest clearance between strands.

8. Cover each interior strand layer with shotcrete of 0.375-inch thickness.

9. The minimum cover over the final strand layer shall be 1.5 inches.

10. The horizontal distance between vertical prestressing tendons shall not exceed 50 inches.

11. Do not consider circumferential reservoir wall systems based on cable- or rod-type tendons involving the circumferential movement of prestressing steel relative to the wall surface. Do not consider systems utilizing strand cables placed inside ducts that are incorporated circumferentially in the core wall or placed manually around the exterior of the core wall.

I. Anchorage for Vertical Posttensioned Tendons:

1. Secure posttensioned prestressing at the ends by means of permanent anchoring devices that shall hold the prestressing steel at a force not less than 95% of the guaranteed minimum tensile strength of the prestressing steel.

2. Distribute load from the anchoring devices to the concrete through steel bearing plates.

3. Use fully threaded anchor connections at each end of the vertical prestressing tendon which incorporates a

spherical-shaped bearing surface which matches the conical bearing surface in the bearing plate.

4. The contact point of the spherical-shaped vertical prestressing bearing surface to conical hole shall be approximately 1/4 inch to 1/2 inch below the bearing plate surface.

5. Do not use wedge anchors for permanent tendon anchor hardware.

J. Anchor Pockets for Vertical Tendons:

1. Form anchor pockets for vertical prestressing tendons with permanently emplaced hot-dipped galvanized cylinders welded securely to the top bearing plate.

2. Seal anchor pockets from moisture and concrete intrusion during concrete activities with wooden plugs and plastic tape.

3. Anchor pockets for vertical prestressing tendons must have provisions to allow flushing of ducts with water during concrete placement.

PART 2 - MATERIALS

2.01 CONCRETE ADMIXTURES

A. Do not use admixtures containing chlorides, fluorides, sulfides, or nitrates in any concrete mix for prestressed concrete reservoirs.

B. Do not use air-entraining admixtures in concrete mix Class PA.

2.02 CONCRETE MIX DESIGN

A. Conform to Section 030500 except as modified herein.

B. The maximum water-cement ratio for Classes PA and PB concrete shall be 0.42 by weight.

C. Use classes of concrete as described in the following table:

Class	Type of Work	Minimum 28-Day Compressive Strength (in psi)	Minimum Cement Content (lbs/C.Y.)
PA	Prestressed reservoir walls	5,000	564
PB	Prestressed reservoir roof slab and columns	4,000	564
PS	Shotcrete	5,000	1c:3s
A	All other concrete	4,000	Section 030500

D. Slump shall be as follows:

1. Prestressed Reservoir Walls, Roof Slab and Columns: 6 inches maximum.

2. Shotcrete: 5 to 8 inches.

3. Other Concrete: See Section 030500.

2.03 SHOTCRETE

A. Shotcrete shall be composed of portland cement, sand, and water applied as a "wet mix" to the reservoir walls.

B. Cement shall be in accordance with Section 030500.

C. Do not use admixtures containing chlorides, fluorides, sulfides, or nitrates.

D. Coarse sand shall conform to the following requirements:

Sieve Size	Percent Passing By Weight
3/8 inch	100
No. 4	95 to 100
No. 8	80 to 90
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

1. The fineness modulus shall fall between 2.70 and 3.00 per ASTM C136.

2. Use plaster sand for finish coatings where smooth surfaces are required. Plaster sand shall meet the following gradation:

Sieve Size	**Percent Passing By Weight**
3/8 inch	100
No. 4	97 to 100
No. 8	90 to 98
No. 16	70 to 85
No. 30	35 to 55
No. 50	15 to 25
No. 100	2 to 8

3. The sand shall have a fineness modulus of no less than 2.40 or more than 2.75.

E. Shotcrete testing shall conform to the cylinder testing requirements of Section 030500.

F. If necessitated by warm weather, up to 50 ounces per cubic yard of a retarder may be added. Retarder shall be Pozzolith 300R or equal.

G. Rebound materials may not be reused.

H. Water shall meet the requirements set out in Section 030500.

I. Fibrous Shotcrete Reinforcement:

1. Shotcrete, unless otherwise specified herein, shall be fibrous reinforced. Such material shall consist of 100% virgin polypropylene non-fibrillated fibers specifically manufactured for use as concrete/shotcrete secondary reinforcement. The required volume of fibers to be added per cubic yard of shotcrete shall be as specified in the subsection on “Shotcrete Proportioning” of these specifications.

2. Polypropylene fibers shall provide maximum control of cracking from drying shrinkage and thermal

expansion/contraction and added toughness of the shotcrete.

3. The fibers shall be manufactured in accordance with applicable building codes and ASTM C1116, Type III 4.1.3 and ASTM C1116 (Ref. ASTM C1018) Performance Level I_5 outlined in Section 21, Note 17. Fibrous concrete reinforcement shall be as manufactured by the Fibermesh Company, Chattanooga, Tennessee, or equal.

4. Acceptable polypropylene fibers shall have the following physical characteristics:

   a. Specific Gravity: 0.91.

   b. Tensile Strength: 80 to 110 ksi.

   c. Fiber Length: Graded per manufacturer.

2.04 SHOTCRETE PROPORTIONING

A. Each cubic yard of shotcrete mortar as delivered to the site or site mixed shall consist of 0.1% (1.5 pounds per cubic yard) polypropylene fibers with a mix ratio of 3 pounds of moist sand to 1 pound of portland cement. Up to 50 ounces of PRO-KRETE-R or POZZOLITH 300R may be added at the option of shotcrete applicator during warm weather conditions.

B. When night temperatures are expected to drop below 35°F, high early strength portland cement shall be used in lieu of regular portland cement. Should high early strength portland cement not be available, the mix design shall consist of a moist sand-portland cement mix ratio, by weight, no greater than 2.59.

C. If the batching procedures require smaller volumes of cement and sand be used, the required cement-to-sand ratio shall still be adhered to.

D. Additives other than PRO-KRETE-R or POZZOLITH 300R (such as POZZOLITH 300N or others) shall not be used unless reviewed by the Owner’s Representative.

E. If used, the total volumetric air content of the shotcrete before placement shall not exceed 7% ±1%, as determined by ASTM C173 or ASTM C231.

F. Unless otherwise shown in the drawings, shotcrete cylinder strengths at 28 days shall be no less than specified. Higher shotcrete cylinder strengths shall not permit a reduction in the specified cement content. The cement content in the mix designs may be increased should the specified 28-day strength requirement not be met.

G. The polypropylene fibers and admixtures shall be added to the shotcrete at the time it is batched and in the amounts specified. Additives shall be mixed in strict conformance to the manufacturer’s instructions and recommendations for uniform and complete distribution. Each certificate of delivery supplied by the shotcrete supplier shall indicate the additive trade name, manufacturer’s name, and amount per cubic yard added to each batch of shotcrete.

2.05 PRESTRESSING STRANDS AND SEISMIC CABLES

A. Galvanized seven-wire prestressing strands and seismic cables shall conform with ASTM A416 except as modified:

Nominal strand diameter	3/8 inch
Nominal area after galvanizing	0.089 square inch
Nominal weight/1,000 L.F.	303 pounds
Ultimate tensile strength	21,400 pounds (min)
Yield strength at 1% extension	16,000 pounds (min)
Elongation in 24 inches at fracture	4.5% (min)
Weight of zinc coating	0.85 ounce/square foot (min)
Pitch	12- to 16-strand diameter

B. Store and protect strands from water, rain, moisture, and foreign material prior to use.

2.06 VERTICAL PRESTRESSING BARS

A. Use high-strength threadbars with deformations and screw threads over the entire length of the bars, suitable for mechanical coupling and attachment to anchor assemblies, and anchor nuts with circular ball-shaped face. Anchor nut shall provide a vent for grouting.

B. Bars shall conform with ASTM A722, Type II and shall meet the following requirements:

Item	Unit	Specification*	
Nominal diameter	inches	1.25	1.375
Minimum tensile force	kips (min.)	187	225
Yield force at 0.2% offset	kips (min.)	150	190
Elongation in 20 bar (diameter)	% (min.)	4	4
Nominal cross-sectional area	square inches	1.23	1.48
Nominal bar weight	lbs/ft	4.17	5.04
Minimum ultimate strength	ksi	150	
*Contractor to select value based on seismic design requirements.			

Only threadbars which are stress relieved after the threads are formed will be accepted. Threadbars shall be proof stressed after stress relieving and threading. Threadbars shall have a maximum carbon content of 0.55%.

C. Bar sizes shall be as indicated in the reviewed calculations.

D. Anchorage plates for vertical prestressing bars shall conform with ASTM A36. The anchor plates shall have a hole with a conical shape at the top of the hole to receive shaped anchor nut.

E. Protect bars during shipping and storage.

F. The threadbars and their deformations shall be hot rolled. Threadbars manufactured with quenched and tempered steels will not be accepted.

2.07 TESTING OF PRESTRESSING MATERIAL

A. The Contractor shall furnish at his own expense mill test certificates showing the dimensional and physical characteristics of each size, heat, or reel of the prestressing steel.

B. Contractor shall furnish evidence to the Owner's Representative, prior to the preparation of shop drawings and installation of vertical tendons, that the proposed tendon anchorage system meets the requirements of these specifications. Should such anchor systems not meet the specifications, the Owner's Representative may order anchorage tests to be made. Such testing expenses shall be paid for by Contractor.

C. Prior to stressing operations, the prestressor shall calibrate recording equipment at an approved testing laboratory to the satisfaction of the Engineer.

D. Continuous force readings for either the vertical or the circumferential prestressing operations shall be developed with electronic or the substantial equivalent strain gauge method force sensing transducers which have a maximum nonlinearity error of ±0.5% and a maximum hysteresis error of ±0.25%.

2.08 CIRCUMFERENTIAL PRESTRESSING EQUIPMENT

A. The circumferential stressing system used shall produce a continuously, electronically (or substantially equivalent) monitored permanent stress or force record along the full length of the strand as it is being applied. The stress variation in any strand at any point around the circumference shall not be greater than ±1.5% of the ultimate strength of the steel. In addition to this record, a system which deflects the tensioned prestressing material between the tensioning device and the wall, after it has left the tensioning device, shall provide a similar continuously monitored stress or force record along its full length as it is being applied to the wall. The recordings shall show that either before or after deflection, the stress variation in the prestressing material at any point around the circumference shall not be greater than ±1.5% of the ultimate strength of the steel.

B. No manually recorded readings will be accepted.

2.09 WATER STOPS

A. Floor Construction Joints: Minimum 3/8-inch by 6-inch water stop with center bulb.

B. Wall-to-Wall Footing Connections: Minimum 3/8-inch by 9-inch water stop with a 3/4-inch-minimum center bulb.

C. Vertical Wall Joints: Minimum 3/8-inch by 6-inch water stop without a center bulb.

D. Water stops shall meet the requirements specified in Section 030500.

2.10 NEOPRENE BEARING PADS

A. Design neoprene bearing pads considering bearing stress, radial wall movement, and shear deflection.

B. Material for the pads shall conform to ASTM D2000 M2BC414A14C12F17 for 40 durometer neoprene pads, ASTM D2000 M2BC310A14C12F17 for 30 durometer neoprene pads, and M2BC517A14C12F17 for 50 durometer neoprene pads.

2.11 CLOSED-CELL NEOPRENE FILLER PADS

Filler pads shall be soft grade conforming to 2A3 of ASTM D1056.

2.12 SEISMIC CABLE SLEEVES

A. Cable sleeves shall be medium-grade closed-cell neoprene conforming to 2A3 of ASTM D1056 and the following:

Compression deflection	9 to 13 psi
Shore 00 durometer	60 to 80 psf
Density	12 to 28 psf
Water absorption by weight	5%
Temperature range	
Low (flex without cracking)	-30°F
High continuous	150°F
High intermittent	200°F
Compression set (average) 1/2-inch sample compressed 50% for 22 hours at 70°F and 24 hours recovery	15% to 25%
Lineal shrinkage (max.) during heat aging (seven days at 158°F)	5%
Tensile strength	115 psi min.
Elongation	180% min.
Resilience (bayshore-% rebound average 1/2-inch thickness at 72°F)	20% to 40%

B. Material shall be Rubatex R431N or R423N or equal.

2.13 DUCTS FOR VERTICAL TENDONS

A. Duct enclosures for vertical prestressing steel shall be standard 1.25- or 1.375-inch-diameter PVC pipe, Class 160, for 1-1/4-inch-diameter tendons, and 1-1/2-inch-diameter PVC pipe, Class 200 for 1-3/8-inch-diameter tendons, unless otherwise specified in the drawings.

B. Provide ducts with expandable valves to facilitate the injection of epoxy after prestressing.

2.14 EPOXY GROUT FOR VERTICAL TENDONS

A. Epoxy grout shall be a two-part epoxy system that will completely encase and protect the prestressing steel inside ducting and anchors.

B. Do not use portland cement grout.

2.15 ACCESSORIES

A. Pipe Connections:

1. Install and encase piping as indicated in the drawings.

2. Locate piping connections as shown in drawings.

B. Overflow: Circular weir inlet and overflow pipe dimensions as shown in drawings.

C. Ladders: See Section 055100.

D. Roof Hatches: See Section 133310.

E. Roof Vent: The roof vent shall be as shown in drawings with removable stainless steel insect screen.

2.16 HANDRAIL

See Section 055200.

2.17 PAINT AND COATINGS

A. Coat exterior walls below grade using Select Shield 300A, Carboline Bitumastic, Select Products Company, or equal.

B. Coat exposed roof areas with Type II asphalt meeting the requirements of ASTM D449, Type II and clean 3/8-inch pea gravel.

PART 3 - EXECUTION

3.01 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Package prestressing steel against intrusion of chemical, dirt, moisture, or other contaminants from the atmosphere and for the protection of the steel against physical damage and corrosion during shipping and storage.

B. Prestressing steel that has sustained physical damage through rust or otherwise will be rejected.

C. Store materials and prestressing material delivered to the jobsite off the ground and wrap with polyethylene or sisal-kraft paper to prevent any moisture from coming in contact with the materials.

D. Neatly stack reels of strand, prestressing tendons, anchorages, etc.

3.02 CONCRETE FORMWORK

A. Do not form beveled edges (chamfer) at the vertical joints in the exterior wall of the reservoir.

B. Comply with the following tolerances or allowable deviations for the circular reservoir exterior wall:

Vertical alignment in total wall height	±1/2 inch
Out-of-round (per 100 feet of diameter)	±1/2 inch
Horizontal gap between prestressing strand and wall surface (in 24 inches)	3/8 inch

Transitions from plus to minus tolerance shall be gradual, even, and smooth.

C. Form ties left in walls shall have water stops and a 1-inch-minimum breakback or cone depth. Do not break snap ties until the concrete has reached the design concrete strength. Do not use tie wires as form ties. Do not use snap ties that are designed so that the ends must be broken off before the forms can be removed. Fully threaded stub bolts may be used in lieu of smooth ties with water stops. Taper ties with plastic or rubber plugs of a proven design may be used.

D. Fill taper form tie holes that extend through the reservoir wall as follows:

   1. Locate large end of taper tie on the "wet" side of the wall.

   2. Sandblast or roughen tie rod hole and blow clean prior to filling.

   3. After sandblasting and cleaning, drive rubber plug with one end open to the center of the hole. Plug size shall be larger in diameter than the diameter of the hole at the center of the wall.

   4. Coat entire annular surface of the hole with epoxy prior to dry-packing of the holes. Apply epoxy in accordance with manufacturer's instructions.

   5. Dry-pack each side of hole with cement mortar consisting of one part cement well mixed with one part sand by volume and only sufficient water such that mortar will ball together when molded by slight pressure of the hands. Apply dry pack to the "wet" side of the wall first prior to dry-packing dry side. Pack into the hole with tool.

   6. Cure dry-pack surfaces. Coat the "wet" side of the dry pack with epoxy coating.

E. The wall form design shall allow wall sections to be poured full height without creating horizontal cold joints. Form ties shall be of sufficient strength and number to prevent spreading of the forms during the placement of concrete and shall permit ready removal of the forms without spalling or damaging the concrete.

F. Concrete placement in walls shall be done only through pour openings in the wall forms and may not be poured from the top through the use of "elephant trunks" or tremies. Either erect the complete form on one side of the wall and erect the form on the other side of the wall while the concrete placement is in progress, or remove pour panels from either the inside or outside form assembly before concrete placement starts. The vertical distance between horizontal rows of openings shall not exceed 8 feet with the lowest row of openings being no higher than 2 feet from the bottom of the wall. The minimum pouring opening size shall be 24 inches by 18 inches.

G. Forms may be removed as soon as the concrete has developed sufficient strength to prevent sagging, misalignment, spalling, cracking, or breaking of edges of the concrete. Do not remove wall forms prior to 12 hours after completion of the wall concrete placement.

3.03 CONCRETE JOINTS AND WATER STOPS

A. Concrete joints shall conform to Section 030500 and as specified herein.

B. Splice water stops at intersections between wall, wall footing, roof slab, and floor slab water stops.

C. Bend up horizontal water stops during placing of concrete until the concrete has been brought to the level of the water stop. Then place additional concrete over the water stop and vibrate the concrete.

D. Prior to installation of water stop, provide water stop regular splice and intersection splice samples with each type and size of water stop. Make splices in the presence of the Owner's Representative. Make splice samples by the workers designated to make field splices.

3.04 CONCRETE FINISHES

A. Finishes shall conform to Section 030500 except as modified herein.

B. Roof slab shall receive a steel trowel and light hair broom finish.

3.05 CONCRETE CURING

A. Cure concrete in accordance with the methods specified herein for the different parts of the work and described in detail in the following paragraphs. These methods are considered to be minimum for curing. The conditions that exist in the field during placement and curing may require additional curing procedures and efforts to ensure proper protection and curing of the concrete. Select and implement the appropriate method commensurate with climatic conditions.

B. Cure floor slab using Method 3 or 4 as specified below.

C. Cure exterior walls using Method 2 or 4 as specified below.

D. Cure roof slab using Method 3 or 4 a specified below.

E. Cure concrete for not less than 14 days after placing in accordance with the following methods:

1. Method 1, Water Spray Method: Tightly close off concrete surfaces to be cured by bulkheads or other means or entirely surround by tight enclosures, and keep the concrete surfaces moist by sprinkling, spraying, or other means.

2. Method 2, Wet-Burlap-Mat Method: Thoroughly wet and cover concrete surfaces to be cured with wet burlap mats as soon as the forms have been stripped or as soon as the concrete has set sufficiently to avoid marring the surface. Keep entire concrete surface and burlap continuously and completely wet during the entire curing period.

3. Method 3, Curing Blanket Method:

a. Thoroughly wet concrete surfaces to be cured and cover with curing blankets as soon as the concrete has set sufficiently to avoid marring the surface. The curing blankets shall be weighted to maintain close contact with the concrete surface during entire curing period. Should the curing blankets become torn or otherwise ineffective, keep surfaces moist and replace damaged sections. The curing blankets shall consist of one of the following two types:

(a) Sheets of heavy waterproof sisal-kraft paper laid with the edges butted together and with the joints between strips sealed with 2-inch-wide strips of sealing tape or with the edges lapped not less than 3 inches and fastened together with waterproof cement to form continuous watertight joints; or

(b) Sheets of clean polyethylene, having a minimum thickness of 4 mils, laid with edges butted together and with the joints between sheets sealed with 1-inch-wide strips of acetate tape.

b. During the curing period, do not permit traffic of any nature or depositing of objects, temporary or otherwise, on the curing blankets.

4. Method 4, Curing Compound Method:

a. Spray the surface with two coats of liquid curing compound. Apply in accordance with the manufacturer's instructions to cover the surface with a uniform film that will seal thoroughly. Apply second coat at 90 degrees to the first coat.

b. Apply curing compound immediately after completion of the finish on unformed surfaces and within two hours after removal of forms on formed surfaces. Repair formed surfaces within the said two-hour period; provided, however, that any such repairs which cannot be made within the said two-hour period shall be delayed until after Method 1, 2, or 3 has been applied. When repairs are to be made to an area on which curing compound has been applied, first sandblast the area to remove the curing compound, then repair.

c. Wherever curing compound may have been applied to surfaces against which concrete subsequently is to be placed and to which it is to adhere, remove the curing compound entirely by sandblasting prior to the placing of new concrete.

d. Where the curing compound method is used, exercise care to avoid damage to the seal during the curing period. Should the seal be damaged or broken before the expiration of the curing period, repair the damaged portions immediately by the application of additional curing compound.

3.06 SHOTCRETE PLACING, CURING, AND FINISHING

A. Surface Preparation: Exterior surfaces of the concrete core wall and dome ring (if any), which will receive strand wrapping, shall be abrasive blasted, regardless of the forming method used, by a mechanical etching or shotblast system combined with a vacuum recovery system, or a self-contained waterblasting system. Systems that have not been used successfully in the past to prepare circular reservoir wall surfaces for shotcreting and strand wrapping or systems that rely on sandblasting or steel shot without a vacuum system will not be allowed. The surface shall be abrasive blasted sufficiently to remove laitance, form oil, or other types of coatings. The surface shall be cut to a minimum CSP5 profile, as established by the International Concrete Repair Institute (ICRI), over a minimum of 90% of the surface being prepared as measured over any 1-foot-square area. The prestressing subcontractor who is performing the abrasive blasting shall make available to the inspector ICRI sample coupons to assist in evaluating the abrasive cut.

B. Placing:

1. Apply shotcrete using the wet mix process. Nozzles shall be mounted on power-driven machinery maintaining the nozzle parallel with and at right angle to the surface being sprayed. No manual application of shotcreting will be accepted except for repair work or architectural treatment. Start shotcreting at the bottom of the wall and progress around the reservoir wall before moving up the wall. Do not build up the shotcrete in front of the strands or reinforcing when applying shotcrete behind strands or reinforcing. The minimum shotcrete cover over the outermost wrapped strand shall be 1.5 inches.

2. Each layer of shotcrete shall have sufficiently set to eliminate sagging during application of the next layer.

3. Do not apply shotcrete if the wind velocity exceeds 5 mph or air temperature is less than 55°F.

4. Remove and replace shotcrete that is damaged by rain, wind, or frost.

5. Apply shotcreting in layers of approximately 3/8 inch to 1/2 inch in thickness until the total thickness has been obtained. Protect adjacent buildings, concrete surfaces, equipment, and vehicles during shotcrete application. Repair damage resulting from shotcreting operations.

6. The air capacity of the compressor shall be large enough that the minimum amount of air to be available at the nozzle shall be no less than 400 cfm, whether or not air from the same air supply is used for other purposes.

7. Deliver shotcrete materials to the jobsite in ready-mix trucks from batching plants. Job mixing will be accepted provided automatic weigh batch plants are used.

8. Shotcrete Covercoats Over Wrapped Strand:

   a. Cover each layer of wrapped prestressing steel with shotcrete until a minimum cover of 3/8 inch over the steel has been obtained.

   b. Apply the final covercoat in at least three layers of equal thickness to make up for the full thickness of shotcrete over the final strand layer.

   c. Complete each layer of shotcrete for the full circumference of the reservoir and substantially the full height of that layer before applying the next layer of shotcrete.

C. Finishing: The finished wall surface shall be a vertical plane with no undulations. Shotcrete transition from multilayer strand wrap to single-layer strand wrap near the bottom of the wall shall be gradual. Finish shall be natural gun finish.

D. Curing:

1. Intermediate shotcrete layers that will not receive subsequent layers of shotcrete for 12 hours or more shall be kept damp until application of the subsequent layers.

2. Completed shotcrete surfaces that do not receive additional coatings shall be water cured for a period of at least seven days by encapsulating the entire shotcrete surface with plastic sheeting. Lap and seal the plastic sheeting to properly cure the shotcrete. Do not use membrane curing methods utilizing curing compounds or wax-based residuals.

3.07 CIRCUMFERENTIAL PRESTRESSING

A. Stressing System: Prestress walls circumferentially by prestressing strand that is wound onto the wall at the uniform strand load required. Provide the stressing system with means to continuously, instantaneously monitor and record the force in the strand at any location around the wall and maintain the force in the strand within a tolerance of ±1-1/2% of the ultimate strength of the prestressing. No manually recorded force readings will be accepted. No die-drawing of prestressing reinforcement is permitted. Upon completion of the stressing operation, all recordings shall become the property of the Owner.

B. In the event that gaps between the core wall and the wrapped prestressing material develop that exceed 3/8 inch, discontinue wrapping and build up the wall with shotcrete to provide the proper curvature. Alternatively, if approved by the Owner’s Representative, the gaps may be dry-packed after wrapping is completed and before shotcreting is started.

C. Wrapping over intermediate shotcrete coats or built-up shotcrete areas may commence 12 hours after the shotcrete has been applied. The compressive stress applied to the mortar shall not exceed 80% of the compressive strength of the mortar at the time of wrapping.

D. Do not allow prestressing material exposed to excessive temperatures to increase by more than 50 degrees at any time during such application due to detrimental stress buildup or damage.

E. Application:

1. Do not start circumferential stressing until the concrete has reached a compressive strength of 3,000 psi. Under no condition shall concrete compressive stress exceed 55% of the concrete strength at the time of stressing. Wrapping over flash coats may commence 12 hours after the shotcrete has been applied providing that the shotcrete has reached a strength of 250 psi.

2. Anchor prestressing strand to the wall at least once for every reel to minimize the loss of strand in case of a strand break. Do not anchor one strand to a previously wrapped strand either temporarily or permanently. Join prestressed strands by splices that

will develop 95% of the guaranteed ultimate strength of the strand. Splice material shall be the same alloy as the prestressing strand.

3. The average vertical spacing between any two strands wrapped circumferentially and to be encased in shotcrete shall have a minimum clearance of 1-1/2-strand diameters or 3/8 inch, whichever is larger. Strands not meeting the spacing requirements shall be spread or otherwise removed.

4. Do not bundle or drape strand around pipe or manhole openings. Spread any strands falling in such areas over a predetermined area above and below such wall openings in conformance with the above strand spacing requirements.

5. Place strands wrapped near openings no closer than 2 inches from the exterior opening surface.

6. If the strand-wrapping load is different from the specified design load, discontinue stressing operations until adjustments are made to the stressing system.

7. Do not use prestressing strand and anchors as a ground for welding operations.

F. Final Force:

1. The initial electronically (or substantial equivalent) recorded steel stress shall not exceed 75% or less than 72% of the guaranteed minimum ultimate strength (M.U.S.) of the steel at any time during and after stressing.

2. An automatic, continuously electronically (or substantial equivalent) monitored permanent recording of the applied force, at any point on the wire, at any point on and around the reservoir wall, shall be made during the entire circumferential prestressing application. Such recordings shall be based on a continuous sensing of the applied force on the strand between the tensioning drum and the wall as the strand is being wrapped and laid on the wall. The loss in stress in post-tensioned prestressed steel due to creep and shrinkage of concrete, creep of steel, and sequence stressing shall be assumed as 25,000 psi. The final stress is the low initial stress of 0.72 M.U.S. reduced

by the stress loss of 25,000 psi. The final force is the steel section multiplied by the final stress. The final force shall be no less than the required working force required by design.

G. Force Readings: Manual, individual, or intermittent force readings taken on wrapped strand in full bodily contact with the wall will not be accepted. Force readings based on other than instantaneous force readings, as the strand is being tensioned and wrapped around the reservoir, will not be accepted. Calibrate recording equipment at an approved testing laboratory prior to starting the stressing operation.

H. Safety Precautions:

1. Every precaution shall be taken to keep personnel and visitors outside the danger area of breaking strands or bars.

2. At no time shall anyone stand in the line of stressed vertical tendons or stressed strand.

3. No work shall be performed by anyone, other than the prestressing crew, within 100 feet from the wrapping operation or the application of the vertical tendon stressing operation.

4. Where access to the site by unauthorized persons is outside the Contractor’s control while prestressing work is in progress, Contractor shall erect protective fencing to prevent breaking strand from endangering such persons.

3.08 VERTICAL PRESTRESSING

A. General: Bars shall have a top and bottom anchor plate, cone nut, and duct enclosure with 1/2-inch-minimum grout tube connectors. Securely fasten duct enclosures at maximum 2-foot intervals to prevent movement. Accurately locate bars as shown in the drawings. Vertical bar components shall be assembled off the ground surface. Maximum tolerance shall be ±1/4 inch. Seal ducts to prevent intrusion of concrete.

B. Epoxy grout the bars in the enclosure duct after completion of stressing operation.

C. Cleaning Ducts: Flush vertical ducts with water immediately upon completion of the concrete vibrating operation after each lift of concrete. This procedure shall continue until placing and vibrating of concrete around the ducts has been completed. Add water at the top of the wall, through the top of the duct, and drain through the bottom of the grout tube. Blow ducts clean with compressed air.

D. There shall be no welding to anchor plates after the bars have been assembled, nor shall prestressing steel be used as a “ground” for welding operations.

E. Stressing System:

1. Provide the stressing system with means to continuously monitor and record the force-elongation for each stressed bar. The system shall be calibrated by an independent laboratory prior to the start of stressing operations and submit reports to Owner's Representative.

2. The force-elongation relationship must be constantly maintained from the beginning, starting with the removal of the slack to the point of lock-off and complete release of the force on the vertical prestressing steel after retraction of the stressing piston or equivalent stressing device.

F. Stressing Operations:

1. Perform stressing in either one or two operations. Perform initial stressing after the concrete in the wall attains the design compressive strength as confirmed by cylinder tests.

2. If a double stress operation is used, perform the final stressing after wall shotcreting is complete and shotcrete attains a compressive strength of 250 psi.

3. Perform stressing operations in the presence of the Owner's Representative.

G. Stressing Equipment:

1. Provide a continuously electronically (or substantial equivalent) monitored permanent force elongation record from zero to full force at the final lock-off for the vertical prestressing work. The ordinate of the

permanent recording shall show the elongation in inches, and the abscissa shall show the force in pounds or kips. Manually recorded force and elongation readings will not be accepted. The vertical tendon stressing machinery shall have automatic electronic tensioning cutoff devices or equivalent means to ensure that the specified force and elongation is not exceeded at any time. The applied force, immediately after lock off for the final stressing operation on any tendon, shall be no less than 72%, and the applied force before lock off shall be no greater than 75% of the minimum ultimate strength of the steel.

2. Force-elongation readings during the vertical tendon stressing operation shall become the property of the Owner.

H. Epoxy Grouting of Vertical Ducts:

1. Pressure grout tendon ducting and anchors with two-part epoxy under a minimum pressure of 100 psi. Grout tubes, valves, and anchor details shall be capable of holding a 200-psi pressure until the epoxy has cured.

2. Provide grouting equipment with a pressure gauge having a full-scale reading of 200 psi.

3. Ducts shall be clean and free of water and deleterious materials that would impair bonding of the grout or interfere with grouting procedures.

4. Provide grout injection pipes with positive mechanical shutoff valves.

5. Perform duct grouting at the lowest grout connection tube. Top of the epoxy grout shall be at least 1/2 inch above the top of the threaded bar.

6. In cold weather, especially during frosts, avoid the freezing of the grout. If the grouting procedure cannot be postponed, keep the wall temperature above the freezing point with hot blankets or by other means.

7. Upon completion of the vertical stressing and grouting operation, dry-pack the anchor pocket areas above the anchor nuts with a 1 cement to 2 sand mortar mix immediately after the epoxy coating on the inside can

surface has become tacky. Alternatively, fill the metal can with concrete aggregates or epoxy.

8. Finish the dry-pack surface flush with the adjoining concrete surface.

3.09 SEISMIC CABLES

A. The strands shall be prebent before placing the units in wall and wall footings.

B. The strands shall be tied to the lower horizontal circumferential tie-bar on the vertical prestress tendons as shown on the Contractor's shop drawings.

C. Tie strands to the radial footing bars.

3.10 NEOPRENE BEARING PADS

A. Glue pads to the top of the concrete surface with a compatible rubber-cement glue. In addition to glue, dense small concrete blocks or plastic shims may be inserted between the pads and adjacent in-place reinforcing. Do not nail pads to the supporting concrete surface.

B. Fill voids, cavities, and spaces between neoprene bearing pads, water stop, and rubber-filler pads with a soft mastic that is compatible with neoprene, rubber, and plastic material.

C. Remove concrete that is deposited on the exposed sides of the pads.

3.11 FILLER PADS

Filler pads shall be of sufficient width to occupy the spaces under the wall adjacent to the bearing pads and water stop. Attach filler pads to the supporting concrete surface as specified for neoprene bearing pads.

3.12 FLOOR SLAB CRACK REPAIRS

Repair slab cracks wider than 0.01 inch by cutting out a square-edged and uniformly aligned joint 3/8 inch wide by 1 inch deep and installing joint sealant per Section 030500. Alternately, cracks may be epoxy injected with an approved water-insensitive epoxy.

3.13 PAINTING AND COATING OF BURIED PORTIONS OF RESERVOIR WALLS

Application: Apply two coats by brush, spray, or roller to completely cover below-grade walls at a minimum rate of 80 square feet per gallon per coat or, if greater, at the manufacturer's recommended usage rate.

3.14 COATING OF EXPOSED ROOF AREAS

A. Surface Preparation: As recommended by coating manufacturer.

B. Primer: Apply concreter primer at a rate of 1 gallon per 100 square feet.

C. Coating: Apply Type II asphalt at a rate of 60 pounds per 100 square feet.

D. Gravel: Apply at a rate of 10 pounds per square foot.

3.15 COATING APPLICATION

A. Each coat shall be free of runs, skips, or holidays.

B. Perform work in accordance with the manufacturer's recommendations, except for the above usage rate of the coating.

C. The application of the coatings shall commence within five days after completion of the water curing.

3.16 PROTECTION OF SURFACES NOT TO BE PAINTED

Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, and other surfaces not intended to be painted. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces. Protect adjacent surfaces from damage during surface preparation.

3.17 DISINFECTION

A. Disinfect the reservoir after construction is complete and prior to filling of the reservoir for testing or storage of potable water. Disinfect the reservoir again if subsequent test or construction operations contaminate the reservoir.

B. Spray water containing 400-mg/L available chlorine on interior surfaces. Following spray application, disinfection shall comply with AWWA C652, Method 3. Bacteriological testing shall conform to AWWA C652, Section 4.4. Should tests fail, the disinfection process shall be repeated. Should any disinfected water require discharge to storm and surface drains, the Contractor shall submit a water dechlorination plan for approval prior to discharge. The plan shall delineate how water shall be dechlorinated and shall be in compliance with applicable regulations of the Regional Water Quality Control Board and the City of Torrance. Reuse and reclamation of spent water for landscaping or construction purposes is encouraged.

3.18 LEAKAGE TESTING

A. Leakage testing of the reservoir shall be in accordance with Section 030510 prior to backfilling.

B. Provide labor and equipment for filling the reservoir with water. The Owner will furnish water for the test. Make arrangements and pay for delivery of the water from the nearest Owner source to the reservoir.

3.19 INSPECTION FACILITIES

Provide the Owner's Representative with facilities for inspection including:

A. Lighting, ladders, safe staging, and manpower to move same.

B. Slump cones, shotcrete test cube plywood forms.

C. Stress-indicating instruments for prestressing.

END OF SECTION

SECTION 400500 GENERAL PIPING REQUIREMENTS

PART 1 - GENERAL

A. Description

This section describes the general requirements for selecting piping materials; selecting the associated bolts, nuts, and gaskets for flanges for the various piping services in the project; and miscellaneous piping items.

B. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit affidavit of compliance with referenced standards (e.g., AWWA, ANSI, ASTM, etc.).

3. Submit certified copies of mill test reports for bolts and nuts, including coatings if specified. Provide recertification by an independent domestic testing laboratory for materials originating outside of the United States.

4. Submit manufacturer's data sheet for gaskets supplied showing dimensions and bolting recommendations.

C. Definitions of Buried and Exposed Piping

1. Buried piping is piping buried in the soil, commencing at the wall or beneath the slab of a structure. Where a coating is specified, provide the coating up to the structure wall. Piping encased in concrete is considered to be buried. Do not coat encased pipe.

2. Exposed piping is piping in any of the following conditions or locations:

   a. Above ground.

   b. Inside buildings, vaults, or other structures.

   c. In underground concrete trenches or galleries.

PART 2 - MATERIALS

A. Materials Selection and Alternative Materials

The drawings may show alternative piping materials for certain services. In such cases, the same pipe material shall be used for all pipe sizes in all locations for the given piping service. Do not intermix piping materials.

B. Thread Forming for Stainless Steel Bolts

Form threads by means of rolling, not cutting or grinding.

C. Bolts and Nuts for Flanges for Steel Piping (Specification Section 402066)

1. Bolts and nuts for Class 150 flanges shall be Type 316 stainless steel conforming to ASTM A193, Grade B8M for bolts and ASTM A194, Grade 8M for nuts.

2. Fit shall be Classes 2A and 2B per ANSI B1.1 when connecting to cast-iron valves having body bolt holes.

3. Bolts used in flange insulation kits shall conform to ASTM A193 (Grade B7). Nuts shall conform to ASTM A194 (Grade 2H).

4. Provide washers for each nut. Washers shall be of the same material as the nuts.

D. Lubricant for Stainless Steel Bolts and Nuts

Lubricant shall be chloride free and shall be RAMCO TG-50, Anti-Seize by RAMCO, Specialty Lubricants Corporation Husky™ Lube O'Seal, or equal.

E. Gaskets for Flanges for Steel Piping in Water Service (Specification Section 402066)

1. Gaskets for flat face and raised face flanges shall be 1/8-inch thick and shall be one of the following nonasbestos materials:

    a. Cloth-inserted rubber with a Shore "A" hardness of 75 to 85. Gaskets shall be suitable for a pressure of 200 psi at a temperature of 180°F. Products: Garlock Style 19 or equal.

b. Acrylic or aramid fiber bound with nitrile. Products: Garlock "Bluegard," Klinger "Klingersil C4400," or equal. Gaskets shall be suitable for a pressure of 500 psi at a temperature of 400°F.

F. <u>Moldable Filler Tape for Pipe Surface Transition Areas</u>

1. Filler tape shall be a 100% solids mastic-like butyl-rubber filler designed to fill and smooth the transition areas between adjacent coating surfaces such as step-down weld areas, surface irregularities beneath heat-shrink sleeves, pipefittings, and exothermic welds for cathodic protection bonding wire connections. Characteristics:

   a. Thickness per ASTM D1000: 1/8 inch minimum.

   b. Peel adhesion to primed pipe: 300 ounces per inch minimum.

   c. Elongation: 600% minimum.

2. Products: Tapecoat “Moldable Sealant,” Polyken No. 939 Filler Tape, or equal.

PART 3 - EXECUTION

A. <u>Installing Pipe Spools in Concrete</u>

Install pipes in walls and slabs before placing concrete. See Section 030500.

B. <u>Raised Face and Flat Face Flanges</u>

Where a raised face flange connects to a flat-faced flange, remove the raised face of the flange.

C. <u>Installing Aboveground or Exposed Piping</u>

Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment.

D. <u>Installing Flanged Piping</u>

1. Set pipe with the flange bolt holes straddling the pipe horizontal and vertical centerline. Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment. Before bolting

up, align flange faces to the design plane within 1/16 inch per foot measured across any diameter. Align flange bolt holes within 1/8-inch maximum offset.

2. Clean flanges by wire brushing before installing flanged fittings. Clean flange bolts and nuts by wire brushing, lubricate carbon steel bolts with oil and graphite, and tighten nuts uniformly and progressively.

3. Bolt lengths shall extend completely through their nuts. Any which fail to do so shall be considered acceptably engaged if the lack of complete engagement is not more than one thread.

4. Do not use more than one gasket between contact faces in assembling a flanged joint.

5. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reset or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.

E. Installing Blind Flanges

1. At outlets not indicated to be connected to valves or to other pipes and to complete the installed pipeline hydrostatic test, provide blind flanges with bolts, nuts, and gaskets.

2. Coat the inside face of blind flanges per Section 099000, System No. 7.

F. Installing Grooved-End Piping

1. Install grooved-end pipe and fittings in accordance with the coupling manufacturer's recommendations and the following.

2. Clean loose scale, rust, oil, grease, and dirt from the pipe or fitting groove before installing coupling. Apply the coupling manufacturer's gasket lubricant to the gasket exterior including lips, pipe ends, and housing interiors.

3. Fasten coupling alternately and evenly until coupling halves are seated. Use torques as recommended by the coupling manufacturer.

G. Installation of Stainless Steel Bolts and Nuts

Prior to assembly, coat threaded portions of stainless steel bolts and nuts with lubricant.

END OF SECTION

SECTION 400515 PRESSURE TESTING OF PIPING

PART 1 - GENERAL

A. Description

This section specifies the hydrostatic and leakage testing of pressure piping for water distribution and transmission mains.

B. Related Work Specified Elsewhere

1. Disinfection of Piping and Well: 331300.

2. Manual, Check, and Process Valves: 400520.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit test bulkhead locations and design calculations, pipe attachment details, and methods to prevent excessive pipe wall stresses.

3. Submit six copies of the test records to the Owner's Representative upon completion of the testing.

D. Test Pressures

Test pressures for the various services and types of piping are shown in Part 3.J.

E. Testing Records

Provide records of each piping installation during the testing. These records shall include:

1. Date and times of test.

2. Identification of pipeline or pipeline section tested or retested.

3. Identification of pipeline material.

4. Identification of pipe specification.

5. Test fluid.

6. Test pressure at low point in pipeline or pipeline section.

7. Remarks: Leaks identified (type and location), types of repairs, or corrections made.

8. Certification by Contractor that the leakage rate measured conformed to the specifications.

PART 2 - MATERIALS

A. Vents and Drains for Aboveground Piping

Install vents on the high points of aboveground piping, whether shown in the drawings or not. Install drains on low points of aboveground piping, whether shown in the drawings or not. Provide a valve at each vent or drain point. Valves shall be 3/4 inch for piping 3 inches and larger and 1/2 inch for piping smaller than 3 inches. Valves shall be as specified in Section 400520 unless otherwise shown in the drawings.

B. Manual Air-Release Valves for Buried Piping

Provide temporary manual air-release valves at test bulkheads for pipeline test. Construct the pipe outlet in the same manner as for a permanent air valve and after use, seal with a blind flange, pipe cap, or plug and coat the same as the adjacent pipe.

C. Test Bulkheads

Design and fabricate test bulkheads per Section VIII of the ASME Boiler and Pressure Vessel Code. Materials shall comply with Part UCS of said code. Design pressure shall be at least 2.0 times the specified test pressure for the section of pipe containing the bulkhead. Limit stresses to 70% of yield strength of the bulkhead material at the bulkhead design pressure. Include air-release and water drainage connections.

D. Testing Fluid

1. Testing fluid shall be water.

2. For potable water pipelines, obtain and use only potable water for hydrostatic testing.

3. Submit request for use of water from waterlines of Owner 48 hours in advance.

4. The Contractor may obtain the water from the Owner at no charge.

E. Testing Equipment

Provide calibrated pressure gauges, pipes, bulkheads, pumps, compressors, chart recorder, and meters to perform the hydrostatic testing.

PART 3 - EXECUTION

A. Testing Preparation

1. Pipes shall be in place, backfilled, and anchored before commencing pressure testing.

2. Conduct pressure tests on exposed and aboveground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters.

3. For buried piping, the pipe may be partially backfilled and the joints left exposed for inspection during an initial leakage test. Perform the final pressure test, however, after completely backfilling and compacting the trench.

4. Provide any temporary piping needed to carry the test fluid to the piping that is to be tested. After the test has been completed and demonstrated to comply with the specifications, disconnect and remove temporary piping. Do not remove exposed vent and drain valves at the high and low points in the tested piping; remove any temporary buried valves and cap the associated outlets. Plug taps or connections to the existing piping from which the test fluid was obtained.

5. Provide temporary drain lines needed to carry testing fluid away from the pipe being tested. Remove such temporary drain lines after completing the pressure testing. Pipes shall remain full after testing.

6. Prior to starting the test, the Contractor shall notify the Owner's Representative.

B. Cleaning

Before conducting hydrostatic tests, flush pipes with water to remove dirt and debris. Maintain a flushing velocity of at least 3 fps for water testing. Flush pipes for time period as given by the formula

$$T = \frac{2L}{3}$$

in which:

T = flushing time (seconds)

L = pipe length (feet).

C. Testing and Disinfection Sequence for Potable Water Piping

1. Perform required disinfection after hydrostatic testing, except when pipeline being tested is connected to a potable waterline.
2. Locate and install test bulkheads, valves, connections to existing pipelines, and other appurtenances in a manner to provide an air gap separation between existing potable water pipelines and the pipeline being tested. Disinfect water and pipeline being tested before hydrostatic testing when connected to a potable waterline.

D. Initial Pipeline Filling for Hydrostatic Testing

Maximum rate of filling shall not cause water velocity in pipeline to exceed 1 fps. Filling may be facilitated by removing automatic air valves and releasing air manually.

E. Testing New Pipe Which Connects to Existing Pipe

Prior to testing new pipelines that are to be connected to existing pipelines, isolate the new line from the existing line by means of test bulkheads, spectacle flanges, or blind flanges. After the new line has been successfully tested, remove test bulkheads or flanges and connect to the existing piping.

F. Hydrostatic Testing of Aboveground or Exposed Piping

1. Open vents at high points of the piping system to purge air while the pipe is being filled with water. Venting during system filling may also be provided by temporarily loosening flanges.

2. Subject the piping system to the test pressure indicated per Part 3.K of this specification. Maintain the test pressure for a minimum of four hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show zero leakage or weeping. Correct leaks and retest until zero leakage is obtained.

G. Hydrostatic Testing of Buried Piping

1. Where any section of the piping contains concrete thrust blocks or encasement, do not make the pressure test until at least 10 days after the concrete has been placed. When testing mortar-lined or PVC piping, fill the pipe to be tested with water and allow it to soak for at least 48 hours to absorb water before conducting the pressure test.

2. Apply and maintain the test pressure by means of a positive displacement hydraulic force pump.

3. Maintain the test pressure for four hours by restoring it whenever it falls an amount of 5 psi.

4. After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure. This amount of water is the loss due to leakage in the piping system. The allowable leakage volume is defined by the formula

$$L = \frac{HND(P)^{1/2}}{C}$$

in which:

L = allowable leakage (gallons)

H = specified test period (hours)

N = number of rubber-gasketed joints in the pipe tested

D = diameter of the pipe (inches)

P = specified test pressure (psig)

C = 7,400

5. The allowable leakage for buried piping having threaded, brazed, or welded (including solvent welded) joints shall be zero.

6. Repair and retest any pipes showing leakage rates greater than that allowed in the above criteria.

H. Repetition of Test

If the actual leakage exceeds the allowable, locate and correct the faulty work and repeat the test. Restore the work and all damage resulting from the leak and its repair. Eliminate visible leakage.

I. Bulkhead and Test Facility Removal

After a satisfactory test, remove the testing fluid, remove test bulkheads and other test facilities, and restore the pipe coatings.

J. Test Pressure and Test Fluids

Testing and design pressures (psig) shall be as listed below:

Pipe Service	**Pipe Material**	**Testing Fluid**	**Design Pressure (psi)**	**Test Pressure (psi)**
Potable Water: well to pump station	Steel, DI	Water	100	150
Potable Water: pump station to system	Steel, DI	Water	150	200
Drain lines	VCP, PVC, RCP, HDPE	Water	10	50

END OF SECTION

SECTION 400520 MANUAL, CHECK, AND PROCESS VALVES

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation of manually operated valves, check valves, and process valves including gate, butterfly, ball, hose bibbs, globe, angle, check, and solenoid valves.

B. Related Work Specified Elsewhere

1. Painting and Coating: 099000.

2. Cold-Applied Wax Tape Coating: 099752.

3. Polyethylene Sheet Encasement: 099754.

4. General Piping Requirements: 400500.

5. Pressure Testing of Piping: 400515.

6. Air-Release and Vacuum-Relief Valves: 400560.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit manufacturer's catalog data and detail construction sheets showing all valve parts. Describe each part by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type.

3. Show valve dimensions including laying lengths. Show port sizes. Show dimensions and orientation of valve actuators, as installed on the valves. Show location of internal stops for gear actuators. State differential pressure and fluid velocity used to size actuators. For worm-gear actuators, state the radius of the gear sector in contact with the worm and state the handwheel diameter.

4. Show valve linings and coatings. Submit manufacturer's catalog data and descriptive literature.

5. Submit six copies of a report verifying that the valve interior linings and exterior coatings have been tested for holidays and lining thickness. Describe test results and repair procedures for each valve. Do not ship valves to project site until the reports have been returned by the Owner's Representative and marked "Resubmittal not required."

6. For butterfly valves, show the clear diameter or size of the port. Show the actual area of the port as a percentage of the area as calculated for the nominal valve size.

PART 2 - MATERIALS

A. General

1. Install valves complete with operating handwheels or levers, chainwheels, extension stems, floor stands, gear actuators, operating nuts, chains, and wrenches required for operation.

2. Valves shall have the name of the manufacturer and the size of the valve cast or molded onto the valve body or bonnet or shown on a permanently attached plate.

B. Valve Actuators

1. Provide lever or wrench actuators for exposed valves 6 inches and smaller. For larger valves, provide handwheels.

2. Where manually operated valves (size 4 inches and larger) are installed with their centerlines more than 6 feet 9 inches above the floor, provide chainwheel and guide actuators.

3. Provide 2-inch AWWA operating nuts for buried valves.

4. Provide enclosed gear actuators on butterfly, ball, and plug valves 6 inches and larger, unless electric valve actuators are shown in the drawings. Gear actuators for valves 6 inches through 20 inches shall be of the worm and gear, or of the traveling nut type.

5. Design gear actuators assuming that the differential pressure across the plug or disc is equal to the pressure rating of the valve and assuming a line fluid

temperature range of 50°F to 100°F unless otherwise required in the detailed valve specifications.

6. Gear actuators shall be enclosed, oil lubricated, with seals provided on shafts to prevent entry of dirt and water into the actuator. Gear actuators for valves located above ground or in vaults and structures shall have handwheels. The actuators for valves in exposed service shall contain a dial indicating the position of the valve disc or plug. Gear actuators for buried or submerged valves shall have 2-inch-square AWWA operating nuts.

7. For buried service, provide watertight shaft seals and watertight valve and actuator cover gaskets. Provide totally enclosed actuators designed for buried service.

8. Traveling nut and worm and gear actuators shall be of the totally enclosed design so proportioned as to permit operation of the valve under full differential pressure rating of the valve with a maximum pull of 80 pounds on the handwheel or crank. Provide stop limiting devices in the actuators in the open and closed positions. Actuators shall be of the self-locking type to prevent the disc or plug from creeping. Design actuator components between the input and the stop-limiting devices to withstand without damage a pull of 200 pounds for handwheel actuators and an input torque of 300 foot-pounds for operating nuts when operating against the stops.

9. Handwheel diameters for traveling nut actuators shall not exceed 8 inches for valves 12 inches and smaller and shall not exceed 12 inches for valves 20 inches and smaller.

10. Self-locking worm gear shall be a one-piece design of gear bronze material (ASTM B427; or ASTM B584, Alloy C86200), accurately machine cut. The worm shall be hardened alloy steel (ASTM A322, Grade G41500 or G41400; or ASTM A148, Grade 105-85), with thread ground and polished. Support worm-gear shaft at each end by ball or tapered roller bearings. The reduction gearing shall run in a proper lubricant. The handwheel diameter shall be no more than twice the radius of the gear sector in contact with the worm. Worm-gear actuators shall be Limitorque Model HBC, EIM Series W, or equal.

11. Design actuators on buried valves to produce the required torque on the operating nut with a maximum input of 150 foot-pounds.

12. Valve actuators, handwheels, or levers shall open by turning counterclockwise.

C. Cast-Iron Valve Boxes for Buried Valves

1. Valve boxes shall be two-piece sliding type, cast iron, with extension shafts. Units shall be as manufactured by Tyler Pipe, Geneco, Star Pipe Products, or equal. Extension pipes shall be cast iron.

2. Install in accordance with Torrance Std. No. T712.

3. Coat buried cast-iron pieces per Section 099000, System No. 21.

D. Extension Stems for Buried Valve Actuators

1. Where the depth of the valve is such that its centerline is more than 5 feet below grade, provide operating extension stems to bring the operating nut to a point 6 inches below the surface of the ground and/or box cover. Extension stems shall be Type 316 stainless steel, solid core, and shall be complete with 2-inch-square operating nut. The connections of the extension stems to the operating nuts and to the valves shall withstand without damage a pull of 300 foot-pounds. Torrance Std. No. T712.

2. Extension stem diameters shall be as tabulated below:

Valve Size (inches)	**Minimum Extension Stem Diameter (inches)**
2	3/4
3, 4	7/8
6	1
8	1-1/8
10, 12	1-1/4
16, 18	1 1/2
20, 24	1 3/4

E. Bolts and Nuts for Flanged Valves

Bolts and nuts for flanged valves shall be as described in Section 400500.

F. Gaskets for Flanges

Gaskets for flanged end valves shall be as described in Section 400500.

G. Painting and Coating

1. Coat metal valves located above ground or in vaults and structures the same as the adjacent piping. If the adjacent piping is not coated, then coat valves per Section 099000, System No. 10. Apply the specified prime and intermediate coat at the place of manufacture. Finish coat shall match the color of the adjacent piping. Coat handwheels the same as the valves.

2. Coat buried metal valves at the place of manufacture per Section 099000, System No. 21.

3. Line the interior metal parts of metal valves 4 inches and larger, excluding seating areas and bronze and stainless steel pieces, per Section 099000, System No. 7. Apply lining at the place of manufacture.

4. Test the valve interior linings and exterior coatings at the factory with a low-voltage (22.5 to 80 volts, with approximately 80,000-ohm resistance) holiday detector, using a sponge saturated with a 0.5% sodium chloride solution. The lining shall be holiday free.

5. Measure the thickness of the valve interior linings per Section 099000. Repair areas having insufficient film thickness per Section 099000.

H. Packing, O-Rings, and Gaskets

Unless otherwise stated in the detailed valve specifications, packing, O-rings, and gaskets shall be one of the following nonasbestos materials:

1. Teflon.

2. Kevlar aramid fiber.

3. Acrylic or aramid fiber bound by nitrile. Products: Garlock "Bluegard," Klinger "Klingersil C4400," or equal.

4. Buna-N (nitrile).

I. Rubber Seats

Rubber seats shall be made of a rubber compound that is resistant to free chlorine and monochloramine concentrations up to 10 mg/L in the fluid conveyed.

J. Valves

1. Gate Valves:

Aboveground Bronze Gate Valves 3 inches and Smaller:

Aboveground threaded end gate valves 1/4 inch through 3 inches, for water service shall be rising stem, screwed bonnet, solid wedge disc type, Class 150, having a minimum working pressure of 300 WOG psi at a temperature of 150°F. Ends shall be female threaded per ANSI B1.20.1. Materials of construction shall be as follows:

Component	Material	Specification
Body and bonnet	Bronze	ASTM B61 or B62
	Bronze	ASTM B61, B62, or ASTM B584 (Alloy C97600)
Stem	Bronze or copper silicon	ASTM B99 (Alloy 651), B584 (Alloy C87600), B371, (Alloy C69400)

Handwheels shall be aluminum, brass, or malleable iron. Packing shall be Teflon or Kevlar aramid fiber. Valves shall be Crane 431, Stockham B-120, or equal.

2. Butterfly Valves:

a. Thrust Bearings for Butterfly Valves:

Provide thrust bearings to hold the valve disc in the center of the valve seat. No bearings shall be mounted inside the valve body within the waterway. Do not use thrust bearings in which a metal bearing surface on the disc rubs in contact with an opposing metal surface on the inside of the body.

b. Bronze Components in Butterfly Valves:

Bronze components in contact with water shall comply with the following requirements:

Constituent	**Content**
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

c. Actuator Sizing for Butterfly Valves:

Actuators shall be sized to produce valve shaft output torques equivalent to at least 75% of the torsional shear stress of the minimum required shaft diameters.

d. Port Sizes for Butterfly Valves:

For valves 24 inches and smaller, the actual port diameter shall be at least 93% of the nominal valve size. For valves larger than 24 inches, the port diameter shall not be more than 1.25 inches smaller than the nominal valve size. The dimension of the port diameter shall be the clear waterway diameter plus the thickness of the rubber seat.

e. Corrosion-Resistant Materials in Butterfly Valves:

Where AWWA C504 requires “corrosion resistant” material, such material shall be one of the following:

(1) Bronze as described above.

(2) Type 316 stainless steel.

(3) Monel (UNS N04400).

(4) Synthetic nonmetallic material.

f. Seating Surfaces in Butterfly Valves:

Seating surfaces in valves having motorized actuators shall be stainless steel or nickel-copper per AWWA C504 or nickel-chromium alloy containing a minimum of 72% nickel and a minimum of 14% chromium.

g. Factory Leakage Testing:

Perform factory leakage tests per AWWA C504 on both sides of the seat.

h. Flanged, Rubber-Seated Butterfly Valves 4 Through 72 Inches, Class 150B:

Butterfly valves shall be short body, flanged type for exposed valves and valves in vaults or structures, and either flanged or mechanical joint for buried valves. Valve shall conform to AWWA C504, Class 150B. Minimum working differential pressure across the valve disc shall be 150 psi. Flanged ends shall be Class 125, ANSI B16.1. Valve shafts shall be stub shaft or one-piece units extending completely through the valve disc. Materials of construction shall be as follows:

Component	**Material**	**Specification**
Body	Cast iron	AWWA C504
Exposed body cap screws and bolts and nuts	Stainless steel	ASTM A276, Type 316
Discs	Cast iron, ductile iron, or Ni-Resist	AWWA C504
Shafts, disc fasteners, seat retention segments, and seat fastening devices	Stainless steel	ASTM A276, Type 316
Seat material	Buna-N	--

The resilient seat shall be retained on the disc by a retaining ring secured with Type 304 stainless steel screws. The seat shall be capable of mechanical adjustment in the field and field replacement without the need for special tools. Valves shall be Mueller, no equal.

3. Ball Valves

   a. Full Port Threaded Bronze Ball Valves 2 Inches and Smaller:

      Ball valves, 2 inches and smaller, shall have a pressure rating of at least 600 psi WOG at a temperature of 100°F. Provide full port ball and body design. Valves shall comply with MSS SP-110. Provide bronze (ASTM B62 or ASTM B584, Alloy C83600 or C84400) body and plug ball retainer. Ball and stem shall be Type 316 stainless steel. Valves shall have threaded ends (ASME B1.20.1), nonblowout stems, reinforced Teflon seats, and have plastic-coated lever actuators. Valves shall be Stockham T-285 Series, Apollo 77C-140 Series, or equal.

   b. Ball Valves--Regular Port Threaded Stainless Steel Ball Valves 2 Inches and Smaller:

      Stainless steel ball valves, 2 inches and smaller, for water service shall be rated at a minimum pressure of 1,500 psi WOG at a temperature of 100°F. Valve body, ball, and stem shall be Type 316 stainless steel, ASTM A276 or A351. Seat and seals shall be reinforced Teflon. Valves shall have lever actuators, plastic coated. Valves shall have screwed ends (ANSI B1.20.1) and nonblowout stems. Valves shall be McCanna Figure M402, Worcester Series 48, Stockham Figure SD 2120-SSMO-R-T, Apollo 76-100 Series, or equal.

4. Bronze Hose Bibbs:

   Hose bibbs of size 1/2 inch, 3/4 inch, and 1 inch shall be all bronze (ASTM B62 or ASTM B584, Alloy C83600) with rising or nonrising stem, composition disc, bronze or malleable iron handwheel, and bronze stem (ASTM B99, Alloy C65100; ASTM B371, Alloy C69400; or ASTM B584, Alloy C87600). Packing shall be Teflon or graphite. Valves shall have a pressure rating of at least 150 psi for cold-water service. Threads on valve outlet shall be American National Standard fire hose coupling screw thread (ANSI B1.20.7). Provide atmospheric vacuum breaker conforming to ASSE Standard 1011 and IAPMO code. Valves shall be Nibco Figure T-113-HC or equal.

5. Check Valves--Steel Wafer Single-Disc Check Valves, Class 150:

   a. Wafer single-disc check valves shall conform to API 594 and API D6 and shall be designed to be installed between the flanges of the adjoining pipe as specified in Section 402057. Valves shall be equipped with an adjustable external spring mechanism to provide for nonslam closure of the valve without backflow, in any position, and will not be dependent on gravity or backflow for closure. Provide a top-mounted flushing port with plug; coat plug threads with Teflon-paste lubricating compound prior to insertion. Shaft packing shall be Teflon, externally adjustable and replaceable.

   b. Materials of construction shall be as follows:

Component	Material	Specification
Body, spring arm and flush port plug	Carbon steel	ASTM A36 or A216, Grade WCB
Disc	Stainless steel	ASTM A240, Type 316
Disc arm, disc arm key, spring arm key, and spring seat ring	Stainless steel	ASTM A313 or A479, Type 316
Follower, gland bottom, inner bushing, bushing, retainer washer, and outer bushing	Bronze	ASTM B584, Alloy C93200
Shaft	Stainless steel	ASTM A351, Grade CF8M
Shaft packing	Braided Teflon	--
Shaft seals and seat outside diameter seal	Buna-N	--

c. Valve shall be K F Eagle Series 20 as manufactured by K F Industries, Inc.; no equal.

6. Solenoid Valves:

a. Design and construct solenoid valves such that they can be used in both horizontal and vertical piping.

b. Metallic Solenoid Valves 1-1/2 Inches and Smaller:

Solenoid valves of sizes 1/4 inch through 1-1/2 inches for water and air service shall have forged brass (Alloy C23000) or bronze (ASTM B62) bodies with Teflon main seats. Internal plunger, core tube, plunger spring, and cage assembly shall be stainless steel (Types 302, 304, or 305). Solenoid enclosures shall be NEMA 4. Valve actuators shall be 120-volt a-c. Seals shall be Teflon. Valves shall have a maximum operating pressure and a maximum differential pressure of 125 psi. Solenoid valves shall be energized to open. Valves shall be ASCO "Redhat" Model 8210, Parker Hannifin “Skinner” Model 2R2, or equal.

7. Gauge Valves:

Gauge valves shall be a combination isolation and vent valve with a minimum pressure rating of 3,000 psi at 200°F. Isolation valve shall have interchangeable hard or soft seat. Body, bonnet, and stem shall be Type 316 stainless steel. Packing shall be Teflon. Valves shall have screwed ends and nonblowout stems. Valves shall be AGCO M9 gauge valve or equal.

PART 3 - EXECUTION

A. Joints

1. Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseat or replace

the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.

2. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.

B. Installing Exposed Valves

1. Unless otherwise indicated in the drawings, install valves in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above the floor with their operating stems vertical. Install valves in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above the floor with their operating stems horizontal.

2. Install valves on vertical runs of pipe that are next to walls with their stems horizontal, away from the wall. Valves on vertical runs of pipe that are not located next to walls shall be installed with their stems horizontal, oriented to facilitate valve operation.

C. Installing Buried Valves

1. Connect the valve, coat the flanges, apply tape wrapping or polyethylene encasement, and place and compact the backfill to the height of the valve stem.

2. Place block pads under the extension pipe to maintain the valve box vertical during backfilling and repaving and to prevent the extension pipe from contacting the valve bonnet.

3. Mount the upper slip pipe of the extension in midposition and secure with backfill around the extension pipe. Pour the concrete ring allowing a depression so the valve box cap will be flush with the pavement surface.

D. Field Coating Buried Valves

1. Coat flanges of buried valves and the flanges of the adjacent piping, and the bolts and nuts of flanges and mechanical joints, per Section 099000, System No. 24.

2. Wrap buried metal valves smaller than 6 inches with cold-applied wax tape per Section 099752.

3. Wrap buried metal valves 6 inches and larger with polyethylene sheet per Section 099754.

E. Installing Extension Stem Guide Brackets

Install at 6- to 8-foot centers. Provide at least two support brackets for stems longer than 10 feet, with one support near the bottom of the stem and one near the top.

F. Mounting Gear Actuators

The valve manufacturer shall select and mount the gear actuator and accessories on each valve and stroke the valve from fully open to fully closed prior to shipment.

G. Field Installation of Gear Actuator

Provide the actuator manufacturer's recommended lubricating oil in each actuator before commencing the field testing.

H. Valve Leakage Testing

Test valves for leakage at the same time that the connecting pipelines are tested. See Section 400515 for pressure testing requirements. Protect or isolate any parts of valves, actuators, or control and instrumentation systems whose pressure rating is less than the pressure test. Valves shall show zero leakage. Repair or replace any leaking valves and retest.

I. Valve Field Testing

1. Operate manual valves through three full cycles of opening and closing. Valves shall operate from full open to full close without sticking or binding. Do not backfill buried valves until after verifying that valves operate from full open to full closed. If valves stick or bind, or do not operate from full open to full closed, repair or replace the valve and repeat the tests.

2. Gear actuators shall operate valves from full open to full close through three cycles without binding or sticking. The pull required to operate handwheel-operated valves shall not exceed 80 pounds. The torque required to operate valves having 2-inch AWWA nuts shall

not exceed 150 ft-lbs. If actuators stick or bind or if pulling forces and torques exceed the values stated previously, repair or replace the actuators and repeat the tests. Operators shall be fully lubricated in accordance with the manufacturer's recommendations prior to operating.

END OF SECTION

SECTION 400560 AIR-RELEASE AND VACUUM-RELIEF VALVES

PART 1 - GENERAL

A. Description

This section includes materials and installation of air and vacuum valves, air-release valves, and combination air-release valves for water service.

B. Related Work Specified Elsewhere

1. Painting and Coating: 099000.
2. Fusion-Bonded Epoxy Linings and Coatings: 099761.
3. General Piping Requirements: 400500.
4. Pressure Testing of Piping: 400515.
5. Manual, Check, and Process Valves: 400520.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.
2. Submit manufacturer's catalog data and detail drawings showing all valve parts and describe by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type. Show linings and coatings.

PART 2 - MATERIALS

A. Bolts, Nuts, and Gaskets for Flanged Valves

See Section 400500 and specification for the pipe to which the valve is attached.

B. Valve Design and Operation

1. Valve design shall comply with AWWA C512, except as modified herein. Class 150 valves shall have a maximum working pressure of at least 150 psi. Class 300 valves shall have a maximum working pressure of at least 300 psi. Class 500 valves shall have a maximum working pressure of at least 500 psi.

2. Air-Release Valves for Water Service:

   Air-release valves for water service 3/4 inch and smaller shall be of the direct-acting type or lever type. Valves larger than 3/4 inch shall have a float-actuated compound lever with linkage mechanism to release air.

3. Air and Vacuum Valves for Vertical Turbine Pump Service:

   a. Air and vacuum valves for vertical turbine pump service (3 inches and smaller) shall have a float assembly. The discharge orifice shall have a double-acting throttling device to restrict air venting; it shall fully open to allow unrestricted air entry when the pump is shut down. Valve shall have a body with flanged top containing the air-release orifice. The float shall rise with the water level in the valve body to close the orifice by sealing against a synthetic rubber seat.

   b. Valves 3 inches and smaller shall include the following features:

      (1) Water diffuser around the float to break up the incoming water column before contacting the float.

      (2) Double-acting throttling device which restricts airflow when the pump is started and opens fully when the pump is stopped.

C. <u>Materials of Construction</u>

1. Materials of construction for air release, air and vacuum, and combination air valves for water service shall be as follows:

Item	Material	Specification
Body and cover	Cast iron	ASTM A48, Class 35; or ASTM A126, Class B
	Stainless steel	AISI Type 304 or 316
Float, lever or linkage, air release mechanism, poppet, guide rod, guide bushings, fasteners, other internal metal parts	Stainless steel	AISI Type 316 or 304
Plugs	Bronze	See paragraph 2 below
Seat, plunger, needle	Buna-N	--

2. Bronze shall have the following chemical characteristics:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

3. Rubber seats shall be made of a rubber compound that is resistant to free chlorine and monochloramine concentrations up to 10 mg/l in the fluid conveyed.

4. Body and cover bolts, nuts, and cap screws shall be Type 316 stainless steel.

D. Seating

Valves shall seat driptight at a pressure of 2 psi.

E. Valve End Connections

1. Valves 2 inches and smaller shall have threaded ends. Valves 3 inches and larger shall have flanged ends.

2. Flanges for Class 150 valves shall comply with ANSI B16.1, Class 125. Flanges for Class 300 valves shall comply with ANSI B16.1, Class 250.

3. Threaded ends shall comply with ANSI B1.20.1.

F. Valves

1. Type 1200--Air-Release Valves, 3/4 Inch and Smaller: Valves shall have an operating pressure of 150 psi. Orifice sizes shall be: 1/8 or 3/32 inch for 1/2-inch valves and 1/8 inch for 3/4-inch valves. Valves shall be APCO 55 or 65; Val-Matic Model 22; Crispin M3, M5, or M8; no equal.

2. Type 1207--Air and Vacuum Valves for Vertical Turbine Pump Service, 3 Inches and Smaller: Valves shall be APCO Series 140DAT, Val-Matic Series 100WST, Crispin Series DL-D/DBL; no equal. Valve shall incorporate an air-release valve, Type 1200. If necessary, modify valve size from that shown in the drawings for 200% of the well pump design point flow shown in Section 432154.

PART 3 - EXECUTION

A. Lining and Coating

1. Coat cast-iron valves the same as the adjacent piping. Apply the specified prime and intermediate coats at the place of manufacture. Apply finish coat in field. Finish coat shall match the color of the adjacent piping.

2. Coat interior surfaces of cast-iron valves at the place of manufacture per Section 099000, System No. 7. Do not coat seating areas and plastic, bronze, stainless steel, or other high alloy parts.

B. Installation

1. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under

pressure testing, loosen or remove the nuts and bolts, reseat or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.

2. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.

C. Valve Pressure Testing

Test valves at the same time that the connecting pipelines are pressure tested. See Section 400515 for pressure testing requirements. Protect or isolate any parts of valves, operators, or control and instrumentation systems whose pressure rating is less than the test pressure.

END OF SECTION

SECTION 400722 FLEXIBLE PIPE COUPLINGS

PART 1 - GENERAL

A. Description

This section includes materials and installation of flexible gasketed sleeve-type compression pipe couplings for steel pipe.

B. Related Work Specified Elsewhere

1. Painting and Coating: 099000.
2. Fusion-Bonded Epoxy Linings and Coatings: 099761.
3. General Piping Requirements: 400500.
4. Pressure Testing of Piping: 400515.
5. General Requirements for Steel Piping: 402001.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.
2. Submit manufacturer's catalog data on flexible pipe couplings. Show manufacturer's model or figure number for each type of coupling or joint for each type of pipe material for which couplings are used. Show coatings.
3. Submit manufacturer's recommended torques to which the coupling bolts shall be tightened for the flexible gasketed sleeve-type compression pipe couplings.
4. Show materials of construction by ASTM reference and grade. Show dimensions.

PART 2 - MATERIALS

A. Coupling System Design and Component Unit Responsibility

The coupling manufacturer shall furnish the gaskets, bolts, nuts, glands, end rings, and hardware for pipe couplings of all types and shall design these components as an integral system. Design the gaskets for the coupling and appropriately size to provide a watertight seal at the design pressure and temperature. Ship gaskets, bolts, nuts, glands, end rings, and hardware for pipe couplings with the pipe coupling and clearly label indicating the origin of the material, including place and date of manufacture. Package the manufacturer's printed installation instructions with each pipe coupling.

B. <u>Steel Flexible Pipe Couplings</u>

1. Steel couplings shall have center sleeves and end rings made of carbon steel conforming to AWWA C219, Section 4. Minimum center sleeve length shall be 5 inches for pipe sizes 3/4 inch through 4-1/2 inches, 7 inches for pipe sizes 5 inches through 24 inches, and 10 inches for pipe sizes larger than 24 inches.

2. Sleeve bolts shall be Type 316 stainless steel per AWWA C219, Section 4.

3. End rings shall be cast, forged, or hot rolled in one piece. Do not use rings fabricated from two or more shapes.

4. Wall thickness of sleeve shall be at least that specified for the size of pipe in which the coupling is to be used.

C. <u>Ductile-Iron Flexible Pipe Couplings</u>

1. Couplings shall have center sleeves and end rings made of ductile iron conforming to AWWA C219, Section 4.

2. Sleeve bolts shall be Type 316 stainless steel per AWWA C219, Section 4.

D. <u>Flexible Pipe Couplings for Plain-End Steel Pipe</u>

Couplings shall be steel, Dresser Style 38, Smith-Blair Type 411, Baker Series 200, or equal.

E. <u>Flexible Pipe Couplings for Plain-End Ductile-Iron Pipe</u>

1. Couplings for pipe 12 inches and smaller shall be cast iron, Dresser Style 253 or 253 long sleeve, Smith-Blair Type 441, Baker Series 228, or equal.

2. Couplings for pipe larger than 12 inches shall be cast iron or steel, Dresser Style 38 or 253, Smith-Blair Style 411, Baker Series 228, or equal.

F. Transition Couplings

Couplings for connecting different pipes having different outside diameters shall be steel: Dresser Style 62 or 162, Smith-Blair Series 413, Baker Series 212 or 220, or equal. Couplings shall have an internal full circumference ring pipe stop at the midpoint of the coupling. Inside diameter of coupling pipe stop shall equal inside diameter of smaller pipe diameter.

G. Flanged Coupling Adapters for Steel Pipe

Adapters for steel pipe shall be steel: Dresser Style 128, Smith-Blair Type 913, or equal. Flange ends shall match the flange of the connecting pipe; see detail piping specifications.

PART 3 - EXECUTION

A. Installation of Flexible Pipe Couplings

1. Clean oil, scale, rust, and dirt from pipe ends. Clean gaskets in flexible pipe couplings before installing.

2. Lubricate bolt threads with graphite and oil prior to installation.

B. Painting and Coating

1. Coat flexible pipe couplings (including joint harness assemblies), located indoors, in vaults and structures, and above ground with the same coating system as specified for the adjacent pipe. Apply prime coat at factory.

2. Line flexible pipe couplings per Section 099000, System No. 7.

3. Alternatively, line and coat flexible pipe couplings with fusion-bonded epoxy per Section 099761.

C. Hydrostatic Testing

Hydrostatically test flexible pipe couplings in place with the pipe being tested. Test in accordance with Section 400515.

END OF SECTION

SECTION 402001 GENERAL REQUIREMENTS FOR STEEL PIPING

PART 1 - GENERAL

A. Description

This section includes general requirements for materials, fabrication, installation, and testing of steel pipe.

B. Related Work Specified Elsewhere

1. Painting and Coating: 099000.

2. General Piping Requirements: 400500.

3. Pressure Testing of Piping: 400515.

4. Fabricated Steel Specials: 402050.

5. CML&C Steel Pipe: 402066.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit materials list showing material of pipe and fittings with ASTM reference and grade. Submit manufacturer's certification of compliance with referenced standards, e.g., ASTM A 53, A 135, and A 587 and AWWA C200. Show piping service (fuel oil, gasoline, water, air, etc.).

3. For piping 6 inches and larger, submit piping layout drawings showing location and dimensions of pipe and fittings. Include laying lengths of valves, meters, in-line pumps, and other equipment determining piping dimensions. Label or number each fitting or piece of pipe and provide the following information for each item:

   a. Material of construction, with ASTM or API reference and grade.

   b. Wall thickness of steel cylinder.

c. Mortar lining thickness (if pipe has been specified to have a mortar lining).

d. Mortar coating thickness, where mortar coating is required.

e. Paint prime coating, where prime coat is required.

f. Manufacturer's certificates of compliance with referenced pipe standards, e.g., ASTM A 53, ASTM A 135, API 5L, AWWA C200.

g. Show weld sizes and dimensions of grooved-end collars, flanges, reinforcing collars, wrapper plates, and crotch plates.

4. Submit coating application test records for field measuring paint coating thickness and holiday detection for each pipe section and fitting. Describe repair procedures used.

D. NDT Qualification

Personnel performing NDT shall meet the requirements of AWWA C200, Section 5 or shall be qualified as an AWS Certified Welding Inspector (CWI or SCWI) or shall hold a current AWS Radiographic Interpreter Certification.

PART 2 - MATERIALS

A. Steel Pipe Cylinders

1. The yield strength of the steel for pipe and fabricated fittings having grooved-end joints shall be minimum 35,000 psi.

2. Provide seamless pipe or pipe having straight longitudinal weld seams where pipe passes through rubber annular sealing devices.

B. Fittings

See Section 402050.

C. Joints

Where piping connects to wall pipes, meters, valves, or other equipment, the pipe ends shall match the ends of the wall pipes, meters, valves, or equipment.

D. Outlets and Nozzles

1. Outlets of size 3 inches and smaller shall be of the thredolet type, per MSS SP-97 and AWWA Manual M11 (1989 edition), Figure 13-23. Outlets shall be 3,000-pound WOG forged steel per ASTM A 105 or ASTM A 216, Grade WCB. Threads shall comply with ANSI B1.20.1. Outlets shall be Bonney Forge Co. "Thredolet," Allied Piping Products Co. "Branchlet," or equal.

2. Alternatively, threaded openings not less than 2 inches or more than 3 inches in nominal size shall be a flat-bottom half-coupling conforming to ANSI B16.11, Class 3000. Where the mounting surface is curved to a diameter of 36 inches or less, the mounting diameter shall be the same as that of the surface upon which it is to be mounted. Forge the threaded outlet and its plug from steel conforming to ASTM A 105 or ASTM A 181, Class 70.

3. For outlets 3 inches and smaller in piping smaller than 4 inches, use a tee with a threaded outlet.

4. For outlets larger than 3 inches, use a tee with a flanged outlet.

E. Grooved-End Couplings

1. Grooved-end couplings shall be ductile iron, ASTM A 536, Grade 60-40-18 or 65-45-12. Gaskets shall conform to ASTM D 2000 and be of the following materials:

Piping Service	**Gasket Material**
Water	EPDM
Sewage, sludge	Nitrile
Fuel oil, gasoline	Nitrile

2. Bolts in exposed service shall conform to ASTM A 183, 110,000-psi tensile strength. Bolts in buried service shall be ASTM A 193, Grade B8M, Class 2.

F. Flanges

1. Forged flange material shall conform to ASTM A 105, A 181, or A 182. Steel flange material shall conform to ASTM A 283 (Grade C or D), A 285 (Grade C), or A 36.

2. Flanges shall comply with AWWA C207, Class D or E as follows. Use welding neck flanges conforming to ANSI B16.5 in piping 10 inches and smaller where connecting to lug or wafer-style valves and in all sizes where connecting to wrought steel elbows and tees. Flanges shall be flat faced. Use the following pressure classes of flanges based on the specified test pressures:

Test Pressure (psi)	**Pipe Size (inches)**	**Flange Pressure Class**
175 and less	4 to 12	Class D
175 to 200	4 to 12	Class E
150 and less	14 to 144	Class D
150 to 200	14 to 144	Class E

3. Provide flat-faced flanges as described above where connecting to cast-iron flanges and where otherwise indicated.

4. Blind flanges shall comply with AWWA C207, Table 7.

5. Van Stone flanges and the associated lap joint pipe ends, when specified in the detail piping specifications, shall conform to ASTM F 2015.

G. Bolts, Nuts, and Gaskets for Flanges

See Section 400500.

H. Lubricant for Stainless Steel Bolts and Nuts

See Section 400500.

PART 3 - EXECUTION

A. Fabrication, Assembly, and Erection

1. Beveled ends for butt-welding shall conform to ANSI B16.25. Remove slag by chipping or grinding. Surfaces shall be clean of paint, oil, rust, scale, slag, and

other material detrimental to welding. When welding the reverse side, chip out slag before welding.

2. Fabrication shall comply with ANSI B31.3, Chapter V. Welding procedure and performance qualifications shall be in accordance with Section IX, Articles II and III, respectively, of the ASME Boiler and Pressure Vessel Code.

3. The minimum number of passes for welded joints shall be as follows:

Steel Cylinder Thickness (inch)	**Minimum Number of Passes for Welds**
Less than 0.1875	1
0.1875 through 0.25	2
Greater than 0.25	3

Welds shall be full penetration.

4. Use the shielded metal arc welding (SMAW) submerged arc welding (SAW), flux-cored arc welding (FCAW), or gas-metal arc welding (GMAW) process for shop welding. Use the SMAW process for field welding.

5. Welding preparation shall comply with ANSI B31.3, paragraph 328.4. Limitations on imperfections in welds shall conform to the requirements in ANSI B31.3, Table 341.3.2 and paragraph 341.4 for visual examination.

6. Identify welds in accordance with ANSI B31.3, paragraph 328.5.

7. Clean each layer of deposited weld metal prior to depositing the next layer of weld metal, including the final pass, by a power-driven wire brush.

8. Welding electrodes shall comply with AWS A5.1.

B. Reinforcement for Specials

See Section 402050.

C. Shop Testing of Fabricated or Welded Components

1. After completion of fabrication and welding in the shop and prior to the application of any lining or coating,

test each component according to the referenced standards. Test fabricated fittings per AWWA C200. Test the seams in fittings that have not been previously shop hydrostatically tested by the dye penetrant method as described in ASME Boiler and Pressure Vessel Code Section VIII, Appendix B. In lieu of the dye penetrant method of testing, completed fittings may be hydrostatically tested. Use the field hydrostatic test pressure or 125% of the design pressure, whichever is higher.

2. Plainly mark each length of straight pipe and each special and fitting at the bell end to identify the design pressure or head, the steel wall thickness, the date of manufacture, and the proper location of the pipe item by reference to the layout schedule. For beveled pipe, show the degree of bevel and the point on the circumference to be laid uppermost.

D. Installing Flanged Piping

See Section 400500.

E. Installation of Stainless Steel Bolts and Nuts

See Section 400500.

F. Installing Grooved-End Piping

See Section 400500.

G. Installing Aboveground or Exposed Piping

See Section 400500.

H. Installing Buried Piping

Install in accordance with Section 312316.

I. Field Hydrostatic Testing

Hydrostatically test pipe and fittings in the field in accordance with Section 400515. See Section 400515 for test pressures.

J. <u>Painting and Coating</u>

1. Coat pipe located above ground or in vaults and structures in accordance with Section 099000, System No. 10. Prime coat shall be shop applied.

2. Pipe that is to be encased in concrete shall have no coating, unless shown otherwise in the drawings.

3. Coat the ends of plain-end buried pipe where flexible pipe couplings are to be installed per Section 099000, System No. 7. Apply coating in shop.

4. The coating thickness on pipe ends having grooved-end joints (gasket seating surface and the entire groove) and on the coupling key, shoulder, gasket pocket, and bolt pad mating surfaces of the groove-end couplings shall be 8 to 10 mils.

5. Coat exposed grooved-end couplings the same as the adjacent pipe.

6. Coat the interior metal surfaces of blind flanges per Section 099000, System No. 7.

K. <u>Coating Buried Bolts, Nuts, and Tie Rods</u>

Coat buried bolts, nuts, and tie rods per Section 099000, System No. 24.

L. <u>Field Thickness Measurement and Repair of Paint Coatings for Steel Pipe</u>

1. Field repair shop applied prime coats per Section 099000.

2. Test linings and coatings per ASTM G 62, Method B, with a holiday detector set at 125 volts per mil coating thickness. Repair holidays and pinholes by applying the prime, intermediate, and finish coatings to each holiday or pinhole and retest.

3. Measure the lining and coating thickness on each pipe section using a calibrated coating thickness gauge. Make five separate spot measurements (average of three readings) spaced evenly over every 15 linear feet (or fraction thereof) to be measured. Make three gauge readings for each spot measurement of either the substrate or the paint. Move the probe a distance of 1

to 3 inches for each new gauge reading. Discard any unusually high or low gauge reading that cannot be repeated consistently. Take the average (mean) of the three gauge readings as the spot measurement. The average of five spot measurements for each area shall not be less than the specified thickness. No single spot measurement in any area shall be less than 80%, or more than 120%, of the specified thickness. One of three readings that are averaged to produce each spot measurement may underrun by a greater amount. If a section of the pipe, item, or piece of equipment does not meet these criteria, remove the entire lining or coating and recoat the entire item or piece of equipment.

4. Thickness determination shall meet the following requirements:

   a. No individual reading shall be below 75% of specified thickness.

   b. Individual spot readings (consisting of three point measurements within 3 inches of each other) shall have an average not less than 80% of specified thickness.

   c. The average of all spot readings shall be equal to or greater than nominal thickness specified.

5. Thickness determinations shall be conducted using a Type 1 magnetic thickness gauge as described in SSPC PA2 specification.

6. If the item has an insufficient film thickness, clean and topcoat the surface with the specified finish coatings to obtain the specified coverage. Sandblast or power-sand visible areas of chipped, peeled, or abraded coating, feathering the edges. Then coat in accordance with the specifications. Work shall be free of runs, bridges, shiners, laps, or other imperfections.

END OF SECTION

SECTION 402050 FABRICATED STEEL SPECIALS

PART 1 - GENERAL

A. Description

This section includes materials and fabrication of steel pipe specials of sizes 4 through 120 inches, in accordance with AWWA C200, C205, and C208 and the following options and restrictions, for use in manifold piping facilities, such as pumping stations, metering structures, and other piping associated with mechanical equipment.

B. Specials

A special is defined as any piece of pipe other than a normal full-length straight section. This includes but is not limited to elbows, manhole sections, short pieces, reducers, adapter sections with special ends, sections with outlets, etc.

C. Related Work Specified Elsewhere

1. Painting and Coating: 099000.

2. General Piping Requirements: 400500.

3. Pressure Testing of Piping: 400515.

4. General Requirements for Steel Piping: 402001.

5. CML&C Steel Pipe: 402066.

D. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit drawings for fabricated steel specials showing dimensions, wall thickness, reinforcing at openings, type of coating, and lining. Label or number each special and provide the following information:

   a. Material of construction, with ASTM or API reference and grade.

   b. Paint primer coating, where primer coat is required.

c. Weld sizes and dimensions of grooved-end collars, flanges, reinforcing collars, wrapper plates, and crotch plates.

3. Submit affidavit of compliance with referenced standards (e.g., AWWA C208, ASTM A53, etc.).

4. Submit welding procedure specifications (WPS) and procedure qualification records (PQR) for each welding process and welder qualification records (WQR) for each welder and welding operator.

5. Submit certified original copies of mill test reports on each heat from which steel is rolled. Tests shall include physical and chemical properties. Submit certified original copies of mill test reports for flanges including details of stress relief used. Manufacturer's certificates of compliance with referenced pipe standards, e.g., ASTM A53, ASTM A135, API 5L. Provide recertification by an independent domestic testing laboratory for materials originating outside of the United States.

6. Submit dimensional check reports on each steel pipe special after fabrication.

7. Submit manufacturer's certificates of welding consumables used for shop and field welding.

PART 2 - MATERIALS

A. Fittings and Specials

1. Provide cement-mortar lined and coated fabricated steel fittings for buried service.

2. Provide fabricated cement-mortar lined steel fittings for exposed service.

3. Mortar Lining: See Section 402066.

4. Ends of the fittings shall be compatible with the pipe joint for the particular type of pipe to which the steel fittings or specials connect.

B. Steel Fittings

1. A fitting is defined as a special piece of pipe other than a normal straight section. Elbows, manhole sections, reducers, and sections with outlets are fittings.

2. Unless stated otherwise in the detailed pipe specifications, fittings shall comply with ANSI B16.9 or AWWA C208, as follows:

    a. Specials and wrought steel butt-welded fittings 4 through 10 inches shall comply with ASME B16.9. Wall thickness shall be standard weight per ASME B36.10. Material shall comply with ASTM A234, Grade WPB. Elbows shall be of the long-radius type unless otherwise shown in the drawings.

    b. For tees and crosses, comply with ASME B16.9 or AWWA C208, Figure 1 and Table 1. Minimum wall thickness for fittings smaller than 12 inches shall be standard weight per ASME B36.10. Minimum wall thickness for fittings 12 inches and larger shall be the same as specified for the pipe cylinder in Section 402066.

    c. For reducing tees, laterals, wyes, reducers, and tangent outlets, comply with AWWA C208, Section 4. Reducers complying with ASME B16.9 may also be used. Minimum wall thickness for fittings smaller than 12 inches shall be standard weight per ASME B36.10. Minimum wall thickness for fittings 12 inches and larger shall be per Section 402066.

    d. For mitered elbows 42 inches and smaller, provide the number of pieces and wall thicknesses of 0.375 inch as tabulated below:

Class A (degrees)	**Class B (degrees)**	**No. of Pieces**
0 to 30	0 to 22.5	2
31 to 60	22.5 to 45	3
61 to 90	45 to 67.5	4
	67.5 to 90	5

e. Locate field-welded lap joints no closer than 4 feet 0 inches to a miter.

3. If no design pressure is shown in the drawings, assume the design pressure to be the test pressure, with a minimum design pressure of 200 psi.

4. Material for fabricated fittings 12 through 30 inches in diameter shall be the same as the pipe or shall comply with ASTM A283 (Grade C or D), ASTM A285 (Grade C), ASTM A36, or ASTM A572 (all grades).

5. Minimum mortar lining thickness shall be 1/4 inch. Mortar lining thickness and I.D. dimensions for specials larger than 10 inches shall be such that the lining inside diameter equals the nominal pipe size.

C. Flanges

See Section 402001.

D. Bolts, Nuts, and Gaskets for Flanges

See Section 400500.

E. Outlets and Nozzles in Steel Specials

See Section 402001.

PART 3 - EXECUTION

A. Fabrication, Assembly, and Erection of Steel Specials

See Section 402001.

B. Reinforcement for Fittings 42 Inches and Smaller

1. The requirement for additional reinforcement of fabricated fittings at branches and openings shall be determined by the procedure given in ANSI B31.3, paragraph 304.3 and Appendix H. If additional reinforcement is required, it shall be accomplished as described below.

2. Select the type of reinforcement for fittings with outlets from the following table:

$$R = \frac{\text{ID outlet}}{\text{ID main run x sinB}}$$

where B = Angle between the longitudinal axis of the main run and the branch

R	Type of Reinforcement
Maximum of 0.5	Collar
Maximum of 0.7	Wrapper Plate
No limit	Crotch Plate

When outlets are located opposite each other in a special (i.e., a cross), the limiting values of "R" shall be 0.25 and 0.35, respectively.

C. Collar Reinforcement

1. For collar reinforcement, select an effective shoulder width "W" of a collar from the inside surface of the steel outlet to the outside edge of the collar, measured on the surface of the cylinder of the main run, such that:

$$W = (1/3 \text{ to } 1/2) \text{ x } \frac{\text{ID outlet}}{\text{sinB}}$$

2. For collar reinforcement of tangential outlets, use

$$\text{SinB} = \sqrt{\frac{\text{OD outlet}}{\text{OD main run}}}$$

3. The minimum thickness "T" of the collar is determined by:

$$T = \frac{\text{P x ID main run x ID outlet x (2 - sinB)}}{\text{4 x F x W x sinB}}$$

where:

P = Design pressure

F = Allowable design stress

= 40% of minimum yield stress

B = As in Part 2 above.

4. Collars may be oval in shape or rectangular with rounded corners.

D. Wrapper Plate Reinforcement

For a wrapper plate, use the above collar formula except that the wrapper is of thickness "T," its total width is (2W + ID outlet/sinB), and it extends entirely around the main pipe diameter portion of the steel fitting.

E. Crotch Plate Reinforcement

Base crotch plate design on Swanson, H.S. et al., *Design of Wye Branches for Steel Pipes*, summarized in AWWA Manual M11 (1989 edition), Chapter 13.

F. Shop Testing of Fabricated Specials

See Section 402001.

G. Hydrostatic, Radiographic, Ultrasonic, Soap and Compressed Air, Liquid Penetrant, and Magnetic Particle Test Methods

See Section 402001.

H. Field Hydrostatic Testing

See Section 402001.

END OF SECTION

SECTION 402057 FUSION EPOXY-LINED STEEL PIPE

PART 1 - GENERAL

A. Description

This section includes materials, fabrication, installation, and testing of fusion-bonded epoxy-lined steel pipe in potable water service having a maximum design pressure of 300 psi for manifold piping in facilities, such as pumping stations and other piping associated with mechanical equipment. Sizes are 2 through 36 inches.

B. Related Work Specified Elsewhere

1. Painting and Coating: 099000.
2. Fusion-Bonded Epoxy Linings and Coatings: 099761.
3. Trenching, Backfilling, and Compacting: 312316.
4. General Piping Requirements: 400500.
5. Pressure Testing of Piping: 400515.
6. Flexible Pipe Couplings: 400722.
7. General Requirements for Steel Piping: 402001.
8. Fabricated Steel Specials: 402050.

C. Submittals

Submit shop drawings in accordance with Section 402001.

PART 2 - MATERIALS

A. General

1. Fabricate fusion-bonded epoxy-lined steel pipe by applying fusion-bonded epoxy per AWWA C213 except as modified herein. The pipe or fitting size in inches refers to the pipe size per ASME B36.10.
2. The Contractor shall require the pipe supplier to provide bare pipe that is free of salts, oil, and grease to the coating applicator.

B. Steel Pipe Cylinders

1. Steel pipe 18 inches and smaller in diameter shall be API 5L, Grade B; ASTM A53 (Type E or S), Grade B; ASTM A106, Grade B; or ASTM A135, Grade B.

2. Steel pipe larger than 18 inches in diameter shall be API 5L, Grade B; ASTM A106, Grade B; ASTM A135, Grade B; ASTM A134; or AWWA C200 or shall comply with the requirements of ASTM A53, Grade B. Pipe conforming to ASTM A134 or to AWWA C200 shall be made of steel conforming to ASTM A283, Grade C or D, or ASTM A285, Grade C.

3. Pipes shall be standard weight per ASME B36.10.

4. See Section 402001 for additional requirements.

C. Shop-Applied Epoxy Lining and Coating

See Section 099761.

D. Shop- and Field-Applied Epoxy Coating for Patching

See Section 099761.

E. Fittings

1. A fitting is defined as a special piece of pipe other than a normal straight section. Elbows, manhole sections, reducers, and sections with outlets are fittings. See Sections 402001 and 402050.

2. Fittings 2 through 12 inches shall be flanged, conforming to ASME B16.9 or grooved-end steel (ASTM A53, Grade B). Material for flanged steel fittings shall conform to ASTM A234, Grade WPB. Wall thickness (except for grooved ends) shall be the same as the pipe.

3. Grooved-end fittings smaller than 24 inches shall be square-cut grooved, flexible type, with the groove dimensions as shown in AWWA C606, Table 3.

F. Joints

1. Joints for aboveground, exposed, or submerged pipe shall be flanged or grooved end, except where flanged joints are required to connect to valves, pumps, and other equipment.

2. Grooved-end joints for pipes 20 inches and smaller shall be flexible, square-cut grooved, per AWWA C606, Table 3.

3. Do not field weld to join pipe and fittings. If connections in addition to those shown in the drawings are required to field join pieces, use either flanged or grooved-end joints.

4. See Section 402001 for additional requirements.

G. Outlets and Nozzles

See Section 402001.

H. Grooved-End Couplings

1. See Section 402001.

2. Couplings for pipe smaller than 24 inches shall be flexible type, square-cut grooved, per AWWA C606: Victaulic Style 77, Gustin-Bacon Figure 100, or equal.

3. Line grooved-end couplings the same as the pipe.

I. Flanges

See Section 402001.

J. Bolts and Nuts for Flanges

See Section 400500.

K. Lubricant for Stainless Steel Bolts

See Section 400500.

L. Gaskets for Flanges

See Section 400500.

PART 3 - EXECUTION

A. Fabrication, Assembly, and Erection

See Section 402001.

B. Reinforcement

See Section 402001.

C. Shop Testing of Fabricated or Welded Components

See Section 402001.

D. Shop Application of Fusion Epoxy Lining

Apply lining per AWWA C213 and Section 099761.

E. Factory Testing of Lining

Test lining with a low-voltage wet sponge holiday detector in accordance with AWWA C213, Section 5.3.3 and Section 099761. If the number of holidays or pinholes exceeds one per 20 square feet for pipe smaller than 14-inch outside diameter or one per 6 linear feet of pipe length for pipe 12 inches and smaller, remove the entire pipe lining and recoat the entire pipe or fitting.

F. Quality of Lining Application

The cured lining shall be smooth and glossy, with no graininess or roughness. The lining shall have no blisters, cracks, bubbles, underfilm voids, mechanical damage, discontinuities, or holidays.

G. Shop Repair of Defective Linings

1. Apply a two-part epoxy coating to defective linings and coatings to areas smaller than 20 square inches. Patched areas shall overlap the parent or base coating a minimum of 0.5 inch. If a defective area exceeds 20 square inches, remove the entire lining and coating and recoat.

2. Prepare the defective area per SSPC SP-10 or SP-11T. Lightly abrade or sandblast the pipe coating and lining on either side of the area before applying the liquid epoxy coating. Apply the liquid epoxy coating to a minimum dry-film thickness of 15 mils.

H. Installing Flanged Piping

See Section 400500.

I. Installation of Stainless Steel Bolts and Nuts

See Section 400500.

J. Installing Grooved-End Piping

See Section 400500.

K. Installing Aboveground or Exposed Piping

See Section 400500.

L. Field Pressure Testing

See Section 402001.

END OF SECTION

SECTION 402066 CML&C STEEL PIPE

PART 1 - GENERAL

A. Description

This section includes materials, fabrication, installation, and testing of cement-mortar lined and coated steel pipe for manifold piping in facilities such as pumping stations. Sizes are 6 through 42 inches.

B. Related Work Specified Elsewhere

1. Painting and Coating: 099000.

2. Trenching, Backfilling, and Compacting: 312316.

3. General Piping Requirements: 400500.

4. Pressure Testing of Piping: 400515.

5. General Requirements for Steel Piping: 402001.

6. Fabricated Steel Specials: 402050.

C. Submittals

Submit shop drawings in accordance with Section 402001.

PART 2 - MATERIALS

A. Steel Pipe Cylinders

1. Steel pipe 18 inches and smaller in diameter shall be API 5L, Grade B; ASTM A 53 (Type E or S), Grade B; ASTM A 106, Grade B; or ASTM A 135, Grade B.

2. See Section 402001 for additional requirements.

B. Mortar Lining and Coating

1. Pipe 12 through 18 inches having grooved-end joints shall have dimensions as shown in the following table:

Nominal Pipe Size (inches)	Steel Cylinder Outside Diameter (inches)	Steel Cylinder Wall Thickness (inches)	Mortar Lining Thickness (inches)	Net Pipe Inside Diameter (inches)
12	14	3/8	5/8	12
14	16	3/8	5/8	14

2. Pipe 12 through 18 inches having joints other than grooved-end shall have dimensions as shown in the following table, except where greater wall thicknesses are required in Section 400722 to accommodate harnesses for flexible pipe couplings:

Nominal Pipe Size (inches)	Steel Cylinder Outside Diameter (inches)	Steel Cylinder Wall Thickness (inches)	Mortar Lining Thickness (inches)	Net Pipe Inside Diameter (inches)
12	14	1/4	3/4	12
14	16	1/4	3/4	14

3. Apply mortar lining in accordance with AWWA C205, using the lining thicknesses specified above. Cement shall be ASTM C 150, Type II.

4. Buried pipe shall be cement-mortar coated per AWWA C205. Cement shall be ASTM C 150, Type II. Mortar coating thickness shall be 1 inch minimum.

5. Hold back the cement-mortar coating 12 inches (minimum) from the end of the plain-end joint where flexible pipe couplings are to be installed.

C. <u>Fittings</u>

1. A fitting is defined as a special piece of pipe other than a normal straight section. Elbows, manhole sections, reducers, and sections with outlets are fittings. See Sections 402001 and 402050.

2. Fittings 12 inches and larger shall comply with Section 402050.

3. Material for fittings larger than 10 inches but less than or equal to 30 inches in diameter shall comply with Section 402050.

4. Grooved-end fittings smaller than 20 inches shall be square-cut grooved, flexible type, with the groove dimensions as shown in AWWA C606, Table 3. Lining and coating of grooved-end fittings shall be as specified previously for pipe. Steel wall thickness shall be standard weight, ANSI B36.10. Mortar lining and inside diameter dimensions shall be the same as the pipe specified previously.

5. Mortar lining thickness and internal diameter dimensions shall be the same as the pipe.

D. <u>Joints</u>

1. Joints for aboveground piping shall be flanged or grooved end, except where flanged joints are required to connect to valves, pumps, and other equipment.

2. Buried joints shall be butt strap welded or bell-and-spigot lap welded, except where flanged joints are required to connect to valves, meters, and other equipment.

3. Grooved-end joints for pipes 18 inches and smaller shall be flexible, square-cut grooved, per AWWA C606, Table 3.

4. See Section 402001 for additional requirements.

E. <u>Outlets and Nozzles</u>

See Section 402001.

F. <u>Grooved-End Couplings</u>

1. See Section 402001.

2. Couplings for pipe smaller than 20 inches shall be flexible type, square-cut grooved, per AWWA C606: Victaulic Style 77, Gustin-Bacon Figure 100, or equal.

G. <u>Flanges</u>

See Section 402001.

H. <u>Bolts and Nuts for Flanges</u>

See Section 400500.

I. <u>Lubricant for Stainless Steel Bolts and Nuts</u>

See Section 400500.

J. <u>Gaskets for Flanges</u>

See Section 400500.

PART 3 - EXECUTION

A. <u>Fabrication, Assembly, and Erection</u>

See Section 402001.

B. <u>Reinforcement</u>

See Section 402001.

C. <u>Shop Testing of Fabricated or Welded Components</u>

See Section 402001.

D. <u>Buried Joints</u>

1. Field-welded joints shall be made in compliance with AWWA C206 and the subsection on "Fabrication, Assembly, and Erection" above.

2. Apply cement mortar to the inside and outside of buried joints per Section 4.7 of AWWA C205. Use cloth diapers to bridge the outside of the buried joint and maintain the specified mortar coating thickness. Pour and rod the mortar from one side only until it is visible on the opposite side.

E. <u>Installing Flanged Piping</u>

See Section 400500.

F. <u>Installation of Stainless Steel Bolts and Nuts</u>

See Section 400500.

G. Installing Grooved-End Piping

See Section 400500.

H. Installing Aboveground or Exposed Piping

See Section 400500.

I. Installing Buried Piping

Install in accordance with Sections 312316 and 402001.

J. Field Pressure Testing

See Section 402001.

K. Painting and Coating

See Section 402001.

L. Coating Buried Bolts and Nuts

See Section 402001.

M. Field Measuring Paint Coating Thickness

See Section 402001.

END OF SECTION

SECTION 402078 STAINLESS STEEL TUBING

PART 1 - GENERAL

A. Description

This section includes materials and installation of stainless steel tubing and fittings 2 inches in diameter and smaller.

B. Related Work Specified Elsewhere

1. Painting and Coating: 099000.
2. Trenching, Backfilling, and Compacting: 312316.
3. General Piping Requirements: 400500.
4. Pressure Testing of Piping: 400515.
5. Manual, Check, and Process Valves: 400520.
6. General Requirements for Steel Piping: 402001.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.
2. Submit materials list showing material of pipe and fittings with ASTM reference and grade. Submit manufacturer's catalog data for swaged fittings and joints.
3. Submit fitting manufacturer's instructions for assembling fittings and joints.

PART 2 - MATERIALS

A. Tubing

1. Tubing shall conform to ASTM A269, Grade TP 316, seamless. Hardness shall not exceed Rockwell B80. Tube wall thicknesses shall be as follows:

Tube O.D. (inches)	Minimum Wall Thickness (inches)
1/8	0.028
3/16	0.028
1/4	0.028
5/16	0.035
3/8	0.035
1/2	0.042
5/8	0.058
3/4	0.065
7/8	0.072
1	0.083
1 1/4	0.109
1 1/2	0.134
2	0.165

2. Tubing shall be free of scratches. Tubing shall be suitable for bending and flaring.

3. Tubing shall be heat treated, which shall consist of quenching in water or rapidly cooling by other means at a rate sufficient to prevent precipitation of carbides, as demonstrated by the capability of passing practice ASTM A262, Practice E (Supplementary Requirement S4 in ASTM A269).

B. Fittings and Joints

1. Fittings and joints shall be of the SWAGELOK type as manufactured by Crawford Fitting Company, utilizing a nut and dual ferrule design to connect to tubing. Fitting and joint material shall comply with ASTM A479, Type 316, or ASTM A182, Grade F316. End connections shall be of the union type.

2. Joints connecting two straight tubes together shall be of the nut and ferrule union type.

C. Protective End Caps

Provide protective end caps on each piece of tubing, completely sealing the piece from contamination during shipment and storage. Provide the same type of seals on each fitting, or ship and store fittings in sealed boxes or containers.

D. Outlets and Nozzles

Use a tee with nut and ferrule union ends to connect to the tubing and with an outlet to match the connecting valve or instrument.

E. Connections to Threaded-End Valves

When connecting tubing to threaded-end valves, provide tube to female NPT connectors. Provide a threaded Schedule 80S Type 316 stainless steel nipple (ASTM A312, seamless) between the connector and the valve end.

PART 3 - EXECUTION

A. Installing Tubing

1. Do not drag tubing out of tube racks. Do not drag tubing across any surface that could scratch it.

2. Keep tube cutters and saws sharp. Do not cut too deeply with each turn of the cutter or motion of the saw.

3. Deburr tube ends before inserting into fittings and joints. Clean both the inside and outside of fitting and pipe ends before making up joints. Do not miter joints for elbows or notch straight runs of pipe for tees. Do not kink tubing.

4. Bends in tubing shall be long sweep. Provide the straight length of tubing recommended by the fitting and joint manufacturer to allow the tube to be inserted into the fitting. Shape bends with shaping tools. Form bends without flattening, buckling, or thinning the tubing wall at any point. Do not use bends to make turns greater than 45 degrees. Use fittings to make turns greater than 45 degrees.

B. Installing Buried Tubing

Install in accordance with Section 312316.

C. <u>Installing Exposed Tubing</u>

Install tubing without springing, forcing, or stressing the tubing or any adjacent connecting valves or equipment.

D. <u>Installing Fittings and Joints</u>

1. Follow the manufacturer's instructions for installing fittings and joints.

2. For fittings and joints larger than 1 inch, use the manufacturer's hydraulic swaging unit to make up the connections.

E. <u>Coating Buried Tubing</u>

Coat buried tubing per Section 099000, System No. 25.

F. <u>Installing Wrapped or Coated Tubing</u>

Install buried tubing having wrapped coatings by extending the wrapping to the first joint after entering a building, penetrating a slab, or 6 inches above finished grade. Wrap joints spirally with a minimum overlap of 50% of the tape width.

G. <u>Field Hydrostatic Testing</u>

1. See Section 402001.

2. Do not allow test water to remain in the tubing for more than five days. Drain and dry the tubing after completing the testing.

END OF SECTION

SECTION 405000 PROCESS CONTROL AND INSTRUMENTATION SYSTEM (PCIS) GENERAL REQUIREMENTS

PART 1 - GENERAL

A. Description

1. This section includes materials, testing, and installation of PCIS as specified herein and indicated on the drawings.

2. These specifications shall not be interpreted as permission or direction to violate any governing code or ordinance. Equipment, materials, and workmanship shall comply with the latest revisions of the following codes and standards:

   a. Instrumentation: ISA - The Instrumentation, Systems, and Automation Society.

   b. Wiring: National Electrical Code (NEC), ISA S5.3, and ISA S5.4.

   c. Control Panels: NEMA 250-2003.

   d. Control Logic: NFPA 79.

   e. Piping: ANSI B31.3 (instrumentation piping).

B. Scope of Work

1. The work involves furnishing all hardware and software, programming, installation, labor, material, equipment, and engineering in strict compliance with the contract documents for the City of Torrance, Well 9 Wellhead Facilities.

2. Interface the new PLC-9 with the existing PLC-6. Modify existing system to allow bi-directional data communications between PLC-9 and existing SCADA system.

3. Modify existing SCADA system to accommodate Well 9. Existing SCADA is Wonderware. Add required screens, trends, alarms, and reports.

C. Submittals

1. Detailed System Drawings and Data: The submittal shall consist of six sets of detailed drawings and data prepared and organized by the Contractor. All drawings, schematics, layouts, and diagrams shall be done on 11" x 17" sheets utilizing AutoCAD. Two sets of submittals will be returned to the Contractor.

2. Submit these drawings and data as a complete package at the same time.

3. Submittals shall be in three-ring hardcover binders and arranged for convenient use including tab sheets, indexed, and cross-referenced with a separate index for each item.

4. Provide manufacturers’ cut sheets and manuals for all hardware to be provided.

5. Provide ISA-type instrumentation data sheets for each component, together with a technical product brochure or bulletin. The data sheets, as a minimum, shall show:

    a. Instrument tag designation.

    b. Component name.

    c. Manufacturer's model number.

    d. Calibrated range.

    e. Instrument location.

    f. Input and output characteristics.

    g. Scale range and units (if any) and multiplier (if any).

    h. Requirements for electric supply.

6. Group the data sheets together in the submittal by type. Provide individual data sheets for each instrument with one brochure or bulletin to cover all identical uses of that component.

7. The detailed construction drawing submittal shall include, as a minimum, the following types of drawings

and diagrams required for the construction of this project:

a. Legend, symbols, and index.

b. System block diagrams.

c. Power distribution diagrams.

d. Instrument control panel layouts/construction drawings/details.

e. PLC/RTU rack elevation drawing for each PLC/RTU.

f. Internal panel wiring diagrams.

g. Digital I/O module wiring diagrams.

h. Analog I/O module wiring diagrams.

i. Detailed NFPA 79-style ladder diagrams (for discrete wiring) to meet the following minimum requirements:

(1) Each subassembly shall be shown as a rectangle in the diagram with all external terminals identified. Terminals unknown at the time of the submittal shall be left blank, to be filled later. Single contacts internal to the subassemblies shall be shown in the rectangle connected to their terminal points.

(2) Where the internal wiring diagrams of subassemblies are furnished on separate sheets, they shall be shown as a rectangle in the schematic diagram with all external points identified and cross-referenced to the separate sheets of the control circuit. Coils and contacts internal to the subassemblies shall be shown in the rectangle connected to their terminal points.

(3) Show unique rung numbers on left side of each rung. A cross-referencing system shall be used in conjunction with each relay coil so that associated contacts may be readily located on the diagram. The contacts shall be referenced to coils as well, so that associated coils may be readily located on the diagram. Where a relay contact appears on a sheet separate from

the one on which the coil is shown, the purpose of the contact shall be described on the same sheet. Spare contacts shall be shown.

(4) Limit, pressure, float, flow, temperature sensitive, and similar switch symbols shall be shown on the schematic (ladder) diagram with all utilities turned off (electric power, air, gas, oil, water, lubrication, etc.) and with the equipment at its normal starting position. If the equipment is shown in a specific position, the position shall be identified.

(5) Contacts of multiple contact devices, e.g., selector switches, shall be shown on the line of the schematic diagram where they are connected in a circuit. A mechanical connection between the multiple contacts shall be indicated by a dotted line or arrow. This does not apply to control relays, starters, or contactors. Additional charts or diagrams may be used to indicate the position of multiple contact devices such as drum, cam, and selector switches.

(6) The purpose or function of all switches shall be shown adjacent to the symbols. The purpose or function of controls such as relays, starters, contactors, solenoids, subassemblies, and timers on the diagram shall be shown adjacent to their respective symbols. The number of positions of the solenoid valve shall be shown adjacent to the valve solenoid symbol.

j. Detailed loop interconnection wiring diagrams (per ISA S5.3 and S5.4) for the entire system showing all control equipment, instrumentation, electrical equipment, components, wiring, routing, boxes (pull, junction, and terminal junction), terminations, wire tags, and wire colors. The diagrams shall show the detailed interconnection of all electrical equipment, instrumentation, panels, enclosures, components, and the like provided under this contract.

k. Arrangement and construction drawings for consoles, control panels, and for other special panels for field installation. These drawings shall include dimensions, location of all components, identification of all components, bill of materials, detailed schematics of all internal wiring, preparation and finish data, nameplates, and the like. These drawings also shall include enough other details to define the style and overall appearance of the assembly, including a finish sample for all panel surfaces.

l. Installation, mounting, and anchoring details for all field instruments and panel-mounted components.

m. An instrument list including all instruments provided under this project.

n. An I/O list for each PLC/RTU in the project.

8. Detailed System Software Submittal: The submittal shall consist of six sets of the software system descriptions and diagrams. Two sets of submittals will be returned to the Contractor. The software submittal can be made as a separate package to be inserted in the original submittal. The following items must be submitted at least eight weeks prior to the factory witnessed test orientation:

   a. Detailed PLC/RTU software logic diagram printouts for each PLC/RTU. Logic diagrams shall be fully annotated such that an individual unfamiliar with the diagram format can fully understand the process control logic presented.

   b. An updated I/O list for each PLC/RTU in the project.

   c. Narrative control descriptions for each analog and discrete control loop. Loop descriptions shall describe how each control loop will operate, the PLC control logic, SCS control and monitoring capabilities, and in general a job-specific description of each control loop in the system.

   d. Sample color printouts of each CRT display, sample printouts of each operator interface display, report, and log for the supervisory control system (SCS) software.

9. Complete Detailed Bill of Materials: Detailed bill of materials for all components shall be provided including complete manufacturer’s name and model number, quantity to be provided, and cross references to data sheet sections.

10. Operation, Maintenance, and Repair Manuals (OMRM):

    a. The organization of the initial submittal required above shall be compatible to eventual inclusion as one volume of the OMRM.

    b. Operation manuals shall be prepared and submitted to the Owner's Representative for preliminary review in six copies. When the Owner's Representative is satisfied that these are complete and properly prepared, six final sets shall be delivered to the Owner's Representative.

    c. The complete OMRM shall contain the following:

        (1) All the information included in the preliminary equipment submittal, the detailed installation submittal, and the additional information required herein, all bound in hard-cover binders and arranged for convenient use including tab sheets, all indexed and cross referenced with a separate index for each item.

        (2) All final “as-built” drawings with the AutoCAD electronic files.

        (3) Electronic files for all PLCs, operator interfaces, and SCADA programming.

        (4) Calibration and maintenance instructions.

        (5) Trouble-shooting instructions.

        (6) Instructions for ordering replacement parts.

D. <u>Qualifications and Responsibility of Contractor</u>

1. The Contractor shall furnish and install all proposed hardware as shown on the drawings and as specified herein. The PLC system installation and wiring connections to peripheral equipment and instruments shall be the responsibility of the system supplier using

qualified personnel possessing the necessary equipment and having experience in making similar installations. Evidence of such qualification, as well as notification of the system supplier assuming unit responsibility, shall be furnished to the Owner in writing prior to commencement of the work.

2. Qualification Evidence: The qualification evidence shall include the following:

   a. Verification that the system supplier shall have had a minimum of five years' experience with the installation and programming of industrial control systems similar in type to those to be installed in this project.

   b. A list of completed similar installations including name, address, and telephone number of the owner, name of project, and date of completion.

   c. The name and qualifications of supervisory personnel to be directly responsible for the programming and installation of the control system.

   d. Software Training Verifications: The supplier shall employ a minimum of two individuals who have been formally trained in the application of the latest revisions releases of following Wonderware SCADA software modules:

      (1) InTouch Advanced.

      (2) InSQL Advanced.

      (3) ActiveFactory.

      (4) IAS - Industrial Application Server.

      The names of programming individuals and the certificates of successful course completion shall be provided upon request.

3. Under this section, the Contractor shall furnish the following:

   a. Instrumentation equipment (Section 405020).

   b. PLC and HMI (Section 405040).

c. Control cabinets (Section 405080).

d. Spare parts per Sections 405020, 405040, and 405080.

e. Special tools and test equipment required by the supplier.

f. Installation, integration, and testing.

g. Documentation.

h. Operator training.

i. Warranty (one year).

j. Shipping and receiving.

4. All calibration and final checkout of the PCIS shall be witnessed by the Owner's Representative to determine if the system complies with the contract documents.

5. The Contractor shall be responsible for coordinating and interfacing with equipment supplied under these contract documents, which are an integral part of the system. Interfacing shall be incorporated in the detailed systems drawings and data section of the contract documents.

6. The system supplier shall be experienced in the design, programming, and service of this type of equipment. In the event of a dispute as to the acceptability of the system supplier, the Owner's Representative shall make the final determination.

E. Guarantee

1. The Contractor shall repair or replace defective components, rectify malfunctions, correct faulty workmanship, all at no additional cost to the Owner during the guarantee.

2. To fulfill this obligation, he shall utilize technical service personnel designated by the Contractor who was originally assigned project responsibility. Services shall be performed within five calendar days after notification by the Owner's Representative.

PART 2 - MATERIALS

A. Designations of Components

In these specifications and on the drawings, all systems and other elements are represented schematically and are designated by numbers, as derived from criteria in ISA standards. The nomenclature and numbers designated herein and on the drawings shall be employed exclusively throughout shop drawings, data sheets, and the like. Any other symbols, designations, and nomenclature unique to a manufacturer's standard methods shall not replace those prescribed above, as used herein, and on the drawings.

B. Instrument Tagging

Attach a stainless steel tag to the instrument at the factory. Permanently mark the stainless steel tag with the instrument tag number and the instrument calibration range. The manufacturer's standard metal nameplate as a minimum shall denote model number, serial number, operating electrical voltage and amperage (when applicable), and date of manufacture.

C. Instrument System Power

1. Power provided for the instrument system at the facility shall be 120-volt ac, single phase, 60 Hz.

2. Where d-c power supplies are not furnished integral with any one instrument system loop, then provide separate solid-state power supplies.

D. Matching Style, Appearance, and Type

All display instruments of each type shall represent the same outward appearance, having the same physical size and shape and the same size and style of numbers and pointers.

PART 3 - EXECUTION

A. Uniformity of Components

Components which perform the same or similar functions shall, to the greatest degree possible, be of the same or similar type, the same manufacture, the same grade of construction, the same size, and the same appearance.

B. Mounting of Equipment and Accessories

1. Mount equipment in accordance with the installation detail drawings as prepared by the Contractor and reviewed by the Owner's Representative. Mount equipment so that they are rigidly supported, level and plumb, and in such a manner as to provide accessibility; protection from damage; isolation from heat, shock, and vibration; and freedom from interference with other equipment, piping, and electrical work. Do not install consoles, cabinets, and panels until heavy construction work adjacent to computer and telemetry equipment has been completed to the extent that there shall be no damage to the equipment.

2. Locate devices, including accessories, where they shall be accessible from grade, except as shown otherwise.

3. Mount local equipment in cabinets or existing panels as specified. Mount associated I/O terminals on a common panel or rack; mounting panels and rack shall be baked enamel.

4. Coordinate the installation of the electrical service to components related to the system to assure a compatible and functionally correct system. All accessories shall be coordinated and installation supervised by the Contractor.

5. Test the completed system after installation to assure that all components are operating within the specified range and all interlocks are functioning properly.

6. Tubing, Valves, and Fittings: All instrument tubing manifolds shall be Type 316 stainless steel, unless otherwise specified elsewhere in these specifications. Tubing runs to transmitters shall be installed with a positive slope in one direction. Fittings and valves shall be Type 316 stainless steel. Block/bleed valves shall be as manufactured by Hex Valve Series HB59 or equal.

C. Calibration

1. Each instrument requiring factory calibration shall be furnished with calibration data. The calibration data shall be factory certified.

2. Calibrate systems after installation in conformance with the component manufacturer's instructions. This shall provide that those components having adjustable features are set carefully for the specific conditions and applications of this installation and that the components and/or systems are within the specified limits of accuracy. Defective elements, which cannot achieve proper calibration or accuracy, either individually or within a system, shall be replaced. Accomplish this calibration work by a technical field representative of the single instrument supplier. He shall certify in writing to the Owner's Representative that all calibrations have been made and that all systems are ready to operate.

D. Factory Testing

1. The fully configured SCADA system shall be successfully submitted to a factory acceptance test before shipment to the jobsite.

2. Factory testing shall take place at a Contractor's facility.

3. Prior to factory system testing, submit a written detailed test procedure for review by the Owner. Notify the Owner in writing four weeks in advance of the scheduled testing.

4. Factory witnessed tests shall demonstrate that the system will perform each operation required for all specified conditions, including both normal and emergency operations and conditions. Provide a certification and log of all tests to the Owner for review and comment.

5. Check panel wiring against approved submittal drawings. Record any changes made during testing of the equipment on the record drawings.

6. The system shall be exercised through operational tests, under factory-simulated conditions, to demonstrate that the system is fully configured to perform all control, logic, monitoring, reporting, logging, archiving, and communications functions as specified and that the system is ready for field installation. All test equipment required to simulate actual field conditions shall be provided by the control system contractor.

7. The factory witnessed test shall take as long as necessary to demonstrate to the Owner and the Owner’s Representative that the system performs each operation.

8. A return visit to the Contractor’s facility for retesting will be at the total expense of the Contractor.

E. Field Testing

1. Exercise systems through field tests in the presence of the Owner in order to demonstrate achievement of the specified performance.

2. Coordinate field tests dependent upon completion of work specified elsewhere. Schedule tests among all parties involved so that the tests may proceed without delays or disruption by uncompleted work.

F. Five-Day Acceptance Test

1. When systems are assessed to have been successfully carried through a complete operational test and the Owner concurs in this assessment, a date to start the system acceptance test involving the Owner's operating personnel will be agreed upon.

2. Recheck the systems at this time to verify proper operation, and make final adjustments. The system testing shall consist of five consecutive days (Monday through Friday) of continuous testing utilizing the Owner's day shift working hours. The Contractor shall be on call ready to respond to the site within two hours after day shift working hours and on weekends. The Owner’s Representative will determine the severity of the problem to the best of his ability and contact the Contractor for disposition. This arrangement will in no way relieve the system supplier of responding within 2 hours and resolving the problem in a mutually agreed upon time frame not greater than 48 hours.

3. The acceptance tests shall have a success factor of 95% system uptime. If the system should fail below the 95% factor, correct the system problems. System start-up shall start over again from day one. This will continue until the system functions for 5 consecutive days with a 95% uptime success factor.

G. Operator Training

1. Provide the Owner's operating personnel and/or the Owner’s Representative with two days of formal instruction in the functions and operations of each system provided under this contract. The training shall cover overall system theory, hardware architecture, the operating system, programming instruction in the applicable languages, utility, programs, system generation, and diagnostics. The programming instruction shall include program development, coding, sample programs, and debugging at every programming level. Actual programming exercises and hands-on experience shall be emphasized. Emphasis shall also be placed on safety features and features which may require readjustment, resetting or checking, and recalibration by them from time to time.

2. Provide the training sessions at the Owner's facilities and on the equipment furnished under this contract. The education and instruction of operating personnel shall be by a qualified instructor familiar with the requirements for this project. Each training session shall be for eight hours of formal instruction. Session dates shall be directed by the Owner. There will be two one-day training sessions, which shall not coincide with any system testing or start-up activities.

END OF SECTION

SECTION 405010 PROCESS CONTROL AND INSTRUMENTATION SYSTEM LOOP DESCRIPTIONS

PART 1 - GENERAL

A. Description

1. The descriptions, together with the detail drawings and instrumentation diagrams, comprise the functional design criteria of the process instrumentation and control system (PCIS). The process and instrumentation diagrams (P&IDs) represent the basic concept of the PCIS requirements, whereas the descriptions supplement the instrumentation diagrams.

2. The PCIS supplier shall utilize the descriptions and P&IDs as the basic criteria for the design of the instrumentation schematics, control software, preparation of data sheets, wiring diagrams, piping layouts, assembly drawings, and other requirements set forth in these specifications.

3. The PCIS will provide an integrated control and reporting system. The function of this system is to monitor, control, report, and safeguard the system. The PCIS system will be based on RTUs, linked to a SCADA computer and peripherals, with selected monitoring and alarm functions displayed in the control room.

4. Status-to-Command Disagreement (STCD): Provide an STCD alarm for all equipment controlled with the control system. The STCD alarm shall be initiated if a piece of equipment is commanded to start/stop or open/close by a PLC and the appropriate run or position status is not reported back within a time interval.

5. Provide high-high, high, low, low-low, rate of change, and instrument fail alarms for all analog points in the system. If a particular alarm is used by ladder logic or requires to be displayed at local operator interface, that alarm shall be implemented at the PLC.

6. All software switches shall be implemented with associated time delays. Time delay value shall be preprogrammed initially to 10 seconds, unless specified otherwise.

7. All flow values and motor elapsed running time shall be totalized and stored at the PLC. Resetting of those totals shall be coordinated with Owner's Representative during submittal stage.

8. If a field instrument with an analog output has additional alarm discrete (dry contact) outputs, at least one common alarm discrete output shall be interfaced with a PLC to send an advisory alarm to SCS.

9. All scaling of analog signals shall be implemented at the PLCs. Each PLC shall interface with an operator interface and with PLC network/SCADA system using data in engineering units.

10. At each PLC, the processor shall monitor the internal operation of the PLC and communication system for failures. If a failure is detected, a dry contact closure shall close and illuminate the “PLC Fail Light” at an ICP.

11. SCADA system shall monitor communication with each PLC. If a communication failure with a PLC is detected, an alarm shall be generated and logged.

B. Related Work Specified Elsewhere

1. PCIS General Requirements: 405000.

2. Instrumentation Equipment: 405020.

3. Programmable Logic Controller and Operator Interface: 405040.

4. Instrument Control Panel: 405080.

PART 2 - MATERIALS

A. Loop 001, Existing Reservoir Level Monitoring

1. The existing reservoir level shall be monitored via existing level transmitter. Level shall be reported to SCS for indication and recording.

2. Provide I/I isolator at the existing RTU 6 Cabinet for proper interface with PLC-9.

B. Loop 097, Intrusion Monitoring

Upon an intrusion, an alarm shall be transmitted to the SCS for indication and logging.

C. Loop 110, Well Level Monitoring

1. Well 9 level shall be monitored via level transmitter. Level shall be reported to SCS for indication and recording.

2. Well low level alarm shall be sent to the SCS.

3. When a well low-low level is detected, the well pump shall be latched disabled and the "Well Low-Low Level Alarm" shall be generated and sent to the SCS.

4. provide a "RESET" button at SCADA.

D. Loop 111, Well Control

1. Well Control Logic:

   a. Well shall be controlled to maintain a reservoir level within a preset range. The operator shall enter low and high reservoir level set points. The PLC shall call the well when the reservoir level drops below the low level set point. The well shall stop once the high level set point is reached.

   b. Well is treated as not available when at least one of the following conditions is present:

      (1) Well is not in AUTO at the SCS.

      (2) Well READY signal from the VFD is not detected.

      (3) Fail alarm signals from VFD is detected.

      (4) Well STCD is detected (see Part 1 Para A.4 above).

      (5) Well low-low level is detected.

   c. To clear STCD latched alarm, an operator shall toggle HOA switch at VFD from AUTO and back to AUTO.

2. An operator shall be able to adjust pump speed from SCS.

E. Loop 117, Flow Monitoring

1. Flow shall be monitored by flowmeter FE/FIT-117.

2. When well pump is running, the flow value shall be totalized.

3. When the well is running and the flow remains below the preprogrammed abnormal low flow set point for a preprogrammed time interval, or if flow remains above the preprogrammed abnormal high flow set point for a preprogrammed time interval, the well shall stop and an alarm shall be generated.

PART 3 - EXECUTION

See Section 405000.

END OF SECTION

SECTION 405020 INSTRUMENTATION EQUIPMENT

PART 1 - GENERAL

A. Designations of Components

In these specifications and on the plans, all systems, meters, instruments, and other elements are represented schematically and are designated by numbers, as derived from criteria in ISA standards. The nomenclature and numbers designated herein and on the plans shall be employed exclusively throughout shop drawings, data sheets, and the like. Any other symbols, designations, and nomenclature unique to a manufacturer's standard methods shall not replace those prescribed above, as used herein, and on the plans.

B. Signal Characteristics

Wherever possible and feasible, components shall be of electronic solid-state design and systems shall utilize the same signal characteristics throughout each and all of the several systems; transmission signals shall be 4 mA to 20 mA. The combined power supply and transmitter loops shall, when tested with appropriate precision resistors, present a voltage signal of 1 to 5 volts dc. Signal isolators shall be provided where required.

PART 2 - MATERIALS

A. Level Transmitter--Submersible

1. The submersible all-titanium pressure transmitter shall provide an electrical 2-wire d-c current signal proportional to the pressure applied to the unit's diaphragm-sensing element. The pressure-sensing element shall be diffused silicon semiconductor with a process media operating temperature range of −4°F to 140°F. Provide the pressure transmitter with the following features:

    a. Waterproof cable with internal vent to atmosphere rated for transmitter suspension up to 300 feet.

    b. Conduit adapter.

c. Cable strain relief.

d. Internally adjustable span.

e. A separate suspension cable for transmitters suspended over 20 feet.

2. Accuracy of the pressure transmitter shall be ±0.25% of calibrated span.

3. The pressure transmitter shall be that manufactured by Druck, Inc., Model PTX 1230 or equal.

LEVEL TRANSMITTER--SUBMERSIBLE

	GENERAL	
1.	Tag No.	LT-110
2.	P&ID No.	N-101
3.	Service	Well Level
4.	Quantity	1
	TRANSMITTER	
5.	Location	Well
6.	Diaphragm Material	Titanium
7.	Output Signal	4 mA to 20 mA
8.	Output Signal to	PLC
9.	Range	0 to 180 feet
10.	Mounting Detail	Det. 2 Dwg. N-102
11.	Cable Length	215 feet
	SERVICE CONDITIONS	
12.	Process Media	H_2O
13.	Specific Gravity	1.0
14.	Oper. Press. (psig)	N/A
15.	Temp. (°F)	40 to 80
16.	Power	24 volts dc

END OF SECTION

SECTION 405040 PROGRAMMABLE LOGIC CONTROLLER AND OPERATOR INTERFACE

PART 1 - GENERAL

A. Description

This section includes requirements for materials, testing, and installation of a control system.

PART 2 - MATERIALS

A. Designations of Components

In these specifications and on the plans, all systems and other elements shall be designated by numbers as derived from criteria in ISA standards. The nomenclature and numbers designated herein and on the plans shall be employed exclusively throughout shop drawings, data sheets, and the like. Any other symbols, designations, and nomenclature unique to a manufacturer's standard methods shall not replace those prescribed above, as used herein, and on the plans.

B. PLC System

1. A fully integrated programmable logic control system shall be furnished as specified in this section. The programmable logic control system hardware shall be intelligent process control units with analog and discrete I/O for process interface.

2. The a-c power of the control system will be 120-volt ±10% ac, 60 hertz, single phase derived from line power. The system shall be designed to operate satisfactorily from 0°C to 60°C ambient temperature for the PLC.

C. PLC

1. The PLC shall be a 16-bit PLC microprocessor-based stand-alone device. It shall be a process and logic controller designed for industrial environments. It shall be capable of a mix of logic, timing, counting, computation, library of preprogrammed subroutines, and PID loop control capabilities necessary for the unit process application. The PLC shall utilize a

"prepackaged"/"preprogrammed" approach to functionality to allow its use by personnel who have no formal training in digital equipment, digital communications, or software programming.

2. The PLC shall come complete with central processor, memory, power supply, interconnecting cables, and discrete and analog I/O interfaces.

3. The logic and variable memory shall be read/write RAM. All RAM shall have integral battery backup that will maintain the memory for a minimum of six months upon a utility power failure. The logic and variable memory shall have a sufficient ladder logic location for programming all specified functions plus 25% spare memory.

4. The PLC shall have the following features:

    a. Logic Control: The PLC shall be capable of performing the same functions as conventional logic systems including on delay timers, off delay timers, counters, and drum sequencers.

    b. Compare Function: The PLC shall perform the compare function that compares two integers or floating point numbers for less than, equal to, greater than, and not equal to. The programmed function shall energize when true and de-energize it when false.

    c. Move Function: The PLC function shall move an integer or floating point value from one memory location to another memory location when an internal permissive is enabled.

    d. Math Function: The PLC shall be capable of performing addition, subtraction, multiplication, and division on integer or floating point numbers.

    e. Analog Controllers: The PLC processor shall perform all the functions of the conventional three-mode (PID) analog controller. The controller shall perform proportional only control, proportional plus reset, and proportional plus reset plus derivative and integral only control. The controller shall be the conventional three-mode controller.

f. The PLC shall be able to generate PID loops with a minimum sample time of 1.0 second. PID tuning constants shall have the following adjustable range:

Proportional Gain	0.0% to 99.99%
Reset Time	0.01 to 999.99 minutes
Derivative Time	0.00 to 999.99 minutes

g. Time-of-Day Clock: The PLC shall have an internal time-of-day clock/calendar running independently of the CPU.

h. PLC System Alarm: The PLC processor shall monitor the internal operation of the PLC system for failures. If a failure is detected, the system shall shut down and freeze all inputs and outputs in their last states until the error is cleared. As a minimum, the following failures shall cause the PLC to shut down:

(1) Memory failure.

(2) Memory parity error.

(3) I/O cycle failure.

(4) Operating system error.

5. Input/Output:

a. The PLC discrete input 16-channel modules shall be 24-volt dc or 120-volt ac and have noise filters or use other techniques to reject short-time constant noise and 60-Hz pickup.

b. The PLC discrete output modules shall be 120-volt a-c or 24-volt d-c solid-state drivers suitable for operating control relays. Each discrete output module shall include fuses and fuse blown indicators.

c. The PLC analog inputs (eight-channel module) shall be suitable for accepting 4 mA to 20 mA from either 2- or 4-wire transmitters. The input power shall be from an external 24-volt d-c power supply. The analog to digital converter shall have a 12-bit minimum resolution with an overall accuracy of 0.5% at 60°C.

d. Discrete PLC I/O modules shall have individual LED status lights for each I/O point.

e. All discrete and analog modules shall have terminal blocks for termination of the I/O wires.

f. Individual I/O points shall be capable of withstanding low energy common mode transients to 1,500 volts.

6. Provide the following minimum spare I/O: 50% of channels used.

7. The PLC shall be CompactLogix or ControlLogix by Allen-Bradley; no equal.

D. PLC Software

1. All PLC programming shall be in ladder logic using a standard Windows-based package developed for this purpose.

2. All programming, monitoring, searching, and editing shall be accomplished with the PLC programming software. The programming software shall be usable while on-line, off-line, and shall have the ability to emulate/run the PLC program using the programming unit. The PLC program shall display multiples of series and parallel contacts, coils, timers, counters, and mathematical function blocks. The software shall be able to monitor the status of all inputs, outputs, timers, counters, and coils. It shall have the capability to disable/force all inputs, outputs, and coils to simulate the elements of the ladder logic by means of color change. The software shall include a search capability to locate any address or element and its program location. PLC status information, such as error indication and amount of memory remaining, shall be shown on the display screen.

3. A licensed copy of a programming package registered to the Owner shall be provided.

4. The programming package shall be RSLogix 500 by Allen-Bradley.

E. <u>Operator Interface</u>

1. Provide, program, test, fully configure, and place into operation operator interface as indicated herein.

2. The operator interface shall be a panel-mounted electronic assembly that allows bi-directional communication with a PLC.

3. The operator interface shall be a TFT type and have touch screen capability. The unit shall employ flash memory for storing the application specific symbols and data. The unit shall be capable of handling up to 160 touch areas per screen display and a minimum of 50 screens. Each touch area shall provide audible feedback to the operator.

4. The unit shall meet the following requirements:

   a. Size: 8-inch diagonal (nominal)

   b. Display View: 7.5-inch diagonal, minimum

   c. Resolution: 640 x 480 pixel, minimum

   d. Brightness: 300 nits, minimum

5. Screens shall be configured using an off-line PC-based software package that operates in the Windows environment. Each display screen shall consist of graphic representations of legend plates, push buttons, pilot lights, numeric data displays, numeric data entry buttons, bar graphs, time displays, text displays, selector switches, illuminated push buttons, counter/timer numeric preset, and increment/decrement buttons. Graphics can be created using any software that produces standard BMP files. Applications shall be downloaded to the operator interface device and stored in flash memory.

6. The unit shall be capable of displaying text messages that can be triggered by the status or values of bits or numeric variables in the PLC. In addition, the unit shall be capable of accepting and displaying text messages that are stored in PLC as ASCII strings.

7. Graphics: The operator shall monitor and control the system using a number of preconfigured graphic displays,

which represent the particular equipment and processes being controlled. Minimum of five screens shall be programmed for each process unit shown on a single P&ID. Graphic displays shall be provided illustrating a process flow using symbols to represent equipment with process flow direction lines connecting the symbols. Symbols shall be used for pumps, motors, valves, and primary elements. Adjacent to each discrete graphic symbol, the description shall be included. Adjacent to each analog graphic symbol, the point description, current value, and engineering units shall be displayed. Alarm messages shall flash. All process lines, structures, and equipment shall be identified with the proper nomenclature. The P&IDs provided under these specifications shall be used to help generate graphics displays.

8. The operator interface shall communicate with the PLC in a fashion as determined by the PLC manufacturer. A communication driver shall be provided with the editing software.

9. All cables for communication between the unit and the PLC shall be provided along with a cable for serially interfacing the device with a personal computer.

10. The operator interface shall be C-more by Automationdirect, PanelView Plus by Allen-Bradley, Silver Plus Series by Maple Systems, EZSeries by EZAutomation, or equal.

F. Ethernet Switch

1. Ethernet switch shall be DIN-rail mountable. Ethernet switch shall be in full compliance with standards set forth by IEEE 802.3. Switch shall have a minimum of five Ethernet ports. LEDs on each port shall indicate link data rate and activity status. A power LED shall indicate that power is applied to the unit.

2. Ethernet switch shall meet the following specific requirements:

   a. Operation: 10/100 Mbps, full and half duplex, auto-negotiation.

   b. Switching Properties: Store and forward.

c. Number of MAC addresses: 1,024.

d. Up to 1.0 Gb/s maximum throughput.

e. Minimum of 64K of message memory.

f. Interface: RJ-45 10/100BaseTX ports.

g. MDIX auto cable sensing.

h. Operating Temperature: -20°C to 60°C.

i. Operating Humidity: 10% to 95% (noncondensing).

j. MTBF: 100,000 hours minimum.

3. The Ethernet switch shall be Contemporary Control Systems Model EISK5-100T, B&B Electronics Model IASW5P, Moxa Technologies Model EDS-205, or equal.

G. Spare Parts

1. The Contractor shall furnish to the Owner all necessary spare parts of components required to maintain the system. Prior to final acceptance of work, the Contractor shall provide a spare parts listing of all necessary spare parts and quantities for review by the Owner's Representative. The spare parts shall include the following minimum requirements:

Part Description	Quantity
Power Supply	1 each
CPU and Memory Module	1 each
Analog Input Module	1 of each type
Discrete Input Module	1 of each type
Discrete Output Module	1 of each type

2. The Contractor shall deliver to the Owner all the required spare parts upon final acceptance of the work. The spare parts shall not be used as replacement parts during the guarantee period.

PART 3 - EXECUTION

Refer to Section 405000.

END OF SECTION

SECTION 405080 INSTRUMENT CONTROL PANEL (ICP)

PART 1 - GENERAL

A. Description

This section includes requirements for materials, testing, and installation of the cabinets and consoles to be provided by the system contractor under Section 405000.

PART 2 - MATERIALS

A. Free-Standing ICP

1. The panel shall be a floor-mounted NEMA 12 enclosure and shall be constructed from 14-gauge formed steel throughout. Access door shall have door bars on inside surface and continuous hinges. All exposed edges and welds on the enclosure shall be ground smooth. No penetration through the cabinet door or exterior with rivets, screws, bolts, or back of panel nuts shall be allowed. The enclosure shall provide protection against dirt, dust, oil, and water. The interior shall be provided with a formed 12-gauge subpanel for attaching surface-mounted components. All components shall be attached with screws, and the subpanel shall be threaded.

2. Rivets or back of panel nuts, screws, or bolts shall not be allowed. No panel penetration is allowed, except for the conduit entry.

3. Provide a fluorescent lamp in the panel. Each interior shall be equipped with a 120-volt, 15-ampere duplex utility outlet and a single-pole, 15-ampere, 120-volt circuit breaker protecting the outlet and the lamp. The utility outlet and the lamp shall be powered by utility power.

4. Power distribution system shall include a UPS to be powered from a designated "Utility Power for UPS" receptacle. The power distribution system shall be connected to the UPS output by a cord with a plug matching the UPS outlet. Provisions shall be made to allow the UPS to be bypassed, i.e., power distribution system to be powered from the utility power by the power

cord connected to the "Utility Power for UPS" receptacle.

5. A folding shelf at least 18 inches wide and a documentation pocket shall be provided at the panel. The shelf shall be secured to the door bars in a way to allow vertical adjustment of the shelf location.

6. Refer to instrument drawings for enclosure size and installation details.

7. The enclosure shall be Hoffman NEMA 12 Quote 144591 or equal.

B. <u>Panel Control Circuit Devices and Components</u>

1. General: All components, except those on the front panels, shall be mounted behind on fixed or swing-out panels; terminal blocks for field connections shall be mounted on fixed channels located near the bottom of the sections but clear of the conduit entry area. Fixed panels shall be located so as not to prevent access within the cabinets to other components, wiring, and terminal blocks on fixed panels or front panels.

2. All electrical devices within the panel shall be identified by tag number, machine printed on a label visible from the panel interior. Labels shall be made of durable plastic tape with an adhesive backing. The labels shall have rounded corners and shall be consistent in size throughout the panel.

3. Control Relays:

   a. Control relays shall have 120-volt a-c or 24-volt d-c coils, except as noted; contacts shall be rated for the various circuit applications shown on the drawings. Control relays shall be 10-ampere, multiple-contact, 300-volt, plug-in type with dust cover and sockets. The relays shall be equipped with the following features:

      (1) Retaining clip.

      (2) Test button lockable in "ON" position.

      (3) Mechanical flag for contact status indication.

      (4) Pilot light for coil power indication.

b. If additional contacts are required, they shall be ganged.

c. The relays shall be Releco General Purpose Relays, Allen-Bradley Bulletin 700-HA, IDEC series RU, or equal. All control relays shall be products of one manufacturer.

4. Circuit Breakers: Circuit breakers shall be single-pole, 120-volt, 15-ampere rating.

5. Feed-Through Terminal Blocks: Feed-through terminal blocks shall be modular DIN rail mounted with plastic insulating housings and screw secured cage clamp wire termination and shall be rated 20 amperes at 300 volts. Current-carrying parts shall be made of at least an 85% copper alloy, nickel plated for maximum conductivity and resistance to corrosion. Terminal blocks shall provide a secure oxide-film free connection to the wire without the use of spades, ring tongues, or ferrules. Terminal blocks shall have captive screws and a built-in vibration resistance mechanism, which locks the screw connection in place after the wire has been terminated. A bridge bar for cross connection shall be provided. A test adapter for a banana jack shall be provided. The test adapter shall provide a positive test connection to the terminal block and shall lock into place for hands-free operation. White marking strips, fastened securely to the molded sections shall be provided and wire (terminal) numbers or circuit identifications shall be marked thereon with permanent marking fluid. Feed-through terminal blocks shall be Phoenix Contact Type UK 4, Allen-Bradley Series 1492-W, ABB (Entrelec) Series M4/6.NC, Sprecher+Schuh Cat. No. V7-W4, or equal.

6. Fuse Terminal Blocks: Fuse terminal blocks shall be the same profile, but different color as the feed through terminal blocks, and shall have blown fuse light indicator. Fuse terminal blocks shall be Phoenix Contact Type UK 4-TG or equal.

7. Disconnect Terminal Blocks: Disconnect terminal blocks shall be of knife disconnect type. The blocks shall have a universal foot for mounting on DIN rail and a width of the feed-through block. Disconnect terminal blocks shall be Phoenix Contact Type UK 5-MTK-P/P or equal.

8. D-C Power Supplies: Provide d-c power supplies as required for analog loops and d-c circuits. Each power supply shall be enclosed and include internal short-circuit protection. Current requirements shall not exceed 75% of manufacturer maximum rating.

9. Receptacles: Duplex receptacles shall be molded composition, ivory, specification grade, with finder groove face. Duplex receptacles for 120-volt, single-phase, 3-wire service to be rated 20 amperes, 125 volts, back or side wired, NEMA Type 5-20R. Duplex receptacles shall be Arrow-Hart No. 5352I, Bryant No. BRY5362-I, Hubbell No. CR5362-I, or equal.

10. Indicating Lights: Indicating light shall be push-to-test transformer type with LED.

C. Panel Control Circuit Wiring

1. Wire Type and Size: Instrumentation signal cables shall be of the type used for process control with shielded pairs or triads with polyvinyl jacket and overall shield over the multiple pairs or triads. The instrumentation cable shall be rated 300 volts at 90°C or better. The size of the instrumentation cable shall be AWG No. 18 with seven strands minimum, unless otherwise specified elsewhere. All instrumentation cables shall meet all the requirements of IPCEA S-61-402 and shall be UL listed.

2. 120-volt a-c wiring within the panel shall be AWG No. 14 THHN. Main power (120-volt ac) to the panels shall be wired using color-coded AWG No. 12. A-C power to all system power supplies. Wires shall be color coded in accordance with the following table:

Black	L1 (hot)
White	L2 (neutral)
Red	AC control circuits
Blue	DC circuits
Yellow	Interlock control circuits wired from an external power source
Green	Equipment ground

3. All interfacing between the cabinets and the field shall be accomplished at a terminal strip (TB-1). No internal panel wiring shall be connected to terminals on the

"field side" of TB-1. Likewise, no field wiring shall be connected to terminals on the "panel side" of TB-1.

4. All intentionally grounded, grounding, and bonding conductors shall be sized by NEC Article 250 as required.

5. Wires carrying voltage from external devices and one wire from an analog loop shall be terminated at the disconnect terminal block.

6. Only one wire shall be terminated at each side of a terminal block. A bridge bar shall be used for cross connection.

7. Wiring run from components on a swing-out panel to other components on a fixed panel shall be made up in tied bundles. These shall be tied with nylon wire ties and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at terminals.

8. Wiring run to control devices on the front panels shall be tied together at short intervals and secured to the inside face of the panel using Panduit adhesive mounts with Eastman No. 910 adhesive.

9. Wiring to rear terminals on panel-mounted instruments shall be run in plastic wireways secured to horizontal brackets run above or below the instruments in about the same plane as the rear of the instruments.

10. Conformance to the above wiring installation requirements shall be reflected by details shown on the shop drawings for the Engineer's review.

11. Signal conditioners and control interface relays shall be provided wherever proper instrument interfacing dictates use of these components. Each auxiliary device shall be assigned a tag number and shall appear on the panel shop drawings.

12. Wire Marking: Each signal and circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all shop drawings. These numbers shall be marked on all conductors at every terminal. The markers shall be permanent sleeve type with machine printed

black markings. Markers shall be Thomas & Betts Series EZS, Tyco Series RPS, or equal.

13. Terminal Marking: Each terminal shall be identified by a single unique number. Hand-written labels shall not be allowed. The match between the terminal identification and the wire identification is not required.

14. All electrical devices within the panel shall be identified by tag number, machine printed on a label visible from the panel interior. Labels shall be laminated plastic with an adhesive backing. The labels shall be consistent in size throughout the panel.

D. Spare Parts

1. The Contractor shall furnish to the Owner all necessary spare parts of components required to maintain the system. Prior to final acceptance of work, the Contractor shall provide a spare parts listing of all necessary spare parts and quantities for review by the Owner's Representative. The spare parts shall include, but not be limited to, the following minimum requirements:

MINIMUM SPARE PARTS LIST	
Part Description	**Quantity**
Power supply	1 each type
Relays	2 each type

2. The Contractor shall deliver to the Owner all the required spare parts upon final acceptance of the work. The spare parts shall not be used as replacement parts during the guarantee period.

PART 3 - EXECUTION

Refer to Section 405000.

END OF SECTION

SECTION 409715 PRESSURE GAUGES AND PRESSURE SWITCHES

PART 1 - GENERAL

A. Description

This section includes materials and installation of pressure gauges, vacuum gauges, compound pressure/vacuum gauges, gauge protectors, diaphragm seals, pulsation dampeners, pressure switches, and accessories.

B. Related Work Specified Elsewhere

1. Pressure Testing of Piping: 400515.

2. Manual, Check, and Process Valves: 400520.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit manufacturer's catalog data and descriptive literature. Call out materials of construction by ASTM reference and grade. Submit manufacturer's certificate of compliance with the referenced ANSI standards. Identify each gauge and pressure switch by tag number to which the catalog data and descriptive literature pertain.

PART 2 - MATERIALS

A. Pressure Gauges

1. Pressure range shall be as designated by the following type numbers shown in the drawings:

Type Number	**Description**	**Pressure Range**
3	Pressure	0 to 30 psi
4	Pressure	0 to 60 psi
5	Pressure	0 to 100 psi

2. If no type number is shown in the drawings, use Type 4 gauges.

3. A suffix "F" on the type number means that the gauge shall be filled with glycerin or silicone. For example, a callout in the drawings of "Type 3F Pressure Gauge" means a 0- to 30-psi gauge, liquid filled.

4. Gauges shall comply with ASME B40.1, Grade 2A. Gauges shall incorporate the following features:

   a. Solid or open front with side or rear blowout relief.

   b. Pressure tight.

   c. 270-degree arc with adjustable pointer.

   d. Stem mounted.

   e. Hermetically sealed unless specified to be liquid filled.

   Size of gauge shall be 4-1/2 inches, unless otherwise indicated in the drawings. Stem or connection size shall be 1/2 inch.

5. Materials of construction shall be as shown in the following table:

Item	Material	Specification
Case	Stainless steel, aluminum, polypropylene, or phenolic plastic	AISI 316, 6061-T6
Bourdon tube	Stainless steel	AISI 316
Windows	Acrylic plastic	---
Ring	Stainless steel	AISI 316
Stem	Stainless steel	AISI 316
Dial face	Aluminum with clear baked-on acrylic coating	ASTM B209, 6061-T6

B. Pressure Switches

1. Pressure switches shall be brass bourdon tube type actuating an enclosed, metal contact snap-action switch. Switch shall have separate set point and reset point adjustments. Adjustment of the switch set points and viewing of the set point indicator shall be accomplished

without having to gain access to the interior of the unit. Pressure switch range and number of switch contacts shall be as indicated in the table below. Enclosure shall be watertight NEMA 4. Provide Mercoid Series DA, United Electric H400 series, or equal.

2. Two-stage pressure switches shall be as described above except with two independent switches, each with separate set point adjustments and fixed differential.

3. Service Conditions:

Pressure Switch Tag Number	Type	Pressure Switch Range (psi)	Number of Contacts	Set Points (psi)	Diaphragm Seal Required?	NEMA Enclosure
PSHL-111	Two Stage	2 to 60	2	5, 15	No	4

C. Gauge and Pressure Switch Protectors

1. Gauge and pressure switch protectors shall consist of three parts: a flexile, impermeable, elastomer cylinder; a captive sensing liquid; and a steel or stainless steel housing. The process liquid pressure shall be transmitted through the elastomer-lined cylinder wall and the sensing liquid to the pressure gauge. An attached 4-1/2-inch pressure gauge shall indicate the pressure. Gauge outlet in the spool or ring shall be threaded, 1/4 or 1/2 inch, per ASME B1.20.1. Spools shall be of either the isolation-spool type with flanged ends or of the isolation-ring type, fitting between two adjacent flanges. Determine the flange rating based on the test pressure shown in Section 400515. For test pressures 200 psi and less, use Class 150 flanges, ASME B16.5. For test pressures greater than 200 psi, use Class 300 flanges, ASME B16.5.

2. Materials of construction shall be as follows:

Item	Material	
	Type 1	Type 2
Housing, flanges	Type 316 stainless steel	Carbon steel
Flexible cylinder	Teflon	Buna N or neoprene
Sensing liquid	Silicone oil	Silicone oil

3. Use Type 1 gauge protectors if no type number is shown in the drawings.

4. Protectors shall be manufactured by Ronningen-Petter; Red Valve Company, Inc.; Onyx; or equal.

D. Type 2 Diaphragm Seals (Plastic)

1. Provide diaphragm seals with gauge assemblies where shown in the drawings. Bodies shall be molded CPVC with Viton membranes. Provide air bleed ports. Mount the pressure gauge directly on the socket of the diaphragm seal top housing. Instrument (gauge) connection shall be 1/2 inch. Diaphragm seal connection socket shall be 1/4-inch threaded female. Pressure rating shall be at least 150 psi. Provide Type 5F gauge per the above specifications. Products: Hayward Industrial Products, Inc., or equal.

2. Gauge and diaphragm seal shall be assembled together at the factory with the liquid fill included.

E. Pulsation Dampeners

Provide pulsation dampeners with gauge assemblies where shown in the drawings. Material of construction shall be Schedule 80 CPVC. Dampening shall be achieved by use of a pin in selected holes. Pin shall move up and down in normal operation. Connections shall be NPT female and shall match the connection size of the attached pressure gauge.

F. Pipe Nipples and Fittings

Nipples for connecting gauges and pressure switches to piping shall be Schedule 80S, Grade TP 304 seamless stainless steel, conforming to ASTM A312. Fittings shall conform to ASTM A403, Class WP304. Threads shall conform to ASME B1.20.1. Size of pipe nipple shall match the gauge or pressure switch connection size.

G. Tools for Gauges

Provide two gauge tool kits, each containing a hand jack set, screwdriver, five reamers (minimum), two pin vise holders, wiggler, tweezer, and carrying case.

PART 3 - EXECUTION

A. Installation

Install gauges and pressure switches before conducting pressure tests. Do not disassemble gauges from the factory-assembled diaphragm seals or isolation sleeves or rings.

END OF SECTION

SECTION 409726 PROPELLER METERS

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation of magnetic-driven propeller-type flowmeters.

B. Related Work Specified Elsewhere

1. Fusion-Bonded Epoxy Linings and Coatings: 099761.

2. Pressure Testing of Piping: 400515.

3. Fusion-Epoxy Lined and Coated Steel Pipe: 402057.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.

2. Submit manufacturer's catalog data and detail drawings, showing dimensions, pressure rating, coatings, and materials of construction specifications (such as AISI, ASTM, SAE, or CDA) and grade or type. Show inside diameter of meter tube.

PART 2 - MATERIALS

A. Manufacturers

Propeller meters shall be McCrometer Standard Model MW-500, no equal, as modified herein.

B. Meter Design and Standards

1. Meter shall comply with AWWA C704 except as modified herein.

2. Propeller meters shall utilize a magnetic drive with sealed housing.

3. The magnetic drive design shall utilize a stainless steel disc or separator assembly to isolate the water area from the mechanical drive. The magnet may be an

axial or radial type. No packing gland seal arrangement will be permitted.

C. Materials of Construction

1. Impeller shall be made of a polyethylene urethane having a durometer hardness of 75 on the "D" scale. Material shall be nonhygroscopic.

2. Propeller shaft bearings shall be hardened 440-C stainless steel ball bearings or water-lubricated ceramic bearings. All other bearings inside gear box or on vertical shaft shall be stainless steel ball bearings.

3. Bearing housing or gear box shall be brass or bronze per paragraph 4 below. Propeller shaft or spindle shall be Type 303 or 316 stainless steel. Provide a rigid stainless steel vertical shaft from the gear box to the totalizer.

4. Bronze shall have the following chemical characteristics:

Constituent	**Content**
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

5. Magnets shall be made of Alnico V or ceramic material. The diaphragm disc or separator between the magnets shall be Type 316 stainless steel.

6. Meter bodies shall be steel, ASTM A53 (Type E or S) or ASTM A135. Wall thickness shall be standard weight per ASME B36.10.

D. Lining and Coating

Line and coat meters with fusion-bonded epoxy per Section 099761. Coat straightening vanes the same as the meter tube.

E. End Connections

Meter end connections shall be grooved end.

F. Registers

Register shall be a six-digit direct-reading totalizer type, with a test hand for timing purposes, calibrated in hundreds of U.S. gallons. Flow indicator shall have a 250-degree dial calibrated in U.S. gpm. The indicator mechanism shall be temperature compensated, so that indicator hand shall be accurate and linear within ±1% at all points on the dial when operating at temperatures of 32°F to 140°F. Provide silica gel envelopes within the register case to absorb moisture. Equip totalizer bonnet with padlock hasp. Register and drive shall be removable without removing the meter from the line.

G. Transmitters

Transmitter shall be solid state and integral within the propeller meter register body. The transmitter shall be powered by an external 10- to 30-volt d-c power supply and shall provide a 4- to 20-mA equal to 0-3,000 gpm. Indicator-totalizer-transmitter shall be Water Specialties Model TR-16, Sparling FT-193-111 with L1-785-9 indicator, or equal.

H. Meter Accuracy and Rated Flows

Accuracy shall be ±2% of the true flow, within the ranges specified in Table 1 herein.

I. Pressure Rating

Minimum operating pressure rating shall be 150 psig.

J. Straightening Vanes

Straightening vanes, where required, shall be three-vane type, equally spaced, with one vane placed at the top or bottom of the meter tube.

PART 3 - EXECUTION

A. Installation

Install meters as shown in the drawings and in accordance with AWWA C704, Appendix A, paragraphs A.6 and A.7.

B. Hydrostatic Testing

Hydrostatically test the meters per Section 400515, with the meters installed in the piping to be pressure tested.

C. Service Conditions

Meter capacity shall be 3,000 gpm.

END OF SECTION

SECTION 432154 VERTICAL TURBINE PUMPS--WATER WELLS

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation of vertical turbine pumps for water well service.

B. Related Work Specified Elsewhere

1. General Concrete Construction: 030500.
2. Painting and Coating: 099000.
3. Electric Motors: 262650.
4. General Piping Requirements: 400500.
5. General Requirements for Steel Piping: 402001.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and Section 013300.
2. Submit dimensional drawings.
3. Submit manufacturer's catalog data and detail drawings showing all pump parts and described by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type. Show linings and coatings.
4. Show shaft diameter and bearing spacing. Submit calculations showing shaft critical frequency and determination of bearing spacings. Show calculated bearing life.
5. Submit pretest pump curves on which the specified operating points are marked. Show efficiency and brake horsepower for the selected pump curve. Include moment of inertia of the complete pumping unit including driver, impeller, and liquid pumped. Show required submergence and NPSH.

6. As part of the test procedure for the pumps, record measurements for impeller adjustment and total radial shaft deflection (shaft runout) above the packing box.

7. Submit manufacturer's sample form for reporting performance test results at least two weeks before the tests. The test form should contain the data presented in the sample form in Section 6 of the ASME PTC 8.2 or ANSI/HI 2.6.

8. Submit manufacturer's certified performance curves for review at least two weeks prior to shipping the units from the factory. Show pump total head, torque, brake horsepower, pump efficiency, required submergence, and required NPSH. Provide copies of the data recorded during the test and methods of data reduction for determining certified test results.

9. Submit report on results of factory resonance test and modal shape signature results.

10. Submit manufacturer’s catalog data and detail drawings showing rotameter parts and describe by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type. Shop scale lengths and flow ranges.

D. Definitions

1. Terms shall be as defined in the Hydraulics Institute Standard ANSI/HI 2.1-2.5 for vertical pumps.

2. Additional terms are defined below:

   Submergence: Vertical distance in feet between the pumping water level and the bottom of the suction bell.

E. Manufacturer's Services

Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

1. One labor day for each service listed in the subsection on "Service Conditions" to check the installation and advise during start-up, testing, and adjustment of the equipment.

2. One labor day to instruct the Owner's personnel in the operation and maintenance of the equipment.

PART 2 - MATERIALS

A. Pump Design

1. All equipment for the pumps, including motors, discharge heads, shafting, columns, and anchor bolts, shall be provided as a complete unit by the pump manufacturer in an ISO 9001-certified facility. Pump units assembled by entities other than the manufacturer will not be acceptable.

2. Each pump shall be capable of at least a 5% head increase at normal operating conditions by installing a larger impeller or an impeller of different hydraulic design.

3. The following criteria shall be used for pump selection:

   a. Bowl diameter shall allow for installation in the well casing as constructed.

   b. Pump head shall continuously decrease with increasing flow.

   c. Pump shall be of current manufacture. Pump characteristic curves are to be included in pump manufacturer's catalog.

4. Pump curve shall be continuously rising and shall be free of dips and valleys from the design point to the shutoff head. The shutoff head shall be at least 120% of the head that occurs at the design point.

5. The NPSH required shall be at least 5 feet less than the minimum NPSH available at all points on the pump curve up to 120% of the flow at the BEP.

6. Design the pump and its components to operate continuously over a flow range of 70% to 120% of the flow at the BEP.

B. Motors

1. Motors shall be vertical high thrust-hollow shaft. Motors shall be as further described in the subsection on "Service Conditions."

2. The driver motor thrust bearing loading shall include the total pump lineshaft downthrust. Design the motor bearings to withstand any momentary total upthrust equivalent to at least 30% of the maximum downthrust developed.

C. Couplings and Coupling Guards

Provide a threaded coupling. Provide coupling guards conforming to CAL/OSHA requirements.

D. Discharge Assembly

1. Provide a discharge assembly for surface discharge. The discharge assembly shall have bolted register or rabbet-fit connections for the motor. Discharge assembly shall have connections for the pump column and discharge piping and shall support the loadings that they impose as well as contain the pump pressure.

2. Design columns and discharge assemblies for 150% of the pump discharge pressure (suction pressure plus pump differential pressure) at shutoff.

3. Access to the stuffing box shall be through windows placed 90 degrees from the discharge. Fit handholes and/or windows with Type 304 stainless steel expanded metal guards per CAL/OSHA requirements. Provide hinged or removable Type 304 stainless steel guards.

4. Design discharge assembly to be aesthetically compatible with the mounted motor and with adjacent pumping units. Where the motor is smaller in horizontal dimension than the discharge pipe, shape a skirt to transition between the two masses. Where the motor is larger than the discharge assembly, a skirt of approximately motor diameter dimension shall enclose the discharge assembly so as to provide an adequate-appearing motor support.

5. The discharge shall be flanged, having a pressure rating as shown in the subsection on "Service Conditions."

a. Class 125 or 150 flanges shall comply with AWWA C207, Class D.

b. Flanges shall be flat face.

c. Groove welds shall be full penetration welds. Fabricated flanges shall be welded both inside and out.

d. Fabricated steel discharge elbows shall have at least three pieces per AWWA C208, Table 2.

6. Provide for lifting the heads by means of lifting eyes that are capable of sustaining the weight of the complete unit less the motor.

E. Stuffing Box

Provide five rings (minimum) of packing plus a lantern ring and repacking space. Provide grease lubrication. Packing shall be one of the following nonasbestos materials:

1. Regular braid, square cross-section graphite-lubricated, and impregnated packing, such as Garlock Style 8909, Phelps Style 2075, or equal.

2. Teflon-impregnated packing with lubricant, such as Phelps Style 2072, Garlock Style 8922, or equal.

F. Lubrication

Pumps shall have open or enclosed lineshafts as shown in the subsection on “Service Conditions.” Open lineshaft pumps shall be self-lubricated.

G. Column Pipe

1. The column pipe joints shall be flanged and bolted to the discharge assembly and to the pump bowl assembly, and shall have register fits at each end. Material shall be as listed in the subsection on "Pump Materials of Construction."

2. Top and bottom column pipe sections shall not exceed 5-foot length.

3. Column pipe joints shall be threaded.

H. Shafts

1. Support the shafting by bearings at intervals so that the first natural frequency of the rotating assembly is at least 30% above the maximum operating speed. Provide an additional bearing retainer just below the head for added support. Calculate and size the shaft diameter for the pump shutoff head.

2. For metal or rigid bearings, support the shafting at intervals per API 610, paragraph 8.3.6, with a maximum spacing of 5 feet.

3. For pumps having operating speeds 1,800 rpm and less with water-lubricated neoprene bearings, the bearing spacing for the intermediate column shall not exceed 10-foot lengths. The bearing spacing for the top and bottom column sections shall not exceed 5 feet.

4. Tolerance on the shaft diameter through the stuffing box or seal chamber shall not exceed 0.002-inch TIR. Shaft runout on the stuffing box or seal chamber face and at the impeller shall not exceed 0.002-inch full indication movement. The shaft stiffness shall limit the total deflection under the most severe dynamic conditions over the allowable operating range of the pump, with the maximum impeller diameter installed, to 0.002 inch at the primary seal faces or at the stuffing box faces.

5. Shafts and sleeves shall be machined and finished per API 610, paragraph 8.3.3. Shaft couplings for shaft diameters 2 inches or larger shall be of the key and thrust-ring types or other nonthreaded design. Threaded couplings may be used for shaft diameters 1-15/16 inches or smaller. Thrust rings, capscrews, and keys where used shall be Type 410 stainless steel.

6. Provide lineshafting with hardened sleeves under neoprene bearings per API 610 (9th edition), paragraph 8.3.10.5 and Table H-1 in Annex H.

I. Bowl Assembly

1. Each bowl assembly shall consist of the bowl, impeller and impeller shafting, and bearings. Bearings shall be located above and below the impeller. Bearings (other than sleeve type) shall have an AFBMA L-10 life of at least 20,000 hours at any specified flow condition,

excluding the shutoff head. Impellers shall be dynamically balanced.

2. Pump bowls shall be of the material listed under the subsection on "Pump Materials of Construction." Bowls shall be sufficiently rigid to prevent adverse changes in bearing alignment and to maintain the running clearance of wear rings. Bowls shall be flanged with male and female rabbets or registers for joining to the suction bell and the discharge column. Waterways and the diffusion vanes shall be smooth and free from nodules, bumps, and dips.

3. Provide the bowls with a renewable wear ring adjacent to the impeller, made of stainless steel or bronze as indicated under "Pump Materials of Construction." Wear rings and running clearances shall not exceed 0.002-inch clearance per inch of diameter.

J. <u>Suction Manifold</u>

The suction manifold shall have, as an integral part, vanes supporting a central hub in which the bottom bearing is carried below the impeller.

K. <u>Impellers</u>

Pump impellers shall be of the enclosed type made of the material listed in the subsection on "Pump Materials of Construction" and shall be cast in one piece. Machine to fit the contour of the bowl, hand file in the waterways, and equip with replaceable wearing rings or with wearing-ring hubs for mounting wear rings in future repair cycles. Attach impellers to the shaft in such a manner that they cannot become loose under any operating condition or under reverse rotation. Provide for adjustment of the axial position of the impeller at the motor connection to the head shaft so that proper clearance between bowls and impellers may be maintained.

L. <u>Vibration and Residual Unbalance</u>

1. The maximum vibration level measured on the top motor bearing housing at the rated pump speed (±10%) and at any total head for which efficiencies are shown on the manufacturer's published performance curve shall not exceed that shown in Figure 9.6.4.13 in ANSI/HI 9.6.4.

2. At any operating speed, the ratio of rotating speed to the pump’s natural reed frequency shall be less than 0.8 and greater than 1.3. A factory resonance test shall demonstrate the motor/discharge head structure’s natural reed frequency. Obtain a modal shape signature with an FFT analyzer and submit to Owner’s Representative for review.

3. The Contractor shall require that the pump manufacturer determine whether the infinite mass and rigidity described in ANSI/HI 9.6.4-2000, paragraph 9.6.4.5.2 is applicable to the service conditions in this project and to select the appropriate analytical method to determine the critical speed and resonant frequencies of the pump system. At a minimum, the pump system shall include the bowls, impellers, lineshaft diameters, lineshaft bearing spacing, column diameter and wall thickness, the design of the discharge stand with discharge nozzle, and the baseplate and soleplate dimensions (length, width and thickness).

M. Pump Materials of Construction

1. Materials of construction shall conform to the requirements listed below. Materials of construction for components not listed below shall conform to API 610, Annex H, Material Class I-2.

Component	Material
Pump head shaft and couplings	Stainless steel, ASTM A 276, Type 316 or 410, or ASTM A 582, Type 416.
Lateral bowl wear ring	Neoprene ring reinforced with embedded steel core.
Bearing retainers (insert type)	Bronze; see paragraph 3 below.
Lineshaft bearings	Neoprene for open lineshaft; bronze for enclosed lineshaft.
Impellers	Bronze; see paragraph 3 below.
Impeller wear ring	Stainless steel, ASTM A 743, Grade CF-8M or CA-15.
Suction strainer	Stainless steel, AISI Type 316
Lantern ring	Bronze; see paragraph 3 below.

Component	Material
Pump bowls and suction manifold	Cast iron, ASTM A 48, Class 30.
Bowl bearings	Bronze; see paragraph 3 below.
All parts made of fabricated steel including discharge head or motor stand	Carbon steel, ASTM A 283, Grade B or C; ASTM A 36; or ASTM A 53, Grade B.
Column pipe	Carbon steel, ASTM A 283, Grade B or C, or ASTM A 53, Grade A or B.
Line shaft	ASTM A 108, Grade 1045 or 1020.
Mounting plate	Carbon steel, ASTM A 283, Grade A or B; or ASTM A 36.
Flanges	ASTM A 105, A 181, or A 182.
Bolts and nuts for discharge head, column pipe flanges, and bowl flanges.	Bolts shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8M. Nuts shall be Type 316 stainless steel conforming to ASTM A 194, Grade 8M.
Stuffing box gland parts	Bronze; see paragraph 3 below.
Gland bolts and nuts	Stainless steel, Type 316.
Any bronze components in contact with water	See paragraph 3 below.

2. Do not construct the impeller wear ring and bowl liner of the same material. Impeller and bowl liner materials shall have a minimum Brinell hardness difference of 50, unless both the stationary and the rotating wear surfaces have Brinell hardness numbers of at least 400.

3. Bronze shall have the following chemical characteristics:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

N. Strainers

Provide suction strainers on the inlet to each pump as stated in the subsection on "Service Conditions."

O. Soleplate and Anchor Bolts

1. The Contractor shall assign the design and construction of the pump (including bowls, column, and discharge head), motor and supporting stand, and baseplate and soleplate system to the pump manufacturer. The pump manufacturer shall design and construct an integrated system to comply with the specified restraint, deflection, vibration, and critical speed criteria.

2. Provide a steel soleplate for base-mounted pumps to be permanently grouted in place. The thickness and bolting to the discharge head base shall be sufficient to restrain the discharge head against shut off head or any other pump operating condition and provide sufficient rigidity such that the pump and baseplate system meets the specified lateral vibration and critical speed criteria. For fabricated steel discharge heads, the sole plate thickness shall be greater than the top column flange thickness plus the bolt head length. Machine the soleplate topside to mate with a fully machined base of the discharge head.

3. Design the soleplate and baseplate system and the associated pump and driver supports and anchor bolts to support the pump and motor in accordance with the following criteria:

   Fp = 0.27 Wp (in accordance with ASCE 7-05, Section 13.3.1.

4. Provide anchor bolts of sufficient quantity and size to restrain any pump operating condition. The anchor bolts shall conform to ASTM A 193, Grade 8M with nuts conforming to ASTM A 194, Grade 8M.

P. Prelubrication System Flow Switch

1. The flow switch shall consist of a roatmeter, of the vertical inline-tube type, with two integrally mounted flow switches adjustable over the full flow range of 10 gallons per minute. Switches shall be SPDT and rated for interfacing with a PLC.

2. Flow measurement shall be by means of a spring-loaded piston suspended in a tube. The indicator assembly shall translate vertical motion of the piston onto an associated vertical scale to indicate flow. The piston shall indicate flow directly to the side or indirectly through a Teflon-coated magnet.

3. Materials of construction shall consist of a polysulphone tube, Teflon-coated Alnico magnet, aluminum, PVC, or brass body and fittings, Viton seals, and Type 316 stainless steel internal parts.

4. Tube connections shall be threaded (ASME B1.20.1) union type.

5. Indicator shall be in units of gallons per minute.

6. Products: Hedland "Flow Alert," Universal Flow Monitors "INSITE," or equal.

Q. Spare Parts

1. Provide the following spare parts:

Quantity	Description
One	Impeller wear ring
One	Bowl wear ring
One	Lantern ring
Two sets	Bowl bearings
Two sets	Shaft bearings and spiders
One	Shaft coupling
Two sets	Packing

2. Pack spare parts in wooden boxes; label with manufacturer's name and local representative's name, address, and telephone number; and attach list of materials contained therein.

PART 3 - EXECUTION

A. Service Conditions

Pump hydraulic performance characteristics shall be as shown below.

Location:	City of Torrance - Well 9
Service:	Indoors environmental temperature range of 50°F to 100°F
Elevation:	66 feet above mean sea level
Relative humidity:	10% to 80%
Fluid temperature range:	65°F to 80°F

Pump Data [modify as necessary for Well Nos. 10 and 11]

Capacity (gpm)	**Pump Total Head (feet)**	**Minimum Pump Efficiency (%)**
2,700	210	81
3,000*	197	81
3,300	180	79.5
*Design point		

Liquid pumped:	Clear water
Maximum pump speed:	1,800 rpm
Motor horsepower (minimum):	200
Motor type (per Section 262650):	1EHNRT
Minimum shaft diameter:	1-11/16 inches
Pump lubrication:	Open lineshaft
Minimum discharge connection size:	16 inches
Minimum column size:	16 inches
Minimum column wall thickness:	0.375 inch
Discharge flange rating:	Class 150
Pump setting (base of discharge head to inlet of first pump stage):	320 feet
Bearing lubrication:	Water
Suction strainer:	Yes
Manufacturers and models:	Flowserve, Goulds, Peerless, (no alternative mfrs.)

B. Welding Procedure and Welder Qualification for Pump Construction

Welding shall comply with the ASME Boiler and Pressure Vessel Code, Section IX. Provide full penetration welds. Open seam butt welds are not permitted. Fabrication, assembly, and erection of pump columns and fabricated discharge heads shall conform to Section 402001.

C. Factory Performance Tests

1. Each pumping unit shall be subjected to a non-witnessed laboratory performance test. Conduct tests in accordance with ASME PTC 8.2 or ANSI/HI 2.6, using the actual job driver. The performance test shall be equivalent to ANSI/HI 2.6.

2. No motor overload above nameplate rating will be allowed at any flow up to 120% of the flow at the BEP.

3. Hydrostatically test columns and discharge assemblies at design pressure.

4. Deviations and fluctuations of test readings shall conform to ASME PTC 8.2, 1.11 (Type A), or ANSI/HI 2.6, paragraph 2.6.5.4.1.

5. Measure flow by the "Capacity Measurement by Weight," the "Capacity Measurement by Volume," or the "Capacity Measurement by Venturi Meter, Nozzle, or Thin Plate Orifice" methods in ASME PTC 8.2 or ANSI/HI 2.6.

6. Perform tests and record data, including head, flow rate, speed, and power, from zero flow to maximum noncavitating flow.

7. Take vibration readings at rated flow at each test speed.

8. Performance tests shall be "full-scale." The complete pump, including column and discharge elbow, shall be used. Shorten the column to suit the sump depth. Measuring devices shall have been calibrated within the previous year.

9. The pressure tap for head measurement shall be located not less than 10 pipe diameters downstream from the discharge elbow of the test pump.

10. No motor overload above nameplate horsepower will be allowed.

11. Should results of the full-scale tests indicate, in the opinion of the Owner's Representative, that the pumps will fail to meet any of the specified requirements, the Owner's Representative will notify the Contractor of such failure. The Contractor shall thereupon require the manufacturer, at no expense to the Owner, to make such modifications and perform additional tests as may be necessary to comply with these specifications.

12. Perform a hydrostatic test on pump pressure-containing parts per ANSI/HI 2.6, paragraph 2.6.4.

D. Painting and Coating

1. Coat interior and exterior of pump columns per Section 099000, System No. 7. Apply coating at factory.

2. Coat interior of discharge elbows per Section 099000, System No. 7. Apply coating at factory.

3. Coat exteriors of bowl assemblies and interiors and exteriors of suction manifold per Section 099000, System No. 7. Apply coating in factory.

4. Coat exterior of discharge head and motor the same as the adjacent piping. Apply the specified prime and intermediate coats at the place of manufacture. Finish coat shall match the color of the adjacent piping.

E. Shipment and Storage

1. Prepare equipment for shipping including blocking of the rotor when necessary. Identify blocked rotors by means of corrosion-resistant tags attached with stainless-steel wire. The preparation shall make the equipment suitable for six months of outdoor storage from the time of shipment, with no disassembly required before operation, except for inspection of bearings and seals.

2. Identify the equipment with item and serial numbers. Material shipped separately shall be identified with securely affixed, corrosion-resistant metal tags indicating the item and serial number of the equipment for which it is intended. In addition, ship crated

equipment with duplicate packing lists, one inside and one on the outside of the shipping container.

3. Pack and ship one copy of the manufacturer's standard installation instructions with the equipment. Provide the instructions necessary to preserve the integrity of the storage preparation after the equipment arrives at the jobsite and before start-up.

4. Store and protect pumps per API 686 (first edition), Chapter 3, paragraphs 1.4 through 1.9, 1.15, 1.17, 1.20, and 1.21 and as described below.

5. Coat exterior machined surfaces with a rust preventative.

6. The interior of the equipment shall be clean and free from scale, welding spatter, and foreign objects.

7. Provide flanged openings with metal closures at least 3/16-inch thick, with elastomer gaskets and at least four full-diameter bolts. Install closures at place of pump manufacture prior to shipping. For studded openings, use all the nuts needed for the intended service to secure closures.

8. Provide threaded openings with steel caps or solid-shank steel plugs. Do not use nonmetallic (such as plastic) plugs or caps. Install plugs at place of pump manufacture prior to shipping.

9. Clearly identify lifting points and lifting lugs on the equipment or equipment package. Identify the recommended lifting arrangement on boxed equipment.

10. Wrap exposed shafts and shaft couplings with waterproof, moldable waxed cloth or volatile-corrosion-inhibitor paper. Seal the seams with oil-proof adhesive tape.

11. If electric motors are stored or installed outside or in areas subject to temperatures below 40°F or are exposed to the weather prior to permanent installation, provide the manufacturer's recommended procedures for extended storage. Provide temporary covers over the motor electrical components. Provide temporary conduits, wiring and electrical supply to space heaters. Inspect electrical contacts before start-up.

F. Installation

1. Prior to installing the pump in the well, review the well vertical alignment data provided by the Owner and advise the Owner if the pump cannot be installed without binding or placing the column and shaft in flexure.

2. Check to ensure that pump baseplates or soleplates have been provided with vertical leveling screws, as opposed to shims or wedges. Do not use shims or wedges.

3. Provide the manufacturer's recommended lubricants and operating fluids and verify that each piece of equipment contains the amount recommended by the manufacturer.

4. Verify that the installed pump is fully self-supporting before bolting pipe flanges, so that no strain is imparted on the flanges, pipes, or pipe supports from the pump assembly. Adjust the position of the pump assembly so that the pump flanges are plumb and aligned with the adjacent pipe flanges. Do not use temporary shims or jacking nuts for leveling, aligning, or supporting equipment. Provide final grouting of the pump assembly base according to Section 030500.

5. When the alignment is correct, tighten the foundation bolts evenly but not too firmly. Then grout the unit to the foundation. The leveling pieces may be grouted in place. Do not tighten foundation bolts until the grout is hardened a minimum of 48 hours after pouring.

6. Provide continuous protection of the installed equipment from the elements, dust, debris, paint spatter, or other conditions that will adversely affect the unit's operation until such time as the equipment is scheduled for start-up testing.

G. Mounting and Alignment of Vertical Hollow-Shaft Drivers

1. Remove the clutch or coupling from the top of the hollow shaft, and mount the driver on top of the discharge head/driver stand. For pump designs requiring the pump head shaft to be installed prior to mounting the driver, lower the hollow shaft driver with care over the head shaft to be sure the latter is not damaged. Check the driver for correct rotation as given in the manufacturer’s installation instructions. Install the head shaft, if not already done, and check it for

centering in the hollow shaft. If off-center, check for runout in head shaft, misalignment from discharge head to driver, or out of plumbness of the suspended pump. Shims can be placed under the discharge head to center the head shaft, but shims shall not be placed between the motor and the discharge head unless recommended by the manufacturer.

2. Install the driver coupling or clutch, and check the nonreverse ratchet for operability, if furnished. Install the coupling gib key and the adjusting nut, and raise the shaft assembly with the impeller(s) to the correct running position in accordance with the manufacturer's instructions. Secure the adjusting nut to the clutch, and double-check the driver hold-down bolts for tightness.

H. Field Testing

1. Bump motor to ensure that motor has been connected for proper rotation prior to coupling pump.

2. Perform field tests for five consecutive days to demonstrate that the pump performs according to the factory test data.

3. If the measured flows are more than 5% below the flows obtained on the laboratory or factory test, adjust the impellers or provide new impellers or otherwise repair or replace the pumps or calibrate meters or pressure gauges.

4. Conduct vibration level tests with pumps operating at their rated capacity. Adjust or replace pumps that exceed the maximum vibration levels.

5. Assure that in the automatic mode each pump responds to its start/stop signal.

6. Assure that the solenoid valve on seal water supply line opens and closes when the pump starts and stops. Start and stop the pump twice and verify that the pump/solenoid interlock functions.

7. Test the pump system to determine its overall efficiency. This test shall consist of measuring flow, discharge pressure, pumping level, and electrical input kilowatts to the motor at a minimum of five points

evenly spaced on the pump curve and determining the ratio of power input to the water to the electrical input power to the motor ("wire-to-water efficiency"). Submit results of this test to the Owner.

8. Demonstrate that the pumping units, drivers, and control system meet the following requirements:

   a. The pumping units operate as specified without excessive noise, cavitation, vibration, and without overheating of the bearings.

   b. Automatic and manual controls function in accordance with the specified requirements.

   c. Drive equipment operates without being overloaded.

I. Field Measurement of Coating Thickness on Columns

Field measure coating thickness on pump columns per Section 402001.

END OF SECTION