WATER AND WASTEWATER DEPARTMENT

CITY OF PHOENIX

SQUAW PEAK WATER TREATMENT PLANT GENERAL PLANT IMPROVEMENTS

VOLUME 4

PART B – PRELIMINARY TREATMENT FACILITIES

TECHNICAL SPECIFICATION

DIVISIONS 2–18
AND STANDARD DETAILS

INDEX NO. W-896225
JANUARY 1992

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WATER AND WASTEWATER DEPARTMENT
CITY OF PHOENIX

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WATER AND WASTEWATER DEPARTMENT
CITY OF PHOENIX

PART B
SQUAW PEAK WATER TREATMENT PLANT
PRELIMINARY TREATMENT FACILITY

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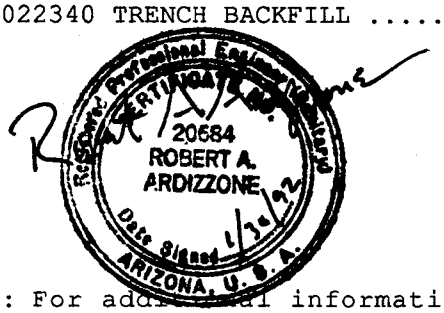

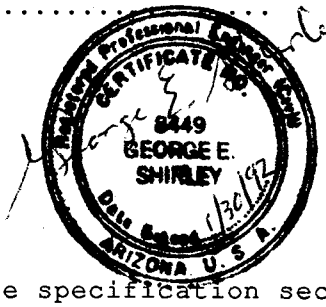

*NOTE: For additional information regarding these specification sections pertaining to Part B Construction, see Part A - Modifications and Upgrades Specification Sections.

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*NOTE: For additional information regarding these specification sections pertaining to Part B Construction, see Part A - Modifications and Upgrades Specification Sections.

*NOTE: For additional information regarding these specification sections pertaining to Part B Construction, see Part A - Modifications and Upgrades Specification Sections.

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*NOTE: For additional information regarding these specification sections pertaining to Part B Construction, see Part A - Modifications and Upgrades Specification Sections.

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*NOTE: For additional information regarding these specification sections pertaining to Part B Construction, see Part A - Modifications and Upgrades Specification Sections.

*NOTE: For additional information regarding these specification sections pertaining to Part B Construction, see Part A - Modifications and Upgrades Specification Sections.

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*NOTE: For additional information regarding these specification sections pertaining to Part B Construction, see Part A - Modifications and Upgrades Specification Sections.

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DIVISION 15 - PIPING, VALVES, GATES AND SPECIALTIES (CONT'D)

*NOTE: For additional information regarding these specification sections pertaining to Part B Construction, see Part A - Modifications and Upgrades Specification Sections.

*NOTE: For additional information regarding these specification sections pertaining to Part B Construction, see Part A - Modifications and Upgrades Specification Sections.

NOTE: For additional information regarding these specification sections pertaining to Part B Construction, see Part A - Modifications and Upgrades Specification Sections.

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DIVISION 2

SITEWORK

020000 GENERAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications DIVISION 2.

020010 PROTECTION OF EXISTING FEATURES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Demolition, Section 02050; and Clearing, Section 02110; and Excavation and Backfill, Section 02233.

020013 PROTECTION OF EXISTING FLORA

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Demolition, Section 02050; and Clearing, Section 02110; and Excavation and Backfill, Section 02233.

020016. PROTECTION OF EXISTING STRUCTURES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Demolition, Section 02050; and Clearing, Section 02110; and Excavation and Backfill, Section 02233.

020020 SITE DRAINAGE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Demolition, Section 02050; and Clearing, Section 02110; and Excavation and Backfill, Section 02233.

020022 EXISTING CHANNELS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Demolition, Section 02050; and Clearing, Section 02110; and Excavation and Backfill, Section 02233.

020030. WORK WITHIN PUBLIC RIGHT-OF-WAY

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

020050 COMPACTION CONTROL AND TESTING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

020100 GEOTECHNICAL REPORT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications DIVISION 0 AND DIVISION 1.

021000 SITE PREPARATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Clearing, Section 02110.

021100. CLEARING AND GRUBBING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Clearing, Section 02110.

021110 STRIPPING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Clearing, Section 02110.

021120 GRUBBING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Clearing, Section 02110.

021300 DEMOLITION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Demolition, Section 02050.

021400 DEWATERING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

021600. STABILITY OF EXCAVATIONS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022000 EARTHWORK

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022001 WORK SEQUENCE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022002 CHARACTER AND AMOUNT OF MATERIAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022003. EARTHWORK ADJACENT TO FCDMC AND SRP STRUCTURES

Excavation and backfill adjacent to existing or to be constructed structures owned by the Flood Control District of Maricopa County (FCDMC) and Salt River Project (SRP) shall conform to the requirements of these specifications, unless noted otherwise or superseded by the requirements of the agency.

In regards to work adjacent to the Arizona Canal Division Channel (ACDC), the Contractor shall perform the work in a timely manner such that the duration of time that the ACDC wall is exposed below elevation 1,230 is less than four (4) months. The Contractor will not be allowed to excavate below elevation 1221.00 adjacent to the ACDC wall. The Contractor will be required to contact the FCDMC 5 working days in advance of doing work on or near the ACDC. The Contact person is: Fred Fuller, Chief Construction Inspector, Phone No. 506-0501.

022150 FINISH GRADE OF EXCAVATION, BACKFILL, AND FILL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022200 EXCAVATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022210. BLASTING

Blasting will not be allowed for this project.

022220 EXCAVATIONS FOR BUILDINGS AND STRUCTURES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022230 EXCAVATION OF LINED CHANNELS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022250 DITCHES AND GUTTERS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022300 TRENCH EXCAVATION AND BACKFILL

022310 TRENCH EXCAVATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022320 TRENCH FINE GRADING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022330. PIPE BEDDING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233; and Buried Piping, Section 15051.

022340 TRENCH BACKFILL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Excavation and Backfill, Section 02233; and Buried Piping, Section 15051.

022341. SLURRY BACKFILL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022400 FILLS, BACKFILLS, AND BASES

022410 SOILS, AGGREGATES, AND MIXES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications DIVISION 2.

022411 NATIVE MATERIAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022412 SELECT MATERIAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022413 SAND

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022414 GRAVEL FILL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Crushed Stone, Gravel and Drainage Material, Section 02225.

022415 DRAIN ROCK

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Crushed Stone, Gravel and Drainage Material, Section 02225.

022418 AGGREGATE BASE COURSE (ABC)

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022420 PREPARING GROUND SURFACES FOR FILL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Rock Excavation, Section 02211; and Excavation and Backfill, Section 02233.

022430 COMPACTED FILLS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022434 BACKFILL AROUND STRUCTURES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022436 EMBANKMENTS AND ROADWAY FILLS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022800 SOIL TREATMENT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications DIVISION 2.

022840 TERMITE TREATMENT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

022860 VEGETATION CONTROL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Excavation and Backfill, Section 02233.

023060. BORING, PIPE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Jacking/Boring Pipe Installation, Section 02452.

025000 PAVING AND SURFACING

025010. RESTORING SURFACES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications DIVISION 2.

025012 LIMITING DIMENSIONS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications DIVISION 2.

025020 PAVEMENT REMOVAL AND REPLACEMENT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025021 ASPHALT PAVEMENT REPLACEMENT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025100 SUBGRADE AND BASE CONSTRUCTION

025110 GRADING UNDER PAVEMENT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Excavation and Backfill, Section 02233; and Pavement, Section 02513.

025120 BASE CONSTRUCTION

025123 AGGREGATE BASE COURSE MATERIAL - ABC

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Excavation and Backfill, Section 02233; and Pavement, Section 02513.

025200 ASPHALT CONCRETE PAVING

025205 WEATHER LIMITATIONS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025210 BITUMINOUS PRIME COAT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025213 LIQUID ASPHALT DISTRIBUTOR

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025218 TACK COAT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025220 ASPHALT CONCRETE PAVEMENT

025221. ASPHALT CONCRETE MATERIAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025222 ASPHALT CONCRETE MIXING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025223 ASPHALT CONCRETE MIXING PLANTS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025224 ASPHALT CONCRETE PLANT OPERATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025225 ASPHALT CONCRETE DELIVERY

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025226 ASPHALT CONCRETE PLACING EQUIPMENT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025227 SURFACE PREPARATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025228 PLACING AND COMPACTING ASPHALT CONCRETE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025229 FOG SEALING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Pavement, Section 02513.

025280 CURBS, GUTTERS, AND SIDEWALKS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications DIVISION 2.

025281. MATERIALS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Curbs, Gutters and Sidewalks, Section 02529.

025282 CONSTRUCTION METHODS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Curbs, Gutters and Sidewalks, Section 02529.

025283 EXPANSION AND CONTRACTION JOINTS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Curbs, Gutters and Sidewalks, Section 02529.

025284 BACKFILLING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Curbs, Gutters and Sidewalks, Section 02529.

026000 UTILITIES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications DIVISION 2.

026010 CONCRETE CATCH BASINS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Drainage Structures, Section 02429.

026050 PRECAST CONCRETE MANHOLE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Manholes, Section 02601.

028000 SITE IMPROVEMENTS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications DIVISION 2.

028300 FENCES AND GATES

028310 CHAIN LINK FENCE AND GATES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Fencing, Section 02447.

028312 FENCE AND GATE MATERIALS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Fencing, Section 02447.

028313 FENCE CONSTRUCTION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Fencing, Section 02447.

028314 SWING GATES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Fencing, Section 02447.

028400. GUARD RAIL BUFFER END SECTIONS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Guardrails, Section 02451.

* * * END OF DIVISION 2 * * *

DIVISION 3

CONCRETE

030000 GENERAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030001 WATERTIGHTNESS OF CONCRETE WORK

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030002. JOINTS AND BONDING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Joints, Section 03251.

030100 WORKMANSHIP AND METHODS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030101 MEASUREMENTS OF MATERIALS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030102 CONCRETE PROPORTIONS AND CONSISTENCY

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030103. CONCRETE MIXES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030104 REQUIRED AVERAGE COMPRESSIVE STRENGTH

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030162 TESTING AND PACKAGING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030180 ADMIXTURES - GENERAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030182 FLY ASH POZZOLAN ADMIXTURE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030183 WATER REDUCING ADMIXTURE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030200 FORMS AND ACCESSORIES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Formwork, Section 03100.

030201 FORM TIES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Formwork, Section 03100.

030202 BUILT-UP PLYWOOD FORMS

030203 STEEL OR STEEL FRAMED FORMS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Formwork, Section 03100.

030204 INCIDENTALS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Formwork, Section 03100.

030250 EPOXY MATERIALS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Joints, Section 03251.

030251 EPOXY

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Joints, Section 03251.

030252 EPOXY GEL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Joints, Section 03251.

030253 EPOXY BONDING AGENT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Joints, Section 03251.

030260 EPOXY INJECTION SYSTEM

Where epoxy injection is required to repair cracks in concrete material, information on the epoxy injection system shall be submitted.

Adequate surface seal shall be applied to the crack or joint to prevent escape of the epoxy. Entry points shall be established at a distance along the seal not less than the thickness of the cracked member.

A 100 percent solid epoxy adhesive as specified above shall be forced into the crack at the first port with sufficient pressure to advance the epoxy to the adjacent port. The original port shall be sealed and entry shifted to the port at which the epoxy appears. This manner of port-to-port injection shall be continued until each joint has been injected for its entire length.

Before processing, the space in the vicinity of a crack location receiving epoxy shall have been swept and left in a generally clean condition. All joints receiving epoxy under this section shall be cleaned free from dirt, laitance, and other loose matter.

Pump unit used for injection shall be a positive displacement type with interlock to provide an in-line mixing and metering system for the two-component epoxy. The pressure hoses and injection nozzle shall be of such a design as to allow proper mixing of the two components of epoxy. The presence of a standby injection unit may be required.

For small amounts, or where excessive grout pressure developed by a pump unit might further damage the structure, premixed material and a hand caulking gun may be used if acceptable to the Engineer.

030312 TYING BAR REINFORCEMENT

The above tying requirements do not apply to reinforcement for masonry. See The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Reinforcement, Section 03200.

030320 WELDED WIRE FABRIC REINFORCEMENT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Reinforcement, Section 03200.

030400 MIXING CONCRETE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030410 MACHINE MIXING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030420 HAND MIXED CONCRETE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030500 CONVEYING AND PLACING CONCRETE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030510 CONVEYING CONCRETE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030520 PLACING AND CONSOLIDATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030610 CONCRETE FINISHING

Concrete surfaces shall be finished as indicated on the Drawings. Where not specified or indicated on the Drawings, the surfaces shall be finished as follows:

Concrete surfaces which are specified or indicated to be painted, and all concrete surfaces, interior or exterior, exposed to view shall have fins removed and joints ground smooth, and shall be "sacked" with cement mortar so that all pits and holes are filled. Surfaces in open channels, basins, and similar structures, which are normally below the water surface shall have fins removed, but need not have joints ground. However, surfaces in such locations which are above the normal water surface and exposed to view shall have fins removed and joints ground smooth, and shall be "sacked" with cement mortar so that all pits and holes are filled. Concrete surfaces in closed boxes or channels where there is normally no access or passageway shall have the fins removed. All form ties shall be removed from all surfaces, and holes shall be filled after being cleaned and roughened by heavy sandblasting.

The following surfaces shall be troweled, then given a light hairbroom finish:

Exterior walkways
Tops of exterior walls or beams which are to serve as walkways
Tops of exterior walls or beams which are to support grating

The following surfaces shall be screeded off to grade and left rough:

Basin bottoms to which a 2 inch layer of grout is to be applied
Projecting footings which are to be covered with dirt
Slab surfaces which are to be covered with concrete fill

The following surfaces shall receive a smooth steel trowel finish:

Tops of center wall footings at expansion joints
Tops of corbels
Tops of walls and beams not covered above
Tops of all slabs not covered above herein
All other surfaces not specified to be finished otherwise

The final steel trowel finish shall be uniformly smooth and free of all irregularities. Building and machine room floors which are not to be covered with surfacing material shall be free from trowel marks. Trowel marks will be permitted in other locations. Concrete floor surfaces to which a surfacing material is to be applied shall be finished level and smooth with a tolerance of not over 1/8 inch in 10 feet in any direction.

030623. CONCRETE SEALER

The concrete sealer shall be "CEM-SEAL" as manufactured by the Hillyard Chemical Company, San Jose, California; DeKote Compound Code T130 as manufactured by W. R. Grace and Company; or equal.

C. Pre-Installation Conference: Contractor shall schedule a meeting with Engineer not less than 24 hours before planned grouting operations to discuss the method of placement of the grout.

030732 PRODUCTS

A. Materials: Cement, sand, and water shall be as specified elsewhere in DIVISION 3.

B. Mix: Grout for basin bottom slab be a mixture of one part Portland cement and 4-1/2 parts sand, by weight.

1. The water content shall be:

a. Sufficient, to allow workability for spreading the grout with the screeds attached to the arms of the equipment mechanism.

b. Not excessive, to prevent formation of surface water and laitance, and to allow the grout to stay in place after screeding.

030733 EXECUTION

A. Basin Bottom Slab Surface Preparation:

1. The slab surface shall have rough texture, suitable for bonding grout to it.

a. Smooth areas shall be roughened by heavy sandblasting.

2. The slab surface shall be sandblasted and cleaned.

a. Dirt, oil, curing compound, laitance, dust, and other matter that may prevent proper grout bonding shall be removed.

3. The concrete slab shall be saturated with water and surface of the slab shall be damp at the time the grout is placed.

B. Placement:

1. Manufacturer's Instructions: The placement of grout shall conform to the instruction given by the equipment manufacturer and to the limitations and precautions given in such instructions.

a. Conflicts between manufacturer's instructions and these Specifications shall be brought promptly to the attention of the Engineer.

4. Following the Grout Placement:

a. After completion of the slab grouting, the mechanism shall be allowed to run continuously until there is no more danger that grout sloughing may occur.

1) Contractor shall prevent dry clumps of grout or rocks from being caught under the screed board and gouging the finish surface of the grout.

5. Corrections:

a. Before Grout has Set:

1) Where sloughing has occurred, Contractor shall remove grout from sloughed areas and place grout in low areas.

2) Gouges in the grouted surface shall be repaired.

b. After Grout has Set:

1) Where the clearance between blades and the grouted surface exceed the tolerance specified hereinafter, Contractor shall grind the high points in the grout surface using a terrazzo machine until the specified tolerance is met.

2) Grout that has not bonded to the concrete slab is not acceptable. Grout that has not bonded shall be defined to be grout that, after placing and setting, has a hollow sound when tapped with a 4 foot long, nominal, 2 inch by 4 inch, piece of lumber. All grout that has not bonded to the concrete slab shall be removed and replaced.

6. Curing: The grout shall be water cured for 7 days. The grout surface shall be continuously wet for this period.

C. Unacceptable Procedures: The following procedures will not be accepted:

1. Grouting by circular sectors or "pie" sections.

2. Grouting from the center outward.

D. Tolerances:

1. The tolerance in the elevation of the finished grout surface shall be plus or minus 1/8 inch and shall be verified as follows:

a. After the grout is set, the equipment shall be operated and the blades set to clear the grout surface.

1) Under these conditions, the blades shall not clear the grout surface by more than 1/4 inch at any point.

2) Correction of excess clearance shall be as specified hereinbefore.

After bonding, dowels shall remain undisturbed for a minimum of 3 hours or until the magnesium phosphate concrete has reached a strength sufficient to support the dowels. Dowels that are improperly bonded, as determined by the Engineer, shall be removed. The holes shall be cleaned or new holes shall be drilled and dowels replaced and securely bonded to the concrete. Removing, redrilling, and replacing improperly bonded dowels shall be performed at the Contractor's expense.

030800 SPECIAL CONCRETES

030811 CONDUIT ENCASEMENT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Cast-in-Place Concrete, Section 03300.

030880 SHOTCRETE

Shotcreting shall conform to all requirements of "Specification for Materials, Proportioning, and Application of Shotcrete (ACI 506.2)" published by the American Concrete Institute, Detroit Michigan, except as modified by the requirements of these Specifications.

Shotcrete may be of either the wet mix or dry mix type.

030881 SHOTCRETE SUPPLEMENTAL REQUIREMENTS

The supplemental requirements listed below are keyed to the article and paragraph numbers of the referenced ACI Shotcrete Specification.

A. 1.6.3 Construction testing shall be by the test panel method in accordance with paragraph 1.6.3.2.

B. 1.6.5 Preconstruction testing shall be required.

C. 2.1 Cement shall be Portland cement conforming to ASTM C 150, Type II, low alkali.

D. 2.2.1 Aggregate shall be normal weight conforming to Gradation No. 1 in Table 2.2.1.

E. 2.4 Admixtures for wet mix shotcrete shall be as specified for concrete elsewhere in these Specifications.

F. 2.5 Shotcrete shall have a 28 day compressive strength f'c of 4,000 psi.

G. 3.2 Formwork for shotcreting shall be as specified for concrete elsewhere in these Specifications. In addition, shotcrete forms must be adequately stiffened and supported to withstand the impact of shotcrete placement and must also permit the escape of air and rebound.

DIVISION 4

MASONRY

040000 GENERAL

The Work includes all labor, materials, equipment, and appliances required to complete the masonry work as indicated on the Drawings and specified herein. Masonry Work shall include, but is not limited to, concrete masonry units, mortar, grout, and miscellaneous materials, complete in place.

041000 MATERIALS

041050. BRICK MASONRY UNITS

Brick masonry shall conform to ASTM Specifications C 216, Grade MW, and shall be 2-1/4 inches by 3-5/8 inches by 7-5/8 inches. Face brick shall be wire cut, scratched face brick as made by the Phoenix Brick Yard, or equal, and shall be of a color to match existing buildings on the site and as selected by the Engineer. Face brick shall be anchored to concrete masonry with metal ties spaced at 24 inches on center horizontally, and 16 inches on center vertically. Ties shall be staggered in alternate courses.

Samples of all brick shall be submitted to the Engineer prior to delivery of any brick to the site.

Brick work shall be laid true to line, level and plumb, properly bonded in a full bed of mortar. All brick shall be thoroughly wet before laying. Units shall be laid in running bond pattern. Joints shall be approximately 3/8-inch wide and shall be tooled when mortar is thumb print hard, with a round jointer to produce a dense, slightly concave surface. Bee holes or other open joints shall be filled and tooled with mortar while mortar is still fresh.

In hot and dry weather, protect masonry against too rapid drying.

041060. GLASS MASONRY UNITS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Glass Unit Masonry, Section 04270.

041100 CONCRETE MASONRY UNITS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Unit Masonry, Section 04220.

041110 CONCRETE MASONRY UNIT SUBMITTALS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Concrete Unit Masonry, Section 04220.

041260 ADMIXTURE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Mortar, Section 04100.

041270 WATER

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Mortar, Section 04100.

041300. REINFORCEMENT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Masonry Accessories, Section 04510.

041500 CONTROL JOINT FILLER

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Masonry Accessories, Section 04510.

041600 CAULKING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Masonry Accessories, Section 04510.

041800. LOOSE FILL INSULATION IN WALLS

Exterior walls of the following buildings shall have such masonry unit cells which are not filled with grout, filled with insulation:

Sludge Pump Electrical Building

Insulation shall be vermiculite in accordance with Federal Specification HH-I-585C, Type II and ASTM C 516 or loose perlite in accordance with ASTM C 549 (loose) Type IV. Perlite shall be silicon treated for moisture and treated for dust. The cells in the masonry unit wall shall be kept as free of mortar as possible as the masonry goes up. Insulation shall be placed in lifts not to exceed 4 feet. Cells shall be filled with insulation poured into place. The laying of masonry units shall not be carried more than 4 feet vertically ahead of the insulation fill. Care shall be taken that no insulation fill gets into cells which are to be filled with grout and that no grout gets into cells that are to be filled with insulation.

Insulation fill shall be asbestos free.

042000. CONSTRUCTION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Unit Masonry Construction, Section 04201.

METALS

050100 STRUCTURAL AND MISCELLANEOUS METALS

050110 GENERAL

This part of the Specifications includes but is not limited to the following items:

Aluminum and miscellaneous nonferrous metals
Anchor bolts
Bolts
Cast iron frames and covers
Grating and frames
Hatches
Ladders
Manhole frames and covers
Metal fasteners and welding
Metal roof decking and siding
Miscellaneous aluminum
Miscellaneous cast iron
Miscellaneous other metal items
Miscellaneous structural steel
Pipe handrails, pipe sleeves, inserts, and gates
Structural steel
Sheet metalwork
Stairs and treads
Stop plank grooves
Tread plates and frames

050120 MATERIALS

Item	ASTM Standard No.	Class, Grade, Type or Alloy No.
Coil (plate)	A 635	
Structural plate, bars, rolled shapes, and miscellaneous items	A 36	
Standard bolts, nuts, and washers	A 307	
High strength bolts, nuts, and hardened flat washers	A 325 A 490	
Eyebolts	A 489	Type 1
Tubing, cold-formed	A 500	
Tubing, hot-formed	A 501	

Steel pipe	A 53	Grade B
Stainless steel		
Plate, sheet and strip	A 167	Type 304 or 316
Bars and shapes	A 276	Type 304 or 316
Aluminum		
Sheet aluminum-flashing	B 209	Alloy 5005-H14, 0.032 inches min. thickness
Sheet aluminum-structural	B 209	Alloy 6061-T6
Structural aluminum	B 308 B 209	Alloy 6061-T6
Extruded aluminum	B 221	Alloy 6063-T42

Stainless steels are designated by type or series defined by AISI.

050130 FABRICATION AND ERECTION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Structural Steel, Section 05120.

050500 METAL FASTENING

050510 BOLTING

Unless otherwise indicated on the Drawings or specified, metal fastening shall be as follows:

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Structural Steel, Section 05120; and Miscellaneous Metal Fabrications, Section 05504.

050512 ASSEMBLY BOLTS

Bolts, nuts, and washers for wood baffles, collectors, and other field assembled construction shall be as follows:

A. Type 316 stainless steel in wet and moist locations, including:

1. For water containing structures,

a. Below and at water level.

b. Above water level,

1) Below top of walls of water containing structures.

2) Under the roof of enclosed water containing structures.

2. Dry side of walls of water containing structures.

3. Pump bases.

B. Type 304 or Type 316 stainless steel for aluminum assemblies.

C. Hot-dip galvanized ASTM A 307 steel for galvanized assemblies and for applications other than those specified hereinbefore.

050520 FASTENERS FOR USE IN CONCRETE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Anchor Bolts, Expansion Anchors, and Concrete Inserts, Section 05503.

050521 ANCHOR BOLTS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Anchor Bolts, Expansion Anchors, and Concrete Inserts, Section 05503.

050522. CONCRETE ANCHORS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Anchor Bolts, Expansion Anchors, and Concrete Inserts, Section 05503.

050523 DEFORMED BAR ANCHORS

Deformed bar anchors shall be D2L Deformed Bar Anchors manufactured by Nelson Stud Welding Company; DA Deformed Anchors manufactured by Blue Arc; or equal. Deformed bar anchors shall conform to ASTM A 496.

The deformed bar anchors shall be butt welded with an automatic stud welding gun as recommended by the manufacturer. The weld shall develop the full strength of the anchor.

050524 STUDS

Headed studs shall be S3L Shear Connectors or H4L Concrete Anchors manufactured by Nelson Stud Welding Company; SC Shear Connector Stud or HA Headed Anchors manufactured by Blue Arc; or equal. Studs shall conform to ASTM A 108 and shall have a minimum yield strength of 50,000 pounds per square inch and a minimum tensile strength of 60,000 pounds per square inch.

The studs shall be butt welded with an automatic stud welding gun as recommended by the manufacturer. The weld shall develop the full strength of the stud.

050526 POWDER ACTUATED FASTENERS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Anchor Bolts, Expansion Anchors, and Concrete Inserts, Section 05503.

050527 CONCRETE INSERTS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Anchor Bolts, Expansion Anchors, and Concrete Inserts, Section 05503.

050528 PREFORMED CHANNEL PIPE SUPPORTS

Preformed channel pipe supports for pipe supports and other applications shall be as specified in DIVISION 15.

050800 WELDING

Welding of structural metals shall be done by welders who have a current American Welding Society (AWS) certificate for the type of welding to be done by the welder. The Contractor shall notify the Engineer at least 24 hours before starting shop or field welding. The Engineer may check the materials, the equipment, and the qualifications of the welders. Welders doing unsatisfactory work shall be removed from the Work, or may be required to requalify.

The Engineer may use gamma ray, magnetic particle, dye penetrant, trepanning, or any other aid to visual inspection which he may deem necessary on any part or all welds to examine the welds.

The cost of retests on defective welds shall be borne by the Contractor. Cost in connection with qualifying welders shall also be borne by the Contractor.

Welds shall be full penetration welds unless otherwise indicated on the Drawings.

050810 WELDING ALUMINUM

Welding of aluminum shall be in accordance with AWS D1.2, Structural Welding Code - Aluminum. Detail requirements for welding aluminum alloy 6061-T6 shall be as specified in the following paragraphs.

Filler metal for welding aluminum shall be aluminum alloys conforming to the requirements of AWS A5.10 and shall be AWS classification ER 4043, ER 5654, ER 5554, ER 5183, ER 5356, or ER 556.

Welding of structures which are to be anodized shall be done using filler alloys which will not discolor when anodized. ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556 filler alloys shall be used.

Dirt, grease, forming or machining lubricants, and organic materials shall be removed from the areas to be welded by cleaning with a suitable solvent or by vapor degreasing. Additional operations to remove the oxide coating just prior to welding shall be performed when the inert gas tungsten arc welding method is used. This may be done by etching or by scratch brushing. The oxide coating may not need to be removed if the welding is done with the automatic or semi-automatic inert gas shielded metal arc.

Suitable edge preparation to assure 100 percent penetration in butt welds shall be used. Oxygen cutting shall not be used. Sawing, chipping, machining, or shearing may be used.

Welding of aluminum shall be done using a nonconsumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG). No welding process that requires the use of a welding flux shall be used.

050830 WELDING STAINLESS STEEL

The general requirements of AWS D1.1, Structural Welding Code - Steel, shall apply to the welding of stainless steel. Welding of stainless steel shall be done with electrodes and techniques recommended in "Welded Austenitic Chromium - Nickel Stainless Steel - Techniques and Properties" distributed by the Nickel Development Institute, Toronto, Canada, and in accordance with AWS D10.4 Recommended Practice for Welding Austenitic Chromium - Nickel Stainless Steel Piping and Tubing.

050850 WELDING STEEL

Welding of steel shall conform to AWS D1.1 "Structural Welding Code - Steel."

Welding of ASTM A 36 structural steel, ASTM A 500 and A 501 structural tubing, and ASTM A 53 pipe shall be with electrodes conforming to AWS A5.1 "Specification for Carbon Steel Covered Arc Welding Electrodes," using E70XX electrodes; AWS A5.17 "Specifications for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding," using F7X-EXXX electrodes; or AWS A5.20 "Specifications for Carbon Steel Electrodes for Flux Cored Arc Welding," using E7XT-X electrodes.

051000 STRUCTURAL METAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Miscellaneous Metal Fabrications, Section 05504.

051100 STRUCTURAL ALUMINUM

The Contractor shall furnish and install structural aluminum items as indicated on the Drawings and as specified. He shall provide supplementary parts necessary to complete each item even though such work is not definitely indicated on the Drawings and specified in the Specifications. Their size, form, attachment, and location shall be such as to conform to the best of current practice.

Materials not otherwise specified shall conform to the applicable ASTM Standards.

051110 ALUMINUM LAYOUT

Hole centers may be center punched and cutoff lines may be punched or scribed. Center punching and scribing shall not be used where such marks would remain on fabricated material.

A temperature correction shall be applied where necessary in the layout of critical dimensions. The coefficient of expansion shall be considered to be 0.000013 per degree F.

051120 CUTTING ALUMINUM

Material 1/2 inch thick or less may be sheared, sawed, or cut with a router. Material more than 1/2 inch thick shall be sawed or routed. Cut edges shall be true and smooth, and free from excessive burrs or ragged breaks. Reentrant cuts shall be avoided wherever possible. If used, they shall be filleted by drilling prior to cutting. Flame cutting of aluminum alloys is not permitted.

Rivet or bolt holes may be punched or drilled to finished size before assembly. The finished diameter of holes for bolts shall be not more than 1/16 inch larger than the nominal bolt diameter. Holes shall be cylindrical and perpendicular to the principal surface. Holes shall not be drifted in such a manner as to distort the metal.

051130 ALUMINUM FORMING AND ASSEMBLY

Structural material shall not be heated, with the following exceptions:

Aluminum material may be heated to a temperature not exceeding 400 degrees F for a period not exceeding 30 minutes to facilitate bending or welding. Such heating shall be done only when proper temperature controls and supervision are provided to ensure that the limitations on temperature and time are observed.

Chips lodged between contacting surfaces shall be removed before assembly.

051400 STRUCTURAL STEEL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Miscellaneous Metal Fabrications, Section 05504.

052000 METAL JOISTS AND FRAMING

052100 OPEN WEB STEEL JOISTS

Open web steel joists shall be manufactured and installed in accordance with the Standard Specifications of the Steel Joist Institute. Size and location of steel joists shall be as indicated on the Drawings. Steel joists shall have ceiling extensions where indicated on the Drawings.

Cross bridging shall be provided and shall be spaced as indicated on the Drawings or shall be equal to that specified in the Standard Specifications of the Steel Joist Institute and shall be anchored to the walls as indicated on the Drawings.

Cross framing members shall be installed as indicated on the Drawings and as required to support the roof deck at openings.

The Contractor shall submit detailed drawings and lists. Fabrication shall be in accordance with the Recommended Code of Standard Practice of the Steel Joists Institute. The submittal shall also include design calculations for joists, cross bridging, and connections not covered in the Steel Joists Institute Standards. The design calculations for the steel joists shall be sealed by a professional engineer registered in the State where the Project is located.

053000 METAL ROOF DECKING AND SIDING

Metal roof decking and siding shall be installed as indicated on the Drawings and as specified herein.

Openings shall be cut in roof deck or siding at the locations indicated on the Drawings or as necessary for installation of required piping and equipment. Openings shall be reinforced with pipe or tubing sleeves or as indicated on the Drawings.

The Contractor shall submit complete erection drawings to the Engineer. The drawings shall show the type of decking or siding section, adaptations around openings, other special conditions, method of securing sections to supporting structural steel, procedure for attaching end closure plates, end butt joint cover plates, and miscellaneous flashing.

The decking or siding section shall be installed in conformance with the manufacturer's drawings, specifications, and erection instructions. The sections shall be accurately placed end-to-end, and adjusted for proper alignment and spacing between sections before being permanently secured to structural supports.

053200. STEEL ROOF DECKING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Metal Roof Decking, Section 05310, except as follows:

For acoustical roof deck sections, the flat bottom plate shall be perforated with 1/8-inch holes staggered 25/64-inch on center in two continuous paths 9 inches wide. Sound absorbing elements shall be installed in acoustical roof deck sections and shall be arch-shaped pressure and thermally molded fiberglass pads which provide an air space of approximately 1/2 inch between the perforated steel plate and pad. The Noise Reduction Coefficient of the complete assembly shall be 0.80 minimum.

Exposed steel roof deck sections with a flat plate bottom shall be stucco embossed. The installed roof decking shall be free of dents or bent members.

Decking stored at the site before erection shall be stacked on platforms or pallets and covered with tarpaulins or other suitable weathertight covering.

053210 STEEL ROOF DECKING FABRICATION AND ERECTION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Metal Roof Decking, Section 05310, except as follows:

055000 METAL FABRICATIONS

055100 LADDERS AND METAL STAIRS

Ladders shall be safety ladders, 18 inches wide between side rails, conforming to local, State, and OSHA standards as a minimum. Stair and ladder wells shall be adequately guarded, and all stairs shall have handrails as specified or as indicated on the Drawings.

Ladders shall be secured to the supporting surface by bent plate clips providing not less than 8 inches between the supporting surface and center of rungs. Where exit from the ladder is forward, over the top rung, side rails shall be extended not less than 3 feet 3 inches above the landing, and be returned with a radius bend to the landing. If exit from the ladder is to the side, the ladder shall extend not less than 5 feet 6 inches above the landing and be rigidly secured at the top.

055110 ALUMINUM LADDERS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Miscellaneous Metal Fabrications, Section 05504.

055140. STEEL STAIRWAYS

Stairway stringers shall be fabricated from ASTM A36 steel. Stair pans shall be fabricated from ASTM A446 sheet with a G90 galvanized coating. Concrete fill shall be Class A concrete. Handrail shall be fabricated of steel pipe as specified under STEEL PIPE HANDRAILS and as detailed on the drawings. Where stair stringer is immediately adjacent to a wall, a single handrail may be provided mounted directly to the wall via a 3-inch standoff.

055200 HANDRAILS AND RAILINGS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Aluminum Handrails and Railings, Section 05523.

055205 HANDRAIL GATES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Aluminum Handrails and Railings, Section 05523.

055210 ALUMINUM HANDRAIL (NONWELDED PIPE)

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Aluminum Handrails and Railings, Section 05523.

055220. STEEL PIPE HANDRAILS

Steel pipe handrails shall be made of new Schedule 40 black steel pipe with a 1.66-inch outside diameter where indicated on the Drawings. Joints shall be welded continuously and ground smooth. Kick plates shall be made of galvanized steel.

Rails shall be bent to the profile indicated on the Drawings, without sharp bends or flat spots. Rails shall be round after bending. Intersection of rails and posts shall be neatly welded with surfaces ground smooth. In general, handrails shall be anchored into the concrete by grouting the posts into core drilled holes in the concrete or into galvanized steel sleeves cast

in the concrete as specified and indicated on the Drawings. Clip angles and other fasteners required to secure railing to other construction shall be provided as indicated on the Drawings.

055300 GRATINGS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Aluminum Grating and Checkered Plate, Section 05532.

055320 ALUMINUM GRATING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Aluminum Grating and Checkered Plate, Section 05532.

055350 FIBERGLASS GRATING

Fiberglass gratings are specified in DIVISION 6 of these Specifications.

056000 MISCELLANEOUS METAL

056100 MISCELLANEOUS ALUMINUM

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Miscellaneous Metal Fabrications, Section 05504.

056200 MISCELLANEOUS CAST IRON

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Castings, Section 05540.

056210 MANHOLE FRAMES AND COVERS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Castings, Section 05540.

056220. STOP PLANK GROOVES

Stop plank grooves shall be cast iron, and shall be R-7500 Series, Types E and L, manufactured by Neenah Foundry Company, Neenah, Wisconsin; or equal. Unless otherwise indicated on the Drawings, the width of the groove opening shall be 3-1/2 inches, and the depth shall be 3 inches.

056400 MISCELLANEOUS STRUCTURAL STEEL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Miscellaneous Metal Fabrications Section 05504.

057000 ARCHITECTURAL AND MISCELLANEOUS SHEET METAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications DIVISION 5.

* * * END OF DIVISION 5 * * *

DIVISION 6

WOOD AND PLASTICS

SECTION 6-B

PLASTICS

065000 PLASTICS

065100 PREFABRICATED STRUCTURAL PLASTICS

065110 FIBERGLASS GRATINGS GENERAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications titled Fiberglass Reinforced Plastic Gratings, Section 06611.

065111 MATERIALS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications titled Fiberglass Reinforced Plastic Gratings, Section 06611.

065112. DESIGN

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications titled Fiberglass Reinforced Plastic Gratings, Section 06611.

065200. FABRICATED PLASTICS

065230. FIBERGLASS LADDERS

Fiberglass ladders shall be of the size, shape, location and details indicated on the Drawings. Ladders greater than 20 feet in height shall have standard FRP ladder cages in accordance with State and OSHA requirements. Ladders shall be designed and fabricated for sustained submerged conditions in potable water.

Ladders shall be fabricated from structural shapes which shall be FRP pultrusions. Reinforcing glass shall be 40 percent minimum by weight, oriented to provide longitudinal and transverse strength to reduce laminar shear. All shapes shall meet dimensional tolerances of ASTM D3917. Color pigment throughout the laminate shall be safety yellow. Metallic hardware shall be kept to a minimum and shall be stainless steel.

Ladders and cages shall be as manufactured by Fibertron, Inc., Bessemer, AL; IMCO Reinforced Plastics, Inc., Moorestown, NJ; JBC Enterprises, Inc. (Enduro), Houston, TX; IKG Industries, Madera, CA; or equal.

Submittals shall be in accordance with the General Conditions and shall include manufacturer's literature on ladder and cage construction. Submittal shall also include installation recommendations, schedule showing sizes and locations, and complete detail drawings of all items specified herein. Fabrication shall not commence until submittal has been reviewed.

* * * END OF DIVISION 6 * * *

DIVISION 7

THERMAL AND MOISTURE PROTECTION

070000. GENERAL

The Contractor shall provide all labor, materials, equipment and services necessary to furnish and install thermal and moisture protection work as indicated or specified.

All work shall be performed in accordance with manufacturer's recommendations. Materials shall be delivered to project site in manufacturer's original packaging, clearly identifying the contents, brand name and applicable standards.

Specification requirements referred to for various materials are minimum requirements. Materials furnished shall be suitable for use under the year-around local climatic conditions of the site at which they are installed.

072000. BUILDING INSULATION

072100. BATT OR BLANKET INSULATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications titled Building Insulation, Section 07210.

072200. LOOSE FILL INSULATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications titled Building Insulation, Section 07210.

072600. ROOF AND DECK INSULATION

072610. RIGID INSULATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications titled Roof Insulation, Section 07220.

072611. MATERIAL FOR RIGID INSULATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications titled Roof Insulation, Section 07220.

072612. GENERAL INSTALLATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications titled Roof Insulation, Section 07220.

075000. MEMBRANE ROOFING

075200. SINGLE-PLY ROOFING

075210. HYPALON SHEET

Single-ply roofing shall be 45 mil, scrim-reinforced, Hypalon based rubber, heat seamed and white in color. The system shall have been found acceptable when tested to meet Factory Mutuals wind uplift test I-90 and shall be approved by Factory Mutual for Class 1 construction.

The roofing assembly shall be the "Hi-Tuff" system as manufactured by J. P. Stevens; HyChoice as manufactured by Carlisle Corporation, or equal.

The roofing contractor shall be named on the roofing manufacturer's current list of "Approved Roofers." He shall inspect the roof deck before men or equipment are sent to the site, shall inform the Contractor of all deficiencies found, and shall assume responsibility for acceptance of materials and conditions by his application of the roof. Installation of roofing shall conform to the manufacturer's terms and conditions as required to secure a system warranty.

It shall be the Contractor's responsibility to coordinate the installation of the roof deck, insulation, roof membrane and counterflashing to insure a warranteed roof assembly. A 10 year manufacturers warranty shall be required on the single-ply roofing.

MATERIALS: The membrane shall be .045-inch overall thickness, acrim-reinforced uncured white Hypalon sheet approximately 65 inches wide by appropriate length conforming to the following minimum physical properties:

Physical Property	Test Method	Specification
Weight	-	.29 lb/sf
Breaking Strength	ASTM D-751 Grab Method	225 lbs.
Tear Strength	ASTM D-751 Tongue Tear	90 lbs.
Low Temp. Bend 1/8 in. Mandrel	ASTM D-2136	-40°C Pass
Shore A Hardness	ASTM D-2240	80± 5
Heat Aging	ASTM D-753 7 days @ 200°F	Maintains 100% of original breaking strength
Ozone Resistance	ASTM D-1149 3 ppm @ 30% strain @ 104°F, 72 hrs. & 2,500 hrs.	No effect
Puncture Resistance, Minimum	FTM 191 B, Method 2031	200 lbs.

Flashing, bonding adhesive, sealant, primer, seam caulk and mechanical fasteners shall be membrane manufacturer provided and approved to insure product compatibility.

Complete specifications and data covering materials furnished under this section, including a membrane sample, shall be submitted for Engineer review. All materials shall be delivered to the site with appropriate labels indicating warnings, storage conditions, lot numbers and usage instructions.

075211 MECHANICALLY ATTACHED

Single-ply roofing shall be mechanically attached. Screw fastener size, type and spacing shall be per membrane manufacturers recommendation. Substrate shall be dry, clean, smooth, free of sharp edges and debris. Insulation shall be fastened as previously specified, joints greater than 1/4-inch wide shall be repaired. Redwood nailers shall be installed where required. Nailers shall be anchored to resist a force of 75 pounds per linear foot in any direction.

Perimeter sheets shall be installed per manufacturer's recommendations. Field sheets shall be unrolled on the area to be covered and placed perpendicular to the slope of the roof, with the edge of the roll aligned with the perimeter sheets. Screw fasteners, spaced per manufacturer's recommendations, shall be installed along the leading edge of the membrane, through the insulation and into the roof deck. Adjoining rolls of membrane shall overlap the fastened edge of the installed membrane by approximately 4-1/2 inches and shall be hot air welded with manufacturer approved automatic hot air welder. Prime cured material as required before hot air welding. Cut edges shall be caulked with seam caulk. Perimeter fastening and flashing shall be in accordance with membrane manufacturers standard details and as indicated on Plans.

Where underside of metal deck is exposed to view, fasteners shall be sized to penetrate deck not more than 1/2-inch. Where penetration exceeds 1/2-inch, the Engineer may require such fasteners to be trimmed.

Where roof walkway is to be installed, a second layer of membrane shall be installed beneath walkway for additional membrane protection.

Provide prefabricated walkway to access rooftop equipment where indicated on the Plans. Walkway shall be "TRAFBLOC" by Siplast, or equal, and shall be adhered to the membrane with bonding adhesive. Walkway shall be cut into sections (maximum 32-inch) and placed with 6-inch gap between sections to allow proper drainage.

Upon completion of the installation, an inspection shall be made by a representative of the membrane manufacturer to ascertain that the roofing system has been installed according to manufacturer's specifications and details. Repair of deficient work required to obtain manufacturer's warranty shall be the responsibility of the Contractor.

076000. FLASHING AND SHEET METAL

Sheet metal work shall be in accordance with the following reference standards:

The Aluminum Association, Specifications for Aluminum Sheet Metal Work in Building Construction.

Architectural Sheet Metal Manual, Sheet Metal and Air Conditioning Contractors National Association, Inc.

Shop drawings shall be submitted in accordance with the GENERAL CONDITIONS and shall show construction, connections, joints, and isolation.

Sheet metal work in connection with roofing shall be in accordance with roofing manufacturer's specifications. Sheet metal shall also be coordinated with other trades.

Sheet metal for metal flashing, counterflashing, gutters, downspouts, expansion joints and other exposed sheet metal work shall be constructed as indicated on the Plans. Where not detailed, the installation shall be executed to meet the standards of the trade. All cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades shall be performed under this section. All accessories or other items essential to the completeness of this sheet metal installation, though not specifically shown or specified, shall also be provided under this section.

Except as otherwise specified or indicated on the Plans, materials for flashing and sheet metal shall be as follows. Specific metal type and gauge shall be as indicated on the Plans.

ALUMINUM EXTRUSIONS: Extruded aluminum shall conform to ASTM B221, alloy 6063-T42.

ALUMINUM SHEET: Sheet aluminum shall be alloy 5005-H14 conforming to the requirements of ASTM B 209 and, unless otherwise required pursuant to the referenced standards, shall be not less than 0.032-inch in thickness.

STAINLESS STEEL: Stainless steel shall conform to ASTM A167, Type 304 or 316, and shall be not less than 0.020-inch thick.

GALVANIZED STEEL: Galvanized steel shall conform to ASTM A 525, with 1.25-ounce coating, and shall be not less than 0.021-inch thick.

BASE FLASHINGS: Base flashings shall be of roofing felt as specified elsewhere herein.

COUNTERFLASHING AND REGLETS: Counterflashing and reglets shall be a prefabricated system. Reglets shall be designed for the substrate to which they are attached; they shall be cast into concrete, built into masonry and installed prior to stucco or wood veneer. Installation shall be complete with preformed corners.

MISCELLANEOUS: Screws, nails, bolts, rivets, and other connectors shall be same material as sheet metal, or Type 18-8 stainless steel, when fastening aluminum.

Washers shall be 0.04-inch minimum thickness. A rubber type washer shall be used beneath the metal washer or fastener head where weathertightness is required.

Provide flashings as indicated on the Plans and in all locations where the use of flashing is necessary to provide leakproof conditions throughout. Surfaces to which sheet metal is to be applied shall be even smooth, sound, thoroughly clean and dry, free from all defects that might affect the installation.

Rises and angles formed into flashing shall be true and straight and exposed surfaces shall be free from waves and buckles. All exposed edges shall be hemmed 1/2-inch. All connections shall be water and weathertight. Joints shall be sized and spaced to provide adequate movement for thermal expansion and contraction.

Except as otherwise specified or indicated on the Plans, reglets and sheet metal counterflashings shall be provided over all membrane base flashings. Counterflashings shall turn down over base flashings not less than 4 inches, and shall be formed to provide spring action against the base flashing.

All pipes, stacks, ducts, vents, conduit, etc., through roofs shall be flashed and counterflashed as indicated on the Plans, as specified, or shall be suitably flashed and counterflashed per referenced standards.

Roof drains shall be flashed and made watertight at the roof with not lighter than 4-pound sheet lead flashing. Vents and pipes shall be provided with similar sheet lead flashing. Flashings shall extend not less than 6 inches up the pipes, where they shall be counterflashed with standard cast-iron or malleable iron recessed roof couplings. Flashing for vents may be carried up to the top of the vent and turned down into the pipe. Flashing flange shall extend not less than 4 inches from the vent or pipe in all directions, shall be set in roofing cement and shall be primed before stripping in.

All sheet metal work shall be furnished complete with supports, hangers, bracing, anchors, and other devices as required for reinforcement and proper attachment to building construction. Fastenings shall be concealed wherever possible. Aluminum shall be isolated from direct contact with other metals with asphaltic coating.

Nails, screws, and bolts shall be of the types best suited for the intended purpose and shall be of a composition that will not support galvanic action in the installation.

All work and finishes shall be protected from scratches and abrasions until construction is complete.

077000. ROOF SPECIALTIES AND ACCESSORIES

077100. METAL COPING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications titled Flashing and Trim, Section 07619.

077500. EQUIPMENT CURBS AND SUPPORTS

Prefabricated metal curbs shall be provided at all roof mounted equipment where specified or otherwise indicated on Plans. Metal curbs shall be Type PC-2 as manufactured by the Pate Company; Model CRC-3 as manufactured by Custom Curb, Inc.; or equal. Where available, curbs may also be provided by the equipment manufacturer whose product is to be installed on the curb.

Curb shall be of box section design (straight sides), 12 inches high, 14-gauge galvanized steel construction, with continuous mitered and welded corner seams, integral base plate and pressure treated wood nailer. Curbs shall be sloped as required to provide level nailer for equipment installation. To finish edge of metal deck at opening, provide sheet metal "C" closure (match deck metal) 4 sides of opening. Provide sheet metal curb liner where curb is exposed to view from below.

Where installed on roof of metal building, provide corrugated curb design with water diverter plate to match roof deck profile.

Linear rails for equipment support shall also be provided where indicated on Plans. Rails shall be type CES-3 as manufactured by Custom Curb, Inc.; Model ES-2 as manufactured by the Pate Company; or equal. Rail construction shall match that of box curb.

078000. CAULKING OR SEALANT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications titled Caulking and Sealants, Section 07920.

* * * END OF DIVISION 7 * * *

DIVISION 8

DOORS, WINDOWS, AND HARDWARE

080000 GENERAL

These Contract Documents cover materials and installation required for all doors, windows, and hardware for doors and windows.

All doors, door frames, windows and window frames shall be fabricated and installed in a workmanlike manner. All doors, windows, and hardware shall be adjusted so that operation will be smooth, free, and easy, and with no binding in the hardware, or between doors and frames, or windows and frames. Doors and windows shall be set plumb, square, and level at their proper elevation and in their proper plane. All hardware shall be adjusted to operate smoothly, freely, and properly. Doors, windows, and frames shall be protected during shipment and storage to prevent warping, bending, or corrosion.

Doors and frames shall be prepared and reinforced for hinges, locksets, strikes, closers, and other items as required. Preparations in pressed steel frames for hinges, strikes, flush bolts, and other items shall be protected with dust boxes.

Door sizes, leaf types, door frames, and window type and size shall be as indicated and/or scheduled on the Plans. Aluminum shall be isolated as specified under DIVISION 5. Shop drawings shall be submitted to the Engineer for review and acceptance.

081000 DOORS AND FRAMES

081100. HOLLOW METAL DOORS AND FRAMES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Hollow Metal Doors and Frames, Section 08116.

081200. THERMOPLASTIC DOORS AND FRAMES

Thermoplastic doors, frames and appurtenances shall be furnished and installed where shown on the Plans and as specified herein.

Doors shall be as manufactured by Corrim Door Systems, Inc., Conroe, TX; CHEM-PRUF Door Company, Brownsville, TX; or equal.

Submittals shall be in accordance with the General Conditions and shall include manufacturer's literature on door construction, installation recommendations, and schedule showing sizes and locations. Complete detail drawings of all items specified herein shall be submitted. Details shall include elevation of each door type; details of frame; location of doors to be installed; typical and special details of construction; location and installation of hardware (plastic).

Doors, frames and appurtenances shall be designed for and suitable for continuous submerged service and shall be safe for potable water systems. Door, frame, hinges, and latch design shall include uplift (buoyancy).

All thermoplastic doors shall be exterior, flush type, 1-3/4 inch thick, grey in color. Face sheets shall be seamless Fiberglass Reinforced Plastic (FRP) with a minimum thickness of 1/8 inch and shall have a textured finish. Doors shall be manufactured complete with round baffle holes as shown on the Plans.

All thermoplastic doors shall have a solid foam core with a minimum compressive strength of 20 psi. Foam core shall be foamed-in-place or laminated to each panel. The strength of the bond between the foam and the panel shall exceed the strength of the foam, so that delamination does not occur under operating conditions which are continuous submergence. Foam density shall not be less than 1.8 pcf.

Thermoplastic doors shall be manufactured with a minimum strike rail thickness of 1/2 inch; a minimum hinge rail thickness of 1 inch; a minimum top edge thickness of 1/4 inch; and a minimum bottom edge thickness of 1-1/2 inch. Finish hardware (plastic) shall include only hinges and latch mechanism. No thresholds, weatherstripping, closures, door sweeps, stops, silencers, plates, bolts or locks shall be provided. All hardware shall be FRP or compatible, no metal hardware shall be used. Door manufacturer shall provide and mount all hardware required.

Hinges shall be FRP or compatible, hinge style will be the option of the manufacturer. Door manufacturer shall provide FRP or compatible door latch, operable from both sides. Use of baffle holes for operation will be allowed. Hinge and latch mounting may be either by solvent welding or covered screws.

Door edge strips shall be solvent welded to the face sheets and completely sealed. Non swelling polymer blocks shall be provided to reinforce doors as required. Any screws used shall be provided with stop caps which shall be adhered to cover exposed screw heads.

Frames shall be set in position, plumbed, aligned and braced securely per manufacturer's instructions until permanent stainless steel expansion anchors are set. Frames shall NOT be caulked but void space within frame may be grouted. Doors shall be installed such that water flow will tend to close doors.

082000 ACCESS DOORS

Doors specified below provide access through ceilings, walls or floors. For roof access doors see DIVISION 7.

082300 FLOOR ACCESS DOORS

082320 EXTERIOR TYPE

Exterior type floor access doors shall be Type J or JD as manufactured by the Bilco Company; Type GT or AM as manufactured by Babcock-Davis Associates, Inc.; or equal.

Door leaf shall be aluminum diamond pattern plate capable of withstanding a wheel load of 1,200 pounds. Channel frame shall be 1/4-inch aluminum with an anchor flange around the perimeter. Doors shall be equipped with a minimum of two heavy forged brass hinges with stainless steel pins, spring operators to afford easy operation, and an automatic hold-open arm with release handle. A snap lock with removable handle shall be provided. A 1-1/2-inch drainage coupling shall be located in the front right corner of the channel frame. Factory finish shall be mill finish with shop coating applied to exterior of the frame in accordance with these Contract Documents. Size and location shall be per Plans. Installation shall be in accordance with manufacturer's instructions.

087000. DOOR HARDWARE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Finish Hardware, Section 08710.

087100. HARDWARE DESCRIPTION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Finish Hardware, Section 08710.

087200. HARDWARE LIST

The various hardware items required for the doors on this project shall be as tabulated below. See Plans for information regarding material quantities.

Again, manufacturer names are listed to establish a standard of quality, appearance and function for hardware required on this project. Equal products by alternate manufacturers may be submitted for Engineer review, except that when matching an existing keying system, new locksets and keys must be compatible with the existing keying system.

HARDWARE GROUP HW-1 (USED AT DOOR NO. 01)

Hinges	6	Stanley FBB 199, 4-1/2 x 4-1/2, US32D
Closer	2	Sargent EN 350 PSH
Threshold	1	Pemko 170A
Weatherstrip	1 Set	Pemko 303 AS
Stop	-	(At closer)
Door Bottom	2	Pemko 222 AV
Flush Bolts	1 Set	Quality 1358, US26D (inactive leaf)
Astragal	1	Pemko 355 AV, bronze anodized (active leaf)
Lockset	1	Sargent 8G05 OB x 32D (RHRBA)

HARDWARE GROUP HW-2 (USED AT DOOR NO. 02)

Hinges	3	Stanley FBB 199, 4-1/2 x 4-1/2, US32D
Closer	1	Sargent EN350 P9
Silencers	3	Quality 1337 A
Stop	1	Quality 307, US26D
Lockset	1	Sargent 8U15 OB x 32D

HARDWARE GROUP HW-3 (USED AT DOOR NO. 03)

Hinges	3	Stanley FBB 199, 4-1/2 x 4-1/2, US32D
Closer	1	Sargent EN350 PSH
Threshold	1	Pemko 170 A
Weatherstrip	1 Set	Pemko 303 AS
Stop	-	(At closer)
Door Bottom	1	Pemko 222 AV
Lockset	1	Sargent 8G05 OB x 32D

088000. GLASS AND GLAZING

Furnish all labor, materials, equipment and incidentals required to install glass and glazing as indicated on the Plans and as specified herein.

All glazing work shall be performed in accordance with the standards of the Flat Glass Marketing Association's Glazing Manual (latest edition) unless noted otherwise, and shall also conform to shop drawings and the manufacturer's glazing instructions.

All doors shall be glazed with tempered glass, except that fire rated or labeled doors shall be glazed with wire glass. Tempered glass at exterior doors shall be bronze tinted. Glazing at interior doors shall be clear glass.

Tempered glass shall be 1/4-inch thick "Herculite" by PPG Industries; "Tuf-flex" by Spectrum Glass Products; or equal.

Wire glass shall be clear type, with diamond welded mesh by Technical Glass Products, or equal.

Glass and glazing shall be in full compliance with all applicable codes and ordinances including safety criteria ANSI Z 97.1 and Federal Standard 16 CFR 1201.

All glass shall be factory labeled, and labels shall not be removed until glass is accepted by the Engineer.

The glazing contractor shall remove from the glazing surfaces any foreign materials to which the glazing compound will not readily adhere. Glazing rabbets and grooves shall be clean and dust free. No glazing shall be done under 40 degrees F. Setting blocks shall be extruded neoprene, of hardness as required for load of glass at quarter points and to position the glass vertically. Proper face clearance shall be provided by a continuous cushioning material, neoprene or equivalent.

Doors shall not be glazed until they have been hung and adjusted. Doors shall be glazed in closed position.

All glass shall be protected against damage after installation. Tong marks in tempered glass, visible after installation, will not be accepted. After inspection by the Engineer, all labels and marks shall be removed from the glass in accordance with the manufacturer's instructions. All glass shall be in a clean, polished, unbroken, unmarked and undamaged condition at the time of acceptance of the completed project."

* * * END OF DIVISION 8 * * *

DIVISION 9

FINISHES

090000 GENERAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications DIVISION 9.

090100. PAINTING - GENERAL

090101 MANUFACTURERS' INSTRUCTIONS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900.

090102. SPECIFIED PRODUCTS LIST

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900.

090103 PREPARATION OF SURFACES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900.

090104 APPLICATION OF PAINT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900.

090110. FACTORY-PAINTED EQUIPMENT

Except as otherwise noted in the Painting Schedule or specified, the following items of equipment shall receive final finish coats at the factory and shall be protected against damage during transit, storage, and erection. Damaged areas must be refinished as the original. Factory-painted items shall be of a color specified, selected, or accepted by the Engineer.

Air conditioning units
Electric distribution centers
Gauges and meters
Hoist
Instrument and control panels
Instruments
Light fixtures not specified to be field painted

Meter panels
Motor control centers
Transmitters
Sample sink
Variable frequency drives
Ventilating fans

All other factory-finished equipment shall be field painted as specified hereinafter and as shown in the Painting Schedule.

090120. ITEMS NOT PAINTED

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900.

090130 PAINTING CONCRETE, MASONRY, PLASTER, AND STUCCO

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900.

090131 EXTERIOR ABOVE GRADE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900.

090131.01. EXTERIOR FLAT FINISH

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Painting, Section 09900, (2.4.J and 2.4.O).

090131.03 MASONRY SEALER

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900 (2.4.P).

090133 INTERIOR ABOVE AND BELOW GRADE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900.

090133.01. INTERIOR SEMIGLOSS FINISH - LATEX ENAMEL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900 (2.4.L).

090134 SUBMERGED CONCRETE AND MASONRY

In general, items shall be treated as submerged if they are to be at any time underwater, are in structures which normally contain water or are below the tops of walls of water containing structures. Except as otherwise noted in the Painting Schedule, specified, or indicated on the Plans, submerged concrete and masonry shall not be coated.

090140 PAINTING METAL SURFACES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900.

090141 PRIMING OF METALS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900.

090142. PAINTING ARCHITECTURAL METAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900.

090143. SUBMERGED METAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900 (2.4.X).

090143.01. WAX COATING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900 (2.4.HH).

090143.02. EPOXY POLYAMIDE COATINGS - POTABLE SERVICE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900 (2.4.X).

090144. MISCELLANEOUS UNSUBMERGED METALS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900 (2.4.C).

090145 UNDERGROUND METALS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900 (2.4.EE).

090146 PIPE COATINGS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900.

090149 DISSIMILAR METALS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900 (2.4.F).

090160 PAINTING GYPSUM BOARD

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900.

090163 SEMIGLOSS FINISH

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900 (2.4.V).

090170. PAINTING FIBERGLASS AND PLASTIC

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900 (2.4.C and 2.4.GG).

090183 PAINTING INSULATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900 (2.4.G).

090184 SPECIAL COLOR AND PAINTING REQUIREMENTS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Painting, Section 09900.

090199. PAINTING SCHEDULE

Painting shall be as specified in this section of the Contract Documents and as indicated on the Plans and specified herein.

In general, all steel, iron, and wood surfaces shall be painted unless specifically indicated or specified otherwise. Concrete surfaces shall be painted only where indicated or specified. In general, exterior concrete and concrete exposed to wastewater inside basins and tanks shall not be painted and concrete and masonry inside buildings, basements, equipment rooms, etc. shall be painted. Aluminum surfaces shall not be painted unless specifically indicated or specified.

The Painting Schedule sets forth a listing of the type of items and type of paint system which they shall receive. This Schedule shall compliment the lists of items to be painted listed hereinbefore. This listing is not necessarily complete, and items of a like nature as shown in the Painting Schedule shall be painted the same as if they were included in the Painting Schedule. In case of question as to whether an item is to be painted, or as to type of paint system to use, the Engineer shall be consulted to render a judgment.

SCHEDULE OF MASONRY, PLASTER, CONCRETE, AND STUCCO SURFACES TO RECEIVE PAINT

A. Exterior Flat Acrylic Emulsion (090131 and 090131.01)

1. Exterior concrete of Presedimentation Sludge Pump Station Electrical Room.

B. Masonry Sealer (090131 and 090131.03)

1. Exterior of Presedimentation Sludge Pump Station Electrical Room.

C. Interior Latex Semigloss Enamel (090133 and 090133.01)

1. Interior walls of Presedimentation Sludge Pump Station Electrical Room.

D. Floor Sealer (See DIVISION 3, CONCRETE)

1. Presedimentation Sludge Pump Station Basement and Electrical Room.

SCHEDULE OF METAL SURFACES TO RECEIVE PAINT

A. Factory Finish (090110)

1. Gauges, meters, and instrumentation.
2. Instrumentation and control panels.
3. Electric distribution centers.
4. Sample sink.
5. Light fixtures.
6. Meter panels.
7. Motor control centers and variable frequency drive cabinets.
8. Air conditioning units.
9. Ventilation fans.
10. Similar equipment with standard factory finish subject to Engineer's acceptance.

B. Grease Or Wax Coating (090143 and 090143.01)

1. Threaded portion of sluice and slide gate stems.

2. Sliding contact surfaces of gate slides, frames, and guides.

3. All other machined or sliding surfaces subject to being submerged.

C. Epoxy Polyamide Coating (090143 and 090143.02)

1. All portions of bar screens below the base of the structure.

2. All portions of the screenings conveyor below the level of the return belt.

3. Slide gates except sliding surfaces, gate stems and guides.

4. Exterior of all submerged piping, sleeves, pipe supports and hangers other than PVC and stainless steel.

5. All sump pumps, underside base plate, exterior sump pump suction pipe and exterior of sump pumps, and suction bell.

6. In flow structures, bell rings, bulkheads, wall thimbles, hatch frames and covers, and all miscellaneous ferrous metals.

7. Rectangular butterfly valves.

8. And all other submerged miscellaneous ferrous metals listed or not listed in the Painting Schedule.

D. Polyester Aliphatic Polyurethane (090144)

1. Interior and exterior of building doors, transoms, sash, metal panels, louvers, and other architectural metals for all buildings and building additions.

2. Bar screen side and base frames, rake arms, wiper assemblies, drive, screen guard and miscellaneous structural steel.

3. Screenings conveyor frame work, roller and skirt board supports above the level of the return belt, motor, drive belt housing (inside and out), and miscellaneous equipment.

4. Raw water mag meters.

5. Premixers drive gear housing, support stand, and motor.

6. Presedimentation sludge collection drive mechanism, bridge, and other equipment not subject to being submerged.

7. Floor-mounted valve and gate operators and stands, and other valve operators and operator supports.

8. Presedimentation sludge pumps and raw water sample pumps, motors, associated piping, and appurtenances.

9. Presedimentation sludge mag meters.

10. Mechanical equipment supports, drive units, and all accessories.

11. Structural steel, hoist rails, hatches, and covers.

12. All exposed piping and associated appurtenances.

13. Other miscellaneous metals listed or not listed in the Painting Schedule.

E. Coal-Tar Mastic (090145)

1. Underground flexible couplings.

2. Steel bulkheads and bell rings.

SCHEDULE OF GYPSUM BOARD SURFACES TO RECEIVE PAINT

A. Semi-Gloss (090160 and 090163)

1. Ceiling of stairwell at Presedimentation Sludge Pump Station Electrical Room.

090400 GYPSUM WALLBOARD SYSTEM - GENERAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Gypsum Wallboard, Section 09250.

090420 NONLOAD BEARING STEEL FRAMING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Gypsum Wallboard, Section 09250.

090430 WALLBOARD INSTALLATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Gypsum Wallboard, Section 09250.

* * * END OF DIVISION 9 * * *

DIVISION 10

BUILDING SPECIALTIES

100000 GENERAL

All building specialties shall be as indicated and scheduled herein, or as shown on the Plans. Items covered by these specifications shall be standard manufacturer's items unless otherwise indicated. Finish and texture shall be as indicated and shall be selected from manufacturer's standards unless specified otherwise under the particular item. Any variations or substitutions of equipment, accessories, or locations shall be submitted to the Engineer for review and acceptance.

Building specialties, furnishings, or equipment covered in this Division shall be properly transported, stored, and installed or applied. Any item showing flaws of any sort or damage either in shipping or installation shall be replaced at no extra cost to the Owner.

100700 SAFETY EQUIPMENT

This section of the Specifications includes miscellaneous safety equipment to be installed throughout job at various locations. The Contractor shall furnish and install all items specified in this section, including bolts, caulking materials, hangers, supports, and such incidental materials and equipment as are required to make the items complete and ready for use. All equipment shall conform to applicable OSHA requirements, and shall be installed in accordance with manufacturer's instructions.

100750 FIRE EXTINGUISHERS AND CABINETS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Portable Fire Protection Equipment, Section 15513.

102000. LABORATORY FURNITURE - GENERAL - METAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Metal Laboratory Furniture, Section 12902.

102010 INSTALLATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Metal Laboratory Furniture, Section 12902.

102015 FURNITURE - METAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Metal Laboratory Furniture, Section 12902.

102040. COUNTER TOPS AND RELATED SURFACES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Metal Laboratory Furniture, Section 12902.

102042 MATERIAL - EPOXY RESIN

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Metal Laboratory Furniture, Section 12902.

102050. SINKS AND ACCESSORIES

Sample sink shall be custom fabricated of slabs of epoxy resin to match countertop. Sample sink shall be 30 inches long, 15 inches wide and 18 inches deep. It shall be provided with molded epoxy resin sink outlet with integral cross bars and be complete with gasket and locknut. Sink supports shall be the hanger type. Sink shall be as manufactured by Durcon or equal.

* * * END OF DIVISION 10 * * *

DIVISION 11

PROCESS EQUIPMENT

110000 GENERAL EQUIPMENT STIPULATIONS

The requirements set forth in this Section, in general apply to all equipment furnished under this Division and as indicated elsewhere. They shall supplement the detailed equipment Specifications, but in case of conflict the detailed equipment Specifications shall take precedence.

All items of equipment shall be the product, modified as specified herein, of a manufacturer experienced in the design, construction, and operation of equipment for the purpose required, and who shall have established a record of successful operation of such equipment manufactured or produced by them. When two or more units of equipment for the same purpose are required, they shall be products of the same manufacturer. Equipment shall be made up of parts which are designed to act as a unit, and the manufacturer shall guarantee that when the component parts are assembled into the final unit, these parts will fit and operate satisfactorily.

Except as otherwise provided, the responsibility of the equipment manufacturer shall extend to the selection and mounting of gear drive units, motors or other prime movers, accessories and auxiliaries required for proper operation.

All items of equipment contained in this Division shall comply with the applicable requirements contained in DIVISION 14 of these Specifications.

The equipment specified herein shall be painted in accordance with DIVISION 9.

110100 BAR SCREENS

110110 GENERAL

The manufacturer or supplier and Contractor are cautioned to review the general requirements of all equipment. Some equipment will require modification from the standard to meet the Specifications. Particular care should be exercised to assure that the electrical and other systems comply with the intended systems as herein and elsewhere specified.

The Contractor shall furnish and install and make operable, as indicated and detailed on the Plans and as specified herein, 3 mechanically cleaned climber type bar screens. The bar screens shall be manufactured and installed compatible with the headworks structure and equipment, including the screenings conveyor.

The manufacturer of the bar screen equipment shall have installations at 5 or more separate facilities in the United States operating successfully for a period of not less than three years. Each installation shall be at least 8'-0" wide in size and be of a similar climber type to the equipment specified herein.

The bar screens shall be Type 3AS as manufactured by Infilco-Degremont, or equal.

Bar screens which employ back-cleaned design, belt-drives, chains (moving or stationary), cables, multiple motors, chain sprockets, chain components, gear plates, or rely upon any moving part of the mechanism (exclusive of rake, rake arms, and rake stabilizer shaft) to travel below the maximum water elevation are explicitly excluded under this Specification.

All parts of the mechanisms shall be amply proportioned for all stresses which might occur during fabrication, erection, or operation. Duplicate parts shall be interchangeable. All structural steel shall conform to ASTM A 36.

All iron castings shall be of tough, close-grained, gray iron, free of blow-holes, flaws, or excessive shrinkage. They shall conform to ASTM A 48. All shafts shall be cold-rolled steel, straight and true.

All anchor bolts and other bolts shall be as specified in DIVISION 5 herein.

Alarms and alarm switches shall be provided and installed as specified hereinafter and as indicated on the Wiring Diagrams.

The bar screens shall be factory assembled and tested before shipment, and the screen mechanism shall be run-through to insure proper operation of the mechanism. The bar racks shall be constructed and shipped in one piece to facilitate installation at the jobsite.

110111 PERFORMANCE REQUIREMENTS

Clear channel width	11'-0"
Channel top of slab elevation	1247.00
Channel bottom elevation	1231.00
Maximum water elevation	1242.00
Upstream - downstream maximum differential	6"
Angle of inclination from horizontal	80°
Clear space between bars	1/2"
Bar size	3/8" x 2-1/2"

The equipment furnished shall positively clean and remove debris by means of a bar screen to retain debris and a traveling rake to remove and elevate debris which has been retained. The bar screen shall be cleaned by a single rake engaging the bar screen from the front (upstream side) at the channel invert and removing debris on its upward travel. There shall be no moving parts permanently in the channel.

110120 EQUIPMENT DESIGN

110121 BAR RACK

The bar rack shall consist of 3/8" x 2-1/2" rectangular 316L stainless steel bars fastened top and bottom to provide a clear spacing of 1/2-inch between the bars. The bars shall be straight and inclined at 80 degrees from the horizontal. The bar rack shall span the full width of the channel and shall extend the full depth of the maximum water stream. The rack shall be

supported by top and bottom angles and firmly bolted to the channel floor, side walls and to the concrete apron at the top. Bolts and angles shall be of 316 stainless steel. A dead plate shall extend from the top of the bar rack to the discharge point to contain the debris after it has been removed from the rack. The dead plate shall be constructed of 1/4 inch 316L stainless steel plate, suitably reinforced.

110122 MECHANISM

The mechanism shall consist of side frames, pin rack, "cog wheels", rake assembly with guide rollers, wiper arm, and drive components. All wetted parts shall be constructed of 316L stainless steel.

The side frames shall consist of welded structural steel members reinforced to support the required loads. The frame shall be securely fastened to the concrete channel. In each side frame, a pin rack shall serve as a track for the "cogwheels". The pin rack shall be linear and consist of 316 stainless steel bolts and nylon collared lockout nuts fitted with hardened and ground steel bushings. Pins shall be individual and easily replaceable. Chain components will not be acceptable in the pin rack area.

The debris shall be removed from the bar screen by a rake assembly including a shaped perforated plate with tines designed to mesh with and extend between the bars of the bar rack. The rake assembly shall consist of an adequately reinforced, perforated rake shelf with replaceable bolt-on teeth. The rake shelf shall be at least 11 inches wide and the rake teeth shall be accurately machined from 3/4 inch plate material. The rake assembly shall use two rake arms to support the rake shelf. The rake assembly shall be connected to both the main drive shaft carriage and the support for the follower guide roller shaft. The rake arm assembly shall be held against the bar screen by a heavy-duty adjustable coil spring. Proper alignment of the rake arm assembly shall be accomplished by guide rollers which travel in machined channel-type tracks attached to the side frames. The rake shall have a lifting capacity of at least 480 pounds.

The main drive shaft carriage shall be supported by "cogwheels" that ride up and down the pin rack. The "cogwheels" shall be a product specifically designed and fabricated for use with the linear pin rack. The "cogwheels" shall have a minimum pitch diameter of 10 inches and a minimum of 17 teeth. The minimum carriage speed shall be 20 fpm. The maximum carriage speed shall be 30 fpm.

The mechanism shall be so designed that the rake can climb over and be free of an object encountered that cannot be removed. After the object has been bypassed, the rake shall again mesh with and continue to clean the screen. A limit switch shall be provided to energize an alarm when such an object bypass event occurs. Positive overload protection against an object which is too large to be bypassed shall be provided by mounting the motor and gear drive on the rotatable rake arm assembly that is held in position by the coil spring. If the load on the motor increases beyond a predetermined value, the rake arm assembly shall rotate as a reaction to torque to a point where a limit switch shall stop the drive and energize an alarm. When the overload condition has been corrected, the drive may be again operated by manual push-button activation. A local switch shall allow reversal of the rake assembly by manual operation. The mechanism shall be able to be reversed completely out of the channel.

The rake shall be traversed laterally over the discharge chute apex by action of the guide follower roller and the debris shall be removed by a wiper arm. The wiper shall pivot to efficiently clean the rake on each pass and shall be cushioned during travel to the rest position by heavy-duty shock absorbers. Designs that use a separate motor to drive the wiper movement are not acceptable.

The discharge chutes shall be constructed of 1/4 inch 316 stainless steel. The discharge edge of the chute shall be 6'-0" above the top of the channel.

The electrical drive motors shall be TEFC, severe duty, with integral induction brake, and be in conformance with NEMA MG-1 or DIN standards. The service factor shall be 1.15 in a 50 degrees C ambient temperature. The insulation system shall be Class F maximum temperature rise limitation at nameplate horsepower. The drive motor shall not be less than 5 horsepower. The 1.15 service factor shall not be used to provide the power required under normal operating conditions. The drive motor shall be directly mounted to a gear reducer, such that no portion is ever below the top of channel. During normal operation, the motor shall operate in one direction only. V-belt drives are not acceptable.

The gear reducer shall be of the helical-worm type with a cast-iron housing and have a service factor of 1.25 based on design running load. Gear reducer bearings shall be anti-friction with oil bath lubrication. The motor shall contain an integral spring loaded electro-mechanical disc brake released by energization of the operating coils simultaneously with starting the motor.

110123 SAFETY GUARD

An expanded metal safety guard of galvanized steel, 8'-0" high, shall be provided to enclose the three open sides of the screen channel. It shall be mounted to the bar screen base frame as indicated on the Plans.

110130 ELECTRICAL REQUIREMENTS

110131 MOTORS

Motors shall comply with the requirements of DIVISION 14 of these Specifications in addition to the requirements specified herein.

110132 LIMIT SWITCHES AND ALARM

Limit switches shall be provided with the screens and shall be General Electric, Square D, Allen Bradley, or equal. Limit switches shall be for the control, protection, and alarm system of the screens and shall be heavy-duty industrial type in NEMA 4X enclosures.

110133 ELECTRICAL WORK

Electrical work shall conform to the requirements of DIVISION 16 of these Specifications, in addition to the requirements specified herein. The power cable to the motor from the fixed connection shall be encased with a rectangular conduit, flexible in one direction, consisting of a series of one-piece molded links of glass filled nylon.

110140 CONTROLS

The bar screen shall be provided with the following switches: object bypass, torque overload, rake up, and reverse motion alternator, mounted on the bar screen. For other bar screen controls shown on the Plans see DIVISION 16 and DIVISION 17.

110150 PAINTING

The bar screens equipment, where applicable, shall be painted as specified in DIVISION 9.

110160 MANUFACTURER'S REPRESENTATIVE

The services of a factory trained representative of the manufacturer shall be provided to inspect the installation of the equipment, make any necessary adjustments, place it in initial trouble free operation, and instruct the operating personnel in its operation and maintenance.

The factory trained representative shall be responsible for providing both classroom and "hands-on" instruction to plant personnel (minimum 8 hours). The classroom instruction shall cover specific operation and maintenance topics and procedures as required in DIVISION 14.

110180 SPARE EQUIPMENT

In addition to items listed in DIVISION 14, spare equipment shall be as follows:

1	Drive motor and brake assembly
1	Gear reducer
2	Cogwheels
150	Rollers and bushings for pin rack
6	Wiper blades
2	Complete sets of pin rack attachment bolts
1	Set of guide roller bearings
1	Pair of shock absorbers
3	N.O. limit switches
3	N.C. limit switches

110190 SHOP DRAWINGS AND OPERATIONS MANUALS

The Contractor shall submit Shop Drawings and Operation and Maintenance Manuals to the Engineer for review as required in DIVISION 14 of these Specifications, and as specified below.

Shop Drawings shall include complete erection, installation, and adjustment instructions and recommendations, and detailed test procedures for the field testing specified herein. Also included shall be electrical schematics and wiring diagrams with conduit and cable requirements to connect the limit switches and other control devices.

The Contractor shall submit with the Shop Drawings, structural and mechanical calculations and details on all parts individually and severally to show that

the equipment offered satisfies the performance, structural strength, vibration, etc., requirements of these Specifications. The submittal information required to satisfy these requirements shall be prepared by the equipment manufacturer.

110200 SCREENINGS CONVEYOR SYSTEM

110210 GENERAL

The Contractor shall furnish and install, in accordance with the Plans and these Specifications, a screenings conveyor with all accessories and appurtenances necessary for a complete installation. The conveyor system shall be located as shown at the bar screens and screenings handling area. The work includes conveyors, drives, gear reduction units, electrical controls, structural supports, tests, and all accessories necessary for a complete installation.

The conveyor system shall be designed and supplied by a company experienced with similar types and sizes of these systems.

Working drawings, including arrangement and erection drawings of the equipment, electrical connection diagrams, and equipment operating characteristics shall be furnished. The submittals shall include manufacturer's certified performance and material records as required.

110220 ITEMS AND WORK INCLUDED

The items and work included under this heading shall include all structural and mechanical components as detailed on the Plans, which items shall include but not be limited to the following:

Shop drawings
All structural steel, plain and galvanized
Belting
Troughing, return, training and impact idlers
Drive and tail pulleys
Electric limit switches
Belt wipers
Manual screw take-up assembly
Cables, bearing blocks, and miscellaneous hardware
Stainless steel bolts and fasteners
Painting
Safety cable
Assembly, adjustment, and testing
Electrical work

Painting shall conform to the requirements under DIVISION 9.

110230 FUNCTION AND OPERATION

The Contractor shall furnish and install a conveyor system for the removal of screenings at the bar screen facility. The conveyor shall have the capability of conveying the screenings to either side of the bar screen structure

for screenings disposal. The normal method of screenings disposal will be to discharge the screenings directly off the conveyor into portable trash containers. The normal system operation shall be as follows:

1. The screenings conveyor shall be interlocked with the 3 bar screens by means of an adjustable counter. The conveyor will be activated after a desired number of passes of the bar screen. The conveyor shall operate on a timed sequence to adequately clean the belt of all screenings.

2. The motor drive for the conveyor shall be reversible so as to convey the screenings in either direction.

3. The failure mode of the conveyor shall be under speed, zero motion, and personnel emergency pull cord.

Operation and control shall be as shown on the electrical schematic diagrams, process and instrument diagrams, and as generally described above. The manufacturer of the conveyor shall provide cable-operated stop switches and a zero-motion switch mounted on the conveyor.

110240 DESIGN AND CAPACITY

The belt conveyors shall be complete with belts; head and tail pulleys; head and tail shafts; carrying, return, impact, training, and transition idlers; bearings and pillow block take-ups; belt cleaners or belt wipers; lubricating devices; drive gear reduction units; drainage trays; skirts; structural steel frame and supports; and auxiliary equipment necessary for a complete installation.

Screening conveyor shall be provided as follows:

Material handled	Screenings
Material unit weight, lb/cu.ft.	60
Type conveyor	Troughed
Belt width, inches	24
Approximate length between terminals, feet	56
Carrying idler troughing angle, degrees	20
Carrying idler spacing, feet	3'-0"
Return idler style	Straight
Return idler spacing, feet	8'-0"
Belt speed, fpm	80
Peak loading rate, tons per hour (tph)	6.0
Head pulley diameter, minimum, inches	18
Tail pulley diameter, minimum, inches	14
Motor drive horsepower, minimum, at 1,750 rpm	1

110241 STRUCTURAL STEEL

It is the Contractor's and manufacturer's responsibility to see that all components fit and to check all details for proper fabrication and assembly.

The conveyor frame and support sizes shall be not less than as indicated on the Plans and shall be designed for applicable wind and seismic loadings in accordance with the latest edition of the Uniform Building Code. The

conveyor manufacturer shall submit structural design calculations for acceptance with the Shop Drawings. All structural steel shall conform to ASTM A 36 as specified in the Structural Steel and Miscellaneous Metals Section of the Standard Specifications.

All anchor bolts and other bolts shall be as specified under DIVISION 5.

110242 CONVEYOR BELTING

Conveyor belts shall be manufactured from nylon and be of the "minimum-ply" design with integral edge or sealed construction. Conveyor belts shall be suitable for vulcanized diagonal butt splices. Vulcanized splices shall be used on all conveyors having adjustable screw take-ups. Conveyor belts shall be "Plylon" as manufactured by Goodyear, or equal.

The conveyor belt shall be 24 inches wide. Top covers for conveyor belts shall be 1/8 inch thick and the bottom cover shall be a minimum of 1/16 inch thick. Covers shall be of material suitable for medium oil duty. Covers shall be of "MORS" by Goodyear, or equal.

110243 IDLERS

CARRYING AND RETURN IDLERS: Carrying idlers shall be spaced on a maximum of 3-foot centers and 8-foot centers for return idlers. All idlers, unless otherwise specified, shall consist of machined outer shells of adequate thickness for the specified service and concentric heavy gauge center tubes continuously welded to die-formed roll heads to form a concentric moisture-proof assembly. All idlers shall have a minimum diameter of 5 inches spaced as shown on the Plans. Outer shells shall be chamfered to protect the belt. All idlers shall be supplied by a single manufacturer.

TRAINING IDLERS: Training idlers shall be similar to the troughing idlers with the carrying roll frame mounted on a central pivot approximately perpendicular to the conveyor belt. Placement of the training idlers shall be based on the manufacturer's calculated belt tension and standard industry practice.

TROUGHING IDLERS: Troughing idlers shall have three equal length steel rolls. End and center rolls shall be freely interchangeable within a given size and type of idler. The idlers shall be 20-degree troughing idlers as specified for each conveyor. The idler frames shall be one piece, jig-welded having formed steel end and center brackets welded to an inverted angle, or equivalent construction. All idlers shall be for continuous operation, medium capacities.

IMPACT IDLERS: Impact idlers shall be used at all bar screen discharge chute locations. These idlers shall have grooved, molded rubber rolls. A minimum of three impact idlers shall be provided at each discharge chute location.

All idler rolls shall have tapered roller bearings with minimum 3/4 inch diameter steel shafts. All idler assemblies shall be provided with grease connections to each end of the assembly, and all grease lines shall be brought out to the north side of the conveyor at an easily accessible location and elevation. All grease lines shall be 304 stainless steel tubing.

All idlers shall be suitable for travel in either direction.

Idlers shall be as manufactured by Jeffrey Manufacturing Co., Rexnord, Link-Belt, Division of FMC Corporation, or equal.

110244 PULLEYS

The drive pulley shall be 18-inch diameter and the tail pulley shall be 14-inch diameter by 26 inches long. The head pulley shall be drum type, crown faced with 1/8-inch per foot on radius from ends of pulley to center of face and face-welded with tapered compression hubs and bushings. The drum shall be of welded steel. Center reinforcing discs shall be provided as required to accommodate the imposed loadings. Vulcanized lagging, 3/8 inch thick, with herringbone grooves shall be provided for the head pulley. The pulley shall meet the requirements of ANSI B105.1.

The tail pulley shall be drum type, welded steel construction, crown faced with 1/8 inch per foot on radius from ends of pulley to center of face and face-welded with tapered compression hubs and bushings. The pulley shall meet the requirements of ANSI B105.1.

The head pulley shaft shall be of cold finished steel of a minimum size of 2-15/16 inches. The tail pulley shaft shall be of cold finished steel of a minimum size of 2-7/16 inches. Shafts shall not be turned down for bearings. Bearings shall be of the self-aligning spherical roller bearing, pillow block type with felt neoprene seals. Lubrication fittings and grease lines shall be provided and located to permit all lubricating from the north side of the conveyor. The grease fitting shall be in an easily accessible location.

Pulleys shall be as manufactured by the Jeffrey Manufacturing Co., Link-Belt Division of FMC Corporation, Rex Chainbelt Company, or equal.

110245 ADJUSTABLE SCREW TAKE-UP ASSEMBLY

A screw type take-up shall be provided for the conveyor. The take-up, to be located at the tail pulley, shall be equipped with double roller bearings. A take-up adjustment of 1.5 feet minimum shall be provided. The screw take-ups shall be Link-Belt Series DSH-B22500H, extra-strength welded steel frame, or equal.

110246 BELT CLEANERS

Each end of the conveyor shall be equipped with a belt cleaner. The cleaner shall be installed to properly clean the return side of the belt and prevent material buildup of the belt which might damage idlers, pulleys, the belt itself or cause other detrimental operation of the belt conveyor. The cleaning mechanism shall be designed such that they can be easily engaged and disengaged, depending on the direction of conveyor travel.

The belt cleaner shall be a double bladed belt wiper. The wiper shall include two cradles, each with one wiper blade. The forward cradle shall have a thick rubber blade and shall be followed by a cradle with a flexible wiper. The cradles shall be positioned in counterweighted arms to ensure constant contact with the belt by all blades. Belt cleaners shall be fabricated by Conveyor Components Company, or equal.

110247 SKIRT BOARDS

The belt conveyor shall be provided with metal skirt boards at the bar screen discharge points as shown and to the heights indicated. The skirt boards shall be fabricated of 304 stainless steel, at least 1/8 inch in thickness, suitably reinforced to resist deflection. Approximately 2-inch clearances shall be provided between the bottom edges of the skirt boards and the belts. A rubber strip shall be provided at the bottom edge of all skirt boards to serve as closure. The rubber strip shall be held in place by a stainless steel retaining strip and shall be installed to permit vertical adjustment in clearance. The rubber strip shall be of 3/8 inch thick solid rubber containing no fabric and of approximately 60 durometer hardness.

The height and width of the skirt boards design will be coordinated with the bar screen manufacturer to allow for positioning of the bar screen discharge chute pan over the belt conveyor.

110248 DRAIN PANS AND DECK PLATE

Drain pans shall be provided beneath the belt conveyor where shown on the Plans. The drain pan shall be of 304 stainless steel construction, at least 12 gauge in thickness, suitably reinforced to prevent buckling. Adequate clearance shall be maintained between the drain pan and the return idlers.

A deck plate of 18 gauge 304 stainless steel sheet shall be provided between the conveyor frame and carrying idler supports, the full length of the conveyor.

110250 CONVEYOR DRIVES

The belt conveyor shall be belt driven through a shaft-mounted speed reducer. The reducer and belt drive shall be of proper ratio to provide the required conveyor belt speed.

The belt drive shall be of the multiple V-belt type with stationary drive sheaves and companion sheaves and shall have a rigid belt guard. A slide base shall be provided for belt slack adjustment. The belt guard shall be of stainless steel with a minimum thickness of 14 gauge and shall be suitably anchored and arranged to be removed without removing belts.

The gear reducer shall be enclosed in a dust-tight cast-iron enclosure with ample space provided for oil. Lubrication shall be by splash lubrication with gears operating in an oil bath. The casing shall include provisions for filling and draining the oil and shall have an oil level gauge in a convenient location.

The gear reducer shall be of the parallel shaft type with split case for easy maintenance. The gear reducer shall be designed for conveyor service, and have a minimum AGMA service factor of 1.5. The gear reducer shall bear an AGMA nameplate.

The maximum noise level measured 5 feet from each drive shall not exceed 90 dBA.

The conveyor drive motor shall have the following characteristics.

Horsepower	Not less than 1
Volts	460
Phase	3
Hertz	60
Insulation	Class F, with B rise
Service factor	1.15
Ambient temperature	50° C
Enclosure	TEFC
RPM	1,750

The gear reducer shall be shaft mounted on the 2-15/16 inch shaft and shall be manufactured by Falk Corporation, Dodge a division of Reliance Electric, or equal.

110260 SAFETY EQUIPMENT

The belt conveyor, as a minimum, shall meet the applicable sections of ANSI B20.1 - 1976, "Safety Standards for Conveyors and Related Equipment," and all OSHA Standards.

A cable-operated stop switch shall be mounted on both sides of the conveyor. The stop switch on the north side of the conveyor shall be installed at the drive end and shall be activated by a tag line the full length of the conveyor. The stop switch on the opposite side shall be installed at the tail end and shall be activated by a tag line that extends the full length of the conveyor. The stop switch shall be designed for cable operation in both directions from one electrical connection. The stop switch shall be equipped with a positive safety lock to prevent accidental reset of the switch. The actuating force on the cable shall be field adjustable.

The safety switch housing and all associated components shall be constructed of aluminum alloy 6061-T6. Cable shall be a 3/32 inch 7 by 7 preformed, galvanized aircraft cable coated with an orange colored vinyl to a 3/16 inch overall O.D. The safety switch shall be as manufactured by Conveyor Components Company Model RS, Croswell, Michigan, equivalent as manufactured by Matrial Control, Inc., or equal.

110270 FORWARD/REVERSE MOTION SWITCH

A zero-motion, or speed switch assembly shall be installed at the conveyor drive assembly. The assembly shall be connected to a forward/reverse speed sensing switch with flexible coupling. The switch shall be housed in a NEMA 4X enclosure and mounted off the side of the conveyor frame with a bolted aluminum bracket. Forward and reverse contacts shall be normally open. Switch shall be Allen Bradley Bulletin 808, or equal.

110280 MANUFACTURER'S REPRESENTATIVE

The services of a qualified representative of the manufacturer shall be provided to inspect the installation, test the equipment, make any necessary adjustments, place it in initial trouble-free operation, and instruct the operating personnel in its operation and maintenance.

The factory trained representative shall be responsible for providing both classroom and "hands-on" instruction to plant personnel (minimum 4 hours). The classroom instruction shall cover specific operation and maintenance topics and procedures as required in DIVISION 14.

110290 INSPECTIONS AND TESTING

Working with the manufacturer's representative, and in the presence of the Engineer, the Contractor shall perform field tests as follows:

A. Full load operating tests on belt conveyor system.

B. The Contractor shall furnish the labor for testing.

C. In the event the equipment fails to meet the above test, the necessary changes shall be made and the equipment retested. If the equipment remains unable to meet the test requirements to the satisfaction of the Engineer, it shall be removed and replaced with satisfactory equipment at the expense of the Contractor.

D. All defects recorded during the above field tests and all defects and failure occurring within the first year of operation shall be corrected by the Contractor at the expense of the Contractor.

110291 SHOP DRAWINGS AND OPERATIONS MANUALS

The Contractor shall submit Shop Drawings and Operation and Maintenance Manuals to the Engineer for review as required in DIVISION 14 of these Specifications, and as specified below.

Shop Drawings shall include complete erection, installation, and adjustment instructions and recommendations, and detailed test procedures for the field testing specified herein. Also included shall be electrical schematics and wiring diagrams with conduit and cable requirements to connect the stop switches and other control devices.

The Contractor shall submit with the Shop Drawings, structural and mechanical calculations and details on all parts individually and severally to show that the equipment offered satisfies the performance, structural strength, vibration, etc., requirements of these Specifications. The submittal information required to satisfy these requirements shall be prepared by the equipment manufacturer.

110292 SPARE PARTS

The Contractor shall provide the following spare parts:

2 - Troughing idlers
2 - Return idlers
1 - Training idler
1 - Impact idler
1 - Set of head pulley bearings
1 - Set of tail pulley bearings

110300 PREMIXERS

110310 GENERAL

Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer, unless exceptions are noted by the Engineer. Each unit shall be furnished and installed complete with all anchors and supports; all mechanical equipment required for proper operation, including a complete drive unit; and all additional materials or construction required by the manufacturer's design.

Drive units will be mounted outdoors and shall be suitable for outdoor operation with exposure to rain and dust.

The premixer shall provide complete and uniform dispersion of treatment chemicals into the raw water. Provisions will be made to add the following chemicals into each mixing chamber:

Alum, Caustic Soda, Coagulant Aid Polymer, Powdered Activated Carbon and Chlorine

The chemical diffusers will be located below the impeller.

Mixers shall be as manufactured by Mixing Equipment Company, Philadelphia Mixer Corporation or Chemineer, Inc. No substitutions will be permitted.

110320 DESIGN REQUIREMENTS

The mixers shall be designed for operation in the premixing chambers as indicated on the Drawings and for the following requirements:

Initial design rate of flow per chamber, mgd	70
Future design rate of flow per chamber, mgd	90
Total detention time per chamber, seconds	
At initial design rate of flow	4.4
At future design rate of flow	3.3
Mixing chamber dimensions, feet	8.5 x 9.5
Initial design flow water depth, feet	11.67 minimum, 13.27 maximum
Future design flow water depth, feet	11.26 minimum, 12.86 maximum
Top of supporting base elevation, feet	1247.0
Chamber floor elevation, feet	1226.83

Minimum velocity gradient, "G", at 68°F, future design rate of flow, and maximum motor speed, sec^{-1}	800
Minimum impeller primary pumping capacity, at maximum motor speed, Q, gpm	64,000
Number of impellers	1 or 2
Impeller type	Axial flow, hydrofoil or pitched blade
Pumping direction	Down
Number of blades	3 or 4
Minimum impeller diameter, inch	60
Maximum output shaft speed, rpm	110
Power supply controller	VFD
Maximum motor nameplate horsepower, hp	40
Maximum motor speed, rpm	1,800

110330 DRIVE UNITS

Drive units shall be designed for the specific requirements of mixer service and shall be suitable for 24-hour a day operation. Each drive unit shall consist of an electric motor and a speed reducer with a flexible coupling provided between the motor and speed reducer. Drive units having a pinion mounted directly on the motor shaft will not be acceptable. Lifting lugs shall be provided on each motor and speed reducer. One set of lifting lugs shall be designed and located to permit lifting the complete mixer and drive unit. Motors shall be readily separated from speed reducers.

The overall installed height of the entire drive unit, including electric motors, shall not exceed 5 feet above the supporting deck elevation. A right-angle drive configuration may be required.

110331 SPEED REDUCERS

Speed reducers shall be double or triple reduction type with helical or spiral bevel gearing, or planetary cycloidal gearing. Worm gearing will not be acceptable. Output shaft shall be fitted with double dual lip seals riding on collar, or shall be enclosed in a dry well which provides positive leakproof sealing.

All speed reducer bearings shall be rolling element, antifriction type. Thrust bearings shall be provided to carry all shafting and impeller loads, plus an allowance of at least 25 percent of the weight of the shaft and impeller. No bearings shall be located below the bottom of the supporting platform.

Speed reducers shall be specifically designed for mixer service. The speed reducers shall be selected, designed, and rated in accordance with the appropriate AGMA standards where applicable. All torque-transmitting components of the reducer shall have strength and durability design lifetimes of not less than 100,000 hours, based on continuous operation at maximum speed and 150 percent of motor nameplate horsepower. Bearings shall have an AFBMA L_{10} Life Rating of at least 100,000 hours, except output shaft bearings, which shall have an L_{10} rating of at least 200,000 hours. The mixer manufacturer shall submit proof of having furnished equipment similar in size, torque, and shaft overhang which has performed successfully.

110331.10 SPEED REDUCER DESIGN

110331.11 TYPE 1

The turbine shaft shall be supported on two antifriction bearings that shall be independent of the speed reducer bearings. The bearings shall be grease lubricated, with accessible grease inlet and lubricant vent, or oil lubricated. Each grease fitting shall be protected with a removable neoprene cover. The design of the impeller shaft bearings shall be such that the entire weight of the vertical turbine shaft and turbines will be supported by a thrust bearing independent of the drive. A flexible coupling shall be used to connect the vertical turbine shaft to the output shaft of the speed reducer. The speed reducer shall be in accordance with AGMA standards as specified herein, and shall have a service factor of 2.0, based on the motor nameplate horsepower rating.

110331.12 TYPE 2

Planetary Cycloidal Speed Reducers (Cyclo-drives) shall be of the extended base type and the housing shall be of cast iron construction designed to support the weight of the flocculation mechanism and the speed reducer.

Cyclo-drives shall be as manufactured by Sumitomo Machinery Corp. of America. No substitutions will be permitted.

The extended base shall be designed for all horizontal and vertical loads; shall rigidly position the cartridge mounted, grease lubricated lower main double row self-aligning ball bearings, and an independent ball-type thrust bearing; and shall provide a rigid mounting for the speed reducer. The extended base shall be of all cast iron construction. The mixer shaft shall be rigidly coupled to the output shaft.

The reducers shall be of the planetary type employing two precision machined cycloidal discs of SAE 52.100 bearing type steel. The cycloidal discs shall mesh with two sets of bearing grade steel rollers. One set shall be mounted to the reducer housing and the second set shall be attached to a precision machined disc on the output shaft. The input power shaft shall impart motion to the cycloidal discs through a set of eccentrically mounted high capacity roller bearings. The speed reducer shall have a minimum service factor of 2.0, based on the motor nameplate rating.

The main output shaft bearings shall be of the "deep grooved ball" type to support all horizontal and vertical loads. The upper and lower main bearings shall be oil lubricated and the extended base main bearing shall be grease lubricated with a grease line and fitting located for easy maintenance.

110331.13 TYPE 3

The mixer speed reducer shall be designed with an output shaft system suitable for the loadings imposed by the specific duty. The reducer's AGMA service factor, based on the motor nameplate rating, shall be at least 2.0. Type 3 speed reducers shall be Mixing Equipment Company Series 70, Philadelphia Mixers Corporation Series 3800-S, or Chemineer, Inc. Series HT.

110332 LUBRICATION

The speed reducer shall be provided with a suitable lubrication system for all-weather starting and operation of the unit. A dipstick or sight glass shall be provided to observe oil levels. All fill and drain lines shall be sized for efficient functioning, and located for easy accessibility. Oil changes, following the initial run-in period, shall not be required at less than 2,500 hour intervals. Oil leakage down the low speed shaft shall be prevented by means of a dry well or double dual lip seals riding on a replaceable sleeve or collar on the output shaft. The oil drain shall be extended from the drive to prevent leakage and spillage during oil changes. The speed reducer breather shall be located above possible oil foam level.

Other forms of lubrication, such as greasing of certain working parts within the speed reducer, are permissible provided adequate separation is made of these parts from oil lubricated parts.

110340 MIXER SUPPORTS

Each mixer shall be designed and mounted so the mixer can be removed from its chamber as a complete unit after the impeller is removed from the shaft. The connection of the drive unit to the mixer shaft shall be such that the shaft and drive unit can be separated above the top deck and workmen are not required to enter the basin to change a drive unit. Each mixer shall be assembled on a rigid base. The base shall be secured to a subbase which shall be permanently leveled and grouted in place on the concrete deck. The opening in the subbase shall be large enough to permit removal of the shaft, including couplings, after removal of the impeller. The base and subbase shall be matched and doweled.

110350 IMPELLERS AND SHAFTS

Each mixer shall be provided with one or two axial flow impellers. The impellers can be either hydrofoil or pitched blade type. The manufacturer shall be responsible for the proper design and selection of the impeller or impellers for the given requirements.

Impellers shall be provided with split hubs or removable arms to permit the impellers to be removed in sections through the grating opening in the cover slab. A keyway shall be provided on the shaft to allow vertical adjustment in the impeller 12 inches up or 12 inches down in 3-inch increments from the initial impeller location. The impeller assemblies shall be made of AISI Type 316 stainless steel.

Vertical shafting for the impeller assembly shall be of ample size and design for the service intended and shall be supported and steadied so that the unit will operate without shaft whip or vibration. Shaft runout shall be less than 1/4-inch per 10 feet of length when turned over by hand.

The Manufacturer shall perform detailed structural calculations for the shaft, impellers, and coupling in accordance with the latest edition of AISC using approximate stresses for the stainless steel furnished. The combined bending and tension stress for the shaft shall not exceed 6,000 psi to provide an allowance for fatigue. The calculations shall allow for the effects of the herein specified flows through the mixing chambers. Shaft diameter shall be the larger of that required by the structural design and analysis or the operating critical speed ratio criterion specified.

Shafts shall be of the solid type made from AISI Type 316 stainless steel. Rigid type couplings shall also be fabricated from stainless steel.

There shall be a coupling assembly at the top of the vertical impeller shaft which shall be attached to the output shaft of the speed reducer. The lower half of this coupling shall be made from AISI Type 316L stainless steel and shall be welded to the shaft. The coupling flanges shall be turned and faced after being welded in place, and shall be provided with a registered fit. The coupling shall be designed to transmit 200 percent of the full torque and 150 percent of the axial load on the coupling. The coupling halves shall be bolted together through the flanges with AISI Type 316 stainless steel bolts. The location of this coupling shall be so arranged that the flange bolts may be removed from the coupling by workmen on top of the concrete floor which supports the drive. The Contractor shall submit with the Shop Drawings details of the coupling-shaft sleeve arrangement for the Engineer's review and acceptance. The arrangement shall be such that the drive unit complete may be removed, and the vertical impeller shaft and impeller may be suspended from above the concrete floor, so that a standby, complete drive unit may be installed on the same sole plate or base and be in alignment. All parts which require field assembly shall be match marked at the factory.

110360 MOTORS

The motors shall be premium high efficiency, high power factor and severe duty motors designed for the horsepower ratings described herein and shall operate continuously at varying speeds over a 2 to 1 speed range, in a 50 degree C ambient temperature from the power supplied by a variable frequency drive (VFD) (see DIVISION 16). The motors shall be nameplated 1.15 service factor for operation on the VFD power supply. Motor leakage reactance shall be matched to the type of VFD drive being provided (i.e., current source, voltage source, or pulse width modulation type) so as to minimize harmonics generated by the VFD/motor combination. (Motors shall also be capable of running across the line.)

Motors shall have the following characteristics in addition to those described herein:

Horsepower	40, maximum
Enclosure	TEFC
Synchronous speed	1,800 rpm
Voltage	460 volts
Phase	3
Nominal frequency	60 hertz

Motors shall be designed such that the insulation system shall be Class F rating and the temperature rise over the complete operating speed range shall not exceed Class B insulation, as determined by NEMA motor standard testing procedures.

110370 POWER NUMBERS AND FLOW NUMBERS

The Manufacturer shall submit certification that design has been performed in accordance with the Specifications, laboratory testing results, and full scale prototype testing results obtained for the axial flow impellers to be supplied. The submittal shall verify power numbers and flow numbers for the impellers, as well as average velocity gradients and primary pumping capacities at the specified temperatures and operating speeds.

110380 MANUFACTURER'S REPRESENTATIVE

The services of a factory trained representative of the manufacturer shall be provided to inspect the installation of the equipment, test the equipment, make any necessary adjustments, place it in initial trouble free operation, and instruct the operating personnel in its operation and maintenance.

The factory trained representative shall be responsible for providing both classroom and "hands-on" instruction to plant personnel (minimum 8 hours). The classroom instruction shall cover specific operation and maintenance topics and procedures as required in DIVISION 14.

110385 FIELD TESTING

The Manufacturer shall demonstrate to the satisfaction of the Engineer that the power demand of each drive motor does not exceed the nameplate horsepower or nameplate full load ampere rating. The Manufacturer shall demonstrate each mixer to be capable of operation without undue noise, vibration or shaft whip over the complete range of operating speeds. Equipment found defective shall be adjusted, repaired or replaced as required, to the satisfaction of the Engineer.

All necessary equipment required for testing, properly calibrated, shall be furnished by the Manufacturer.

110390 SHOP DRAWINGS, DATA AND OPERATIONS MANUALS

Complete assembly, foundation, and installation drawings, together with detailed specifications and data covering material used, power drive assemblies, accessories forming a part of the equipment furnished, and operation and maintenance manuals shall be submitted in accordance with DIVISION 14 of these Specifications. Data and specifications for each unit shall include, but shall not be limited to, the following:

Impeller information, including diameter, power number, and flow number.

Impeller shaft size, material, and number of sections.

VFD and motor data in accordance with the submittals section.

Type, specifications, details, input and output speeds, exact gear ratios, and service factor (24-hour continuous service) of speed reducers.

Maximum horsepower requirements.

Ratio of maximum rotative speed to critical speed of shaft.

Details of supporting base structure.

110400 CIRCULAR SLUDGE COLLECTORS

110401 GENERAL

The Contractor shall furnish, install and make operable three sludge collector mechanism(s) for the rectangular preliminary sedimentation basin with all necessary appurtenances for the complete installation as indicated on the Plans and as specified herein. The equipment shall be as manufactured by Eimco Process Equipment Company; Envirex, Inc.; Walker Process Corp; or equal.

110402 EXPERIENCE OF MANUFACTURER

The sludge collectors shall be made by a manufacturer which has been regularly engaged in the manufacture of sludge collectors for not less than five years. Said sludge collectors shall have been successfully utilized in domestic water treatment and wastewater treatment applications for not less than five years. The Contractor shall submit a list of five sludge collector installations which:

A. Have been designed and fabricated by the manufacturer.
B. Are at least 100 feet in diameter.
C. Have been in operation for at least five years.
D. Are in current operation.

The list shall include the name, address, and telephone number of the Owner, design flow of the plant, sludge collector dimensions and time in operation.

110403 DESCRIPTION

The sludge collector mechanism shall be of the center column type, with central driving mechanism which shall support and rotate a center cage with two rake arms attached thereto. Scraping blades and squeegees attached to the rake arms shall be arranged to scrape the settled sludge to the hopper at the center of the basin.

Generally, the items to be furnished include a center column, center cage, drive mechanism, a drive motor, electrical controls in NEMA 4X control panel, overload devices, walkway, rake arms, scraping blades, squeegees, anchor bolts, and all accessories necessary for an operational system.

110420 DESIGN CRITERIA

110421 BASIN GEOMETRY

The sludge collector mechanisms shall be installed in a rectangular, reinforced concrete basin divided into three sections. Each section has a side wall depth of 22 feet and inside dimensions of 140 feet by 140 feet. Sections are divided by baffle walls. The bottom of each section is sloped at approximately 1 inch per foot towards the center. The side water depth can vary between 15 feet and 12 feet.

110422 MECHANICAL

Sludge collectors shall be designed so that there will be no chains, sprockets, bearings, or gears below the water surface in the clarifier.

The collectors and drive units shall be designed to operate at a rake arm tip speed of approximately 10 feet per minute. The collectors shall have sufficient structural and mechanical strength to sweep in the 2-inch grout on the tank bottom under its own power. Numerical design loading criteria for bearing life, gear strength, gear durability, speed reducer rating, mechanism structural design, and alarm and shutdown set points are specified herein as a percentage of a reference torque. The reference torque shall be 428,750 foot-pounds.

110423 STRUCTURAL

All structural steel used in the fabrication of the sludge collector mechanism shall conform to the requirements of "Specifications for Structural Steel, ASTM Designation A 36". All welding shall conform to the latest Standards of the American Welding Society. All welds shall be of the continuous seal weld type.

The design of all structural elements of the sludge collector shall conform to the requirements of the AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings," latest edition, except that the maximum allowable stresses for the loading conditions of any member shall be two-thirds of the value allowed by AISC and the minimum thickness of all members shall be 1/4 inch thick. Slenderness ratios of tension members shall be not greater than 240 and for compression members not greater than 200. The thickness of all structural members including the center column, used for the final design calculations to check member stresses and buckling, shall be increased by 1/8 inch to allow for loss of metal due to corrosion. Member weights used for the design shall be based on the final member thickness. Bolting shall be Type 316 stainless steel, except bolts which are removed after erection.

Structural elements, including fasteners and anchor bolts, shall be designed for all live and dead loads, seismic loads and a design total torque equal to 100 percent of the reference torque. The collector shall be designed for the following:

A. The center drive cage shall be designed to carry the dead load of the rake arms plus its own dead load, as well as the design total torque assuming the entire design torque is distributed uniformly along each rake arm.

B. Each rake arm shall be designed for its own dead load plus 120 percent of its proportionate share of design total torque. The loading used to produce the specified design total torque shall be assumed to be distributed uniformly along each rake arm.

C. The horizontal and vertical deflection at the ends of the rake arms shall not exceed a deflection equal to the length of the rake arm divided by 1,000. The deflection shall not be exceeded for an equal distribution of the design total torque or when there is a 60 percent and 40 percent distribution of the design total torque between the two arms. The deflection of the rake arms may be checked using the full member thickness.

D. The sludge collector mechanism shall be designed with sufficient structural strength to sweep in a 2-inch grout layer on the basin bottom under its own power.

E. The maximum allowable stress in any member shall not be exceeded as a result of the cut-out torque test specified hereinafter.

If structural members are placed back-to-back, and the members are below the maximum liquid level, the members shall be welded with continuous watertight welds. Optionally, if the members are above the maximum liquid level, there shall be a space between them of at least 1/2 inch to allow for cleaning and painting.

110430 ELEMENTS

110431 WALKWAY ACCESS BRIDGE

The walkway shall be of welded steel truss, beam, or channel construction and composed of two main members laterally braced together. Fiberglass grating conforming to DIVISION 6 shall form the walking surface. The walkway access bridge shall be designed for a minimum live load of 100 pounds per square foot and a maximum deflection equal to or less than the span length divided by 360 for dead load plus live loads. Walkways shall be designed to support light standards and fixtures as indicated on the Plans.

Handrailing with kickplate shall be installed on both sides of the walkway and around the center drive platform. Handrailing shall conform to DIVISION 5 and shall be identical to all other handrailing supplied under this Contract.

The walkway access bridge shall be supported at the center column at one end and the concrete wall at the other end as indicated on the Plans. A platform shall be provided at the center drive to provide a minimum clearance of 2 feet 6 inches around all sides of the drive mechanism.

Provision shall be made at the outer concrete wall for expansion and contraction of the walkway as a result of temperature changes by means of self-lubricating plate bearings. Nonlubricated metal-to-metal slide plates or metal-to-concrete bearing will not be acceptable for this application. Lateral movement of the bridge at the outer wall shall be prevented by suitable means.

110432 CENTER COLUMN

The center column shall support the entire sludge collector mechanism including the inboard end of the access bridge. The center column shall be either cast-in-place concrete or steel, and be sized and designed by the collector manufacturer. The column shall have a minimum diameter of 48 inches; and for a steel column, a minimum wall thickness of 3/8 inch. The center column shall be mounted at the center of the basin.

The center column shall attach to the drive assembly with bolts. For a steel column the bottom of the column shall have a bolting flange for anchorage to the concrete tank using Type 316 stainless steel anchor bolts. The equipment manufacturer shall supply a rigid steel template to accurately locate the anchor bolts for the center column and coordinate with the Contractor to whatever degree is necessary to insure that the anchor bolts are properly located. Anchor bolts shall be designed to resist loads induced by the design total torque, seismic loads, and other loads. In no case shall the anchor bolts at the base of the column be less than 8 in number, not less than 24 inches long, nor less than 1-1/2 inches in diameter.

110433 CENTER DRIVE CAGE

The center drive cage shall be of a box truss design, constructed of structural steel members. The center drive cage shall be fastened to the spur gear assembly by bolted connections. The rake arms shall be connected to the center drive cage by bolted connections. The center drive cage shall support and rotate the two rake arm assemblies.

110434 SLUDGE COLLECTOR RAKE ARMS

The sludge collector mechanism shall have two structural steel rake arms rigidly connected to the center drive cage. The rake arms shall be of a truss construction conforming to the slope of the tank floor.

To ensure alignment and proper connection to the center drive cage, the width of the rake arms shall be the same as the center drive cage. The design of the arms shall not incorporate the use of any tie rods.

The blade length and setting shall be established by the manufacturer but shall be similar for each rake arm with the blades spaced so that the entire circular portion of the tank bottom will be scraped twice for each revolution of the mechanism. The rake blades shall have a minimum depth of 6 inches. All blades shall be provided with adjustable spring brass or stainless steel squeegees projecting approximately 2 inches below the bottom of the blade and secured by Type 316 stainless steel nuts and bolts. Each squeegee shall have a thickness of not less than 16 gauge and be designed to be adjustable to within 1/2-inch of true theoretical grade, with a minimum 2-inch adjustment in the vertical plane.

110440 MOTORS, DRIVES, AND CONTROLS

The center drive mechanism shall consist of a primary speed reducer which is driven by the electrical motor, a roller chain, an intermediate gear set consisting of a worm and worm gear, and a main gear set consisting of a pinion and internal spur gear.

110441 DRIVE MOTOR

The drive motor shall have the following characteristics:

Minimum Horsepower	5
Volts	460
Phase	3
Frequency, hertz	60
Insulation	Class F, with B rise
Service Factor	1.15
Ambient Temperature, degrees C	50
Enclosure	TEFC
Synchronous Speed, rpm	1,800

The motor nameplate shall include the preceding data. Motors shall conform to the provisions specified in DIVISION 14.

110442 GEAR MOTOR SPEED REDUCER

The speed reducer shall be a cylindrical-worm or helical-worm gear motor. Planetary gear units are not acceptable. All gears shall be supported by anti-friction bearings. The speed reducer shall conform to AGMA 440.04. The speed reducer shall have a minimum service factor of 1.4 (based on motor nameplate horsepower) and a minimum service factor of 2.0 (based on the imposed specified reference torque). The output shaft of the speed reducer shall connect to the drive sprocket of the chain drive. The speed reducer shall have an overhung load rating which exceeds the chain pull (based on the imposed specified reference torque) by 1.50 minimum. The lubricant shall conform to AGMA 250.04. Oil fill, drain and oil level indicator devices shall be provided.

110443 CHAIN DRIVE

A standard roller chain conforming to ANSI B29.1 shall be used to connect the drive sprocket of the gear motor speed reducer to the driven sprocket. The sprockets shall be steel with a minimum of 12 teeth in the drive sprocket. The roller chain and sprockets shall be enclosed in a weatherproof, fabricated steel guard provided with service openings and as specified in DIVISION 14. The minimum tensile strength of the chain shall exceed 4 times the chain pull based on a momentary peak torque not less than 200 percent of the specified reference torque. The power rating of the chain shall exceed the transmitted power (based on the imposed specified reference torque) by 1.50 minimum.

110444 INTERMEDIATE GEAR SET

The intermediate gear set shall be a cylindrical-worm and worm gear. The worm shall be alloy steel, hardened, ground and polished. The worm gear shall be centrifugally cast bronze or ductile (nodular) iron. If the worm gear is bolted to a drive hub, it shall be piloted for concentricity. Hardened steel washers shall be used to prevent embedding of the bolt head or nut. The design of the worm and worm gear shall conform to AGMA 341.02. The load capacity of the intermediate gear set shall be rated according to AGMA 440.04. Ductile iron worm gears shall be rated using a value for the materials factor of Ks = 500. The intermediate gear set shall have a minimum

service factor of 1.5 based on the specified reference torque. The worm shaft shall be supported by anti-friction bearings or a combination of anti-friction bearings and a bronze bushing. The worm gear shaft shall be supported by anti-friction bearings. The worm and worm gear shaft anti-friction bearings shall have an AFBMA B-10 life of not less than 20 years based upon the specified reference torque. The lubricant shall conform to AGMA 250.04. The intermediate gear set shall be enclosed in a cast iron housing conforming to ASTM A 48 Class 30 minimum. The worm gear shaft shall drive the pinion of the main gear set.

110445 MAIN GEAR SET

The main gear set shall be a spur pinion and internal spur gear. The spur pinion shall be ductile (nodular) iron conforming to ASTM A 536, or heat treated alloy steel. The internal spur gear shall be ductile (nodular) iron conforming to ASTM A 536, cast steel conforming to ASTM A 148 or AISI 1050, 4135, or 4140 heat treated alloy steel. The spur pinion shall be integral with its shaft or keyed to a heat treated alloy steel shaft. No welding shall be acceptable on the spur pinion or its shaft. If the spur pinion has a keyway, it shall have a wall thickness about the keyway equal to one tooth whole depth minimum. The main gear set shall have full depth teeth conforming to AGMA 201.02. Stub-pitch gear teeth shall not be acceptable. Undercut gear teeth shall not be acceptable. The load capacity of the main gear set shall be rated according to AGMA 218.01. The power rating of the gear set shall be the lower of the pitting resistance and the bending strength power ratings for the pinion and gear. The power rating shall be based on continuous 24 hour/day service and a 20 year design life (175,200 hours). The main gear set shall have a minimum service factor of 1.25 based on a continuous running torque not less than 40 percent of the specified reference torque. The momentary peak strength (bending strength) of the main gear set shall not be less than 200 percent of the specified reference torque. The center drive cage shall be bolted to the internal spur gear.

110446 TURNTABLE BASE

The turntable base shall be ductile (nodular) iron, ASTM A 536; or cast iron, ASTM A 48 Class 40 minimum. The turntable base shall be designed to be bolted to the center column and to provide support for the internal spur gear, the entire rotating collector mechanism and one end of the access bridge. Fabricated steel bases shall not be acceptable.

110447 RACEWAYS, BALL BEARINGS, AND OIL BATH

The turntable base and internal spur gear shall have replaceable annular raceways (minimum diameter of 48 inches) to support the vertical and horizontal forces transmitted by bearing balls. Replacement of the annular raceway shall be accomplished without removing the access bridge. The raceways and balls shall be heat treated allow steel designed for an AFBMA B-10 life of not less than 20 years at the specified reference torque and speed. The turntable base and internal spur gear shall be provided with an oil bath which shall be protected by a felt seal and a dust shield. The lubricant shall conform to AGMA 250.04. Oil fill, oil drain and oil level indicator devices shall be provided in readily accessible locations.

110448 ELECTRICAL CONTROLS

Electrical controls shall be as indicated on the Plans and specified in DIVISION 16, DIVISION 17 and herein.

110449 OVERLOAD DEVICES

Torque overload devices shall be incorporated into each drive assembly.

A mechanical overload device shall be provided with a visual load indicator and dry contacts required for (1) use in the plant alarm annunciator system, and (2) use in opening the motor circuit. The alarm switch shall be adjusted to actuate the alarm at 70 percent of reference torque. The cut-out switch shall be adjusted to stop the drive motor at 90 percent of reference torque, and actuate the plant alarm annunciator. These switches shall be of watertight NEMA Type 4, or shall be mounted in a watertight gasketed enclosure. Switches shall have DPDT dry contacts.

There shall be incorporated in the drive train an easily serviced, torque-limiting device designed and factory-adjusted to mechanically interrupt power transmission at 100 percent of the reference torque herein specified. This device shall be a quick-release-type clutch, or a shear pin arrangement. There shall also be included D.P.D.T. dry contacts arranged to change state upon activation of this device, and suitable for (1) use in the plant alarm annunciator system, and (2) use in opening the motor circuit. These switches shall be of watertight NEMA Type 4, or shall be mounted in a watertight gasketed enclosure.

If a shear pin arrangement is used, the Contractor shall furnish, at the time of final acceptance, a minimum of 4 spare shear pins for each shear pin used in the equipment. Each shear pin shall be permanently stamped to indicate the equipment item with which it is to be used. Shear pins, if furnished, shall be of corrosion resistant material.

110450 INSTALLATION AND TESTING

The sludge collector mechanism and its appurtenances shall be installed as indicated on the Plans and in accordance with the manufacturer's recommendations.

110451 SERVICES OF THE MANUFACTURER'S ENGINEER

The manufacturer shall furnish to the Contractor the services of an engineer experienced in the erection and operation of sludge collector to check and supervise the collector installation. The period of the above services shall not be less than 5 working days. Services of the manufacturer's engineer shall include the following:

A. Installation consultation and advice.

B. Inspection and certification that the unit is ready to sweep in the grout prior to the grouting operation.

C. Final inspection and adjustments prior to testing.

D. Supervision of testing.

110452 SUBASSEMBLIES

The equipment subassemblies shall be assembled in the shop to ensure proper fitting of parts, marked with erection marks, and knocked down for shipment. Subassemblies shall include, but not be limited to, complete center column, drive cage, drive assembly and rake arms.

110453 FIELD WELDING

The manufacturer's shop drawings shall clearly show complete information regarding location, type, size, and length of all field welds. Special conditions shall be fully explained by notes or details. The Contractor shall perform all field welding in conformance with information shown on these drawings.

The Contractor's welding procedures, welders, and welding operators shall be qualified and certified in accordance with the requirements of AWS D1.1 "Welding in Building Construction" of the American Welding Society. All field welding shall be shielded arc welding and shall conform to the requirements of the design loads.

110454 FIELD TESTING

Working under the direction of the manufacturer's engineer, the Contractor shall perform field tests on each mechanism as follows:

A. A cutout torque (90 percent of the reference) test shall be conducted prior to placement of grout topping of the floors. The manufacturer shall propose a method of conducting this test and shall verify that the method of testing will not impose stresses in any member which exceed the maximum allowable stresses specified hereinbefore.

B. The necessary adjustments and setting to the overload device shall be made at this time to ensure that the sludge collector mechanism will sound an alarm and switch off the drive motor and sound an alarm when the specified overload conditions occur in the basin. A test run shall follow this work to confirm the effectiveness of the overload device.

C. The tests shall be conducted in the presence of the manufacturer's Engineer.

D. In the event the mechanism fails to meet the above test, the necessary changes shall be made and the mechanism retested. If the mechanism remains unable to meet the test requirements to the satisfaction of the Engineer, it shall be removed and replaced with a satisfactory mechanism at the Contractor's expense.

110460 PAINTING

The sludge collectors shall be painted as specified in DIVISION 9. The units shall be field painted with the exception that the drive mechanism shall be primed before shipping to the jobsite. Paints and preparation shall be as specified in DIVISION 9. The drive mechanism shall be finish coated after installation.

Inaccessible parts of the sludge collection shall be painted before assembly of the mechanism.

110470 SHOP DRAWINGS

In addition to the requirements presented in DIVISION 14, shop drawings shall include the following:

A. Detailed drawings of the sludge collector mechanism indicating dimensions, member thicknesses, welds and connection details.

B. Calculations prepared and signed by a registered professional engineer demonstrating compliance with all structural criteria and requirements contained herein.

C. Calculations prepared and signed by a registered professional engineer substantiating the output torque rating and the overload torque rating of all components of the drive mechanism.

D. Calculations prepared and signed by a registered professional engineer demonstrating that all bearings in the drive mechanism meet the life requirements of this Specification.

E. Sufficiently detailed drawings to clearly describe the sizes, dimensions and arrangement of all major drive components. Detail drawings shall be supplied for all gears except those contained in the gear motor speed reducer, the following minimum data shall be supplied for each gear:

Number of teeth
Net face Width
Outside Diameter (external gears)
Inside Diametral (internal gears)
Normal Diametral Pitch (or axial pitch for worms)
Normal Generating Pressure Angle
Lead Angle (for worms)
Operating Center Distance)
Addendum Modification Coefficient
Tooth Thickness (or pin or span measurements)
Quality Number (AGMA 390.03)
Material Alloy
Type of Heat Treatment
Tooth Surface Hardness
Tooth Core Hardness
For Case Hardened Gears, The Effective Case Dept to Rc 50
Lubricant Type (mineral/synthetic/EP)
Lubricant Viscosity

110480 OPERATION AND MAINTENANCE INSTRUCTION

A factory representative who has complete knowledge of proper operation and maintenance of the equipment furnished under this and related sections shall be provided for one working day to instruct representatives of the Owner and Engineer on the proper operation and maintenance of the equipment.

* * * END OF DIVISION 11 * * *

DIVISION 12

PUMPS

120101 GENERAL

The Contractor shall furnish, install, and test all pumps and drives as indicated on the Plans, or as specified herein. It is the intent of these Specifications to obtain pumps and drives of highest quality construction only, for heavy-duty continuous service or for intermittent service, whichever imposes the most severe service on the pump. Equipment of lesser quality will not be accepted. The Engineer shall be the sole judge as to the quality of the equipment that will be accepted. Pumps are not intended to necessarily be standard units. Pumps will be installed at an elevation of approximately 10 feet above sea level and shall be suitable for use at such altitude.

In addition to this section of the Specifications the pump shall conform to the applicable requirements of other Contract Documents including the following Divisions of the Specifications:

DIVISION 1	-	SPECIAL CONDITIONS
DIVISION 9	-	FINISHES
DIVISION 14	-	MECHANICAL EQUIPMENT
DIVISION 15	-	PIPING
DIVISION 16	-	ELECTRICAL
DIVISION 17	-	INSTRUMENTATION

Each pump shall be furnished as a complete, ready-to-install unit by a single supplier, including but not limited to pump, motor, mountings, and (if so specified and equipped) variable speed drive, and/or drive shaft assembly. All pumps for the same service shall be of one make and manufacturer and identical in all respects and characteristics. Unless otherwise noted, controls for variable speed drives shall be supplied with the pump.

Pumps that have mechanical defects or do not meet the requirements for head-capacity, horsepower, efficiency, and vibration requirements will be rejected, and shall be replaced without additional cost to the Owner for furnishing, removal, reinstallation, and retesting. Mechanical defects shall include excessive vibration, improper balancing of any rotating parts, improper tolerances, binding, excessive bearing or motor heating, defective materials, including materials that do not conform to the Specifications, improper fitting of parts, and any other defect which will in time damage the pump or unreasonably impair its efficiency or operation.

Pump friction losses, including entrance, column, shaft, and discharge losses shall be added to the total dynamic heads that are specified under each pump in order to get the head that the impeller must pump against. Pump head-capacity curves shall indicate that these losses have been included.

120110 CONSTRUCTION

Any bronze used in the manufacture of any pump shall not contain more than 2 percent aluminum nor more than 6 percent zinc.

Impellers, cases, seals, shafts, bearings, and any other item which does not comply with these Specifications as to its metallurgy, material, or hardness shall be replaced without additional cost to the Owner. Except for submerged or special service pumps, or as approved by the Engineer, pumps or adjacent piping within 3 inches of its pump flange shall be tapped at the suction and discharge for pressure gauges. Where packing gland drains are required or where water flushing or sealing of packing glands or mechanical seals is specified or shown, the Contractor shall furnish and install all necessary piping and valves. Except for submerged or special service pumps, or as approved by the Engineer, all pumps shall be provided with drip pans piped to drains.

120120 INSTALLATION

Before installation, the Contractor shall furnish five sets of installation instructions and five sets of lubrication instructions for each type of pump. These instructions shall include detailed instructions for adjustment and recommendations for the proper type of lubricant.

Pumps shall be installed and adjusted as specified and in accordance with the manufacturer's recommendations and in such manner that connecting piping will not impose any strain whatever on any pump. Pumps shall be set upon level, fully grouted foundations, so that connecting flanges, screwed connections, or flexible connections will meet without strain or distortion. Pump foundation pads shall be doweled and keyed to the floor slab upon which it rests. The pump leveling nuts shall be blocked out during grouting of foundations, the grout allowed to set for no less than three days, the leveling nuts loosened and following by grouting of the blockouts, with nonshrink grout. Any other proposed method of installation shall be submitted for the Engineer's approval prior to installation. Pumps shall be level when installed.

120130. MOTORS

Motors shall be as specified in each Section of this DIVISION 12, and in accordance with the provisions of DIVISION 14. The rated horsepower and full-load amps shall not be exceeded at any point on the pump curve within the specified operating range of the pumps.

120140 TESTS

In addition to the tests required by DIVISION 14, each pump and driver, unless otherwise specified, shall be field tested for compliance with these Specifications as to head-capacity and horsepower. Where specified, each pump shall be factory tested at the place of manufacture.

Factory tests shall include head-capacity, efficiency, and brake horsepower. Four copies of certified test results shall be submitted to the Engineer for approval before the pump is delivered to the jobsite. Unless otherwise specified, the Contractor shall furnish all manpower, facilities, power, and equipment required for making tests. Field and factory tests shall be conducted in accordance with the latest requirements of the Hydraulic Institute Standards. Pumps with variable speed drives shall be tested at maximum speed, and at the average and minimum speeds listed under the specification for the pumps. A copy of actual test data shall be furnished to the Engineer.

In case factory testing of pumps provided is not specified, certified test curves for pumps of the same type as provided shall be submitted with the shop drawings.

120145 VIBRATION

Tests for acceptable vibration shall be made, at no additional cost to the Owner, in the field on each pump system, which in the opinion of the Engineer, seem to have excessive vibration. All field tests shall be running tests with the pump pumping the product for which it is intended and each pump system shall be tested separately with no other pumps running. All testing shall be done in the presence of the Engineer.

Amplitude as used in this Specification, shall mean total peak-to-peak displacement. The required test for acceptable vibration will be the measurement of this peak-to-peak displacement and will be performed with an IRD Vibration Meter, Model 306; Bently-Nevada TK-8; or equal.

No pump, complete with drive system, in place at the jobsite, shall exceed acceptable field vibration limits given in the latest revisions of the Hydraulic Institute Standards, no limits (if any) stated under the individual pump specification. All pumps shall be free of static unbalance; shall be free of dynamic unbalance up to the maximum speed of the pump and drive system; shall be free of torsional vibration from 10 percent below the minimum speed to 10 percent above the maximum speed of the pump and drive system; and shall be free of apparent unbalance caused by defective bearings, by close fittings parts which may rub on the rotating parts intermittently, or by loose discs or rotor parts, unbalanced loads, or by oil whip.

120147. WARNING SIGNS

Warning signs shall be furnished and installed as specified in DIVISION 14.

120148. EQUIPMENT GUARDS

Equipment guards shall be furnished and installed as specified in DIVISION 14.

120149 PAINTING

Requirements for painting of equipment shall be as specified in DIVISION 9.

120150 SHOP DRAWINGS

The Contractor shall submit for review to the Engineer, sufficient literature, detailed specifications, and drawings to show dimensions, make, style, speed, size, type, horsepower, head-capacity, efficiency, materials used, design features, internal construction, weights, and any other information required by the Engineer for review of all pumping equipment. For pumps, certified test curves shall be submitted showing this specified data. No pumping equipment will be accepted, and installation will not be allowed, until such review has been completed.

Shop drawings submitted for review also shall include electrical diagrams, schematic control diagrams, and a detailed description of how the control system is to function. Submittal information for control panels to be furnished with equipment shall be in accordance with the head "Control Panels" below.

Additional requirements for information to be included with shop drawings are specified with the particular piece of equipment.

As specified in DIVISION 1, SPECIAL CONDITIONS, copies of each approved shop drawing shall be submitted to the Engineer, prior to completion of the Contract, for each piece of equipment or each system. This shall include all drawings, lists, schedules, etc., larger in size than 11-inch by 17-inch, for all pumping equipment.

120160 OPERATING MANUALS

The Contractor shall furnish acceptable bound operating, installation, and maintenance instructions covering each component and each assembly furnished under this Contract in accordance with DIVISION 1, SPECIAL CONDITIONS. Manuals of instruction shall be furnished prior to equipment delivery.

The operating, installation, and maintenance instructions shall include as a minimum the following data for each item furnished hereunder.

A. Lubrication Schedule, if required.

B. Recommended preventive maintenance procedures and schedules.

C. Recommended spare parts.

D. Parts lists by generic title, material of construction, and identification number (actual manufacturer's number, not supplier's).

E. Disassembly and reassembly instructions.

F. Recommended troubleshooting and start-up procedures.

G. Electric schematics.

H. List of special tools and description of use, as specified previously.

In addition, the instructions shall include prints of the installation drawings.

120572. SUMP PUMPS - DUPLEX SUBMERSIBLE

Furnish and install duplex submersible sump pumps in the sludge pump station.

Pumps shall be as manufactured by Hydr-O-Matic, Peabody Barnes, or equal.

Each pump shall be capable of delivering 50 gpm at 38 feet head. Motor shall be 2 horsepower.

Each pump shall be equipped with enclosed, nonclog type, cast iron impeller, capable of passing 2-inch diameter spheres, securely locked to a stainless steel motor shaft. Impeller shall have pump-out vane on rear shroud to prevent stringy material and grit from building up in seal area.

Pump casing shall be close grained cast iron and equipped with legs to support it on bottom of sump, with correct clearance for suction entrance.

Each pump shall be close coupled to an oil filled, enclosed, 460-volt, 3 phase, 60 hertz, 3,450 rpm submersible type motor. Motor shall have ball bearings with adequate thrust capacity for the pump, and equipped with mechanical shaft seal and expansion diaphragm. Each motor shall have ample capacity to operate continuously without exceeding its service factor when immersed in cold water. The pump shall be nonoverloading throughout the entire pump curve.

An armored, waterproof cable, 15 feet in length, shall be securely attached to each motor with a watertight fitting.

Level control float switches sealed in watertight ball housing shall be furnished. Lead pump to turn on at approximately 2'-6" of water, turn off at approximately 6 inches of water; lag pump to turn on at approximately 3'-0" of water, turn off at approximately 6 inches of water. Provide a motor control panel in single NEMA 12 enclosure having circuit breaker type disconnect switches, magnetic motor starters with overload protection on all phases, hand-off-automatic selector switches, start-stop push buttons, and running light.

All electrical devices shall conform to the requirements of DIVISION 16. Level control switches shall conform to the requirements of DIVISION 17.

120700. PRESEDIMENTATION SLUDGE PUMPS - VORTEX TYPE

Furnish and install, complete in place in operable condition, dry pit, vortex type pumps, complete with motor, in the presedimentation sludge pump station. Pump shall be equipped with faced and drilled flanges to receive 125-pound standard bolting. Pump shall be rated for operating conditions as specified.

Pumps shall be as manufactured by WEMCO Model EVP 4x14, Essco VDA, or equal. All pumps shall be rated for variable operating conditions as follows:

No.	GPM		TDH		RPM		Minimum Impeller	Minimum HP	Flange Diameters	
Units	Min	Max	Min	Max	Min	Max	Diameter	Motor	Suction	Discharge
3	200	750	110	170	900	1,800	13	75	4	4

Variable speed shall be achieved through a variable frequency drive furnished by the pump manufacturer, as specified in DIVISION 16.

The pumps shall be of a fully recessed design, with the impeller mounted completely out of the flow path between the pump inlet and discharge connections, so that solids are not required to flow through the impeller. All

flow path clearances within the pumps shall be equal to or greater than the discharge diameter, so that all solids which will pass through the discharge will pass through the pump.

The pumps shall be specifically designed to pump slurries of grit, debris and solids.

All cast parts exposed to wear shall be constructed of Ni-Hard material, conforming to ASTM A-532, and be a minimum of 650 Bn. Brinell values below this are not acceptable.

The pump casing shall be of Ni-Hard material and thickness shall be a minimum of 3/4-inch, with normal casting tolerances.

The impeller shall be of the recessed design, Ni-Hard material, and secured by an impeller bolt.

A removable wear plate of Ni-Hard shall be provided in back of the impeller designed to direct flow from behind the impeller to the center of the volute for maximum protection to the casing. The packing housing shall be a separate piece bolted to the bearing housing for ease of removal.

The shaft shall be of ASTM A-108, Grade 1141 steel, and shall be protected throughout the packing area by a removable, hardened stainless steel shaft sleeve. The stuffing box shall contain graphite-impregnated packing rings and Teflon lantern ring arranged for water lubrication.

Radial and thrust ball bearings shall be provided which shall safely carry all radial and thrust loads. The bearings shall run in grease and shall be contained in a dust and moisture-proof housing. The bearings shall be rated for a B10 life of 60,000 hours.

The pump shall be supported by a pedestal base with openings large enough to permit access to the suction line and to the inspection opening in the suction elbow. The base shall be rugged enough to support the full weight of the pump and motor. The legs of the pedestal shall be of such a length that the suction elbow of the pump will not touch the floor or level foundation upon which it stands.

The pump shall be installed as indicated on the Plans and as recommended by the pump manufacturer. It shall be the Contractor's responsibility to insure that there is sufficient and suitable lateral bracing of the installed pumping unit to prevent excessive vibration of the combined pump and motor at any point within the operating range of the unit. Vibration in any plane shall not exceed 3 mils peak-to-peak at any point on the pump or motor. If such vibration occurs during the testing of the unit, the Contractor shall install, as approved by the Engineer, suitable structural members and/or braces and connections from the unit to the structure containing the unit in such a manner as to diminish these vibrations to acceptable limits.

Before final shipment, foundry certificates and results of Brinell testing showing compliance to ASTM A-532 shall be submitted for acceptance. Each individual casting shall be Brinell tested at the manufacturer's plant to ASTM Method E-10. Each casting shall be checked in a minimum of two places, in an area that is representative of casting thickness. Results of the

Brinell tests shall be certified by a registered, professional engineer and submitted for acceptance before final shipment. Such tests may be witnessed by the Owner, at his option.

A water seal and gauge system shall be provided at each pump as indicated on the Plans, with all seal, gauge and flushing piping, valves and accessories; gauges; panel; and all related work. Drain lines shall be provided from the pump drains to equipment drains in the floor as indicated on the Plans.

120700.01. MOTOR

The electrical motors shall have characteristics as follows:

Horsepower	75
Speed - rpm	1,800 MAX - 900 MIN
Voltage	460
Phase	3
Hertz	60
Service factor	1.15
Minimum insulation	F with B Rise
Ambient temperature	50°C
Enclosure	TEFC
VFD Operating Range	2:1

The above data shall be stated on the motor nameplate.

120830. SAMPLE PUMPS

Furnish and install two raw water sample pumps in the Presedimentation Basin Sludge Pump Station.

The pumps shall be positive displacement, self-priming progressing cavity type, suitable for low capacity high head operation. Pumps shall be specifically constructed for pumping solids in suspension and entrained, stringy material without clogging.

The pump body, body supports, and packing glands shall be of high quality, close-grained cast iron conforming to ASTM A 48. Castings shall be free from sand holes, blow holes, and other detrimental defects. Piping connections shall be flanged as per ANSI B 16.1, Class 125.

The pump rotor shall be solid one-piece tooled steel hardened to a Rockwell (C) of 57-60, with not less than 0.010 inch hard chrome plating of Rockwell (C) 70 hardness. Rotor diameter shall be not less than 1.8 inches, and crest-to-crest dimension shall be at least rotor diameter plus 1.0 inch. The unit shall be capable of passing 0.4 inch solids.

The rotor shall be driven by means of a hollow shaft and connecting rod assembly of ample strength and stiffness to operate without distortion or vibration. The connecting rod shall be joined to the rotor and drive shaft with hardened drive pins or gear joint seals designed to transmit the required thrust and torque while allowing the rotor to move freely through its eccentric path. To maximize joint and seal life, the connecting rod operating angle shall not exceed 1.25 degrees off center. To minimize the moment of the transmitted radial force on the bearings, shaft deflection in

the stuffing box area, and overall pump length, the connecting rod shall telescope within the hollow drive shaft or shall connect to a solid drive shaft.

The connecting rod shall be AISI B620 carbon steel rod. The drive shaft shall be AISI B620 seamless steel tubing, 1.625 inch OD minimum with the packing area case hardened 0.040 inch deep to Rockwell (C) 58-61, and with Rockwell (C) 70 hard chrome plating. Connecting pins shall be AISI D 2 tool steel hardened to Rockwell (C) 60-65.

The drive shaft shall be mounted in two grease lubricated high quality ball of tapered roller bearings adequate to withstand any radial or thrust forces. The L-10 life of the bearings shall be excess of 60,000 hours at maximum design rating of the pump. Provision shall be made in mounting to prevent distortion of the shaft due to temperature expansion. Bearings shall be protected by seals from entrance of contaminants. Lubrication fittings shall be provided for regreasing of bearings.

A stuffing box arranged for grease sealing shall be provided where the shaft passes through the pump case. The arrangement shall be such that the gland may be adjusted or the pump repacked without dismantling any other parts of the pump. Packing shall be graphite-impregnated acrylic with lantern ring.

The pump stator shall be Buna-N of not less than a durometer hardness of 60.

The pump shall be mounted on a rigid cast iron or steel base. Reinforced bolt holes shall be provided in the base for anchorage to the mounting surface below.

The capacity of each pump shall be 8 gallons per minute at 126 feet total head, speed of not more than 400 rpm, and 28 feet maximum suction lift.

The pumps shall be as manufactured by Moyno Division of Robbins and Meyers; equivalent as manufactured by Netzsch, Inc.; or equal.

120830.01. MOTORS

Pumps shall be driven through V-belt drives. Pulleys and V-belts with guard shall be sized in accordance with DIVISION 14. V-belts shall be unitized.

Motors shall be furnished by the pump manufacturer and shall be coordinated to the requirements of the pumps and to the following characteristics.

	Sample Pumps
Horsepower, not less than	1/2
Volts/Phase/Hertz	460/3/60
Motor Speed, maximum	1,200 rpm
Insulation	Class H with B/Rise
Ambient Temperature	40°C
Temperature Rise	80°C rise by resistance @ 100% full load
Service Factor	1.15
Enclosure	TEFC

* * * END OF DIVISION 12 * * *

DIVISION 14

MECHANICAL EQUIPMENT

140000 GENERAL REQUIREMENTS

Specifications contained in this section shall apply to all items of mechanical equipment the same as if these Specifications were contained in the individual section for the equipment in this Division, or any other Division herein.

All items of equipment shall be the product, modified as specified herein, of a manufacturer experienced in the design, construction, and operation of equipment for the purpose required, and who shall have established a record of successful operation of such equipment manufactured or produced by them. When two or more units of equipment for the same purpose are required, they shall be products of the same manufacturer. Equipment shall be made up of parts which are designed to act as a unit, and the manufacturer shall guarantee that when the component parts are assembled into the final unit, these parts will fit and operate satisfactorily.

Except as otherwise provided, the responsibility of the equipment manufacturer shall extend to the selection and mounting of gear drive units, motors or other prime movers, accessories and auxiliaries required for proper operation.

140010 SUBSTITUTION OF EQUIPMENT

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Substitutions, Section 01630.

140011 SHOP DRAWINGS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Shop Drawing Submittal and Correspondence Procedure, Section 01341.

140012 OPERATION AND MAINTENANCE MANUALS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Operation and Maintenance Data, Section 01730.

140013 MATERIALS AND WORKMANSHIP

All equipment shall be designed, fabricated, and assembled in accordance with the best modern practice in the manufacture of high grade machinery.

All parts and components of mechanical equipment shall be designed for satisfactory service under continuous duty without undue wear under the specified and indicated operating conditions for a period of not less than one year. Any part of mechanical equipment that shows undue or excessive wear or that

fails due to wear under normal operating conditions within the first year of operation after final acceptance shall be considered as evidence of defective material or defective workmanship, and it shall be replaced by the Contractor with equipment or parts to meet the specified requirements at no cost to the Owner.

Individual parts shall be manufactured to standard sizes and gauges so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

Materials shall be suitable for the service conditions to be encountered. Structural steel shall conform to ASTM A 36. Iron castings shall be of tough, close-grained gray iron, free from blow-holes, flaws, or other imperfections and shall conform to ASTM A 48. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection.

Unless otherwise specified, all materials shall conform to the structural and miscellaneous standards of the American Institute of Steel Construction.

Bronze which will be in contact with water or any liquid, used in the manufacture of any equipment shall not contain aluminum nor more than 6 percent zinc, and shall conform to ASTM B 62, or equivalent.

Surfaces requiring painting or coating for corrosion protection shall be smooth, free from sharp edges, burrs, and projections, and shall have all welds ground smooth and all edges and corners of structural members rounded.

All steel bars, shapes, and plates shall be clean and straight before being worked. Straightening or flattening, if necessary, shall be done by a process and in a manner that will not injure the metal. Sharp kinks or bends shall be cause for rejection. Steel that has been heated partially shall be annealed, unless it is to be used in minor parts. Finished members shall be true to line and free from twists, bends, and other joints.

Tolerances and clearances shall be as indicated on the Shop Drawings and these tolerances and clearances shall be closely followed to secure proper operation of the equipment.

Unless otherwise specified, piping, fittings, and valves shall be as specified elsewhere herein. All flanges on equipment and appurtenances furnished shall conform in dimensions and drilling to ANSI B 16.1, Class 125 or 150, or as required.

Field welding, where required, shall be as specified elsewhere herein.

140013.10 BEARINGS

Unless otherwise specified, all equipment bearings shall be oil or grease lubricated, ball or roller antifriction type of standard manufacture. Bearings shall be conservatively designed to withstand all stresses of the service specified. Each bearing, except as otherwise noted, shall be rated in accordance with the latest revisions of Anti-Friction Bearing Manufacturer's Association's (AFBMA) Methods of Evaluating Load Ratings of Ball and Roller Bearings for B-10 rating life of 40,000 hours.

All grease lubricated bearings, except those specified to be factory sealed lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings of the standard hydraulic type. Extension tubes shall be provided for easy access.

Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 40 degrees C and shall be equipped with a filler pipe and an external level gauge. Fittings for pressure lubrication shall be 1/4-inch straight-type.

To avoid work hardening or "Brinelling" damage from vibration, bearings shall be separately packed or otherwise suitably protected during transport.

140014 PROTECTION OF EQUIPMENT

All equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. All equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities prior to installation.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to final acceptance of the work shall be repainted to meet Specification requirements.

140015 INSTALLATION

The Contractor shall take measurements from his work at the installation sites, verify all subcontractor's drawings and be responsible for the proper installation of the equipment within the available space as specified and indicated on the Plans, and he shall secure the acceptance by the Engineer for any variations before making any changes.

The Contractor shall obtain and follow installation instructions and other recommendations from the equipment manufacturers. Manufacturer's recommendations as to grout spaces required, type of grout to be used, and tolerances for level and alignments, both vertical and horizontal, shall be obtained and followed.

Skilled workmen experienced in installation of the equipment or similar equipment shall be used. Applicable special tools and equipment, such as precision machinist levels, dial indicators, and gauges shall be utilized as required in the installations. The work shall be accomplished with good workmanship to produce satisfactory equipment installation free of vibration or other defects. Whenever applicable, the Contractor shall obtain the service of a manufacturer's representative specifically trained in erection of his equipment to supervise the installation.

Metalwork to be embedded in concrete shall be accurately placed and held in correct position while the concrete is being placed. The surface of all metalwork to be in contact with concrete shall be thoroughly cleaned immediately before concrete is placed. All anchor bolts shall be cast in place

when the concrete is placed. Anchors shall be installed as recommended by the manufacturer to develop the full strength of the bolt. No use shall be made of expansion shields.

Anchor bolts for pumps and blowers, and such other equipment where so specified, shall be encased in metal tubing having an inside diameter not less than two times that of the bolt. Pump and other similar foundations shall be left 1 inch below the grade of machine base unless otherwise noted on the Shop Drawings. After the proper setting of machine for alignment and grade, the recess below the base together with recess between the anchor bolt and the metal tube shall be grouted and carefully finished with an acceptable quick setting, nonshrink, rust-prohibitive mortar.

Prior to installation of equipment, all sacking and concrete preparation shall be completed, and the work area shall be maintained in a clean condition during the equipment installation.

Equipment not intended to vibrate during normal operation shall be rigidly attached to the foundation or other adequate support to prevent lateral and vertical displacement. Equipment intended to vibrate during normal operation shall be provided with isolators with mechanical stops which are securely anchored to foundation or other adequate support.

140016 BASES AND BED PLATES

A heavy cast iron or welded steel base shall be provided for each item of equipment which is to be installed on a concrete pad or slab. Equipment assemblies, unless otherwise specified or indicated on the Plans or accepted Shop Drawings, shall be mounted on a single, heavy, cast iron or welded steel bed plate. Bases and bed plates shall be provided with machined support pads, dowels for alignment of mating or adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits. All seams and contact edges between steel plates and shapes shall be continuously welded and ground smooth. The bottom of all bases and bed plates shall have at least two coats of zinc chromate primer before installation or grouting.

140016.10 JACKING SCREWS AND ANCHOR BOLTS

All equipment shall be anchored to supporting members by bolts or other connections to accommodate all operating forces and satisfy the seismic restraint requirements of the Uniform Building Code. Anchors shall provide resistance to a lateral force of at least 0.10 times the weight of the equipment, including its contents. Equipment installed on flexible mounts shall be given special consideration with design calculations including resonance determinations, submitted for review with Shop Drawings.

Jacking screws shall be provided in the heavy equipment bases and bed plates and where required elsewhere to aid in leveling prior to grouting.

Equipment suppliers shall furnish anchor bolts, nuts, washers, and sleeves of adequate design as required for proper anchorage of the bases and bed plates to the concrete bases. Unless otherwise indicated or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1 inch of grout beneath the baseplate and to provide adequate anchorage into structural concrete.

Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed.

All bolts and anchor bolts shall be of Type 316 stainless steel.

140016.20 GROUTING

After assembly and installation on the concrete base, each unit shall be leveled and aligned in place but not grouted until connecting piping has been fitted and aligned. Equipment bases shall not be grouted nor foundation bolts finally tightened until all piping connections are complete and in satisfactory alignment with no strain transmitted to the equipment. Adjacent couplings shall be loosened to determine if pipe strain exists immediately before foundation is grouted. Concrete surfaces shall be cleaned and thoroughly wetted before grout or mortar is placed. To bond mortar or grout to concrete which has reached its initial set, the surface of the set concrete shall first be coated with epoxy liquid polysulfide bonding agent. Nonshrink grout and bonding agent shall be as specified elsewhere herein of these Specifications. The grout shall extend to the edge of each base or baseplate and shall be beveled at 45 degrees all around the unit and the finished surface shall not pond water within the grouted area. After grout has set, jacking screws shall be removed and nuts or anchor bolts shall be tightened, followed by an overall check on leveling and alignment.

140017 LUBRICATION

140017.10 LUBRICANT

The Contractor shall furnish all mechanical equipment with its proper supply of correct lubricant for starting, testing, and adjustment. All lubricants shall be as recommended by the equipment manufacturer. The Contractor shall limit the various types and brands of lubricants by consolidating, with all the equipment manufacturers' approval, into the least number of different types and brands. Before starting, testing and adjusting equipment, the Contractor shall provide the Owner with four copies of a list showing the proper lubricants, after consolidation, for each item of mechanical equipment and the estimated quantity of lubricant needed for a full year's operation, assuming all equipment to be operating continuously.

140017.20 FITTINGS

All lubrication fittings shall be brought to the outside of all equipment so they are readily accessible from the outside without the necessity of removing covers, plates, housing, or guards. Fittings for underwater bearings shall be brought up above the surface of the water with 1/4-inch stainless steel tubing and mounted on the edge of the structure above. Fittings shall be buttonhead type. Lubrication fittings shall be mounted together wherever possible. They shall not be individual fittings field-mounted together, but use shall be made of factory-mounted multiple fitting assemblies.

140018 SAFETY REQUIREMENTS

All equipment furnished under these Specifications shall comply with all applicable Federal safety regulations, including OSHA regulations and also all applicable State and local safety regulations and codes.

All sprockets, belts, drive chains, gearing, couplings, and all other moving parts on drive assemblies shall be enclosed in removable safety enclosures in compliance with said safety regulations.

Safety guards shall be fabricated from 16 USS gauge or heavier galvanized or aluminum clad sheet steel or 1/2-inch galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories including bolts, shall be hot-dip galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

140019 PAINTING AND COATING

Prime and finish coating materials and procedures shall be as specified elsewhere herein, except where otherwise specified.

Machined, polished, and other ferrous surfaces and nonferrous surfaces which are not to be painted shall be coated with acceptable rust preventative compound.

140020 NAMEPLATES

Equipment nameplates shall be engraved or stamped on stainless steel and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. The nameplate shall include manufacturer's name, equipment model number, identification tag number, drive speed, motor horsepower, and rated capacity. Nameplates for pumps shall also include rated total dynamic head and impeller size.

140021 WARNING SIGNS

Permanent warning signs shall be mounted at all mechanical equipment which may be started automatically or from remote locations. Signs shall be in accordance with OSHA regulations and shall be suitable for exterior use. Mounting details shall be in accordance with manufacturer's recommendations; location as acceptable to the Engineer.

Warning signs shall be 7 inches high by 10 inches wide, colored yellow and black, on not less than 18-gauge vitreous enameling stock. Copy shall read:

CAUTION
THIS EQUIPMENT STARTS
AUTOMATICALLY
BY REMOTE CONTROL

140022 SPECIAL TOOLS AND ACCESSORIES

The Contractor shall supply one complete set of any special wrenches or other special tools necessary for the assembly, adjustment, and dismantling of the equipment. Special tools shall include any type of tool that has been specifically made for use on an item of equipment for assembly, disassembly, repair, and maintenance. When special tools are provided, they shall be marked or tagged, and a list of such tools shall be included with the maintenance and operation manuals describing the use of each marked tool. All

wrenches and spanners shall be of best quality, hardened steel forgings with bright, finished heads and with work faces dressed to fit nuts. Each set of tools shall be neatly mounted in a tool box of suitable design provided with a hinged cover.

140023 INSTALLATION CHECKING, TESTING, AND OPERATOR INSTRUCTION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Starting of System, Section 01650; and Field Tests of Equipment, Section 01660.

140030 COUPLINGS

Unless otherwise specified, mechanical equipment with a driver greater than 1/2 horsepower, where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have the two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment, and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber.

The flexible member shall be attached to flanges by means of clamping rings and cap screws, and the flanges shall be attached to stub shaft by means of taper-lock bushings which shall give the equivalent of a shrunk-on fit. There shall be no metal-to-metal contact between the driver and driven unit.

Coupling sizes shall be as recommended by the manufacturer for the specific application, considering horsepower, speed of rotation, and type of service, and shall be installed as recommended by the manufacturer. The use of couplings as specified herein shall not relieve the Contractor of his responsibility for precision alignment of all driver and driven units.

In every case where a drive motor is connected to a driven piece of equipment by a flexible coupling, the coupling halves shall be disconnected and the alignment between the motor and the equipment checked and corrected after the complete unit has been leveled on its foundation and again after grout has set and foundation bolts have been tightened.

In general, checking and correcting the alignment shall follow the procedures set up in the Standards of the Hydraulic Institute, Instructions for Installation, Operation, and Maintenance of Centrifugal Pumps. Equipment shall be properly leveled and brought into angular and parallel alignment.

140040 GEAR REDUCTION UNITS

Unless otherwise specified, all gear-reduction units shall be the helical or herringbone type, designed and rated in accordance with the latest AGMA standards. Planetary gear units and worm gear type units may be used only where specified.

Gear reduction units shall be selected for the class of service specified or intended in accordance with the detail equipment Specifications, and shall not be less than AGMA Class II.

Speed reducers that are separate from motors shall be designed for a service factor of 1.50 based on full horsepower rating of driving motor. Motor reducers shall be designed for Class II service based on full horsepower rating of motor. Variable speed transmission units shall have a service factor of not less than 1.5 based on full horsepower rating of driving motor. Speed reducers shall have a thermal horsepower rating of not less than the horsepower rating of the driving motor.

Gears of gear-reduction units shall be made of highest quality alloys treated for hardness and severe service. The gear shafting stresses shall be within the limits set by AGMA standard for shafting, allowable torsional and bending stresses.

The complete gear reduction unit shall be fully enclosed in a heavy cast iron or fabricated steel housing. The housing shall be relieved of all internal stresses that would cause misalignment of the gears, and shall be sufficiently rigid to preclude distortion under operating loads and prevent excessive vibration. Gear housing shall be provided with lifting lugs and inspection openings.

All gearing shall run in oil and bearings shall be of anti-friction type. Means shall be provided to prevent foaming of the lubricating oil. Oil piping and passageways shall be cleaned of mill scale or foreign materials before closing the system. Shaft seals shall be easily removable without dismantling shafts and couplings. They shall prevent loss of lubricating oil from gear housing of material that will not cause excessive wear of the shafts.

The actual and rated horsepower capacity, torque, overhung capacity, and bearing capacity of each reduction unit shall be not less than the horsepower rating of the drive motor nor less than that which will be encountered under full load and under the most severe operating conditions which the equipment will be called upon to operate.

Gears shall be designed to acceptable noise levels in accordance with AGMA Standard 295.03. Gears shall be of adequate mechanical and thermal ratings to prevent overloading when operating under full load conditions.

Shop Drawings shall be submitted for review and acceptance and shall include thermal and mechanical ratings.

The Contractor shall furnish to the Engineer complete engineering information, catalog data, design features, load capacities, and mechanical efficiency ratings for every gear reduction unit incorporated in the work. Class of service or service factor shall be stated on each gear reduction unit nameplate.

140050 V-BELT DRIVES

Unless otherwise noted, V-belt drives shall be Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-lock bushings; Wood's Super-V belts with matching Sure-grip sheaves and Wood's Sure-grip bushings; or equal.

Sheaves and bushings which operate at a peripheral speed of more than 5,500 feet per minute shall be dynamically balanced. All pulleys and bushings shall be statically balanced. Pulleys shall be separately mounted on their bushings by means of three pull-up bolts or cap tightening screws. Bushings shall be key seated to the drive shaft.

Motor for V-belt equipment shall be mounted on an adjustable base.

Belts shall be selected for not less than 150 percent of rated driver horsepower and, where two pulley sizes are specified, shall be capable of operating with either set of pulleys. Belts shall be of the anti-static type where explosion-proof equipment is specified.

Each different type and size of belt-driven unit shall be furnished with a complete set of spare belts. Spare belts shall be properly identified as to equipment, design, horsepower, speed, length, pulley size and use, and shall be packaged and stored. Where two or more belts are involved, matched sets of belts shall be provided.

140060 IDLER SPROCKETS

Idler sprockets shall be installed so that not less than one-quarter of the total adjustment is available for future use.

140070 MOTORS, GENERAL

Motors shall be manufactured in accordance with NEMA MG-1 Standards and shall be as specified herein or as specifically excepted in the individual equipment specifications.

140071. MOTOR STANDARDS

Unless otherwise specified for specific application, motors shall be: Type - Induction, squirrel cage; Polyphase Design "B;" Environment Protection - Open, splashproof, with stainless steel rodent guards, encapsulated winding for motors less than 100 horsepower and sealed windings for 100 horsepower and above; Speed - Constant, where two speed are specified they shall be dual winding; Rating - 460-volt, 3-phase, premium efficiency, high power factor, 50 degrees C ambient, Class "B" insulation.

140072 SPECIAL CONDITIONS

Altitude rating shall be the responsibility of the Contractor. Sound (noise) limits, when applicable, shall be as specified elsewhere. Aluminum frame motors must be individually reviewed for acceptance and they shall be manufactured with specially processed steel bearing inserts in each end shield and supplied with special long life bearings. Motors controlled by variable speed drive units shall each be protected by internal motor thermostats for overtemperature protection.

140073 FRACTIONAL HORSEPOWER MOTORS

Fractional horsepower motors shall meet the requirements specified herein, and in addition shall be 115-volt, 1-phase, special high efficiency, special high power factor, 40 degrees C ambient.

140074 HORSEPOWER RATING

Motor horsepower ratings noted in individual equipment specifications or indicated on the Plans are estimates only and it is the responsibility of the equipment manufacturer and of the Contractor to coordinate and furnish motors, electric circuits, starters, and other equipment of ample horsepower capacity to operate the equipment furnished without exceeding the nameplate full-load current at rated nameplate voltage. Full-load amps information shall be furnished with submittal.

140075 MOTOR EFFICIENCY AND POWER FACTOR

Integral horsepower motors shall be high performance motors. The Contractor shall submit for review each motors nominal and guaranteed minimum efficiency and power factor rating. Nominal minimum acceptable efficiency and power factor at full load for 2-, 4-, and 6-pole motors shall be:

		Full Load Rating				Full Load Rating	
Hp	RPM	Eff. %	PF %	Hp	RPM	Eff. %	PF %
1	1800	84.0	79	30	3600	91.0	91
	1200	78.5	75		1800	93.0	86
1-1/2	3600	81.5	91		1200	92.4	85
	1800	84.0	79	40	3600	91.7	90
	1200	82.5	75		1800	93.0	87
2	3600	84.0	89		1200	93.0	85
	1800	84.0	79	50	3600	91.7	91
	1200	84.0	68		1800	94.1	87
3	3600	82.5	89		1200	93.0	86
	1800	88.5	85	60	3600	92.4	90
	1200	86.5	74		1800	94.1	87
5	3600	86.5	86		1200	93.6	86
	1800	88.5	86	75	3600	93.0	92
	1200	87.5	85		1800	94.1	87
7-1/2	3600	86.5	88		1200	94.1	86
	1800	90.2	85	100	3600	93.6	90
	1200	88.5	85		1800	94.5	90
10	3600	87.5	90		1200	94.1	86
	1800	90.2	86	125	3600	93.6	90
	1200	86.5	85		1800	95.0	90
15	3600	89.5	88		1200	94.5	90
	1800	91.7	85	150	3600	94.1	90
	1200	90.2	85		1800	95.0	90
20	3600	90.2	90		1200	94.5	90
	1800	91.7	86	200	3600	94.1	93
	1200	91.0	85		1800	95.0	90
25	3600	91.0	90		1200	94.5	87
	1800	93.0	87	250	3600	94.1	93
	1200	92.4	85		1800	94.5	87

The basis for motor efficiency evaluation shall be the IEEE test procedure 112, Method B using accuracy improvement by segregated loss determination including stray load loss improvement.

Power factor correction capacitors shall be added at the motor if required to meet the above standards and when added, the power factor shall be corrected to over 90 percent.

Motors with 8 or more poles shall have power factor corrected to over 90 percent.

140100 HEATING, VENTILATION, AND AIR CONDITIONING

140101 GENERAL

The Contractor shall furnish and install all equipment and services for complete heating, ventilating, and air conditioning systems as indicated on the Plans and as specified herein.

Each item of equipment shall be furnished and installed complete with all supports, mounting frames, duct work, piping, louvers, panels, grilles, electric drive units and controls, mechanical equipment, electrical work, insulation and appurtenances ready for operation.

All equipment and appurtenances shall be anchored or connected to supporting members as specified herein or as indicated on the Plans.

All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials and shall be interchangeable. All equipment shall be of the manufacturer's top line, industrial-commercial grade.

The Contractor shall ascertain that all chassis, shafts, and openings are correctly located, otherwise he shall cut all new openings required at his own expense. Cutting of new openings shall be coordinated with other trades. Proposed new cutting shall be submitted to the Engineer for review and acceptance prior to cutting.

The Plans shall be taken as diagrammatic. The Contractor shall check the Structural Plans and sections for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.

Alignment of ducts may be varied where necessary to account for slight architectural changes or to avoid conflict with the work of other trades without additional expense to the Owner.

All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise. Equipment shall be supported on spring-type vibration isolators.

The air conditioners, coolers, heaters, and all fans, blowers, etc., furnished and installed by the Contractor shall carry the manufacturer's standard guarantee, and all such guarantees shall be forwarded to the Owner upon final acceptance of the completed systems by the Owner. All reciprocating refrigerant compressors shall carry a 5-year warranty.

The Contractor shall test and make tight all work, furnishing all equipment necessary to carry out the tests and thoroughly clean the system before starting same. The Contractor shall make sure that the system is free from all objectionable vibration and noise. Flexible connections shall be provided at connections to all mechanical equipment.

All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Uniform Plumbing Code, the Uniform Building Code, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules, and regulations.

Electrical work and power and motor control equipment shall be as specified in DIVISIONS 16 and 17.

Electric motors shall be as specified in DIVISION 14.

140102 DUCTWORK AND ACCESSORIES

140102.10. GENERAL

Furnish and install all ductwork, registers, and accessories required to make air ventilation systems complete and ready to operate.

140102.11. DUCTWORK

140102.12. GENERAL

Sheet metal ducts and plenums shall be constructed with airtight joints and seams, and shall conform to applicable codes as specified herein.

Ductwork materials shall be galvanized steel or aluminum, unless otherwise noted.

Duct gauges required are listed below:

Maximum Size of Duct (inches)	Galvanized Steel U.S. Standard Gauge	Aluminum Duct Thickness
12 and less	26	0.035-inch
13 through 30	24	0.043-inch
31 through 54	22	0.052-inch
55 through 84	20	0.071-inch

Supports for horizontal ducts and plenums shall be galvanized steel angles. Supports for vertical ducts shall be band iron strap or angle bracket type.

Tape all joints on concealed ducts, except welded or soldered joints, with pressureless tape and adhesive.

Provide wood ground or metal plaster frames for fastening grilles at walls and gypsum board or plaster ceilings.

All ductwork shall be routed or installed to be free from transmitting vibration to building components. Ductwork shall not touch or come in contact with ceilings, partitions, or piping. Duct and duct supports shall not be used to support ceiling or piping.

Ducts shall be fabricated of joint types, pressure type, reinforcing, bracing, supporting, fabricating, installing, and other requirements in accordance with Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems of the Sheet Metal and Air Conditioning Contractors National Association, Inc.

140103 GRAVITY VENTILATORS

140103.10. GRAVITY VENTILATORS - INTAKE

Furnish and install gravity intake ventilator on the sludge pump station as indicated on the Drawings.

Unit shall be complete with heavy gauge aluminum hood and base, low silhouette design, bird screen and factory applied protective finish.

The ventilator shall have a capacity of not less than 2,100 cfm at 0.200-inch static pressure and 18" x 18" throat size. Unit size shall be 33" x 36".

Units shall be as manufactured by Greenheck Fan Corporation, Penn Ventilator Co., Inc., or equal.

140104 DIFFUSERS, GRILLES AND REGISTERS

140104.10. GENERAL

Furnish and install all supply, return, exhaust, door, relief and transfer grilles and registers of size, capacity and air flow pattern as indicated on the Plans.

Units shall be the product of one manufacturer, constructed of steel or aluminum with factory standard finish of color selected by the Owner. Units in each space shall be similar in appearance.

Units shall be complete with style, frame and accessories as indicated hereafter.

Units shall be as manufactured by Titus Manufacturing Corp., Metalaire Metal Industries, Inc., or equal.

140104.20. AIR REGISTERS

140104.23. AIR REGISTERS

Units shall be steel or aluminum, complete with flanged frame, gasket, double deflection adjustable horizontal and vertical blades spaced at 3/4-inch centers, horizontal blades on front and multi-opposed blade volume control damper.

Unit shall be similar to Titus Model 300, or equal.

140108 EXHAUST FANS

140108.10. EXHAUST FANS, ROOF MOUNTED

Furnish and install roof mounted exhaust fans on the raw water meter vault and sludge pump station as indicated on the Plans.

Units shall be complete with heavy gauge spun aluminum weatherproofed housing, integral curb flashing, nonoverloading backward inclined centrifugal type aluminum wheel, statically and dynamically balanced, vibration isolation mounts, automatic backdraft dampers, integrally mounted safety disconnect switch and bird screen.

Each fan shall be belt drive with capacity not less than 2,000 cfm at 0.250 inches water column static pressure, 650 rpm maximum, and 1/4 horsepower. Motor shall be 120 volt, 1 phase, totally enclosed fan cooled.

Units shall be as manufactured by Greenheck Corp. Model GB-180, Penn Ventilator Co., Inc., or equal.

140121. AIR CONDITIONING UNITS

140121.01. GENERAL

Furnish and install air conditioning units as indicated on the Plans and specified herein. Unit will be installed at an elevation of approximately 1,200 feet above sea level.

140121.02. AIR CONDITIONER CONDENSING UNIT AND AIR HANDLER

Condensing unit shall be as manufactured by Trane Company Model TTA 090 A4, Carrier Corporation equivalent, or equal. Unit shall be UL listed, CSA certified and rated in accordance with ARI Standard 210 and 270.

Unit shall have a total cooling capacity of not less than 78,000 Btuh with a sensible capacity not less than 60,000 Btuh at 110 degrees F condenser entering air temperature, indoor coil entering air at 80 degrees DB and 67 degrees WB and 3,000 cfm. The unit shall be 460 volt, 3 phase.

Condensing unit shall have weather-protective cabinet with baked-on enamel finish, direct drive hermetic reciprocating compressor, crankcase heater, temperature and current overloads, high and low pressure cutouts, sound muffling, spring isolators, copper tube/aluminum fin condenser coil, and totally enclosed direct drive permanently lubricated condenser fan motor. Unit shall be completely factory wired with necessary controls, transformers, fuses, and contactors. Unit shall have low ambient head pressure controls, vibration isolation package, anti-short cycle timer, and condenser coil guard.

Air handler unit shall be as manufactured by Trane Company Model TWE 090 A3, Carrier Corporation equivalent, or equal. The unit shall be rated and tested in accordance with ARI Standard 210 and shall be UL listed and labeled.

The horizontal air handler unit shall be completely factory assembled, including coil, condensate drain pan, fan motors, filters and controls. The unit shall have a galvanized steel casing with corrosion protection, baked enamel finish, fiberglass insulation, condensate pan, thermal expansion valve, aluminum fin copper tubing coil, double inlet, double width, forward curved, centrifugal fan, adjustable belt drive, fan motor 1-1/2 hp, 460 volt, 3 phase, magnetic contactor, single point power entry, all controls factory installed and wired, defrost control, horizontal air supply and return, and grilles and factory supplied filters.

The manufacturer shall provide a 24 volt, wall mount thermostat.

The control wiring between the thermostat, condensing unit, and air handler unit shall be provided and installed in accordance with manufacturer's requirements.

140200. HOIST AND TROLLEY

Furnish and install a hoist and trolley in the Presedimentation Basin Sludge Pump Station.

Hoist shall be hand chain operated, all steel, ball bearing, spur geared, positive action Weston type load brake, and lifetime lubricated. Lift shall be minimum 20 feet. Chain shall be zinc galvanized. Hoist shall be Chester Hoist No. 130-1, 2,000-pound capacity, Harnischfegar P&H equivalent, or equal.

Trolley shall be hand propelled, geared, for overhead I-beam, and with steel side plates, through-hardened cast-iron wheels, and fully sealed lifetime lubricated ball bearings. Chain shall be zinc galvanized. Trolley shall be Chester Hoist Model PT, No. 1632-1, 2,000-pound capacity, Harnischfegar P&H equivalent, or equal.

140200.01. INSTALLATION

All hoisting equipment shall be installed by competent personnel who are experienced in, and regularly engaged in, field installation of monorail systems. Monorails shall be level and accurately aligned within a 1/8 inch tolerance.

140200.02. LOAD TESTING

After complete installation, the hoist and monorail equipment shall be tested with a load 25 percent above the rated capacity, and the tests shall be certified by the Contractor. Load and slings shall be provided by the Contractor and removed when the tests are completed. The equipment shall be operated through a complete lift and lowering cycle and through complete travel of the trolley to determine that the equipment will perform the functions of hoisting and traveling, quietly, smoothly, and safely. Any defects in the equipment shall be corrected. Testing shall be done in the presence of an authorized representative of the hoist manufacturer, the Engineer, and the City's Crane/Hoist Inspector. No hoisting equipment shall be used to handle any equipment until the load testing is concluded.

At the time of the load testing, an inspection of the hoist and monorail equipment will be performed by the City's Crane/Hoist Inspector. Inspection and acceptance by the City's Crane/Hoist Inspector will not relieve the Contractor from his contractual responsibility, nor his warranty for that installation.

* * * END OF DIVISION 14 * * *

DIVISION 15

PIPING, VALVES, GATES, AND SPECIALTIES

150000 GENERAL

Piping shall be installed as indicated on the Plans. The Contractor shall submit to the Engineer, for review and acceptance, his detailed proposed piping layouts.

Any pipe which does not meet specifications or has been rejected, shall be removed from the jobsite and disposed of by the Contractor at no extra cost to the Owner.

Where new fittings are to be cut into or attached to existing piping or where connections are to be made to existing piping, the Contractor shall furnish and install the necessary sleeves, flanges, nipples, couplings, fittings, or other devices needed to accomplish the cutting-in or connections, whether indicated on the Plans or not.

Lines under low head shall be laid flat or with a continuous grade so that there will be no air traps or humps in them, except at the ends where means for venting shall be provided.

In no case shall copper or copper alloy pipe or fittings carrying water or water based solutions or slurries be attached to cast-iron or steel pipe except by means of a dielectric coupling expressly made for this purpose and service.

All pipe which will operate under pressure shall be properly blocked at all fittings where the pipeline changes direction, changes size, or ends, using concrete thrust blocks in trenches and suitable anchors in structures. Concrete thrust blocks shall be sized so as to give bearing against undisturbed vertical earth banks sufficient to absorb the thrust from line pressure, allowing an earth bearing of 200 pounds per square foot per foot of depth below natural grade. (Earth bearing value may be increased, if substantiated by soils analysis.) The line pressure shall be the product of the nominal cross sectional area of the pipe and the test pressures as specified for each type of pipe. The concrete shall be placed, unless indicated otherwise on the Plans, so that the pipe joints and fittings will be accessible.

Flowmeters and other similar in-line devices, as described in DIVISION 17 of these Specifications, shall be installed per the manufacturer's recommendations under the general requirements of this Division of these Specifications.

150010 EXPOSED PIPING

Where not detailed, exposed pipe shall be installed in straight runs parallel to the axes of the structures. Pipe runs shall be horizontal and vertical except that gravity drain lines shall be sloped down in the direction of flow not less than 1/8-inch per foot.

No exposed piping shall be erected until all equipment to which the pipe is to be attached has been installed and it can be determined where piping and fittings shall be located to make a neat efficient arrangement.

The Plans shall be taken as diagrammatic for piping that is not shown in detail. Sizes of piping and their locations are indicated, but it is not intended to show every offset and fitting nor every structural difficulty that will be encountered during the installation of the work.

The alignment of pipes shall be varied from that indicated on the Plans, without extra expense to the Owner where necessary to avoid structural or mechanical difficulties or to avoid the work of other trades. The Contractor shall furnish such parts and pieces as may be necessary to provide a complete and operable system.

Pipework shall be suspended and supported in such manner as to prevent sagging or overstressing of pipe and connections and, also, so that no item of the piping system shall transfer any load or stress to any equipment.

Piping shall be made up with a sufficient number of unions or flanged joints to permit ready breaking of lines as necessary for inspection and maintenance, in addition to such joints as are definitely indicated on the Plans.

Pipe and fittings shall be assembled so there will be no distortion or springing of the pipelines. Flanges, unions, flexible couplings, and other connections shall come together at the proper orientation. The fit shall not be made by springing any piping nor shall orientation alignment be corrected by taking up on any flange bolts. Flange bolts, union halves, flexible connectors, and similar devices shall slip freely into place. If the proper fit is not obtained, the piping shall be altered to fit.

150011 WALL AND SLAB PENETRATIONS

Unless indicated otherwise on the Plans, no pipe shall pass through or be built into any reinforced masonry or concrete wall, floor, ceiling, roof, pilaster, column, pier, or beam, unless it is inside of a sleeve; and such sleeves shall have an inside diameter not less than the outside diameter of the pipe plus 2 inches, except that for pipe smaller than 2 inches the ID of the sleeve shall be not less than twice the OD of the pipe. Such sleeves shall be placed not closer than three diameters center to center, nor shall they impair the strength of construction. The arrangement of sleeves shall be such that pipe can be pulled out of a sleeve and replaced without disturbing the structural member. Ends of sleeves shall be flush with surfaces of concrete, masonry, or plaster.

Where pipes pass through floors, walls, or ceilings of finished spaces, the end of the pipe sleeve shall be concealed with an appropriate escutcheon. Escutcheon plates shall be chrome plated steel plates, Keeney Manufacturing Company, No. 102 or 105; Beaton and Corbin No. 1 or 13; or equal. The space between the pipes and sleeves shall be sealed as indicated on the Plans.

Openings around any pipes through interior walls or floor of chlorine rooms and chlorine storage rooms shall be sealed gastight with synthetic rubber caulking compound.

150020 BURIED PIPING

All pipelines laid in open trenches shall conform to applicable parts of DIVISION 2.

Gravity pipelines shall be laid to the lines and grades indicated on the Plans, and shall be laid upgrade. Where not otherwise indicated on the Plans, all buried lines shall be laid with a minimum of 3-foot cover without air traps or humps. Where two lines of similar service run parallel to each other, they may be laid in the same trench as close together as possible and still provide adequate room for jointing.

Before excavation is started for any run of underground piping, the Contractor shall locate and expose all existing structures, piping, conduit, etc., which intersect the line of the piping, to avoid possible damage to these during excavation operations and so that it may be determined if there will be any conflicts in location. In the event of conflicts in location or grade or both, between new piping and existing piping, the Contractor shall make adjustments in location or grade of new piping acceptable to the Engineer.

Unless otherwise indicated on the Plans or specified, where pipe of any type is to be encased in concrete, the encasement shall provide a minimum of 6 inches of concrete completely around the pipe, shall fill the bottom of the trench from bank to bank, if not formed, and shall be reinforced with four continuous longitudinal reinforcing bars, one in each corner of the encasement. Concrete shall be Class C. The length of encasement indicated on the Plans, or specified, shall be the minimum length, and the encasement shall terminate at each end at a joint in the pipe. Reinforcing bars shall be No. 4 for encasement of pipe 36 inches and smaller and No. 6 for encasement of pipe larger than 36 inches.

Where buried ductile iron, reinforced concrete, vitrified clay, or similar rigid pipe enters a structure, it shall be by means of a coupling or wall piece cast into the wall, having a mechanical push-on, or similar flexible joint as specified or indicated on the Plans at the outside face of the wall. An additional similar joint shall be installed in the line at the edge of the structure excavation where the pipe trench leaves undisturbed ground. For steel pipe a single joint may be used located not more than 2 feet from the outside face of the wall.

At the close of the day's work, and at such other times when the pipe is not being laid, all openings in the end of the pipeline shall be closed with an accepted plug.

150021 LAYING OF PIPE AND FITTINGS

In laying pressure pipelines, the deflection in a standard joint shall not exceed the manufacturer's recommendation. Horizontal and vertical deflections of not more than the recommended combined angle, including curves as indicated on the Plans, shall be made by deflections in standard pipe joints within 10 feet of the indicated stations. Five degree beveled joints may be used. Deflections of more than 5 degrees shall require special bends or fittings. Departure from and return to established alignment and grade shall not exceed 1/16-inch per linear foot of pipe and at no point shall the maximum departure from established line and grade be greater than 1 inch.

The laying of all pipe shall be in finished trenches free from water or debris. The joining of pipe sections shall be such as to produce watertight lines. Pipe shall be laid on an unyielding foundation with uniform bearing under the full length of the barrel. If the pipe bears top or bottom markings, it shall be placed with the markings in the proper position. All adjustments to line and grade shall be made by scraping away or filling in under the pipe. Pipe shall not be dropped or pounded to fit grade. If the joints are the type which require external grouting, banding, or pointing, space shall be provided under and immediately in front of the bell end of each section laid of such shape and size as to permit sufficient room for the grouting, banding, or pointing of the joints.

Each section of pipe shall be lowered into the trench, utilizing a sling or other device, in a manner that shall prevent injury to the pipe, coating, lining, or joints. Under ordinary conditions of laying, the work shall be so scheduled that the bell end of the pipe faces in the direction of laying. In placing pipe in the trench, the pipe shall be held by the lowering device at the balancing point of the section. It shall not be dragged on the bottom of the trench but shall be supported while being fitted into the adjacent section. Supporting the pipe on blocks, or blocking of any nature, either temporary or otherwise, will not be allowed.

It is the responsibility of the Contractor, when the pipeline and appurtenances are finally laid, to see that all joints are protected and that any damage to the coating or lining of the pipe and fittings has been adequately repaired or replaced in order to preserve their integrity for corrosion protection.

150022 JOINTING OF RUBBER GASKETED PIPE

Unless specified otherwise under a particular type of pipe, the jointing of pipe with rubber gaskets shall be in accordance with the manufacturer's published instructions and this section.

The ends of the pipe shall be thoroughly cleaned with wire brushes or the equivalent to remove all foreign materials, including sealing compound, if any, from surfaces which are to be incorporated in the joint. The spigot recess, the rubber gasket, and the bell shall be lubricated with a soft, vegetable compound. After lubrication, the gasket shall be thoroughly stretched when placing in the spigot groove so that there is a uniform volume of rubber distributed around the circumference. The gasket shall not be twisted, rolled, cut, crimped or otherwise injured or forced out of position during closure of the joint. Prior to assembling the joint in position, metal or wooden spacers shall be placed against the inside shoulder of the bell to provide the proper space for mortar between abutting ends of the pipe. After the joint is assembled, a "feeler" gauge shall be inserted between the bell and the spigot and the position of the rubber gasket checked around the complete circumference of the pipe. If the gasket is not in the proper position, the pipe shall be withdrawn, the gasket checked to see that it is not cut or damaged, the pipe relaid, and the gasket again checked.

Where indicated on the Plans and at locations where make-up field joints are required, the pipe shall be joined by lap welded field joints. Welded field joints at locations where a bell end is not provided shall be made by means

of a bell end formed by a 4-inch butt strap welded to one side of the joint prior to assembly. All welding of field joints shall be in accordance with the requirement of AWWA Specification C 206.

Where welding is required in the field for pipe restraints in accordance with the Plans or Specifications, the welded surface shall be given an SP-3 power tool cleaning in accordance with the Specifications of the Structural Steel Painting Council. Following power cleaning, the Contractor shall recoat the power cleaned areas with an acceptable coating furnished by the pipe manufacturer and equal to the material and thickness supplied on the pipe by the pipe manufacturer. Following application of the coating, the pipe joint shall be grouted as specified hereinafter.

After the pipe has been laid, and before trench backfill may commence, the outside annular space between pipe sections shall be completely filled with grout. The grout shall be poured in such a manner that all exposed portions of the joint shall be completely protected with cement grout. Grout used for filling the outside joints by the pouring method shall be mixed in proportions of one part cement by weight, to not more than one part, by weight, of sand passing a No. 16 mesh screen and thoroughly mixed with water to the consistency of rich cream. A band of canvas or polyethylene shall be placed around the outside of the pipe and centered over the joint. The joint band shall be bound to the pipe by use of steel box strapping. The band shall completely and snugly encase the joint except for an opening at the top through which to pour the grout. The outside grout space, prior to filling with grout, shall be flushed with water so that the surfaces of the joint to be in contact with the grout filling will be thoroughly moistened when the grout is poured. Fluid grout shall be poured in only one opening in this joint and pouring shall be continuous until grout appears at the other side. The grout shall be rodded on both sides of the pipe to settle the grout and more grout added, as necessary, to fill the joint completely. Exposed portions of the joint, after filling, shall be covered with wet burlap. Joint bands shall not be removed.

Backfilling shall not be started until the exterior joint protection grout has set (2 hours) and the Inspector has checked and accepted each joint as completed.

After trench backfill is complete, the interior joint recesses shall be filled with mortar, tamped into the joint with a thin block of wood or other suitable tool, and pointed. The finished joint shall be smooth and flush with the adjacent pipe surfaces. Mortar for the inside of pipe joints shall be mixed in the proportion of one part, by weight, of cement, to two parts, by weight, of clean well-graded sand, and just sufficient water shall be used so that the resulting mortar will crumble to the touch after being "balled."

All mortar or grout shall be newly mixed. No mortar or grout that has begun to set shall be used, and no retempering will be allowed.

150022.10 CURING AND PROTECTION OF JOINTS

Joints requiring mortar or grout shall be cured and protected as follows: Immediately after each exterior joint is completed, if not already by canvas or polyethylene band, it shall be protected from the sun by means of a covering of wet burlap and an initial covering of fine, moist earth or sand

approximately 6 inches above the top of the pipe. Extreme care shall be taken in placing such earth around the pipe to avoid injury to freshly applied mortar or grout. At the close of the day's work and at such other times when the pipe is not being laid, if the inside joints are pointed, all openings in ends of the pipeline shall be covered by sacks and moist earth or sand to prevent drying out of the joint mortar by the circulation of air within the pipe.

150023 STEEL SURFACES EXPOSED TO WATER OR EARTH

All steel surfaces exposed to water or earth, including but not limited to blind flanges used in access manholes, construction manholes, bell rings at structures, all cast-iron or steel nuts and bolts, and dead ends shall be painted with an epoxy polyamide system of 10 mils dry film thickness conforming to the requirements of the FDA, Section 175.300 for potable water. The epoxy polyamide system used shall be as manufactured by Glidden, Tnemec, or equal, applied in accordance with the paint manufacturer's recommendations, to a clean surface, free of dust, dirt, mill scale, rust, oil, or grease, commercial blasted cleaned in accordance with SP-6, Steel Structures Painting Council Specifications.

150025 LAYING OF DUCTILE IRON PIPE

Trenching, bedding, and backfill shall be in accordance with the requirements of DIVISION 2.

The handling, storage, and installation of ductile iron pipe shall be in accordance with the requirements of these Specifications and AWWA C 600.

150027 LAYING OF PVC PIPE OR CPVC PIPE

Trenching and backfill shall be in accordance with the requirements of DIVISION 2.

The handling, storage, bedding, and installation of PVC pipe shall be in accordance with the manufacturer's recommendations and ASTM D 2774.

150030 CLEANING AND TESTING

The interior of all pipelines, above or below grade, shall be thoroughly cleaned of all adhering matter and other debris. No testing of any pipeline shall be started until the cleaning is complete and accepted by the Engineer.

Special precautions required in the cleaning of a particular pipeline shall be as stated in the various parts of this Division of these Specifications.

All pipelines, above or below grade, shall be tested to the pressures indicated in the various parts of this Division of these Specifications. Any piping for which test pressure is not specified shall be tested under a pressure of 25 psi above the operating head.

Pipe underground may be tested before backfilling unless otherwise specified, and pipes to be encased in concrete or under concrete slabs shall be tested before the encasement or slabs are placed.

The Contractor shall furnish all necessary personnel, supplies, equipment, bulkheads, and whatever additional equipment is required to make any and all tests specified and shall make any and all repairs, including relaying, if necessary, to any and all pipelines failing to pass the testing requirements of these Specifications.

The Contractor shall give the Engineer a list of the scheduled pipeline tests by noon of the day preceding the scheduled test or tests. The Contractor shall notify the Engineer by written memorandum of his readiness (not just his intention) to test a line or portion of line. All bulkheads, thrust blocks, anchors, temporary connections, pumps, etc., shall be in place before the Contractor's notification of readiness is given to the Engineer. After testing, all pipes shall be flushed or blown out and left clean.

In testing with water, the test pressure specified shall be the pressure at the lowest point in the piping concerned. In testing with water, the lines shall be examined and any visible leaks repaired. In testing with air, the lines shall be examined and tested with soap suds and any leaks repaired. Testing shall be repeated until the lines are in satisfactory condition.

Despite any previous testing, any leaks developing before the end of the one year guarantee period shall be repaired by the Contractor at no additional expense to the Owner.

150031 SPECIAL PIPING TESTS

Plumbing piping, natural gas piping, and bottled gas piping shall be tested in accordance with Code or Underwriters' requirements.

150032 GAS AND AIR PIPING TESTS

All gas and air lines shall be tested with air at the pressure specified.

150033 LIQUID PIPING TESTS

All liquid piping shall be tested with water at the pressure specified.

150034 LARGE DIAMETER, LOW HEAD, CONCRETE PIPE TESTS

For large diameter concrete pipe, in lieu of testing by filling the pipe with water, the Contractor may test each joint separately by the use of an inflatable ring that will seal on each side of joint on the inside of the pipe when inflated. Air or water may then be used to fill the space between the inflated ring and the pipe joint to a pressure not less than the specified test pressure of the pipe. Leaks shall be corrected before backfilling.

150036 POTABLE WATERLINES

Potable water pipelines shall be disinfected, prior to being placed in service, by filling the pipeline with a chlorine solution, expelling all air from the pipeline, and retaining the solution in the pipeline for 24 hours. The strength of the chlorine solution shall be such that at the end of the 24-hour period, the solution shall contain a chlorine residual of not less than 10 ppm at all points in the pipeline. Disinfection of the pipelines shall conform to AWWA C 601 except as modified herein. All details of the procedure shall be subject to the review and acceptance of the Engineer.

The effectiveness of the disinfection of the waterlines shall be demonstrated by laboratory examination of samples in accordance with AWWA C 601. Should the initial treatment fail to result in a disinfected system, the Contractor shall repeat chlorination of the system until satisfactory results are obtained, all at no additional cost to the Owner. The Owner will furnish the water required for the initial disinfection; if additional disinfection is required, then the Contractor shall pay for such additional water.

150060. PIPING SCHEDULE

PIPING SCHEDULE

Use	Piping	Joints/Fittings	Test Pressure
Air, high pressure (over 15 psi)	Black steel, Sch. 40, screwed	Black malleable iron, 300#	200 psi
Caustic soda	CPVC, Sch. 80	Solvent weld or flanged	125 psi
Chemical solutions and slurries not specifically mentioned	PVC, Sch. 80	Solvent weld or flanged	125 psi
Condensate drain	PVC Sch. 40	Solvent weld	20 feet
Drains under slabs or within structures	Ductile iron, Class 51, cast-iron soil	Mechanical joint, Bell and Spigot	20 feet
Drain, waste and vent within structures	Cast-iron soil	Bell and Spigot or no-hub	20 feet
Potable service water aboveground	Galvanized steel, Sch. 40, ASTM A53, Grade B; copper ASTM B 88	Screwed, galvanized malleable iron 150 pounds; soldered	125 psi
Potable water underground 3" and under	Galvanized steel, Sch. 40, ASTM A53, Grade B wrapped; copper ASTM B 88	Screwed, galvanized malleable iron, 150 pounds wrapped; soldered	125 psi
Potable water underground, over 3" diameter	Ductile iron C-53, cement lined	Mechanical joint, cement lined	125 psi
Raw water	RCP-ASTM C361; fabricated steel, cement lined and coated	Rubber gasketed; push-on joints	25 psi

PIPING SCHEDULE (CONTINUED)

Use	Piping	Joints/Fittings	Test Pressure
Sample lines	PVC, Sch. 80	Flanged or solvent weld	125 psi
Service water in presedimentation basin	Galvanized steel, Sch. 40, ASTM A53, Grade B	Flexible couplings above Elev. 1242.0; screwed; galvanized malleable iron, 150 pounds	125 psi
Sludge lines aboveground	Ductile iron Class 53	Flanged, D.I. 125 pound standard, grooved	125 psi
Sludge lines underground	Ductile iron Class 53	Mechanical joint	125 psi
Storm water drainage	RCP-ASTM C 76	Rubber gasketed	
Sump discharge line aboveground	Galvanized steel, Sch. 40, ASTM A53, Grade B	Mechanical joint	125 psi
Sump discharge line underground	PVC Schedule 80	Solvent weld or flanged	125 psi

150070 CONNECTION TO IN-SERVICE LINES

Existing pipe to which connections are to be made shall be exposed by the Contractor to permit field changes in line, grade, or fittings, if necessary.

All connections to existing lines shall be constructed according to the Plans.

When shutdown of an in-service line is necessary in order to connect to the new lines, a conference between the Contractor's representative, the Engineer, and operating supervisory personnel shall establish the time and procedures to insure that the shutdown will be for the shortest possible time. If necessary, shutdowns may be scheduled during other than normal working hours, at no additional cost to the Owner.

150071 CONNECTION TO WATER DISTRIBUTION SYSTEMS

On water distribution systems, the water supply to some customers, such as hospitals, cannot be shut off at any time. Provisions to furnish a continuous supply of water to such establishments will be required. After the procedures and time for a shutdown are agreed upon, it shall be the Contractor's responsibility to notify all customers in advance that the water will be turned off. When possible, customers shall be notified 24 hours in advance, and in no case, except in emergency, shall notification be less than 1 hour. Notification shall be in writing, giving the reason for the shutdown and the time and duration the water service will be shut off.

The Owner will close existing valves, but will not guarantee a "bone-dry" shutdown. Valves connecting new work to the existing system shall be kept closed at all times. If it is necessary to obtain water from the existing system, clearance must be obtained from the Owner. Valves shall not be operated until such clearance is obtained.

After disinfection samples have been taken and the new work passes the bacteriological tests, the new line shall then be turned over to the Owner with all branch lines and tie-in valves closed. Owner's crews will put the line into service.

150100 DUCTILE-IRON PIPE

Wherever cast-iron pipe is called out on the Plans, or specified herein, ductile-iron pipe shall be used in its place.

Ductile-iron pipe shall conform to the requirements of ANSI A 21.50 and ANSI A 21.51 (AWWA C 150 and AWWA C 151). Ductile-iron pipe fitted with threaded flanges shall conform to ANSI 21.15 (AWWA C 115). Unless indicated otherwise on the Plans, ductile-iron pipe shall be thickness Class 50.

150101 GROOVED-END DUCTILE-IRON PIPE - GENERAL

Grooved-end pipe with mechanical pipe couplings (victaulic type) and fittings may be installed in place of flanged systems at certain locations and in certain services on this project. Grooved-end pipe shall not be used underground or underwater unless indicated otherwise on the Plans. Grooved-end pipe shall not be used for systems which may be steamed.

Pipe and fittings shall be cut grooved. Method of grooving shall be in accordance with mechanical pipe coupling manufacturer's specifications. Pipe to be grooved shall have wall thicknesses not less than the minimum recommended by the coupling manufacturer for cut-grooving and AWWA C 606. Connections to valves and flanged-end pipe shall be by grooved-end to flanged pipe adapter flange or flanged adapter nipple. Grooved pipe and fitting ends shall be lightly coated with lubricant approved by the coupling manufacturer prior to placing gasket.

Grooved-end pipe shall be supported in accordance with manufacturer's recommendations. In addition, at least one support shall be used between any two couplings.

The Contractor shall submit for review a listing of services and locations where he proposes to use grooved-end pipe prior to start of installation of any grooved-end piping. This listing is subject to the Engineer's acceptance and acceptance must be granted in writing by the Engineer prior to the delivery of any grooved piping materials to the jobsite.

The Contractor shall submit for review complete information showing fittings, gaskets, mechanical pipe couplings, grooving of pipe and pipe lining or coating prior to installation of any pipe. All materials proposed for use are subject to the Engineer's acceptance.

Mechanical pipe couplings and grooved-end pipe shall be installed in accordance with the coupling manufacturer's representative's recommendations.

150102 GROOVED-END DUCTILE-IRON PIPE COUPLINGS

Grooved-end ductile-iron pipe shall be joined by mechanical pipe couplings. Mechanical couplings shall be self-centering and shall engage and lock in place the grooved pipe and pipe fitting ends in a positive watertight couple. Couplings shall be fabricated in two or more parts of malleable iron in accordance with ASTM A 47, Grade 32510. Couplings shall be the rigid grooved type, conforming to AWWA C 606 and as specified herein.

Coupling assembly shall be securely held together by two or more steel bolts and nuts of heat-treated carbon steel. Nuts and bolts shall be in accordance with ASTM A 183 and A 194, Grade 2.

Couplings shall hold in place a composition water-sealing gasket designed so that internal water pressure serves to increase the seal's watertightness. Sealing gaskets shall be chlorinated butyl in accordance with ASTM D 2000, Grade No. 3BA615A14B13Z with special heat-resistance test of 16 hours at 350 degrees F and maximum elongation change of minus 30 percent.

All pipe fittings used in connection with mechanical pipe couplings shall be radius grooved for grooved-end ductile-iron pipe. Radius grooved ductile-iron fittings shall conform to the requirements of ANSI B 16.1. The outside surface of pipe between the groove and pipe end must be smooth and free from deep pits or swells and shall provide a leaktight surface for the gasket.

150110. JOINTS

Where so indicated or specified, joints shall be made with flexible couplings or with mechanical couplings for grooved or shouldered end pipe. Unless otherwise noted, joints that are not buried in the ground and those that are indicated on the Plans or in the Specifications to be flanged shall be flanged joints. All other joints shall be mechanically restrained mechanical joints, or mechanically restrained push-on joints. Concrete thrust blocks shall be used only when specifically detailed or accepted by the Engineer. Mechanical joint, or push-on joint pipelines shall have flanges where necessary for valves and cleanout connections.

Restrained mechanical joints shall be designed with a safety factor of 2:1 at the line test pressure.

Restrained mechanical joints shall use an integral retainer weldment, or lugged type joint with 304 stainless steel tie rods and nuts. If field welding of the retainer weldment is required, the Contractor shall submit the welder's qualifications showing the welder has been certified by the factory to do field welding of the retainer. Acceptable joints shall be American Cast Iron Pipe Company's LOK-Fast joint or Lugged Fastite joint; Pacific States Cast Iron Pipe Company's Restrained Tyton joint, Pacific States Lock mechanical joint.

An alternative to the above restrained joints shall be a follower gland which includes a restraining mechanism. The restraining mechanism shall grip the pipe and shall increase its resistance as pressure is increased. The gland shall be ductile iron per ASTM A536. Restraining devices shall be ductile iron heat treated to 370 BHN. Twist off nuts shall be used to insure

actuating of the restraining device. Systems using set screws as locking devices shall not be acceptable. Acceptable joint shall be EBAA Iron, Inc., MEGALUG.

150111 FLANGED JOINTS

Flanges may be cast integrally with the pipe, in which case they shall conform to ANSI B 16.1 as to diameter, thickness, drilling, etc., or they may be screwed on the threaded ends of the pipe. Screwed-on flanges shall conform to ANSI B 16.1 as to material, diameter, thickness, drilling, etc., but shall have long hubs threaded specially for ductile-iron pipe. Screwed-on flanges shall be attached to the pipe by the pipe manufacturer, and after attachment the faces of the flanges and the ends of the pipe shall be refaced so that the end of the pipe will be even with the face of the flange and both will be perpendicular to the axis of the pipe. Bolt holes on the two flanges on a piece of pipe shall be in perfect alignment. Bolts shall conform to ANSI B 16.1 except that flanges underground, in concrete valve boxes, or in water may be cast-iron bolts and nuts, and all bolts and nuts under these conditions shall be painted with an asphaltic coating as specified in AWWA C 104, of at least 10 mils thickness.

Cast-iron bolts and nuts shall be made of material having at least 50,000 psi tensile strength. The cast-iron bolts used with mechanical joints will be acceptable.

Where cap screws or stud bolts are required, flanges shall be provided with tapped holes for such cap screws or stud bolts.

Gaskets shall be ring gaskets suitable for the intended application, manufactured by Garlock, Cranite, or equal.

All flange bolts shall be cut and finished to project not less than two threads, and not more than 1/4-inch beyond outside face of nut after joint is assembled.

150112 MECHANICAL JOINTS

Mechanical joints shall be in accordance with ANSI A 21.11 (AWWA C 111).

150113 PUSH-ON JOINTS

Push-on rubber gasket joints shall be in accordance with ANSI A 21.11 (AWWA C 111).

150120 FITTINGS

Except as otherwise provided, fittings for ductile-iron pipe shall be as specified in ANSI A 21.10 (AWWA C 110), of the same pressure rating as the pipe with which they are used.

150121 PUSH-ON

Push-on rubber gasket joint fittings shall have bodies as specified above with bells dimensioned and arranged to match the push-on joints on the pipe.

150122 FLEXIBLE FITTINGS

Flexible fittings applicable to ductile-iron pipe shall be as specified under the PIPING SPECIALTIES section of these Specifications.

150130. LINING AND COATING

Except as otherwise specified, all ductile-iron pipe and fittings shall be smooth cement lined in accordance with ANSI A 21.4 (AWWA C 104). Special attention shall be given to the lining of fittings. Lining shall be applied to bare metal. All lining shall extend to the faces of flanges, to the end of spigots, or to the shoulder of hubs, as the case may be.

In addition, all ductile-iron pipe and fittings shall be coated on the outside with bituminous material except that pipe which is to be painted shall not be coated on the outside.

150140 HANDLING OF PIPE AND FITTINGS

All ductile-iron pipe shall be carefully handled during loading, unloading, and installation. No pipe shall be dropped from cars or trucks to the ground. All pipe shall be carefully lowered to the ground by mechanical means. In shipping, pipe and fittings shall be blocked in such manner as to prevent damage to castings or cement lining. Any broken or chipped lining shall be carefully patched. Where it is impossible to repair broken or damaged lining in pipe because of its size, the pipe shall be rejected as unfit for use.

All mechanical joint pipe shall be laid with 1/8-inch space between the spigot and shoulder of the pocket.

150150 CLEANOUTS

Cleanouts for flanged pipe shall have blind flange closures. Cleanouts for mechanical joint pipe shall have mechanical joint plugs or flanged adapters and blind flanges. Where noted on the Plans or specified, closures shall be bored and tapped for steam cleaning connections or reduced size cleanout plugs. Mechanical joint pipe and fittings shall be adequately harnessed or otherwise secured to resist the internal pressure against the cleanout closure.

150160 CORROSION PROTECTION

Ductile-iron pipe buried in soil shall be protected against external corrosion by loose polyethylene sleeves in accordance with AWWA C 105.

150170 TESTING

All pipelines for which testing is not otherwise specified shall be tested for watertightness by subjecting each section to Hydrostatic Pressure and Leakage Tests in accordance with applicable provisions of AWWA C 600, except as modified below. The Contractor shall provide all vents, piping, plugs, bulkheads, valves, bracing, blocking, pump, measuring device, and all other equipment necessary for making the tests, except pressure gauges. The Owner will furnish the water required for the first test, if more than one test is

required, the Contractor shall pay for the water required to make the additional tests. Each section of a new line between sectionalizing valves or between the last sectionalizing valve and the end of the project shall be tested separately as required in AWWA C 600, and/or as modified in these Specifications, except that any such section less than 500 feet in length may be tested with the adjacent section, if both sections of line have the same pipe class rating. The duration of each test shall be at least two hours.

150171 PRESSURE TEST

All pipelines shall be tested by subjecting each section to a pressure, measured at the lowest end of the section, of at least 125 percent of the class rating or design pressure of pipe under test.

The test may be made before or after backfilling. However, if mechanical compaction is to be used in the backfilling operations as spelled out in AWWA C 600, the test shall not be made until the backfilling is completed and compacted. All connections, blowoffs, hydrants, and valves shall be tested with the main as far as is practicable.

The test section shall be slowly filled with potable water, and all air shall be vented from the line. The rate of filling shall be as acceptable to the Engineer, with at least 24-hour notice required before tests are scheduled. While the test section is under test pressure, a visual inspection for leaks shall be made along the pipeline, and all visible leaks repaired. The pressure test shall not begin until the pipe has been filled with water for at least 24 hours to allow for absorption.

150172 LEAKAGE TEST

Leakage test shall be made after pressure test has been satisfactorily completed and all backfilling and compaction is completed to top of trench. The Contractor shall furnish the necessary apparatus, and assistance to conduct the test.

To pass the leakage test, the leakage from the pipeline shall not exceed the leakage allowed by the following formula:

$$L = \frac{ND\sqrt{P}}{3700}$$

in which L = allowable leakage in gallons per hour.

N = number of joints in the pipeline being tested, this "N" being the standard length of the pipe furnished divided into the length being tested, with no allowance for joints at branches, blowoff, fittings, etc.

D = nominal diameter of pipe in inches.

P = average observed test pressure of the pipe being tested, equal to at least 100 percent of the class rating of pipe being tested, in pounds per square inch gauge, based on the elevation of the lowest point in the line or section under test and corrected to the elevation of the test gauge.

Should the test on any section of the pipeline show leakage greater than specified above, the Contractor shall locate and repair the defective pipe, fittings, or joint until the leakage is within the specified allowance of two-hour duration. All repairs and retests, if required, shall be made without additional cost to the Owner.

Connections to the existing pipelines or existing valves shall not be made until after that section of the new construction has satisfactorily passed the hydrostatic tests.

150200. STEEL PIPE

Except as otherwise specified or indicated on the Plans, steel pipe and fittings shall be as follows.

Steel pipe 12 inches and smaller in nominal diameter shall be seamless or straight seam electric resistance welded pipe conforming to the requirements of ASTM A 53 or ASTM A 120. Pipe 6 inches and smaller shall be Schedule 40. Pipe over 6 inches but not larger than 12 inches shall be no lighter than Schedule 20.

Steel pipe over 12 inches in nominal diameter shall be in accordance with AWWA C 200, except that butt strap, riveted, or swaged joints may not be used. Pipe over 12 inches in diameter shall have a wall thickness of not less than 1/4-inch to 72-inch diameter and 5/16-inch over 72-inch diameter, unless indicated otherwise on the Plans. All pipe shall be black unless indicated otherwise on the Plans or specified to be galvanized. If galvanized, it shall be galvanized in accordance with ASTM A 120. The working stress for any of the steels specified as acceptable for fabrication of pipe shall not exceed 50 percent of the yield point of the steel used.

The Contractor shall submit pipe design calculations to the Engineer for review and acceptance. The design calculations shall indicate the pipe wall thickness that will be satisfactory for all conditions of internal pressure, special physical loadings, external pressure, and earth loadings where applicable. Refer to Section 150300 for design parameters.

Wherever flexible (Dresser or Victaulic) couplings are to be used on pipe 24 inches in diameter, or over, having a wall thickness of less than 1/2-inch, stub ends not less than 6 inches long and 1/2-inch in thickness shall be provided for insertion into the couplings.

Steel pipe for liquid or gaseous dry chlorine shall be ASTM A 106, Grade A, Schedule 80, assembled with 300 psi malleable iron fittings and ammonia type flanges.

150201 GROOVED-END STEEL PIPE - GENERAL

Grooved-end pipe with mechanical pipe couplings (Victaulic type) and fittings may be installed in place of flanged systems at certain locations and in certain services on this project. Grooved-end pipe shall not be used underground or underwater unless indicated otherwise on the Plans. Grooved-end pipe shall not be used for systems which may be steamed.

Pipe and fittings shall be cut-grooved. Method of grooving shall be in accordance with mechanical pipe coupling manufacturer's specifications. Pipe to be grooved shall have wall thicknesses not less than the minimum recommended by the coupling manufacturer for cut-grooving. Connections to valves and flanged-end pipe shall be by grooved-end to flanged pipe adapter flange or flanged adapter nipple. Grooved pipe and fitting ends shall be lightly coated with lubricant approved by the coupling manufacturer prior to placing gasket.

Grooved-end pipe shall be supported in accordance with manufacturer's recommendations. In addition, at least one support shall be used between any two couplings.

The Contractor shall submit for review a listing of services and locations where he proposes to use grooved-end pipe prior to start of installation of any grooved-end piping. This listing is subject to the Engineer's acceptance, and acceptance must be granted in writing by the Engineer prior to the delivery of any grooved piping materials to the job site.

The Contractor shall submit for review complete information showing fittings, gaskets, mechanical pipe couplings, grooving of pipe and pipe lining or coating prior to installation of any pipe. All materials proposed for use are subject to the Engineer's acceptance.

Mechanical pipe couplings and grooved-end pipe shall be installed in accordance with the coupling manufacturer's representative's recommendations.

150202 GROOVED-END STEEL PIPE COUPLINGS

Steel pipe may be grooved-end and joined by mechanical pipe couplings. Mechanical couplings shall be self-centering and shall engage and lock in place the grooved pipe and pipe fitting ends in a positive watertight couple. Coupling housing clamps shall be fabricated in two or more parts of malleable iron castings, in accordance with ASTM A 47, Grade 32510. Coupling assembly shall be securely held together by two or more steel bolts and nuts of heat-treated carbon steel. Nuts and bolts shall be in accordance with ASTM A 183 and A 194, Grade 2.

Couplings shall hold in place a composition water-sealing gasket designed so that internal water pressure serves to increase the seal's watertightness. Gaskets for use with cement lined steel pipe shall be captured between the ends of the pipe to protect the exposed metal from corrosion. Gaskets shall be Buna-N in accordance with ASTM D 2000, Grade No. 4AA615A13B13.

Gaskets for use with unlined steel pipe shall be chlorinated butyl in accordance with ASTM D 2000, Grade No. 3BA615A14B13Z with special heat-resistance test of 16 hours at 350 degrees F and maximum elongation change of minus 30 percent.

All pipe fittings used in connection with pipe couplings shall be grooved. Pipe fittings shall be malleable iron castings in accordance with ASTM A 47 or ductile-iron Grade 60-45-10 in accordance with ASTM A 536.

150210 JOINTS

Steel pipe joints shall be screwed, welded, flanged, or flexible joints as is appropriate to the pipe size and application, except that galvanized pipe shall not be welded. Welding shall be in accordance with AWWA C 206.

Piping shall be made up with a sufficient number of unions, flexible couplings, or flanged joints to permit ready breaking of lines for maintenance in addition to any unions or flanges indicated on the Plans. The location of unions to permit readily breaking of the lines shall be acceptable to the Engineer. In general, all valves, meters, critical items of equipment, and runs of pipe at bends shall have unions, flanges, or other means for easily disassembling the piping system.

Unions shall be railroad type with bronze-to-iron seat, galvanized if used with galvanized pipe. Flanged joints may be used instead of unions.

Unless otherwise specified or indicated on the Plans, pipe joints shall be of the type specified below. Pipe smaller than 2 inches shall have screwed joints or flexible couplings. Pipe 2 inches through 4 inches shall have screwed, flanged, or welded joints, or flexible couplings. Pipe larger than 4 inches shall have flanged or welded joints or flexible couplings.

Threading shall be done with clean, sharp dies. Pipe threads carelessly made, wavy, rough, or chewed shall be rejected. All screwed joints shall be tightly and neatly made up with an application of Teflon tape or acceptable paste compound applied to the male threads only, except that liquid and dry chlorine lines and liquid LPG lines shall be made up with litharge and glycerine.

Flanges shall come together at the proper orientation with no air gaps between the flanges after the gaskets are in place. The fit shall not be made by springing any piping, nor shall the orientation alignment be corrected by taking up on any flange bolts. Flange bolts shall slip freely into place with absolutely no binding. If the proper fit is not obtained, the piping shall be altered. Machined flanges or tapered fillers shall be used to accomplish changes in grade or to slope lines for drainage.

All welded joints shall be electric welded. Welding shall be in accordance with AWWA C 206. Qualification of welders shall be as covered in AWWA C 206. All testing of welders shall be at the Contractor's expense, including cost of test nipples, welding rod, and equipment.

150220 FITTINGS

Fittings used with screwed pipe shall be 150-pound malleable iron banded screwed fittings in accordance with ANSI B 16.3, galvanized in accordance with ASTM A 153 if used with galvanized pipe, or cast-iron drainage screwed fittings in accordance with ANSI B 16.12, galvanized in accordance with ASTM A 153 if used with galvanized pipe. Drainage fittings shall be used with drain lines, and other lines which are required to be graded.

Flanged fittings 12 inches and smaller shall be 125-pound cast-iron flanged fittings in accordance with ANSI B 16.1 or 150-pound steel flanged fittings in accordance with ANSI B 16.5. Flanged fittings for pipe larger than 12-inch may be as above or may be fabricated from sections of steel pipe in accordance with AWWA C 208, with flanges as specified in AWWA C 207.

Companion flanges 4 inches and smaller may be 125-pound screwed cast-iron companion flanges in accordance with ANSI B 16.1 or 150-pound slip-on or welding neck steel flanges in accordance with ANSI B 16.5, except that ammonia type flanges shall be used on chlorine liquid or gas piping. Companion flanges for pipe from 4 inches to and including 12 inches shall be slip-on or welding neck flanges in accordance with ANSI B 16.5.

Companion flanges for pipe larger than 12 inches may be as above or may be steel plate or raised hub flanges in accordance with AWWA C 207.

Slip-on flanges shall be attached to pipe by two fillet welds, in accordance with AWWA C 207. Welding neck flanges shall be secured by full penetration butt welds without backing rings. After welding in place, the faces of flanges shall be perpendicular to the axis of the pipe, or, in the case of fittings, at the proper angle to each other, and bolt holes shall be in proper alignment. Flanges shall be shop welded to pipe or fittings before lining is applied.

Machined flanges or tapered fillers shall be used to accomplish changes in grade, or to slope lines for drainage.

Flange bolts shall be in accordance with ANSI B 16.1, except that flanges underground or in water may be cast-iron, and all bolts and nuts under these conditions shall be painted with an asphaltic coating, as specified in AWWA C 104, of at least 10 mils thickness. Cast-iron bolts and nuts shall be made of material having at least 50,000 psi tensile strength. The cast iron bolts and nuts used with mechanical joint cast-iron pipe will be acceptable.

All flange bolts shall be cut and finished to project not less than two threads and not more than 1/4-inch beyond outside face of nut after joint is assembled. Where cap screws or stud bolts are required, flanges shall be provided with tapped holes for such cap screws or stud bolts.

Gaskets shall be ring gaskets of 1/16-inch suitable for temperatures up to 750 degrees F, manufactured by Garlock, Cranite, or equal.

Welding fittings for pipe 8 inches and smaller in size shall be butt-welding fittings in accordance with ANSI B 16.9, standard wall or standard weight. Welding fittings for pipe larger than 8 inches shall be butt-welding fittings in accordance with ANSI B 16.9, or may be made up out of sections of pipe welded together, except where smooth bends are indicated in air lines. Fittings made up of sections of pipe welded together shall be made of pipe of at least the same wall thickness as the pipe with which used, and bends shall be miter bends, fabricated in accordance with AWWA C 208. Welding of these made-up fittings shall be in accordance with AWWA C 206.

150230 LINING

Except as otherwise provided, lining in steel pipe shall be as follows.

150231 CEMENT MORTAR LINING

Steel pipe specified or indicated on the Plans to be cement mortar lined may be shop lined in accordance with AWWA C 205, or lined after installation by means of a pipe lining machine. If a lining machine is used, it must be acceptable to the Engineer and be capable of applying a lining comparable in density and smoothness and of the same thickness as the above specified shop applied lining. In-place lining shall conform to applicable portions of AWWA C 602.

150300. STEEL PIPE - CEMENT MORTAR LINED AND COATED

GENERAL: This Specification covers steel pipe, cement-mortar lining, and reinforced cement-mortar coating, designed and manufactured in accordance with AWWA C 200 and AWWA C 205.

The pipe diameter, specified or called for on the Plans, shall be the inside diameter of the concrete section. An affidavit of compliance as specified in Section 1.12 of AWWA C 200 is required. A tabulated layout schedule in accordance with Section 1.6 of AWWA C 200 shall be submitted to the Engineer for review and acceptance.

Identification marks as specified in Section 1.9 of AWWA C 200 are required. The pipe manufacturer shall clearly stencil or mark at the top of the pipe on the outside surface of each pipe the following:

A. Name or trademark of manufacturer.

B. Date of manufacture.

C. Internal diameter in inches.

D. Number consecutively according to design schedule from initial station to end station.

Laying lengths shall be not less than 20 feet or greater than 40 feet except that pipe less than 24 inches in nominal diameter shall not be longer than 32 feet. Short pieces shall be provided as required for curves, closures, and proper location of fittings and specials.

The number of longitudinal and girth seams for straight seam pipe shall be no greater than would be required in fabricating the pipe from 96- by 120-inch plates. Longitudinal seams shall be broken at the girth seams.

The manufacturer shall submit design calculations to the Engineer for review and acceptance. The design calculations shall indicate the pipe wall thickness that will be satisfactory for all conditions of external pressure and earth loadings, special physical loadings, and internal pressure.

PIPE DESIGN: Steel pipe, pipe specials and fittings shall be designed to limit deflection under the external load specified. The allowable deflection for pipe sizes 60-inch and less shall be less than $(I.D.)^2/4000$. The allowable deflection for pipes sizes greater than 60-inch shall be less than 2 percent of the diameter. Pipe wall stiffness used in determining deflection shall not include mortar lining and mortar coating. When welded joints

or flanged joints are called for on the Plans to restrain the pipe under hydraulic thrust, the cylinder and the attachment of joint ring or flange to the cylinder shall be designed for this stress. Stress in the steel cylinder shall be limited to 50 percent of the yield or 15,000 psi, whichever is less.

Deflection of steel pipe, steel plate pipe specials, and fittings shall be calculated from "Spangler's formula" using a bedding constant, K, of 0.100, a modulus of soil reaction, E', of 700 and a deflection lag factor, $D_1 = 1.00$. Reinforcement of fittings shall be designed in accordance with supplementary data contained in the AWWA Steel Pipe Design Manual M11.

Earth loads shall be calculated using the formula $W = 192\ H\ B_c$. H is the height of fill over the pipe in feet and B_c is the outside diameter of the pipe in feet. H-20 loading shall be added to all earth loads.

Wall thickness of pipe, fittings, and specials shall be as indicated on the Plans. If wall thickness is not indicated on the Plans, then the minimum thickness shall be 1/4-inch for pipes 26-inch diameter and smaller, 5/16-inch for pipes 28- through 36-inch diameter, and 3/8-inch for pipes 38- through 54-inch diameter.

MATERIALS: Cement used in the manufacture of pipe shall conform to ASTM C 150, Type II, low alkali. Mill certificates shall be furnished in triplicate for each load of cement delivered.

Steel for manufacture of pipe shall conform to Section 2.1.1. Certificates for steel as specified in Section 2 of AWWA C 200 shall be submitted in triplicate.

Rubber gaskets shall conform to the following requirements:

Minimum tensile strength - ASTM D 412	2,000/2,700 psi
Minimum elongation - ASTM D 412	400/350%
Hardness Shore A - ASTM D 2240	50-65
Specific gravity - ASTM D 297	0.95 to 1.45 ±0.05
Compression set - ASTM D 395, Method B	20% maximum
Tensile strength loss - ASTM D 573, 96 hours, 70 degrees C air	20% maximum
Elongation loss - ASTM D 573, 96 hours, 70 degrees C air	20% maximum

Test reports shall be furnished in triplicate showing the physical properties of rubber used in gaskets.

FABRICATION OF PIPE: Joint rings for spigot ends for rubber gasket joints shall be Carnegie shape M-3516.

Flanges shall be Class "D" steel ring flanges in accordance with AWWA C 207. Where flanged valves are to be installed, the pipe flange shall match the valve flange. At flanged joints connecting to valves, a steel pipe section without rod reinforcing not less than 24 inches long measured from the face of the flange shall be provided. Cement mortar lining and coating shall be applied to the steel pipe section. Flanges and portions of joint rings which are exposed on the completed pipe shall be given a shop coat of primer.

Specials and fittings shall be designed and fabricated in accordance with AWWA C 208, except bend radius may be 2.5 times the nominal diameter. Specials and fittings shall be furnished as required to provide a complete pipeline as indicated on the Plans. Specials and fittings not detailed on the Plans shall conform to the details furnished by the manufacturer and accepted by the Engineer.

150400 CAST-IRON SOIL PIPE AND FITTINGS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Waste and Vent Piping Systems, Plumbing, Section 15430.

150410 BURIED CAST-IRON SOIL PIPE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Waste and Vent Piping Systems, Plumbing, Section 15430.

150420 CAST-IRON SOIL PIPE ABOVE GRADE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Waste and Vent Piping Systems, Plumbing, Section 15430.

150430 FITTINGS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Waste and Vent Piping Systems, Plumbing, Section 15430.

150440 COATING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Waste and Vent Piping Systems, Plumbing, Section 15430.

150800 COPPER PIPE AND TUBING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Copper Pipe, Section 15063.

150810 ASTM B 88 TUBING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Copper Pipe, Section 15063.

150820 ASTM B 280 TUBING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Refrigerant Piping System, Section 15780.

150830 INSTALLATION

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Refrigerant Piping System, Section 15780.

151400 REINFORCED CONCRETE PIPE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Drainage Pipe, Section 02433.

151410 JOINTS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Drainage Pipe, Section 02433.

151420 FITTINGS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Drainage Pipe, Section 02433.

151430 CURVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Drainage Pipe, Section 02433.

151440 PIPE DELIVERY AND HANDLING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Buried Piping Installation, Section 15051.

151450 TESTING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Buried Piping Installation, Section 15051.

151500. REINFORCED CONCRETE PIPE, PRESSURE

Reinforced concrete pressure pipe shall be in accordance with ASTM C 361, unless otherwise specified herein. Each pipe shall be of the class required to meet the pressure specified and for the external load and field installation procedure used at each location. Contractor shall base the external load on embankment conditions. External loads shall include the effects of H-20 loading. Contractor shall furnish the Engineer design calculations and drawings of all pipes prior to pipe fabrication. Cement used in manufacture of pipe shall be in accordance with ASTM C 150, Type II, low alkali. At least one hydrostatic test will be required for each size pipe. A hydrostatic test shall be made on two pipes jointed together so that a joint is tested.

151501. JOINTS

All joints shall be of the neoprene rubber gasket type wherein the gasket is the sole element utilized in sealing the joint from either internal or external hydrostatic pressure. The neoprene rubber gasket shall be captured such that it cannot be forced out of proper position due to hydrostatic pressure, or in the process of making the joint during the laying of the pipe. If steel bands or collars are used for making the joint, all surfaces which will be exposed to the sewage shall be painted with coal-tar epoxy as specified in DIVISION 9 of these Specifications. Drawings in detail of all joints proposed to be used must be submitted to the Engineer for review and acceptance before commencing pipe manufacture. Plastic or fiberglass bell rings or collars shall not be used. Flush type joints which utilize embedded steel bell rings and spigots will not be allowed.

151502. FITTINGS AND SPECIALS

Fittings and specials shall be Type B in accordance with AWWA C 302. All fittings shall be hydrostatically shop tested before lining or coating to a watertight condition under a pressure not less than 120 percent of that specified. Fittings and specials shall be reinforced in accordance with AWWA Steel Pipe Design and Installation Manual M11. Working pressure for purposes of calculations shall be not less than test pressure specified. The manufacturer shall submit detailed drawings and calculations for review and acceptance before fabrication. Flanges on fittings shall be in accordance with AWWA C 207, Class B. Wall thickness of steel shall be not less than 3/8-inch for fittings.

Flexible couplings shall be used where indicated on the Plans.

151503. CURVES

In general, horizontal or vertical curves shall be made by using pipe with beveled joints or by slight deflections in the joints of straight pipe. The total angular deflection for beveled pipe shall not exceed five degrees at any joint. Maximum joint opening shall not exceed 3/4-inch for 36-inch pipe and smaller, and 1 inch for pipe larger than 36-inch. If necessary, short length pipe shall be made for curves of shorter radius than can be made with beveled pipe of usual length. Detailed layouts of curves shall be submitted by the pipe manufacturer for review and acceptance before fabrication of the beveled pipe.

If curves are to be installed with slight deflections of straight pipe, the joint test shall be performed with the pipe in the deflected position. Deflection during the joint tests shall be not less than that proposed to be used on the curves in the work.

151504. RUBBER GASKET MATERIAL

O-ring synthetic rubber gaskets shall be used for sealing joints. The gasket material shall be in accordance with requirements of ASTM C 361, except that tensile strength shall be not less than 2,100 pounds per square inch. The basic polymer of the synthetic rubber gasket material shall contain not less than 50 percent by volume of neoprene stock.

151505. REPAIRS

Repairs shall be in accordance with ASTM C 361, except epoxy bonding agent shall be used for bonding mortar to concrete.

151510. DELIVERY AND HANDLING

All pipe shall be manufactured, handled, loaded, and shipped in such a manner as to be delivered undamaged, in sound condition, and conforming in all respects to these Specifications. Each section of pipe shall be plainly marked with the date of manufacture, and internal diameter.

151520. STRUCTURE AND PIPE CONNECTIONS

Wherever a concrete pipe connects to steel pipe or fittings, a steel bell ring of proper size and shape to fit the end of the concrete pipe shall be welded to the steel pipe or fitting. Wherever concrete pipe connects to a structure, a steel bell ring shall be cast in the structure and a flexible joint with gasket provided. Details of connections shall be as indicated on the Plans. In general, the connections shall be made with Carnegie type joint utilizing an O-ring gasket. The manufacturer shall submit detailed shop drawings for review and acceptance before fabrication. Bell rings shall be constructed of A 283 or A 36 steel.

151530. CLEANING AND TESTING

After installation, all concrete pipelines shall be left thoroughly clean. Concrete pipelines shall be slowly filled with water, kept full for at least eight hours under a slight head, and then tested as follows:

> With the lower end plugged and the line full of water, the line of the pipe shall be subjected to the pressure specified. The pressure shall be maintained for not less than four hours. The line shall be examined and any leaks shall be fixed. After repairs, the pipe shall be retested. Leakage shall not exceed 20 gallons per inch of diameter per mile of pipe for 24 hours. Testing shall be done before backfilling.

This test shall include joints into structures, including existing bell rings.

151800 PLASTIC PIPE, TUBING, AND FITTINGS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Thermoplastic Pipe, Section 15064.

151810 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Thermoplastic Pipe, Section 15064.

151820 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Thermoplastic Pipe, Section 15064.

151850 POLYETHYLENE TUBING AND FITTINGS

Small bore plastic tubing for instrumentation and similar applications shall be black flexible virgin polyethylene tubing, OD copper tubing size, Dekoron Products Division, Type P, with Dekoron E-Z compression fittings, or equivalents. Plastic tubing may be bundled in groups of parallel tubes within a protective sheath, Dekoron "Poly-Cor," Cresent Multitube Type PT, or equal. Tubes within said sheath may be color coded, but tubing other than black shall be protected outside the sheath by wrapping with black plastic electrician's tape. Plug-in fittings for connections to instruments shall be brass quick-connect fittings.

Plastic tubing shall be of the following inside diameters for the sizes indicated:

1/4"	0.170"
5/16"	0.187"
3/8"	0.251"
1/2"	0.375"

Plastic tubing shall be able to withstand a test pressure of 200 psi at a temperature of 200 degrees F.

Plastic tubing shall be installed in neat, straight lines, supported at close enough intervals to avoid sagging and in continuous runs wherever possible. Plastic tubing connected to meters, etc. shall be carefully graded in one direction. All details indicated on the Plans shall be followed, and tubing shall be installed in strict accordance with manufacturer's instructions.

152100 PIPING SPECIALTIES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Pipe Hangers and Supports, Section 15094; and Piping Specialties, Section 15080.

152110 FLEXIBLE PIPE COUPLINGS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Piping Specialties, Section 15080.

152120 STRAINERS AND FILTERS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Potable Water Piping Systems, Section 15407.

152121 Y-TYPE STRAINERS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Potable Water Piping Systems, Section 15407.

152135 PIPE SADDLES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Valves, Specials and Appurtenances, Section 15099.

152200. PRESSURE GAUGES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Products, Primary Sensors and Field Instruments, Section 17025.

152600 PLUMBING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Waste and Vent Piping Systems, Plumbing, Section 15430.

152610 SOIL, WASTE AND VENT PIPING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Waste and Vent Piping Systems, Plumbing, Section 15430.

152611 FITTINGS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Waste and Vent Piping Systems, Plumbing, Section 15430.

152612 UNION CONNECTIONS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Waste and Vent Piping Systems, Plumbing, Section 15430.

152613 JOINTS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Waste and Vent Piping Systems, Plumbing, Section 15430.

152614 CLEANOUTS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Waste and Vent Piping Systems, Plumbing, Section 15430.

152615 FLASHINGS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Flashing and Trim, Section 07619.

152616 TRAPS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Waste and Vent Piping Systems, Plumbing, Section 15430.

152617 DRAINAGE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Installation of Plumbing Systems, Section 15413.

152618 EQUIPMENT AND FLOOR DRAINS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Waste and Vent Piping Systems, Plumbing, Section 15430.

152620 ROOF DRAINS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Roof Drainage Systems, Section 15406.

152640 WATER PIPE, FITTINGS AND CONNECTIONS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Installation of Plumbing Piping, Section 15413.

153000 VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Valves, Specials and Appurtenances, Section 15099.

153010 INSTALLATION OF VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Valves, Specials and Appurtenances, Section 15099.

153200 GATE VALVES ABOVEGROUND

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Valves, Specials, Appurtenances, Section 15099.

153210 GATE VALVES UNDERGROUND

Gate valves for buried installation shall be iron body, resilient seat, double disc, nonrising stem conforming to AWWA C 509 with double O-ring stem seal. Valves shall open counterclockwise. Valve ends shall be flanged, mechanical joint, or "Ring-Tite" joint as required for the type of pipe used.

153300 ECCENTRIC PLUG VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Valves, Specials, Appurtenances, Section 15099.

153400 CHECK VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Valves, Specials, Appurtenances, Section 15099.

153410 SWING CHECK VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Potable Water Piping Systems, Section 15407.

153440. BACKFLOW PREVENTERS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Valves, Specials, Appurtenances, Section 15099.

153500 BALL VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Valves, Specials, Appurtenances, Section 15099.

153510 METAL BODY BALL VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Potable Water Piping Systems, Section 15407.

153520. PLASTIC BODY BALL VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Valves, Specials, Appurtenances, Section 15099.

153530. ELECTRIC ACTUATED BALL VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Valves, Specials, Appurtenances, Section 15099.

153600 GLOBE AND ANGLE VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Potable Water Piping Systems, Section 15407.

153610 GLOBE VALVES FOR ORDINARY SERVICE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Potable Water Piping Systems, Section 15407.

153700 HOSE VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Potable Water Piping Systems, Section 15407.

153710. PLAIN HOSE VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Potable Water Piping Systems, Section 15407.

153801. SPRAY NOZZLES

Spray nozzles in the presedimentation basin shall be 304 stainless steel and shall be structurally suitable for pressures up to 200 psig. Operating pressure shall be 60 psig, at which pressure each nozzle shall discharge not less than 2.5 nor more than 7.0 gallons per minute. Each shall be provided with NPT according to the schedule indicated on the Plans.

Nozzles shall be an easy flush type. Spray shall be stabilized with a replaceable stainless steel insert which shall prevent distortion of specified spray pattern. Spray shall form a flat, heavy sheet, fan with uniform distribution. Elevation of the nozzles shall be 1 inch above the basin bottom. Nozzles shall be installed such that spray patterns are directed towards the center of the basin.

Spray nozzles shall be as manufactured by Spraying Systems, Co., Wheaton, IL, or equal.

153803 CORPORATION STOPS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Valves, Specials, Appurtenances, Section 15099.

153810. DIAPHRAGM VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Valves, Specials, Appurtenances, Section 15099.

153835. SOLENOID VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Valves, Specials, Appurtenances, Section 15099.

153850 WATER PRESSURE REGULATING VALVES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Potable Water Piping Systems, Section 15407.

153856. AIR FILTER-REGULATOR-LUBRICATOR PACKAGE

The air filter-regulator-lubricator package shall consist of a moisture separator, air line regulator, air line lubricator and necessary connecting hardware. The moisture separator shall be two-stage filtration to remove entrained condensate and foreign material. Moisture separator shall have manual drain unit with built-in sight glass to monitor fluid level. The air regulator shall be a balanced valve type with strainer and relief ability. The pressure regulators shall have a pressure gauge installed integrally with the valve. The air lubricator shall add regulated amounts of lubricant to the air via a single dial control. The unit shall be all metal construction with built-in sight glass. All units shall be designed for 200 psi inlet pressure at an operating temperature of 150 degrees F. The filter-regulator-lubricator package shall be manufactured by Alemite, a Division of Stewart-Warner Corporation, Wilkerson, or equal.

153870 FIRE HYDRANTS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Valves, Specials, Appurtenances, Section 15099.

153875 PLUG COCKS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Products: Primary Sensors and Field Instruments, Section 17025.

154000. RECTANGULAR BUTTERFLY VALVES

A. General

Rectangular butterfly valves shall be as manufactured by Henry Pratt Company, DeZurik, or equal, modified as required to conform to the requirements as specified herein. The rectangular butterfly valves shall be as indicated on the Plans.

The Contractor shall furnish valves, operators, torque tube floor stand, support brackets, and all incidental materials necessary for installation of the valves, such as flange gaskets, flange bolts and nuts, and all other materials required for the complete installation.

Operators shall be crank operators with portable operator nuts and as specified under Valve and Gate Operators.

Rectangular butterfly valves shall be designed for maximum operating torque, with safety factors as required in AWWA C 504. The maximum torque shall be calculated in accordance with the procedures set forth in the Appendix of AWWA C 504 and the following:

Maximum Velocity: 5 feet per second. Maximum pressure drop (valve closed): shall not be less than 10 psi. Coefficients of seating/ unseating torque, dynamic torque, bearing friction: based on manufacturer's data.

B. Valve Vane

The vane shall be fabricated from carbon steel. It shall be designed for maximum head specified herein. Design stresses for all structural parts shall have a safety factor of 3.0 of the yield, or 5.0 on ultimate, whichever is less. A stainless steel seating face shall be securely fastened around the inside of the vane. The four corners of the vane shall be rounded with a radius to seal with similar rounded corners in the valve frame.

At the Contractor's option, the stainless steel seating face may be mounted on the valve frame, in which case a resilient rubber seat shall be recessed and clamped with a stainless steel retaining ring onto the periphery of the vane. The valve seat shall be field adjustable and replaceable. The design shall permit removal and replacement in the field without removing the valve vane, shaft, or valve actuator from their mountings. The valve seat shall not be interrupted by the valve shaft.

C. Valve Frame

The valve frame shall be fabricated from A 36 carbon steel and shall be arranged to bolt to front of a fabricated steel or cast iron wall thimble embedded in the concrete with the face of the thimble being flush with the face of the concrete wall. The thimble shall incorporate a water stop. The front flange shall be machined with tapped holes for frame attaching bolts. A gasket shall be provided between the frame and thimble. Bolts shall be stainless steel. A resilient rubber seat shall be firmly attached to the interior of the valve frame with a stainless steel retainer ring to provide a watertight contact with the valve seat face on the valve vane when the valve is in the fully closed position. The valve seat shall be field adjustable and replaceable. The design shall permit removal and replacement in the field without removing the valve vane, shaft, or valve actuator from their mountings. The valve seat shall not be interrupted by the valve shaft.

D. Shaft Bearings

The shaft housings shall be bored and fitted with self-lubricating type shaft bearings. The maximum unit pressure on the bearings shall not exceed 2,500 psi when the valve is subjected to the design head indicated herein. All portions of the shaft bearings shall be stainless steel, bronze, nylon, or fiberglass and teflon in accordance with AWWA C 504.

E. Adjustable Thrust Bearing

A stainless steel thrust collar or collars shall be located above the valve opening and shall be designed to take the load that is developed during valve operation. The thrust collar or collars shall be supported on the valve frame or its own pedestal and provided with a self-lubricating thrust bearing or bearings. The assembly shall be adjustable after the valve is installed to provide for vertical centering of the vane within the valve frame.

F. Valve Shafting

The valve shaft shall be 18-8 Type 304 stainless steel and with the diameter required to operate the valve under the maximum specified head. The shaft shall be the stub type and extend into the valve vane a minimum of 1-1/2 shaft diameters. The top shaft shall be removable from the top of the valve frame without removal of the vane. "O" ring gasket or self-adjusting "V" type packing shall be provided around the shafting at the top of the valve opening to prevent water from leaking around the shaft. Keys, dowel pins or taper pins used for attaching the valve shaft to the valve disc shall be Type 304 or 316 stainless steel.

G. Torque Tube Floor Stand Assembly

Valve shall be provided with torque tube floor stand assemblies. Assemblies shall consist of a torque tube and a floor stand. Torque tubes shall be designed for a maximum deflection of no more than 0.75 degrees when measured at the disc edge. The torque tube shall be fabricated from carbon steel. The floor stand shall support the full weight of the torque tube by use of corrosion resistant thrust bearings located in the floor stand. Design of torque tube shall allow ±2 inches of free movement along the tube longitudinal axis. Floor stand shall have a height of 3 feet above the floor. Torque tube floor stand assemblies shall be factory assembled and shipped as integral units. The floor stand shall be designed to mount an operator on the floor stand. Operators shall be as specified in the schedule.

H. Painting

1. Rectangular butterfly valves shall be painted in the factory, prior to testing.

2. Painting shall be as specified in DIVISION 9 of these Specifications.

3. Valves shall not be painted in the field, except for minor repairs or touch-up of the factory applied paint.

154010. MATERIALS

Materials used in the construction of the rectangular butterfly valves shall conform to the following requirements.

Carbon Steel - ASTM A 36, or ASTM A 516.

Stainless Steel - ASTM A 276, Type 304 or 316.

Bronze - Low zinc type containing no aluminum and not more than 6 percent zinc. Acceptable types are ASTM B 61, ASTM B 62, ASTM B 139 Alloy C 54400 or ASTM B 584 Alloy C 87200.

Valve Seats - Natural rubber or synthetic rubber complying with Section 3.5 of AWWA C 504-87.

Bolts, Nuts, and Fittings - Stainless steel for machine bolts, anchor bolts, cap screws, and fittings for valves and stem guides.

The Engineer may, at his discretion, take material samples from the valves for laboratory tests and analysis for compliance with the Specifications for materials.

154020. RECTANGULAR BUTTERFLY VALVE SCHEDULE

The Rectangular Butterfly Valve Schedule is not a valve take-off list. Refer to the Drawings for additional information.

RECTANGULAR BUTTERFLY VALVE SCHEDULE

Reference Name	Reference Drawing	Opening Size W x H	Maximum Depth of Water From Valve Invert	Type of Frame	Operator Type	Operator Mounting	Comments
Presedimentation Basin Inlet Valve	M-5, M-6	144"x144"	10.0′	Embedded	CO	BS	Installed in Existing Slots
Presedimentation Basin Bypass Valve	M-5, M-6	108"x144"	10.0′	Flat Back	CO	BS	

NOTES: 1. All valves are three-sided, unless noted otherwise.
CO Crank operator with portable operator nut.
BS Bench stands mounted to valve frames.

154100. SLIDE GATES

154101. GENERAL

A. The provisions under this title include slide gates and accessories. Gates shall be rising stem or nonrising stem, and shall be flat-back or spigot-back; self-contained or with separate lift; and with resilient seals; all as shown on the Drawings and as specified in the SLIDE GATE SCHEDULE.

B. Submittals: Contractor shall submit installation and adjustment instructions from the gate manufacturer along with the shop drawings for every type of gate.

154102. DESIGN REQUIREMENTS

A. Gate Slide:

1. The gate slide shall be of sufficient strength to withstand the stresses from hydraulic forces and mechanical operating loads which will be imposed upon the individual gate.

2. The gate slide shall be designed for a deflection of less than 1/360 of the span.

3. For upward opening gates the slide shall be equipped with a resilient seal for flush bottom closure. The seal shall contact a weld angle on the bottom of the frame. As an alternative design, the bottom seal may be attached to the bottom frame section.

B. Frame:

1. The frame shall consist of guides, invert member and cross-bars welded together to form a one piece frame. Structural angles and other frame members shall be selected shapes that shall provide true dimensions within tolerances and shall prevent binding and excessive wear of the sliding parts.

2. The frame shall be embedded or face mounted as indicated on the Drawings.

3. For self-contained gates, the yoke to support the bench stand operator shall be formed by two angles welded to the gate frame.

4. The yoke arrangement shall allow the removal of the slide.

5. The yoke deflection shall be limited to 1/360 of the yoke span under full operating load.

6. The frame shall be of sufficient height to retain at least one half of the gate slide when the gate is in the open position.

7. The frame shall require no additional support in members above the operating floor.

8. Where indicated, the frame shall have self-adjusting UHMWPE seals or adjustable J bulb seals around the perimeter of the gate slide. The seal shall be held in place by stainless steel bar and fasteners. The seal shall be set so that it will be slightly compressed with the slide in the closed position. The seal shall be fully field adjustable and replaceable.

9. The frame shall be mounted with neoprene or polyethylene sleeves and neoprene-backed stainless steel washers to dielectrically isolate frame from anchor bolts. Frame bolt-holes shall be drilled oversized as required to accommodate the dielectric sleeves.

C. Stem:

1. Stem diameter shall be selected to withstand the opening and closing thrusts encountered in operation of the gate under the specified head and shall be furnished in reasonable lengths to permit ease in installation and removal.

2. The stem shall be designed to have a slenderness ratio L/r of less than 200.

3. The stem shall be designed to withstand in compression twice the rated output of the bench stand, with a 40-pound force on the crank or handwheel.

4. Stem guides shall be provided in the quantity and spacing necessary to meet the following simultaneous conditions:

   a. A slenderness ratio L/r of the stem not exceeding 200.

   b. No buckling of the stem under a compressive load equal to the output of the lift with an 80-pound effort.

D. Operators:

1. Operators shall be of the type indicated in the SLIDE GATE SCHEDULE.

2. Operators shall be as specified in Section 154500 VALVE AND GATE OPERATORS.

154103. PRODUCTS

A. Manufacturers: Waterman Industries; Rodney Hunt; H. Fontaine; or equal.

B. Materials

1. Gate Slide: Type 316L stainless steel plate with welded structural shapes reinforcement.

2. Frames: Frames shall be Type 316L stainless steel

3. Stem: Stem shall be solid rolled Type 316 stainless steel.

4. Bottom Seal: The bottom seal shall be made with a resilient neoprene or Buna N seal compressed by the closing action of the gate slide against a stop plate.

5. Stem Guides: Stem guides shall be cast iron or stainless steel, split collar, adjustable in two directions, and shall have silicon bronze or ultrahigh molecular weight polyethylene bushings.

6. Fasteners: 316L Stainless steel.

154104. PAINTING

A. Where called for on the Drawings or on the schedule, gates and frames shall be painted.

B. Surfaces in sliding contact, loose fasteners, operating shaft, and non-metallic surfaces shall not be painted.

C. When painting is required, it shall be done in the factory. Gates shall not be painted in the field, except for minor repairs or touch-up of the factory applied paint.

D. When painting is required, it shall be as specified in DIVISION 9 of the Specifications.

154105. QUALITY CONTROL

A. After installation and checking by Contractor, each gate shall be run through at least two full cycles from the closed position to fully open and back to the closed position, by the Contractor.

154106. SLIDE GATE SCHEDULE

A. The slide gate schedule is not a gate take-off list. Refer to the Drawings for additional information.

SLIDE GATE SCHEDULE

Reference Name	No. of Gates	Reference Drawing	"A" Width Inches	"B" Height Inches	"C" Height Inches	"D" Height Inches	"E" Height Inches	Max. Depth of Water From Gate Invert, Ft.	Mounting	Operator
Bar Screen Influent Gates	3	M-1	72	72	72	168	36	9.0, Unseating	Concrete Wall	Yoke Mounted Bench Stand
Bar Screen Effluent Gates	3	M-1	72	138	138	192	36	11.0, Seated or Unseated	Embedded Frame	See Plans
Raw Water Meter Inlet Gates	2	M-1	84	84	84	242.04	36	15.2, Seated	Concrete Wall	Motorized Operator
Presedimentation Effluent Gates	6	M-5 M-6	60	60	60	216	36	13.0, Seated	Concrete Wall	Geared Pedestal Operator
Drainage Gate Type 1	2	M-5 M-6	12	12	12	216.96	-18	13.0, Seated	Wall Thimble	Square Nut
Drainage Gate Type 2	3	M-5 M-6	12	12	12	228	-18	14.0, Seated or Unseated	Mechanical Sleeve Mounted on DIP	Square Nut

Notes:

1. Refer to Typical Detail 314.
2. Gates shall be self-contained unless noted otherwise.
3. All gates shall have invert, side and top seals. Leakage shall not exceed 0.1 gpm per foot of perimeter.

154500. VALVE AND GATE OPERATORS

All valve operators other than T-wrenches or keys, and portable operators intended for operating more than one valve, or type of valve, shall be furnished by the valve or gate manufacturer as an integral part of the valve or gate. All similar operators shall be of one manufacturer. All gates and hand operating lifts shall be of the same manufacturer. All hydraulic gate lifts shall be of the same manufacturer and shall be furnished with shop drawings through the manufacturer of the gates as completely integrated units.

Similarly all hydraulic valve operators shall be of one manufacturer, and all motorized operators shall be of one manufacturer, etc.

Operators for gates or valves having threaded stems that project above the operator as the gate or valve is opened shall have stem covers to cover the threaded portion of the greased stem. Stem covers shall be aluminum pipe with threaded cap on top and bolted aluminum flange on bottom. Slots, 1 inch wide and 12 inches long at 18 inches on center shall be cut in front and back of pipe. Flange, pipe, and cap shall be given an AA-A31 anodic treatment after fabrication.

After installation of the gate and stem cover, the stem cover shall be marked at the point where the top of the stem is at full-open position and where the top of the stem is at the closed position. Gate stem cover shall be plumb and shall be subject to the Engineer's acceptance.

All other operators shall have a means of determining the valve position. These may be tail rods on hydraulic cylinders, dial indicators calibrated in number of turns or percentage of opening, or other means acceptable to the Engineer. Dial indicators shall have the full-open and full-closed positions clearly indicated.

All manual or power operators shall be sized to deliver the maximum force that may be required under the most severe specified operating conditions including static and dynamic forces, seat and wedge friction, seating and unseating forces, etc., with a safety factor of 5 unless otherwise specified. All operators shall be capable of supporting the weight of any suspended shafting unless such shafting is carried by bottom thrust bearings. Shaft guides with wall mounting brackets shall be furnished and installed as required.

All crank or handwheel operated geared valve operators or lifts, shall be positioned and equipped for alternate operation by means of a tripod mounted portable gate operator.

Operators for all valves and gates shall turn counterclockwise to open and shall have an arrow and legend so indicating cast on the handwheel or chain wheel rim, crank, or other prominent place on the operator. All operators shall have suitable and adequate stops, capable of resisting at least twice the normal operating force, to prevent overrun of the valve or gate in open or closed position.

Buried operator housings for buried valves shall be oil and watertight, shall be specifically designed for buried service, and shall be factory packed with a suitable grease. The space between the operator housing and the valve body shall be completely enclosed such that no moving parts are exposed to the soil. Operators for buried valves shall be furnished with a 2-inch square AWWA operating nut.

Gearing on worm gear operators shall be self-locking, and the gear ratio shall be such that a torque in excess of 160 foot-pounds will not have to be applied to operate the valve at the most adverse conditions for which the valve is designed.

Traveling nut operators shall be designed such that a torque in excess of 100 foot-pounds will not have to be applied to operate the valve at the most adverse condition for which the valve is designed. Limit stops shall be installed on the input shaft of all manual operators in the OPEN and CLOSED positions. The vertical axis of the operating nut shall not move as the valve is opened or closed.

Gate operators shall be as listed in the GATE SCHEDULE on the Plans.

154510 HANDWHEEL PEDESTAL OPERATORS

Handwheel type pedestal lifts shall be furnished and installed where called for in the schedule or indicated on the Plans. These lifts shall be equipped with ball or roller bearings above and below finished threaded bronze operating nut. The lifts shall have a wheel diameter of not less than 24 inches and shall be counterclockwise opening with an arrow and word OPEN cast on top of the handwheel to indicate the proper direction of opening. Suitable grease fittings shall be provided to allow lubrication of the bearings. Setscrew locked stop nuts shall be provided above and below the lift nut to limit the stem travel. Handwheels shall require not more than 40 pounds pull to operate the lift at the most adverse design condition. Operators shall be Hydro Gate Corporation, Rodney Hunt, or equal.

154511 GEARED PEDESTAL OPERATORS

Hand crank operated geared lifts and operators shall be of the single removable crank type, fully enclosed. All geared lifts with a ratio higher than 4 to 1 shall be two-speed. Sufficient grease fittings shall be provided to allow lubrication of all moving parts, such as bearings, gears, etc. Roller or ball bearings shall be provided above and below the flange on lift nuts to take the thrust developed by opening and closing gates under the maximum operating heads specified. Sleeve bearings shall be bronze. An arrow with the word OPEN shall be cast in a prominent location readily visible to the operator indicating the correct rotation of the crank to open the gate. Hand cranks shall have revolving brass sleeves, 15-inch radius, and not require over 25 pounds pull to operate the gate at the maximum operating heads given. All gears, spur pinions, bevel gears, and bevel pinions shall have cut teeth. Lift nuts shall be of cast manganese bronze, and the cast-iron lift parts must have smooth exterior surfaces. Operators shall be Hydro Gate Corporation, Rodney Hunt, or equal.

154512 BENCH STANDS

Bench stands shall conform to the same specifications as pedestal lifts except that they shall be designed for mounting on a haunch, wall bracket, or self-contained gate yoke. Wall brackets or haunches supporting bench stands shall be as shown on the Plans.

Bench stands shall be Hydro Gate Corporation, Rodney Hunt, or equal.

154520 KEY OPERATED VALVES

The Contractor shall furnish the number of keys or wrenches specified, but not less than two, for operating key operated valves. Each key or wrench shall have a 4-foot shaft and 3-foot handle. Keys having pipe handles shall have the handles supplied by the Contractor.

154530 GEARED VALVE OPERATORS

All manually operated butterfly valves larger than 6 inches on liquid service or 10 inches on gas or air and all plug valves 6 inches and larger shall be provided with geared operators. These operators shall be mounted on the valves at the factory. Valves mounted 6 feet or less above the floor shall have handwheel operators. Valves mounted more than 6 feet to center line above the floor shall have chain wheel operators. Operator shall have cut gears, either spur or worm, and shall be sized to operate the valve at the most adverse design condition with a pull at the handwheel or chain wheel rim of not more than 40 pounds.

154550 MOTORIZED OPERATORS

Motorized valve or gate operators shall be furnished and installed where called for in the schedules. These motorized operators shall be Limitorque SMB, as manufactured by Philadelphia Gearworks; EIM Company equivalent, or equal. These operators shall be of sufficient size and power to move the gates or valves from full-open to full-closed position at a rate of not less than 12 inches per minute under maximum operating load. The rate of closure or opening for a butterfly valve disc shall be measured at the disc edge on the diameter at a right angle to the valve shaft.

The motor operator shall include the motor, gearing, limit switches, push-button station position indicator and indicator lights in one assembly. The reduction gearing shall consist of generated helical gears of heat-treated steel. The worm shall be of hardened alloy steel with the thread ground and polished. The worm gear shall be one piece and of chilled nickel bronze accurately cut. All reduction gearing shall run in lubricant. Ball or roller bearings shall be used throughout. Stem nuts shall be of high tensile manganese bronze accurately machined and mounted in heavy ball or roller bearings. The length of thread in lift nuts shall be not less than 2-1/4 times the stem diameter.

The closing travel shall be protected by a mechanical torque responsive switch with normal gear limit stopping at full-closed position. The torque switch shall be operative during the entire closing travel of the gate or valve to protect the parts from damage in the event an obstruction is met in

closing. The torque switch must be adjustable and shall function without auxiliary relays or devices. The limit switch for the opening and closing directions shall be adjustable and of the gear driven type governed by rotation of the driving mechanism.

The motor shall be of high torque ball bearing, totally enclosed squirrel cage construction with Class B or F insulation and epoxy treated windings. Power supply shall be 120-volt for valves 12 inches and smaller and shall be 240-volt for valves larger than 12 inches or as shown on the Plans. Starting torque shall be not less than five times full load torque.

A handwheel or crank shall be provided for hand operation. This handwheel shall not rotate during motor operation; and during hand operation, the motor rotor shall not be turned. The unit shall be responsive to electrical control at all times. The operator shall be provided with a declutchable manual override for manually operating the valve.

The unit shall be so designed that the motor and drive train may attain full speed and momentum before torque is applied to the valve shaft or valve stem nut.

For pedestal mounted units, the pedestal shall be of cast-iron or fabricated steel of substantial proportions and with ample base area to distribute vertical and torsional loads to the supporting structure.

Units exposed to the weather shall be of weatherproof construction.

Three push buttons shall be provided, OPEN, STOP, and CLOSE, integral with the operator or on the pedestal; and for operators so specified, as indicated on the Plans a parallel set shall also be provided at the remote location indicated or specified.

Two indicating lights are required at each operating location, along with the three buttons. The green light shall be on when the gate or valve is fully closed, the red light when the valve is fully open. Both lights must be on when the valve is in any intermediate position.

154552. MOTORIZED OPERATORS FOR OPEN-CLOSE SERVICE

Motorized operators for open-close service shall be installed where indicated on the Plans and specified herein.

The operator and motor shall be sized by the manufacturer to open and close the valve under full torque conditions of full velocity and pressure including seating and unseating. The time for the valve to go from full open to full close or full close to full open shall not exceed one minute.

The valve operators shall operate automatically and by a remote and/or local control station as specifically called for on the Plans. The control station shall be a three-point push-button station to open, close, or stop the valve in any desired position. The control station shall be mounted as indicated on the Plans. The valve shall be provided with a valve position indicator. The indicator shall be mounted on the operator housing. The valve operator shall have factory built-in limit switches. The operator shall be provided with a declutchable manual override for manually operating the valve.

154560. PORTABLE OPERATOR

The Contractor shall furnish one portable gate operator suitable for use with all crank operated geared valve or gate operators. The portable gate operator shall be electric powered, tripod-mounted operator, Rodney Hunt Model No. 15PO, equivalent Armco, or equal. The operator shall be equipped with reversing features and an overload release clutch for the protection of the operated equipment, and shall be for operation on 120-volt, single-phase 60 hertz. The portable operator shall be furnished with an extension cord 100 feet long. One hundred foot extension cord for electric valve operator shall be three No. 12 conductors. Cap shall be polarized for use with grounding type outlets. The operator shall be of sufficient power and speed so that any gate can be moved from fully closed to fully open against the maximum design load.

The tripod shall be of lightweight construction, adjustable to vary the height of the output shaft to coincide with the input pinion shaft of the floor or bench stands to be operated.

If it is necessary that the portable gate lift operator be supported in the floor stand while being used to operate a gate, suitable brackets or supports shall be installed on each floor stand concerned. In no case shall it be necessary to hold the gate operator while it is being used. Operator shall be given the manufacturer's standard finish.

The overload release clutch shall be of the adjustable, spring-loaded, drive-pawl type which releases instantly at preset predetermined torque. Disc friction clutches or shear pins shall not be used.

154600 PIPE SUPPORTS

A. Exposed pipe, fittings, valves, and appurtenances shall be properly supported, suspended, or anchored to prevent sagging, overstressing, or movement of piping; and to prevent thrusts or loads on or against connected pumps, blowers, and other equipment.

B. Prior to installation of piping, the Contractor shall submit a schedule and drawings of hangers, supports, anchors, and other components of the pipe support system.

    1. In addition to other information, the schedule shall indicate where the supports will be installed.

C. As a minimum, pipe hangers and supports shall be installed where indicated on the Plans. In addition:

    1. Exposed piping shall be supported at intervals not to exceed 5 feet on horizontal and vertical runs of pipe 2 inches and smaller, and at intervals not to exceed 10 feet on horizontal and vertical runs of pipe larger than 2 inches, except as follows:

        a. Exposed PVC and other plastic pipes shall be supported at intervals not to exceed 5 feet, regardless of size.

b. Plastic pipe and tubing, copper pipe and tubing, fiber-reinforced plastic pipe or duct, and rubber hose and tubing shall be supported at intervals close enough to prevent sagging greater than 1/4-inch between supports, or shall be carried in trays.

2. Supports shall be installed at:

a. Horizontal bends.

b. Both sides of flexible pipe supports.

c. The base of risers.

d. Floor penetrations.

e. Connections to pumps, blowers and other equipment.

f. Valves and appurtenances.

D. Plastic pipe, valves, and headers shall be securely anchored to prevent movement during operation of valves.

1. Plastic pipe shall be anchored between expansion loops and direction changes to prevent axial movement through the anchors.

E. Ductile iron elbows or tees supported from the floor shall be furnished and installed with base fittings.

1. Supports for the base fittings shall be metal supports unless concrete piers are indicated on the Plans.

F. Hanger rods, supports, clamps, anchors, brackets, and guides shall conform and shall be sized in accordance with ANSI/MSS SP-58 and SP-69.

1. No use shall be made of chains, plumbers' straps, wire, or similar devices for suspending, supporting, or restraining pipes.

G. Supports for plumbing drainage and vents shall be in accordance with the Uniform Plumbing Code.

H. Supports, clamps, brackets, and portions of the support system bearing against copper pipe shall be copper plated, copper throughout, or isolated with neoprene or PVC tape except trays which shall be galvanized steel.

I. Brackets, supports, inserts, hangers, and other components of the support system shall be hot-dip galvanized after fabrication and coated as specified in DIVISION 9.

J. Where pipe is insulated, oversized supports and hangers shall be provided.

1. A galvanized steel insulation shield shall be installed in accordance with ANSI/MSS SP-69, Type 40.

154610 ANCHOR BOLTS AND CONCRETE INSERTS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Anchor Bolts, Expansion Anchors and Concrete Inserts, Section 05503.

154620 HANGER RODS

A. Hanger rods shall be sized to match the suspended pipe hanger or shall be as indicated on the Plans.

B. Continuous threaded rod shall be used only where indicated on the Plans.

C. Eye bolts shall be welded and shall be rated equal to the full load capacity of the rod.

D. Rods shall be hot-dip galvanized.

E. Manufacturers:

1. Hanger rods shall be manufactured by Grinnell, Figure 140; Elcen, Figure 72; or equal.

2. Continuous threaded rods shall be manufactured by Grinnell, Figure 146; Elcen Figure 73; or equal.

3. Welded eyebolt rod shall be manufactured by Grinnell, Figure 278; Elcen, Figure 69; or equal.

154630 PIPE HANGERS

A. Pipe hangers shall be suspended from hanger rods and secured with double nuts.

B. Hangers for pipe six inches and smaller in diameter shall be adjustable ring hangers or adjustable clevis hangers at the option of the Contractor.

C. Hangers for pipe larger than six inches in diameter shall be adjustable clevis hangers.

D. Oversized clevis hangers shall be provided for insulated pipe.

E. Hangers shall be hot-dip galvanized.

F. Standards and Manufacturers:

1. Adjustable ring hangers shall meet the requirements of ANSI/MSS SP-69 Type 7 and shall be manufactured by Grinnell, Figure 269; Elcen, Figure 13; or equal.

2. Adjustable clevis hangers shall meet the requirements of ANSI/MSS Type 1 and shall be manufactured by Grinnell, Figure 260; Elcen, Figure 12; or equal.

3. Adjustable clevis hangers for insulated pipe shall be manufactured by Grinnell, Figure 300; Elcen, Figure 12A; or equal.

4. Single rod hangers for steam pipe shall be malleable iron or steel yoke and roller hangers. Hangers shall meet the requirements of ANSI/MSS SP-69 Type 42 and shall be manufactured by Grinnell, Figure 181; Elcen, Figure 14A; or equal.

5. Double rod hangers for steam pipe shall meet the requirements of ANSI/MSS SP-69 Type 41 and shall be manufactured by Grinnell, Figure 171; Elcen, Figure 15; or equal.

154640 WALL BRACKETS

A. Wall brackets shall be hot-dip galvanized steel with back plate.

B. Pipes shall be secured with galvanized double nutted U-bolts or suspended from galvanized hanger rods and hangers.

C. Standard and Manufacturers:

1. Bracket shall meet the requirements of ANSI/MSS SP-69 Type 32 and shall be manufactured by Grinnell, Figure 195; Elcen, Figure 57; or equal.

2. Standard U-bolt shall be manufactured by Grinnell, Figure 137; Elcen, Figure 68 or 68A; or equal.

154650 RISER CLAMPS

A. Riser clamps shall be installed at floor penetrations and where indicated on the Plans.

B. Riser clamps shall be hot-dip galvanized.

C. Standard and Manufacturers: Riser clamps shall meet the requirements of ANSI/MSS SP-69 Type 8 and shall be manufactured by Grinnell, Figure 261; Elcen, Figure 39; or equal.

154660 FLOOR STANDS AND STANCHIONS

A. Floor stand or stanchion saddles shall be furnished with hot-dip galvanized U-bolt hold down yokes, and shall be Grinnell Figure B 259, Bergen Patterson Figure 12, or equal.

154690 PREFORMED CHANNEL PIPE SUPPORT SYSTEM

A. Preformed channel pipe support system shall consist of an engineered system including preformed channel pipe supports, fittings, clamps, and fasteners.

B. Manufacturers: The system shall be manufactured by Unistrut, Elcen, or equal.

154691 DESIGN

A. The installed support system shall be satisfactory for the live, dead, and seismic loads related to the affected piping, valves, and appurtenances.

   1. The design shall conform with applicable provisions of:

      a. AISC "Manual of Steel Construction" and

      b. AISI "Cold-Formed Steel Design Manual."

   2. Maximum allowable stress of the channels shall not exceed:

      a. 25,000 pounds per square inch, nor

      b. 0.66 times the yield stress of the steel.

   3. Maximum deflection shall not exceed 1/240 of span.

   4. Allowable column loads shall be as recommended by the manufacturer for the column's unsupported height and for a "K" value for calculating effective column length of not less than 1.0.

B. Maximum spacing of supports shall not exceed 5 feet.

   1. Cantilevered supports may be used where the load allows.

      a. Otherwise, an additional support post shall be installed.

C. Minimum preformed channel pipe support size shall be as manufactured by Unistrut, Series P-1000; Elcen, "Speed Strut" Figure 600; or equal.

154692 SUBMITTALS

A. The Contractor shall submit a layout of the support system including pipe loads, selected channel size, fittings, and appurtenances.

B. The submittal shall include structural design calculations.

154693 FINISHES

A. The components of the support system shall be hot-dip galvanized after fabrication to the required length and shape.

   1. Cut or otherwise damaged galvanized surfaces shall be field repaired to equivalent original condition with a galvanize repair manufactured by Galvinox, Galvo-Weld, or equal.

B. The support system shall also be coated as specified in DIVISION 9.

154694 PREFORMED CHANNEL CONCRETE INSERTS

A. Insert length shall not be less than 12 inches.

B. Not less than four inserts shall be installed for each vertical support.

1. The actual number shall be based on the manufacturer's recommended capacity for the specified concrete strength and a safety factor of three.

C. Preformed channel concrete inserts shall be manufactured by Unistrut, Series P-3200; Elcen, "Speed Strut" Figure 1150; or equal.

154695 PIPE CLAMPS

A. Pipe, tubing, and conduit shall be clamped to the channel section.

1. For pipe two inches in diameter and smaller, clamp shall consist of two-piece, universal clamp with slotted hex head screw and nut and shall be manufactured by Unistrut, Series 2900; or equal.

2. For pipe larger than 2 inches, a one piece pipe strap shall be used and shall be manufactured by Unistrut, Series P-2558; or equal; or shall be a specially manufactured strap.

154696 WALL AND CEILING INSTALLATION

A. Wall Installation:

1. Pipe shall be fastened to preformed channel pipe supports with pipe clamps.

2. Preformed channel pipe supports shall be fastened to the wall using:

a. Preformed channel concrete inserts embedded in the wall and "U"-shaped fittings or "Z"-shaped fittings, as indicated on the Plans.

b. An embedded anchor in the wall, at the bottom, as indicated on the Plans.

B. Ceiling Installation:

1. Ceiling Installation with Preformed Channel Concrete Inserts:

a. Pipe shall be fastened to preformed channel pipe supports with pipe clamps.

b. Preformed channel pipe supports shall be fastened to preformed channel concrete inserts embedded in the ceiling using "U"-shaped fittings.

2. Ceiling Installation with Threaded Rods:

   a. Pipe shall be fastened to preformed channel pipe supports with pipe clamps.

   b. Preformed channel pipe supports shall be supported with threaded rods.

   c. Threaded rods shall be suspended from concrete inserts embedded in the ceiling.

155000. QUICK DETACHABLE FEMALE HOSE COUPLING

The Contractor shall furnish and install quick detachable female hose coupling at each air valve location as indicated on the Plans. The couplings shall be hardened plated steel, 3/8-inch pipe size, and 1/4-inch I.D. hose size. The couplings shall be Am-Flo, C20, or equal.

155600. INSULATION FOR CAUSTIC SODA PIPING

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Insullation of Exposed Sodium Hydroxide Piping, Section 15065.

* * * END OF DIVISION 15 * * *

DIVISION 16

ELECTRICAL

160100 GENERAL

It is the intent of this part of the Contract Documents to cover all work and materials necessary for erecting complete, ready for continuous use, a tested and working electrical system, substantially as indicated on the Plans and as hereinafter specified.

160101. GENERAL PROVISIONS

Minimum sizes of equipment, electric devices, etc., are indicated but it is not intended to show every offset and fitting, nor every structural or mechanical difficulty that will be encountered during the installation of the work.

All work indicated on the Plans is approximately to scale, but actual dimensions and detailed drawings should be followed as closely as field conditions permit. Field verification of scale dimensions on Plans is directed since actual locations, distances, levels, etc. will be governed by field conditions.

Discrepancies indicated on different Plans, between Plans and actual field conditions, or between Plans and Contract Documents shall be promptly brought to the attention of the Engineer for a decision.

The alignment of equipment and conduit shall be varied due to architectural changes, or to avoid work of other trades, without extra expense to the Owner.

The Contractor shall furnish and install all parts and pieces necessary to the installation of equipment in accordance with the best practice of the trade and in conformance with the requirements of these Contract Documents.

All items not specifically mentioned in these Contract Documents or noted on the Plans or accepted shop drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.

The Contractor shall lay out and install electrical work prior to placing floors and walls. He shall furnish and install all sleeves and openings through floors and walls required for passage of all conduits. Sleeves shall be rigidly supported and suitably packed or sealed to prevent ingress of wet concrete.

The Contractor shall furnish and install all inserts and hangers required to support conduits and other electrical equipment. If the inserts, hangers, sleeves, etc. are improperly placed or installed, the Contractor shall do all necessary work, at his own expense, to rectify the errors. All inserts and hangers shall be stainless steel.

All electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of 50 degrees C, and specifically rated for an altitude of 2,000 feet.

The Contractor shall submit shop drawings, data and details to the Engineer on all controls, fixtures, wiring, electrical equipment, conduit, etc. for review and acceptance prior to use of any components in the work.

160102. GENERAL WORK

Existing electrical circuits requiring modifications shall be verified by the Contractor before work commences. The temporary control rack design, shown on the Temporary Rack Drawing, shall be the responsibility of the Contractor. The MCC "J" circuits require field investigation by the Contractor prior to the rack design. Submit sketches of the design for Engineer's acceptance.

Price the temporary control rack design, components and installation into the Proposal. No additional cost to the Owner shall be accepted.

Relocation of existing equipment shall be performed such that no damage is done to equipment. This includes all indoor equipment and outdoor equipment. Existing equipment damaged by the Contractor shall be repaired at no cost to the Owner.

Some of the work to be performed will necessitate shutdown of plant electrical power. It shall be the responsibility of the Contractor to coordinate plant shutdowns with other trades and to submit sequencing schedules of work to be performed during shutdowns to the Engineer for acceptance.

All plant shutdowns shall be the responsibility of the Contractor.

160103. REGULATIONS AND CODES

Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations of the National Electrical Code (NEC), National Electrical Safety Code (NESC), State and local codes, and according to the latest Institute of Electrical and Electronics Engineers (IEEE); American National Standards Institute (ANSI); American Society for Testing and Materials (ASTM); Insulated Cable Engineers Association (ICEA); National Electrical Manufacturers Association (NEMA) Standards; National Electrical Contractors Association (NECA) Standard of Installation; and the latest published regulations of the Federal Occupational Safety and Health Act (OSHA). When applicable, the material and equipment used in the performance of the electrical work shall be approved by the Underwriters' Laboratories, Inc. (UL) for the class of service for which they are intended.

160104. SEISMIC REQUIREMENTS

The Contractor is informed herein that all electrical equipment installed in this project shall be securely anchored, tied, restrained, or attached to the structures in such a manner that such equipment shall remain in place and function when subjected to seismic forces. The Contractor shall be responsible for assuring the Owner that all subcontractors and suppliers furnish

and install equipment and its anchorage in a manner that shall conform to these requirements. Shop drawings for this equipment shall be provided to show anchorage provisions which comply with seismic requirements of Zone 1 in Arizona as defined by the Uniform Building Code. Equipment to be in compliance shall include, but not be limited to, the following:

A. Motor control centers
B. Control panels and devices
C. Cable tray
D. VFD's

160105. TEMPORARY POWER

The Contractor shall furnish, install and maintain all temporary power and lighting systems needed for construction. This temporary system shall include weatherproof panel(s) for the Contractor's main breakers and distribution system.

The Contractor shall make a study of the power availability, plan for installation of temporary power, and submit the means and routing drawings to the Engineer for approval.

Ground fault interrupting equipment shall be installed. All connections shall be watertight with wiring done with Type SO portable cable. After construction is completed, the Contractor shall remove all temporary power equipment and devices. Natural grade and landscape shall be restored.

160106. CUTTING AND REPAIRING

Where it becomes necessary to cut into existing structures for the purpose of making electrical installations, core drills shall be used for making circular holes. Other demolition methods for cutting or removing shall be reviewed by the Engineer prior to starting the work.

The Contractor shall repair all damage caused thereby and restore damaged areas to original condition. It shall be the responsibility of the Contractor to verify existing electrical circuits being modified under this contract are made safe before and after completion of work as called for in these Contract Documents.

160107. CORROSION PROTECTION

Wherever dissimilar metals, except conduit and conduit fittings, come in contact, the Contractor shall isolate these metals as required with neoprene washers, 9-mil polyethylene tape, or gaskets. Where fastening conduit, electro plated, or equivalent fasteners and stainless steel bolts shall be used.

Factory finishes damaged and/or rusting shall be restored to original new condition.

All electrical panels, switchgear, motor control centers, etc. shall be shipped in sealed dust and moistureproof plastic sheet enclosures and the seal maintained until units are installed. Said units shall be in new condition, no dirt, dust, water, grease, rust, damaged parts, components, etc.

All relay, starter, circuit breaker, switches, etc., contacts, insulators, mechanisms, and buses shall be free of dust, dirt, oil, moisture, metal shavings, etc. before testing and energizing.

The Contractor shall provide for delivery, unloading, transportation and storage of all equipment under this Contract until such time as installation is required. To insure adequate protection of all electrical and instrumentation equipment and panels, all such equipment shall be stored in a suitable, air conditioned enclosure designed to protect this equipment from temperatures above 90 degrees F. The City shall assume no liability for either the storage facilities or equipment stored therein. The Contractor shall be responsible for maintaining the storage facilities and equipment stored therein and shall make provision for all utilities required. Continuous access shall be provided to the City for all equipment so stored.

Once equipment is installed, it shall be protected at all times with plastic sheet covers until the area is secure from dirt, dust, workers, paint spray, water, etc. Heat shall be provided to eliminate condensation.

160108. COORDINATION OF THE ELECTRICAL EQUIPMENT RATING

The Contractor shall verify all actual equipment and motor full-load and locked-rotor current ratings. The necessary minimum equipment, wire, and conduit sizes are indicated on the Drawings. If the Contractor furnishes equipment of different ratings, the Contractor shall coordinate the actual current rating of equipment furnished with the branch circuit conductor size, the motor overload protection, the controller size, the control power transformer, and the branch circuit overcurrent protection, and satisfy these requirements at no additional cost to the Owner.

The branch circuit conductors shall have a current carrying capacity of not less than 125 percent of the actual full-load current rating of the equipment. The size of the branch circuit conductors shall be such that the voltage drop from the branch circuit protection devices up to the equipment shall not be greater than 2 percent when the equipment is running at full-load and rated voltage.

The motor running overload protection devices shall be rated or selected to trip at no more than 125 percent of the actual motor full-load current rating for motors marked to have a temperature rise not over 40 degrees C or motors marked with a service factor not less than 1.15 and at no more than 115 percent for all other types of motors.

160109. ACCEPTANCE TESTS

The electrical work shall be free from improper grounds, short circuits, and overloads. The correctness of the wiring shall be verified first by visual comparison of the conductor connections with connection diagrams. Individual circuit continuity checks shall next be made by using electrical circuit testers. Then, the correctness of the wiring shall be verified by the actual electrical operation of the electrical and mechanical devices in both manual and automatic modes of operation. Any deviation from the wiring indicated on the Drawings or accepted shop drawings shall be corrected and indicated on the Drawings and accepted shop drawings.

The Contractor shall megger test all power and control wiring of all circuits. Records of these tests shall be submitted and results shall be included in the Record Documents.

Testing performed by Contractor shall be subject to witnessing by Engineer and shall be performed by Electro-Test, Inc., Westinghouse Field Services, GE Field Services, or Square D Company Field Services.

160109.10. EQUIPMENT TESTING AND DOCUMENTATION

Motorized equipment shall be acceptance tested by Contractor to verify conformance with the Contract requirements.

The following data shall be tabulated for each piece of equipment and submitted to Engineer. Acceptance of equipment will not be effective until Engineer has reviewed and approved these data.

Circuit number
Equipment or motor name and tag number (where applicable)
Nameplate full-load-ampere rating
Motor service factor, enclosure type, code letter
Motor ambient temperature rating
Overload relay rating, including catalog number
Measured full load amps

The electrical data shall be incorporated in the Record Documents, which shall also be submitted by the Contractor.

160110. CONFORMS TO RECORD DOCUMENTS DRAWINGS

Prior to completion of the Contract, the Contractor shall furnish the Engineer with a set of electrical plans marked with any changes, deviations or additions to any part of the electrical work.

Each conductor shall be identified as required by the Contract Documents. This identification shall be indicated on the record documents drawings to enable rapid and accurate circuit tracing by maintenance personnel. In each enclosure, motor control center section, etc., a record drawing showing wire numbers, terminations, etc., shall be permanently affixed and covered with clear plastic protector. The Contractor shall produce drawings of terminal box wiring and drawings of all electrical equipment which was modified on-site. Refer to DIVISION 17 for specific submittal requirements.

160111 SINGLE LINE DIAGRAMS

Single line diagrams, as indicated on the Plans, show circuit voltages, (4xx is 480V, 3xx is 277V, 2xx is 240V, 1xx is 120V circuits), wire and conduit sizes, circuit protection rating, and other pertinent data. Where conflicts exist on the Plans the single line diagrams shall take precedence. Grounding conductors are not necessarily indicated. See grounding requirements specified elsewhere herein.

160112. CIRCUIT IDENTIFICATION

The 3 phase wire or cable shall be identified at electrical equipment such as meters, switchgear, panelboards, and motor control centers as Phases A, B, and C, and shall match the Owner's existing electrical system identification scheme or shall be in accordance with the requirements of the authority responsible for the project.

For the purpose of clearly defining the requirements for circuit/cable/conductor identification as specified herein, including DIVISION 17 of the Specifications, a meeting including representatives of the Contractor, the Owner, and the Engineer shall take place prior to any cable or conductor installation/termination, as requested by the Engineer or the Contractor.

The neutral shall be white or gray. Insulated ground wire shall be green. General purpose AC control conductors shall be red. General purpose DC control conductors shall be blue. Color coding and phasing shall be consistent throughout the site. Bus bars at panelboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right facing connecting lugs.

In addition to color coding, all 1 phase and 3-phase conductors, each cable (single or multi-conductor) and conductor shall be identified at each end and in each manhole, pullbox, cable tray, and any other component of the raceway system. This identification is applicable to all power, control, alarm, and instrumentation cables and conductors.

Each cable (single or multi-conductor) and groups or bundles of individual single conductors shall be identified in each manhole, pullbox, cable tray and any other component of the raceway system with circuit identification markers. The Contractor shall implement a "from-to" cable/conductor bundle tagging system as part of this identification effort as accepted by the Engineer. The materials used to accomplish this tagging shall be manufactured by Brady; Seaton; or equal and shall be submitted. The installed cable/conductor bundle tags shall be documented on the Contract Record Documents.

Each individual conductor shall be identified and tagged at each termination. This includes such locations as switchgear, motor control centers, variable frequency drives, control panels, junction/terminal boxes, all field devices, and all other locations where conductors are terminated. These conductors shall be identified in accordance with the accepted shop drawings. These conductors shall be tagged utilizing sleeve type labels manufactured by Brady; Seaton; or equal. Any deviations from the conductor identification indicated on the accepted shop drawings shall be recorded on these same shop drawings and on the Contract record documents.

Where more than one nominal voltage system exists, each ungrounded system conductor shall be identified by phase and system. The means of identification shall be permanently posted at each branch-circuit panelboard, switchboard, or other distribution panel.

Wire/cable identification/labeling shall be per the following system:

Duct bank cables shall be identified with the designation numbers shown on the cable and conduit schedule on the drawings. The cable in ductbank "FF, Designation No. 1, shall be labeled FF-1, per the schedule. Each conductor in that group shall be assigned a number. The first conductor shall be FF-11, the second FF-12, etc. The numbers shall be utilized for the entire conduit/cable run, disregarding the fact that designation numbers on the drawings change from manhole to manhole.

Markers shall be slip-on PVC sleeve or strap-on type manufactured by Brady; Seaton; or equal. Markers shall be printed using a Brady Marker "XC PLUS" printer; or equal.

Markers used in tunnels or other wet locations shall be on heat-shrinkable marking sleeves. Within electrical equipment such as panels, termination cabinets, motor control centers, markers shall be self-laminating vinyl on white background.

Marker products shall be submitted for review and acceptance by the Engineer.

160113. NAMEPLATES

For all electrical switchgear, motor control centers, VFD's, control panels, control stations, disconnect switches, panelboards and field instruments, the Contractor shall furnish and install nameplates which shall be black lamicoid with white letters. The nameplates shall be fastened to the various devices with round head stainless steel screws. Each disconnect means for service, feeder, branch, or equipment conductors shall have nameplates indicating its purpose. NEMA 4 enclosures shall have nameplates attached by means of suitable adhesive as recommended by the enclosure manufacturer. Nameplates shall have equipment name, tag number, and circuit number. Motor nameplates shall reflect full load amps and locked rotor amps of motor installed. All equipment mounted internal to MCC, switchgear and control panels shall also be provided with permanent nameplates.

160114. AUTOMATIC EQUIPMENT WARNING SIGNS

Permanent warning signs shall be mounted at all mechanical equipment which may be started automatically or from remote locations. Signs shall be in accordance with OSHA regulations and shall be suitable for exterior use. The warning signs shall be fastened with round head stainless steel screws or bolts, located and mounted in a manner acceptable to the Engineer.

Warning signs shall be 10 inches high by 14 inches wide, colored red, black and white, on not less than 18 gauge vitreous enameled steel or OSHA approved warning signs. Sign shall read:

DANGER
THIS EQUIPMENT STARTS
AUTOMATICALLY
BY REMOTE CONTROL

160116. CONDUCTOR FASTENERS

Glue-on type conductor fasteners shall not be used in any panels, panelboards, switchboards, switchgear, motor control centers, or other enclosures containing electrical devices and/or conductors. The Contractor shall

provide backplates to accommodate nonglue-on type conductor fasteners. Exception to this requirement is where an electrical device is mounted on the door of a control panel.

160200. MATERIALS AND METHODS

160201 GENERAL

All materials, equipment, and parts comprising any unit or part thereof specified or indicated on the Plans shall be new and unused, of current manufacture, and of highest grade consistent to the state of the art. Damaged materials, equipment and parts are not considered to be new and unused and will not be accepted.

Field verification of scale dimensions on Plans is directed since actual locations, distances, and levels will be governed by actual field conditions. The Contractor shall also review architectural, structural, yard, mechanical and other Plans, and the accepted electrical and mechanical shop drawings, and shall adjust his work to conform to all conditions indicated thereon.

The fabricator of major components, such as distribution panelboards, switchgear, motor control centers, shall also be the manufacturer of the major devices therein.

160202. RACEWAYS

Raceways include rigid metal conduit, rigid nonmetallic conduit, or any other channel for holding wires, cables, or bus bars that is designed for, and used solely for, this purpose.

Raceways shall be installed complete between outlets and junction boxes before conductors are installed.

160202.10 CONDUIT

160202.11. GENERAL

All conduit shall be rigid steel unless specifically indicated otherwise on the Plans. All wiring, except as otherwise noted, shall be in conduit. Conduit size shall not be less than the National Electrical Code (NEC) size required for the conductors therein and shall not be smaller than 3/4-inch. No underground or stub-embedded conduit shall be less than 1 inch. Underground or stub-embedded conduit shall be PVC coated rigid steel.

Conduit runs are schematic only, and shall be modified as required to suit field conditions, subject to review and acceptance by the Engineer.

Conduit shall run continuously between outlets and shall be provided with junction boxes where connections are made, except in special pull boxes indicated on the Plans. Couplings, connectors, and fittings shall be acceptable types designed and manufactured for the purpose and shall provide a firm mechanical assembly and electrical conductivity throughout.

Conduits entering or exiting concrete shall be PVC coated or equivalent. Coating shall extend 6 inches above finished concrete and 12 inches below finished concrete.

Conduit runs shall be straight and true; elbows, offsets, and bends shall be uniform and symmetrical. Changes in direction shall be made with long radius bends or with fittings of the condulet type. Condulet type fittings shall be Crouse-Hinds, Appleton, or equal with wedge nut covers.

Conduit runs in buildings and structures shall be exposed except as specifically noted or accepted by the Engineer.

Conduit runs shall not interfere with the proper and safe operation of equipment and shall not block or interfere with ingress or egress, including equipment removal hatches. Conduits containing cables above 600 volts shall be sealed per NEC Article 710.

Exposed conduits shall be securely fastened with clamps or straps. All exposed conduit shall be run on the walls and ceiling only and shall be parallel to the planes of the walls or ceiling. No diagonal runs will be permitted. Flexible conduit shall be used only for short lengths required to facilitate connections between rigid conduit and motors or control equipment. The maximum length of flexible conduit shall be 5 feet. Where flexible conduit is used, it shall be grounding type, weatherproof and watertight as manufactured by American Brass Company, General Electric, or equal. All condulets located outdoors or in wet locations shall be weathertight.

Conduit runs on water-bearing walls or below grade shall be supported 1 inch away from the wall on an accepted channel. When channel galvanizing or other coating is cut or otherwise damaged, it shall be field coated to original condition. No conduit shall be run in water-bearing walls, unless specifically designated otherwise.

In rooms with architecturally finished (furred out or dropped) walls and ceilings, conduit runs shall be concealed. Receptacles shall be mounted 18-inch A.F.F. to center line of device unless otherwise noted.

Underground conduit runs shall be steel reinforced concrete encased, as detailed on the Plans, unless otherwise noted.

All conduit shall be thoroughly reamed after the threads have been cut to remove burrs. All joints shall be made with acceptable sealing compound and shall be watertight. Bushings or conduit fittings shall be used at all conduit terminals. The total of all bends in any run between pull boxes or junction boxes shall not exceed 360 degrees. Pull boxes shall be installed at points acceptable to the Engineer. Conduits brought into pull boxes, condulets, and other openings shall be capped until used to prevent the entrance of moisture. All spare conduits shall be capped and shall contain a suitable plastic pulling tape. All spare conduits shall be verified as non-clogged and ready to be used.

Joints shall be set up tight. Hangers and fastenings shall be secure and of a type appropriate in design and dimensions for the particular application.

After installation of complete conduit runs 2 inches and larger, conduits shall be snaked with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Conduits through which the mandrel will not pass shall not be incorporated as part of the contract.

New and existing conduit runs shall be cleaned and internally sized (obstruction tested) so that no foreign objects or obstructions remain in the conduit prior to pulling in conductors.

Couplings, connectors, and fittings shall be threaded and shall be certified types specifically designed and manufactured for the purpose. They shall be installed expertly to provide a firm mechanical assembly and electrical conductivity throughout.

Expansion fittings shall be installed across all expansion joints and at other locations where necessary to compensate for thermal expansion and contraction. Expansion fittings shall be O.Z. Gedney Type AX with jumper for exposed locations and Type DX at structural expansion joints, Spring City, or equal.

Shop drawings shall be submitted showing conduit routing, size, wire sizes, and number of wires in each conduit for all existing and new underground duct banks. Duct bank elevations shall be shown with concrete dimensions, and size and depth of conduit windows entering manholes and pullboxes. No duct bank concrete shall be poured prior to Engineer approval of shop drawings.

160202.12. RIGID STEEL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Rigid Conduit, Section 16111, 2.1, A.

160202.14 PVC COATED STEEL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Rigid Conduit, Section 16111, 2.1, B.

160202.16. RIGID NONMETALLIC - PVC

Where specifically indicated on the Plans, or elsewhere specified, conduit may be high density Schedule 40, 90 degrees C, heavy-duty PVC and shall be 2-inch in diameter minimum. The conduit shall be UL listed and manufactured from virgin polyvinyl chloride compound which meets ASTM standards. Smoke emissions shall be limited to less than 6 grams per 100 grams of material tested. Encasement shall be reinforced as indicated on the Plans. Conduit supports shall be installed at 2-1/2 foot intervals. PVC conduit shall be manufactured by Carlon, Triangle Conduit and Cable, or equal.

160202.19. CONDUIT USES

PVC coated rigid steel conduit shall be used for all exposed outdoor runs.

PVC nonmetallic conduit shall be used in all underground ducts encased in concrete, except when otherwise indicated on the Plans. The minimum PVC conduit size shall be 2 inches. If rigid steel conduit is used the minimum size shall be one inch.

Conduit embedded in concrete slabs and walls, and all other conduit runs not identified herein or otherwise noted on the Plans, shall be rigid steel conduit.

160202.20. CABLE TRAY SYSTEM - ALUMINUM

The Contractor shall furnish and install a complete cable tray system as specified herein and indicated on the Drawings. The system shall include all straight trays, fittings, covers, splices, barrier strips, and related accessory and support items as required for a complete installation.

The cable tray shall conform to NEMA Standard VE-1. The system installation shall be in accordance with the National Electrical Code (NEC). Tray shall be of the ladder type and shall have 9-inch rung spacing to insure adequate cable bearing surface for the installed conductors. Rungs shall be of double rung or box type and shall be free of sharp edges or corners to protect conductor insulation. Rungs shall be capable of supporting a 200 pound concentrated load, applied to the middle 6 inches without permanent deformation. The tray loading shall meet requirements of NEMA Class 20A, which has a minimum uniform loading capacity of 147 pounds per linear foot when supports span 12 feet. Tray sides shall have an interior cable loading depth of 5-3/8 inches minimum. Tray widths shall be as indicated on the Drawings.

The trays shall be provided with a dividing strip for use as needed, to separate analog, instrument wire from low voltage and control. Trays shall be provided and installed with fastened solid covers. Trays shall be supported each 5 feet on center, with channel under the entire width of the tray. Support shall be from ceilings, walls, or as shown on the Plans. Trays shall be aluminum, NEMA Class 8A or stronger, of aluminum alloy No. 6061-T6 as manufactured by P-W Industries, Globetray-United States Gypsum Company, or equal.

Trays shall be installed 2 inches minimum from adjacent wall surface, and with a minimum 6 inch clearance over the cover.

Where aluminum trays are supported on steel supports, separation of aluminum from steel shall be provided as specified in Section 160107 of these Specifications.

Cables installed in trays shall be grouped by circuits (power and control) by lashing with manufactured plastic lashing ties spaced approximately 36 inches apart. Each circuit group shall be neatly tied to the cable tray ladder rungs also on approximate 36-inch centers.

160202.25. SUPPORT STRUT

All support struts used for the support of electrical devices, conduits, trays, etc., shall be electro-galvanized. Where galvanized is cut or damaged during installation, the damaged area shall be thoroughly cleaned and painted with a cold galvanizing as recommended by the manufacturer.

160202.30 METAL PULL BOXES

160202.31. GENERAL

Furnish and install pull boxes as indicated on the Plans and specified herein, NEMA rated for the classification of the area.

Installation of pull boxes shall be such that access to the pull boxes is not restricted by obstructions such as pipes, valves, ladders, etc. Exact locations and sizes shall be submitted to the Engineer for review and acceptance prior to fabrication and installation.

Additional pull boxes shall be installed as required to meet cable manufacturer's pulling tension requirements.

Covers shall be secured with 316 stainless steel screws or bolts with coated threads.

160202.32. CONSTRUCTION

Pull boxes shall be compatible with the type of conduit systems on which they are used. Pull boxes shall be fabricated from 11 gauge (minimum) steel or aluminum and shall be completely weatherproof with gasketed removable covers. Weatherproof conduit hubs shall be furnished for all conduit connections to pull boxes. Pull boxes used outdoors shall be stainless steel NEMA 4X.

160202.33. FINISH

All metal surfaces shall be phosphatized and primed with a rust-resistant paint. Finish shall be two coats of enamel paint. Finish shall be two coats of ANSI 61 grey enamel paint.

160202.34. SIZING

Pull boxes shall be sized according to NEC code and shall be sized to provide room for the future conduits and cables indicated on the Plans.

160202.40. MANHOLES

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Manholes and Handholes, Section 16404.

160202.41. MANHOLE COVERS

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Manholes and Handholes, Section 16404.

160202.50. CAST BOXES FOR EMBEDMENT IN CONCRETE

Cast boxes for embedment in concrete shall be feraloy-hot-dip galvanized with neoprene gaskets and nonskid galvanized covers, secured with stainless steel cover screws. The sizes shall be as indicated on the Plans. Where no size is given, the size shall be large enough to accommodate the conduits and conductors which enter the box.

Cast boxes shall be O.Z. Gedney, Crouse-Hinds Type WGB, Appleton equivalent, or equal.

160202.60. CONCRETE PULL BOXES

The Contractor shall furnish and install precast concrete pull boxes in the locations indicated on the Plans and as required.

The pull boxes shall be installed on 12 inches of 3/4-inch rounded rock and shall be installed in such a manner that the cover of the pull box will be 6 inches above the finished grade or as noted on the Plans. Pavement shall slope away from the box over a 10-foot slope.

The pull boxes shall be designed for traffic conditions, and the pull box and cover shall be designed for heavy traffic bridge loading. The pull boxes shall be a minimum of 4 feet by 4 feet by 36 inches deep with 3/4-inch diameter pulling irons located at each end. The pull boxes shall be constructed of reinforced Class A concrete.

The pull boxes shall be Quickset Model Number E-333, Utility Vault Company, or equal, with covers. The covers shall be engraved "ELECTRICAL."

160203 CONDUCTORS

160203.01. GENERAL

All wiring shall be as indicated on the Plans. Wires shall be newly manufactured (not more than 12 months old) and shall be soft drawn copper with not less than 97 percent conductivity. The wire and cable shall have size, grade of insulation, voltage, and manufacturer's name permanently marked on the outer covering at not more than 2-foot intervals. All wires shall conform to the latest Standards of the ASTM and ICEA and shall be tested for their full length by these Standards. Insulation thickness shall be not less than that specified by the National Electrical Code.

Wire sizes shall be American Wire Gauge sizes with Class B or Class C stranded construction.

No. 2 AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Color coding shall be in accordance with Section 160112 of these Specifications. Larger cables shall be coded by the use of colored tape.

As far as practicable, all circuits shall be continuous from origin to termination without splices in intermediate pull boxes. Sufficient slack shall be left at the termination to make proper connections. In no case shall a splice be pulled into the conduit.

160203.02 PULLING LUBRICANT

All cables shall be properly coated with pulling compound recommended by the cable manufacturer before being pulled into conduits so as to prevent mechanical damage to the cables during installation.

Other lubricants to be substituted must be accompanied by a statement from the cable manufacturer as to its acceptable use with the cable being installed.

Cables shall be as manufactured by Okonite, Cablec, or equal.

160203.12. TERMINATIONS AND SPLICES (600-VOLT AND LESS)

Above ground, and in weatherproof enclosures, terminations shall be terminal board type with set-screw pressure connectors. Splicing shall join conductors mechanically and electrically to provide a complete circuit prior to installation of insulation. Conductors, including grounding conductors, of different sizes shall be spliced and then soldered or welded. Splices in wet locations and all splices below grade shall be water proof heat shrink type as manufactured by Elastimold, Thomas-Betts, or equal.

160203.20. 600-VOLT CLASS CABLE

Individual or multiple conductor cables for power, control, and alarm circuits of 480 volts or less shall be insulated for not less than 600 volts and shall have Type THWN or RHW insulation. Multiple conductor cables shall have Type TC insulation. Where wire size is not indicated, they shall be of the size required by the NEC, except that no wire external to panels and motor control centers shall be less than No. 12 AWG, unless specifically noted on the Plans. Panel control wiring shall not be less than No. 14 AWG. Wire and cable shall be as manufactured by Okonite Company, Cablec Corporation, or equal.

The pulling tension and side-wall pressures, as recommended by the cable manufacturer, shall not be exceeded.

160203.21 TERMINATIONS AND SPLICES (600-VOLT AND LESS)

Terminations shall be terminal board type with set-screw pressure connectors. Splicing shall join conductors mechanically and electrically to provide a complete circuit prior to installation of insulation. Conductors, including grounding conductors, of different sizes shall be spliced and then soldered or welded. Splices in wet locations and all splices below grade shall be waterproof heat shrink type as manufactured by Elastimold, Thomas-Betts, or equal.

160203.30. INSTRUMENTATION CLASS CABLE

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications section titled Instrumentation Cable, Section 16126.

160203.35. COMMUNICATION CABLE

Communication (telephone) cable shall have the number of twisted pairs indicated on the Plans.

Telephone cable shall be 600-volt rated and shall be submitted to the Engineer for approval by Phoenix Telecommunications Department prior to installation.

The jacket shall be of high molecular weight polyethylene surface printed with the year of manufacture and cable description at 2-foot intervals. The shield shall be 8-mil aluminum or copper overlapped to provide 100 percent cover. A copolymer or equal coating shall be applied to both sides to provide an effective moisture barrier. An inner jacket shall also be provided which shall be of high molecular weight polyethylene to provide strength and surge barrier.

Conductors shall be solid soft bare copper with thermoplastic insulation color coded per telephone industry standards. The insulated conductors shall be twisted into pairs with varying lengths of lay. A nonhygroscopic core tape shall be applied over the cable core as a dielectric and heat barrier.

Communication cables shall be installed in separate raceways. This includes cable through manholes and pullboxes.

Communication cable shall be as manufactured by General Electric, Okonite, or AT&T, or equal.

160204. GROUNDING

The grounding systems shall consist of concrete encased ground conductors and/or ground rods. Each duct bank shall contain a concrete encased system ground conductor. The system ground conductors shall run continuously in duct banks, through manholes, handholes, and other raceway boxes. The system ground shall be connected to the structure grounding systems to provide a continuous ground system. Each metallic raceway, panel, switchboard, and other metallic devices associated with the electrical and instrumentation systems shall be bonded to this grounding system.

All equipment cases, devices, etc. shall be grounded. Ground rods shall be driven or concrete encased conductors installed before a building or structure is built and ground conductors brought through the concrete to accessible points for grounding equipment. These systems shall be installed at each structure where switchgear, motor control centers, switchboards, panelboards, etc. are installed.

Where ground conductors are not sized, the NEC shall govern. Driven ground rods shall be Copperweld, or equal, 5/8-inch in diameter and not less than 10 feet in length.

All connections of ground cable to rods or to cable shall be thermoweld connections. Maximum allowable ground resistance shall be 5 ohms.

Tests shall be conducted by the Contractor and witnessed by the Engineer to determine the ground resistance for the entire system and at each building where there is switchgear, motor control, etc.

A green insulated grounding conductor for all device and equipment grounds shall be run as a separate conductor in the conduit from the equipment to the respective motor control center switchgear or panelboard. All wireways, enclosures, etc. shall be properly bonded and grounded, and grounding conductors shall be run for all circuits. All metal conduits shall have ground bushings and shall be bonded per NEC. For existing or new equipment fed from existing MCC or switchgear, the grounding conductors shall be connected to respective existing ground bus of MCC or switchgear.

160204.10. MAGNETIC FLOWMETER GROUND

An individual ground system shall be installed for each magnetic flowmeter, as required by the manufacturer.

The ground system shall consist of a ground rod with No. 4 ground conductor at each magnetic flowmeter.

160205 OUTLET, SWITCH, PULL AND JUNCTION BOXES

160205.01 GENERAL

The work included in Part B of this project that is covered in this section of the Specifications shall be as specified in Part A Specifications sections titled Pull and Junction Boxes, Section 16131; and Outlet Boxes, Section 16134.

160205.10 FASTENERS

Fasteners used with wiring devices shall be aluminum or stainless steel and all screws, nuts, bolts, etc. shall be stainless steel.

160206 LIGHTING SWITCHES

160206.01. GENERAL

Snap switches shall have the number of poles as indicated on the Plans, shall be specification grade, rated at 20-ampere, and shall be as manufactured by Hubbell, General Electric, or equal. Special switches, covers, etc. shall be as specified herein or indicated on the Plans.

Momentary type lighting switches shall be three position with spring return to center positions. They shall be specification grade rated at 20 amps and shall be manufactured by Hubbell, G.E., or equal.

160206.10 INDOOR

Stainless steel cover plates shall be utilized.

160206.20. OUTDOOR AND CORROSION RESISTANT AREAS SPECIFIED ON PLANS

Enclosures shall be weatherproof, with yellow "fiberglass" lift cover plate, or equal.

160206.40. THREE AND FOUR-WAY SWITCHES

Three and four-way switches shall be specification grade, 20 amp, and shall have cover plates as specified herein.

Switches shall be as manufactured by Hubbell, General Electric Company, or equal.

160207 RECEPTACLES

160207.01. GENERAL

Duplex receptacles shall be 2-pole, 3-wire grounded, 120 volts, industrial, rated at 20 amperes, and shall be as manufactured by Hubbell, General Electric, or equal. Special receptacles, covers, etc. shall be as specified herein or as indicated on the Plans.

160207.10 INDOOR

Stainless steel cover plates shall be utilized.

160207.20. OUTDOOR AND CORROSION RESISTANT

Enclosures shall be weatherproof with yellow "fiberglass" lift cover plates or accepted equal.

160207.30. GROUND FAULT INTERRUPTER RECEPTACLES (GFI)

Provide GFI receptacles for all outdoor outlets and where shown on the Plans. GFI outlets shall be rated at 20 amperes at 125 volts AC as manufactured by Leviton, Bryant, or equal.

160207.50 240-VOLT RECEPTACLES

The 240-volt receptacles shall be of the ampere rating as indicated on the Plans, however, the minimum rating shall be 20 amperes at 250 volts AC and shall be as manufactured by Leviton, Bryant, or equal.

160208. PUSH-BUTTON STATIONS AND PILOT LIGHTS

160208.01. GENERAL

Push buttons, selector switches and pilot lights shall be heavy duty, oil-tight with chrome plated lock rings, rugged construction for indoor installation as shown on the Plans. Enclosures for indoor installations shall be NEMA 12. Furnas Class 52, Allen-Bradley 800T series or equal.

Enclosures for outdoor installations shall be NEMA 4X, corrosion resistant fiberglass, and all equipment and devices shall be rated as such. Crouse-Hinds N series, Allen Bradley 800 series or equal.

Nameplates shall be provided for all devices as noted on control schematics.

"Start/lockout-stop" push button stations shall be installed adjacent to every motor unless specifically indicated otherwise. All lockout mechanisms shall be made of stainless steel.

160209. TRANSFORMERS - DRY TYPE

160209.10. DISTRIBUTION TRANSFORMERS - LOW VOLTAGE LIGHTING AND POWER

Transformers shall be of the premium high efficiency quiet type and shall be installed where indicated on the Plans. The primary winding of the transformers shall have two 2-1/2 percent taps above and below normal.

The transformers shall have a BIL of 10 kV with a temperature class of 185 degrees C for transformers up to 37-1/2 kVA and a temperature class of 220 degrees C for transformers rated at 37-1/2 kVA and larger.

The sound level shall not exceed 44 dBA measured at 5 feet from the transformer after installation. Core and coil assemblies 30 kVA and larger shall be mounted on rubber vibration isolators designed specifically to reduce 120 HZ sound and multiple harmonics. Transformer windings shall be copper.

Transformers shall be of the types manufactured by General Electric Company, Westinghouse Corp., or equal.

160210 RELAYS

160210.10. CONTROL RELAYS

Control relays shall be General Electric, Westinghouse, Square D Company, or equal, industrial rated, 600-volt, 10 amperes type with contact arrangement and operating coils of the proper voltage as required by the control circuit sequence. Each relay shall have a minimum of 4 reversible pole contacts. The coils shall be sealed by pressure molding.

160210.20. PHOTOELECTRIC CONTROL

Photoelectric control units shall consist of a cadmium sulfide photocell and contactor housed in a sturdy aluminum enclosure. Contacts shall be rated at 30 amp, 120-volt AC. Control shall be Tork Model 2100, or equal.

160211 TIMERS

160211.01 GENERAL

Timers which require pins or other removable trip devices shall be provided with at least one pin or trip device for each possible time setting.

160211.10 RESET TIMERS AND REPEAT CYCLE TIMERS

Timers of this type shall be heavy-duty industrial timers as manufactured by Eagle, Paragon, or equal.

160211.20 TWENTY-FOUR HOUR TIMERS

Timers of this type shall be heavy-duty industrial timers as manufactured by Paragon, Tork, or equal.

160211.30 TIMING RELAYS

Timing relays shall be heavy-duty industrial 600-volt, 10-ampere as manufactured by Square D Company, Westinghouse, or equal.

160212 ENCLOSURES

160212.01. GENERAL

This specification includes enclosures to house electrical controls, instruments, terminal blocks, etc. If not indicated otherwise they shall be NEMA 12 for indoor and NEMA 4X fiberglass or stainless steel for outdoor installations.

160212.10. CONSTRUCTION - STEEL (NEMA 12)

Enclosures shall be from 14-gauge steel with seams that are continuously welded. Doors shall have full length piano hinges with the door removable by pulling the hinge pin. They shall be as manufactured by Hoffman, Fischer & Porter, or equal.

A rolled lip shall be provided around three sides of the door and around all sides of the enclosure opening. The gasket shall be attached with oil-resistant adhesive and held in place with steel retaining strips. Exterior hardware, such as clamps, screws, and hinge pins, shall be of stainless steel for outdoor installations. A hasp and staple shall be provided for padlocking. Each enclosure shall have a print pocket.

160212.11. FINISH - STEEL (NEMA 12)

Finish shall be white enamel interior, light gray enamel, ANSI 61 exterior, over phosphatized surfaces.

160212.20 CONSTRUCTION - FIBERGLASS (NEMA 4X)

Enclosures shall consist of base and cover which shall be heavy-duty hot compression molded from fiberglass reinforced polyester compound containing not less than 25 percent fiberglass by weight. Transparent covers, where indicated, shall be polycarbonate. The enclosures shall be provided with cover hinges manufactured from nonmetallic materials. The cover latch system shall be nonmetallic.

The gasket system shall be of neoprene material cemented into a molded labyrinth on the cover.

The enclosures shall be NEMA 4X and shall be manufactured by Crouse-Hinds; English Electric Corp.; or equal.

160213.30 PANELBOARDS

160213.31. GENERAL

Dead-front panelboards, including lighting distribution and control panels, shall be furnished and installed as indicated on the Plans. All bus shall be copper. Mounting and type enclosures shall be as indicated on the Plans. Where not indicated, indoor enclosures shall be NEMA 12 and outdoor enclosures shall be NEMA 4X. The minimum interrupting capacity of any device shall be 10,000 amperes for 240-volt.

120213.32 INTERIORS

Protective devices shall be such that they can be replaced without disturbing adjacent units. Wire connectors shall be suitable for wire sizes indicated. Branch circuits shall be numbered as indicated on the Plans and a complete typed circuit schedule shall be furnished under a transparent cover and affixed to the panel. Phase busing shall be full height without reduction. Full size neutral bars shall be included and shall have suitable lug for each outgoing circuit requiring neutral connection. Spaces for future protective devices provided in lighting panels shall be bused for the maximum device that can be fitted into them.

160213.33. ENCLOSURES

Panelboards shall be finished with a primer, rust-resistant phosphate undercoat and two coats of oven-baked enamel with finish color to be selected by the Engineer. Panelboards shall have sufficient size to provide a minimum of 4 inches of gutter space on all sides. Doors shall be such that they:

A. In making switching devices accessible, shall not uncover any live parts;

B. Are hinged and have latches that require no tool to operate; and

C. Can be locked. Lock and two keys shall be furnished.

D. Inside pocket is provided for circuit directory.

160213.34. IDENTIFICATION

Each panelboard shall have, on the outside of the door, a lamicoid nameplate with 3/4 inch letters as specified on Plans.

Panelboards shall be manufactured by Westinghouse Electric Corp., Square D, General Electric Company, or equal.

160218. TERMINAL BLOCKS

Terminal blocks shall be manufactured by Square D Company; Buchanan; or equal. Terminal blocks 600 volts rated shall be of the size required for conductors therein and a minimum of 25 percent spares shall be provided in each terminal box.

160219. DISCONNECT SWITCHES

Disconnect switches shall be heavy-duty, lockable, safety switches with a quick-make, quick-break operating mechanism, full cover interlock and indicator handle, unless indicated otherwise on the Plans. The disconnect switches shall be furnished with fuses where indicated on the Drawings. One set of spare fuses shall be furnished for each fused disconnect switch.

Disconnect switches shall be manufactured by Square D Company; Westinghouse Electric Corporation; or equal.

160300 ELECTRICAL METERING AND RELAYING

160300.01 GENERAL

Instruments, relays, and other devices for panels shall be industrial grade and shall be flush or semiflush mounted with cases of similar design.

Instruments shall have antiglare glass fronts, antiparallax scales, and white faces with black numerals and markings. Instruments shall be selected with the full-load reading at approximately 75 percent of full scale, unless otherwise specified or accepted. Accuracy of instruments shall be one percent of full scale values. Transformer accuracies shall be suitable for relays and meters.

160300.10. POTENTIAL TRANSFORMERS

Potential transformers shall be indoor, dry type, single phase, 60 Hertz, with a zero to 120 volt secondary and rated as required for the equipment furnished. They shall be furnished with current limiting fused disconnects. They shall be equipped with resistors as required to limit the fault current to a value which the fuse is able to interrupt without damage.

160300.20 CURRENT TRANSFORMERS

Current transformers shall be indoor, dry type insulated for the voltage for which it is used and rated as required for the equipment furnished. They shall have sufficient thermal and mechanical capacity to withstand the maximum momentary current rating of the associated circuit breaker.

161000 MOTOR CONTROL CENTERS (MCC)

161000.01. GENERAL

The Contractor shall furnish and install, ready to use, motor control centers for use as indicated on the Plans and specified herein.

The motor control center fabricator shall also be the manufacturer of the major components therein, such as circuit breakers, starters, etc. Engineered motor control centers shall be by the component and housing manufacturer. The manufacturer shall comply with equipment specifications such as transformers, relays, circuit breakers, push buttons, etc., contained elsewhere in these Contract Documents.

New equipment shall be manufactured by General Electric, Westinghouse, Allen-Bradley, or equal.

161000.02. STANDARDS

Each component, as well as the complete assembly, shall be constructed and tested in accordance with latest NEMA Standards for Industrial Control. The type of construction of the control centers shall be NEMA Class IIS, Type B special wiring.

Lifting eyes shall be provided on each section to facilitate handling. Circuit breakers, push buttons and selector switches shall not be located higher than 72 inches from the bottom of the MCC.

Unit doors shall be mounted on the stationary structure and hinged on the side away from the vertical wireway. They shall be held closed with slotted thumb screws.

Unit doors shall have positive action linkage with disconnect operating mechanism. Mechanism shall be designed so that it can be locked in the OFF position with from 1 to 3 padlocks. When the handle is not padlocked, it shall be possible to open the door by releasing the door interlock with a small tool. The control units shall be of the plug-in type. When doors are closed, the operating mechanism shall clearly indicate whether the disconnect is in the ON or OFF position, and the door interlock shall automatically become effective. The disconnect operating mechanism shall be designed against inadvertent operation when the door is open. Each plug-in unit door shall be provided with a nameplate, specified elsewhere herein, that indicates the circuit number and circuit name. The nameplate shall be attached to the door with stainless steel screws.

It shall be possible to install up to six NEMA size one units in one vertical section. Units shall be completely enclosed with sheet steel. A small wireway shall be provided inside of unit so all wiring can be laid in place without removing barriers or plates. Each vertical section that holds the units shall be rigidly formed of minimum 12-gauge, cold-rolled sheet steel. The vertical front-of-board-construction shall be supplied with minimum 20-inch depth.

Continuous horizontal wiring troughs shall be provided at both top and bottom of each section. These troughs shall line up to form a continuous wireway for the full length of the center. A large continuous, full height vertical wiring trough shall be provided in the right side of each section.

All starter wiring, control, and power shall be terminated in terminal strips in this trough for Size 2 and smaller starters. Size 3 and larger starters shall have control leads terminating on the terminal strips in the trough. Terminal strips shall be split-type to facilitate wiring connections without disconnecting factory or field conductors. Terminal strips shall be rated to accept conductor sizes as indicated on the Plans.

161000.10. BUS

All bus bars shall be silver plated copper, and shall be of the ampacity indicated on the Plans. Unit bus bar stabs shall insure high contact pressure. The vertical bus bars shall be effectively isolated from accidental contact by plastic insulating medium. Horizontal bus shall be silver-plated at every joint. The entire vertical bus shall be silver-plated copper.

Bus bar supports shall be of high impact strength, noncarbonizing insulating material mounted on padded steel brackets and shall provide adequate dielectric strength and creepage distance. The bus structure shall be capable of withstanding a not less than 42,000 rms ampere short circuit current in accordance with NEMA standards. Higher rms amperage shall be as specified herein or indicated on the Plans.

Horizontal bus other than 600 amperes and vertical bus other than 300 amperes shall be as specified herein or indicated on the Plans.

Each section shall be equipped with horizontal ground bus which shall be continuous across the MCC.

161000.20 MOTOR CONTROL CENTER ENCLOSURES

The motor control centers shall be as indicated on the Plans and as specified herein and in accordance with NEMA Standard Pub. IS 1.1, latest edition. The motor control centers shall be enclosed in NEMA Type 1 gasketed industrial use enclosures, unless otherwise designated.

161000.30 PAINTING

All metal surfaces and structural parts shall be given a phosphatizing, or equal, treatment prior to painting. The control centers shall then be given a gun-metal gray undercoat which is equal to zinc chromate. Interior surfaces shall be white. The exterior of the enclosure shall be finished in a color selected by the Engineer.

161000.40 FUTURE SPACE REQUIREMENTS

In the motor control centers are spaces for future combination starters. These spaces shall have all the hardware necessary so that a future plug-in control unit can be installed without having to modify the vertical sections. The number of spaces for future control units shall be as indicated on the Plans.

161000.50. DEVICES

Devices, such as, but not limited to, starters, circuit breaker, relays, timers, conductors, shall conform to other sections of these Contract Documents. Control transformers within shall be oversized for their duty by an additional 150 VA, or as noted on the Plans.

161000.60. SPARE PARTS

The Contractor shall provide spare parts to the Owner with delivery of the MCC. The following shall be supplied; and shall match original equipment:

A. 1 - NEMA Size 1 plug-in unit, prewired with MCP-15, full voltage, reversing starter, 2 - indicating lights, running time meter, 200 VA control power transformer and motor starter coil.

B. 1 - NEMA Size 1 plug-in unit, prewired with MCP-15, full voltage non-reversing starter, indicating light, running time meter, 200 VA control power transformer and motor starter coil.

C. 1 - 15A, 3P molded case circuit breaker and 1 - MCP-15 motor circuit protector.

D. 2 - Dozen push buttons with normally open contacts.

E. 2 - Dozen push buttons with normally closed contacts.

F. 3 - Dozen fuses.

G. 10 - 200 VA rated control power transformers.

H. 2 - Dozen indicator lamps.

I. 6 - Control relays.

161000.70. INFORMATION FOR REVIEW

The motor control centers shall meet the requirements of the latest edition of Standards for Industrial Control No. ICS published by the National Electrical Manufacturers Association. The following minimum information and drawings shall be submitted for review and acceptance by the Engineer:

A. Plan, front, side views and overall dimension of each motor control center.

B. Internal wiring diagram of each plug-in unit.

C. Internal wiring diagram of the motor control centers.

D. External connection diagram showing the wiring to the external controls and devices associated with the motor control center. This drawing shall be custom for this project.

E. A one-line and a schematic diagram for the motor control centers.

F. Bill of material list.

G. Upon acceptance by the Engineer, Contractor shall submit two sets of contract record drawings of motor control centers system. Drawings and details shall be referenced explicitly to the contract drawings by circuit numbers, equipment designations, locations, etc.

H. Nameplate schedule with equipment and circuit numbers as shown on the Plans.

161000.90. MOTOR CONTROL CENTER INSTALLATION

Motor control centers shall be installed to allow complete enclosure door swing which is required for unit removal.

161050.10 PROGRAMMABLE CONTROLLERS

Programmable controller shall be supplied for control and monitoring as shown on the Drawings. The field inputs and outputs shall be connected to the programmable controller (PLC). The programmable controller shall be located inside the MCC and shall be of the same manufacturer as the MCC.

All input and output shall be modular. Light emitting diodes shall be supplied with each modular input and output device that shall indicate malfunction. All ladder logic and control diagrams shown on the Plans as PLC software shall be fully implemented by the Contractor.

Input and output modules shall be furnished and installed plus 50 percent spare for each type of input or output. The I/O count shall be obtained from both the electrical and instrumentation drawings. However, as a minimum the implemented input and output complement shall be:

64 discrete inputs (dry contact type)
64 discrete outputs (relay emulation)
8 analog inputs (4-20 milliamperes D.C.)
2 analog outputs (4-20 milliamperes D.C.)
2 pulse inputs (0 to 20 pulses per second)

PLC shall be manufactured by Allen Bradley, Westinghouse, General Electric, or equal.

161050 PROGRAMMABLE CONTROLLER PROCESSOR

The programmable controller (PLC) shall be a microprocessor based industrial controller with a temperature rating of 0 to 60 degrees C and a humidity rating of 5 to 95 percent noncondensing, minimum. A local face plate programming terminal shall be installed on the PLC. A data table access module shall be installed on the PLC enclosure for set point adjustment access.

It shall contain programmable CMOS circuitry to store user-programmed instructions. The memory capacity shall be sufficient to fully implement implement the control algorithms shown on the plans and described in these Contract Documents plus 100 percent spare programming space for each PLC. However, in no case shall the fully implemented programming capacity be less than 2,000 8-bit bytes.

The PLC shall be supplied with register memory which shall retain information on power failure for a minimum of 48 hours. Each location shall be capable of storing 16 bits of data. The numerical information storable shall be binary, 2's complement, or binary coded decimal. This information shall represent process set points, times, counter presets, accumulated values, positions, or other measured process variables. Register and auxiliary status tables shall be supplied for the PLC.

The PLC shall be supplied with logic memory. Logic memory shall be retentive on power failure. Program control and logic functions shall be solved sequentially during each CPU scan. The scanning mechanism shall additionally perform PLC system tasks to include:

1. Update of time reference from a built-in clock.

2. Diagnostic self-test of PLC to include input and output.

3. Reset watchdog timer which shall be used to verify correct functioning of the PLC and which shall be preset to 100 to 250 milliseconds.

In the event of DC input power failure the PLC shall complete an executing, pending function and go to a safe state.

After power is restored and during power-up, the physical PLC outputs shall be disabled until the PLC shall read all inputs, solve all logic, perform preliminary input-output, and verify all other functions of the PLC. The PLC shall be configurable to allow the system supplier to program which digital outputs should resume control after power failure, which digital outputs should remain set in their last position before power failure until manually reset, and which digital outputs shall be de-energized until manually reset.

The PLC shall be clock driven with a resolution of plus or minus 10 milliseconds or better.

Twelve bit minimum analog inputs and outputs shall be available with the following ranges:

1 to 5 volts DC
4 to 20 mA DC

Each discrete output shall have a fuse, with fuse blown indicators on each module. Indicator lights shall also be provided on each I/O point to indicate status of each input or output signal. Each individual input or output point shall be opto-isolated to protect the controller I/O circuitry from user input and output high voltage transients. The I/O modules and structures shall be universal in design and be compatible with all of the processors available from the selected supplier. All external wiring shall be made to removable wiring arms or swing arms to allow simple quick installation or extractions of I/O modules. Labels shall be provided on modules and wiring arms for user to mark data. Wire terminals on I/O shall accept a maximum 12-gauge stranded wire.

The power supply shall provide power for the processor, I/O modules, and meter receiver/transmitters. It shall have built-in overvoltage and undervoltage detection circuitry, protection against overcurrent conditions, and automatic power-up sequence which enable outputs only when proper operating tolerances are reached. The power supply shall accept 24-volt direct current input.

A surge suppression shall be included for PLC protection.

161050.30 INPUT/OUTPUT STRUCTURE

The Input/Output (I/O) Structure shall consist of a rack or racks of input/output modules which shall interface between the processor and control devices. The I/O structure shall be field expandable to the maximum capacity without modifications of the processor. I/O modules shall be available as listed.

D.C. (12 to 24-volt)	Input or Output
AC/DC Isolated (120-volt)	Input or Output
Dry Contact	Input

The programmable controller shall be supplied with extended functions that shall include 3 mode, proportional, derivative, and integral control algorithms and communication interface. Programmable controller shall not be

accepted unless the programmable controller supplier can document, to the satisfaction of the Engineer, that the supplier has communication interfaces, along with the required software; all of which shall be the PLC manufacturers' standard, cataloged, product.

The programmable controller shall have reset counters, repeat cycle timer and reset timer, and the system supplier shall review the specific project requirements to implement the counter/timer requirements.

161050.40 PORTABLE PLC PROGRAMMING TERMINAL

A portable microcomputer-based programming unit shall be provided for PLC field programming and program documentation. The programming unit shall meet or exceed the following requirements:

1. 1 MB RAM.
2. One 1.2 MB floppy disk drive.
3. Two parallel ports and 20 foot printer cables.
4. Two serial ports.
5. 30 MB or larger hard disk with not more than a 35 Msec average access time.
6. Integral gas plasma screen.
7. One wide carriage printer capable of 300 character-per-second printing in draft quality mode. Printer shall be Epson EX-1000 or equal.
8. Keyboard, with full alphabetic keys, 10-key numeric pad, and function keys.
9. AC power supply surge protector.
10. Shall be furnished and installed with the latest version of software for PLC programming. The most advanced software available from the manufacturer shall be furnished and installed and the software shall include annodating, printing, and editing of PLC programs.
11. Shall be furnished and installed with all software, hardware, expansion slots, and interconnecting cables needed to interface with the PLC and Data Highway, both via direct connection. All softwares supplied shall come complete with technical descriptions and documentations.

PLC terminal shall be Compaq Laptop 386, or equal.

The following PLC programming functions shall be provided:

1. Examine and alter controller memory.
2. Change I/O allocations.

3. Produce ladder listings with cross-references when connected to a standard RS-232 printer.

4. Create networks using any valid logic elements.

5. Delete and edit any logic element or network.

6. Add networks anywhere in the SCAN operation.

7. Display up to 50 references.

8. Search for any reference or logic element.

9. Display the power flow of discrete logic references and trace for all occurrences of the same reference.

10. Record, dump and verify user programs on disk.

11. Communicate with the controller over telephone lines.

12. Communicate with the controller at baud rates up to 9600 baud.

13. Force coils.

161050.50 UPS

A micro-UPS such as Best FERRUPS shall be sized based upon the PLC requirements, including spare I/O, with a submittal of calculated load. The UPS shall be within the MCC enclosure with a status light on the panel face indicating alarm or running status.

161100 CIRCUIT BREAKERS - LOW VOLTAGE

161100.01. GENERAL

All circuit breaker frame and trip ratings shall be as indicated on the Plans, except that they shall be coordinated with the ratings of the equipment actually furnished and shall be modified where necessary to suit this equipment. Circuit breakers to be used in motor control centers shall be as indicated on the Plans. Where no indication of type is given on the Plans, the following shall govern:

Circuit breakers protecting motors shall be motor circuit protectors sized as shown on the Drawings. All other circuit breakers shall be molded case circuit breakers.

Circuit breakers shall be as manufactured by Westinghouse, General Electric, or equal.

161100.10. MOLDED-CASE CIRCUIT BREAKERS

Circuit breakers for mounting in motor control centers or for separate mounting shall be of the air-break type, quick-make and quick-break, 600 volt, with number of poles as indicated on the Drawings. The minimum frame size shall be 100 amperes.

Each pole of these breakers shall provide inverse time delay and instantaneous circuit protection.

The breakers shall be operated by a handle and shall have a quick-make, quick-break switching mechanism that is mechanically trip free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping due to overload, short circuit, or ground fault shall be clearly indicated by the handle automatically assuming a position between the manual ON and OFF positions. All latch surfaces shall be ground and polished. All poles shall be so constructed that they open, close and trip simultaneously.

Breakers must be completely enclosed in a molded case. Noninterchangeable trip breakers shall have their covers sealed; interchangeable trip breakers shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Contacts shall be of nonwelding silver alloy. Arc extinction must be accomplished by means of arc chutes.

The minimum interrupting ratings of the circuit breakers shall be at least equal to the available short circuit at the line terminals (42,000 AIC minimum).

Circuit breakers shall conform to the applicable requirements of NEMA Standards Publication No. AB1.

Circuit breaker ratings and modifications shall be as indicated on the Drawings.

Molded case circuit breakers shall be ambient compensating that provides inverse time delay overload and instantaneous short circuit protection by means of a thermal magnetic element. The breaker shall carry rated current between 25 degrees C and 40 degrees C with tripping characteristics that are approximately the same throughout this temperature range.

On breakers with interchangeable, thermal, adjustable magnetic trip, the accessibility and position of the adjustment knob shall not be changed from those on the standard breaker.

161100.20. MOTOR SHORT CIRCUIT PROTECTORS

Motor circuits shall be protected by motor short circuit protectors (MSCP or MCP) 600 volt, manufactured by Westinghouse Electric; General Electric Company; or equal.

The MSCP shall be operated by a handle and shall have a quick-make, quick-break switching mechanism that is mechanically trip free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping shall be clearly indicated by the handle automatically assuming a position between the manual ON and OFF positions. All latch surfaces shall be ground and polished. All poles shall be so constructed that they open, close, and trip simultaneously.

MSCP's must be completely enclosed in a molded case. MSCP's shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Contacts shall be of nonwelding silver alloy. Arc extinction must be accomplished by means of arc chutes.

Each pole of these MSCP's shall provide instantaneous short circuit protection by means of a single adjustable magnetic only element. The single adjustment screw shall adjust all poles simultaneously.

Provision shall be furnished in the MSCP for locking the maximum achievable trip setting to values less than maximum obtainable trip setting. Each adjustment shall typically have eight main setting points and mid-setting points following a linear scale so that each point has a significant value within calibration tolerances.

MSCP's shall be suitable for use with current limiters, having 100,000 ampere interrupting capacity and a built-in trip indicator, that are fully coordinated with the MSCP so that the MSCP will open all three phases if the limiter operates. Current limiters shall be so constructed that they can only be replaced by an identical or similar limiter having the same interrupting capacity.

The minimum interrupting ratings of the MSCP shall be 42,000 AIC.

MSCP ratings and initial settings shall be selected by the motor starter manufacturer to protect the motor and as indicated on the Drawings. The Contractor shall set all MSCP's as recommended by the manufacturer and based on motor nameplate currents or actual motor currents.

An instantaneous trip circuit breaker or motor short-circuit protector shall be used only as part of a listed combination motor controller which provides coordinated motor branch-circuit overload, and short-circuit and ground-fault protection in accordance with NEC Article 430-52.

161200 MOTOR CONTROL - LOW VOLTAGE

161200.01 GENERAL

Starters Size 2 and larger shall have arc quenchers on all load breaking contacts. Starters shall be suitable for the horsepower ratings specified, except the Contractor shall verify the motor ratings and coordinate the starter and overload trip ratings with the actual horsepower ratings of the motors installed. Extended overload reset buttons shall be mounted so as to be accessible for operation without opening the door of the enclosure.

Magnetic contactors shall be factory adjusted and shall be chatter free. Magnetic contactors shall have bimetallic type overload relays in each line conductor as indicated on the Plans.

Starters shall be furnished complete with a 120-volt control transformer unless otherwise noted.

Where above normal ambient temperatures are anticipated, circuit breaker trip elements and starter overload trip elements shall be supplied to meet such conditions and shall be acceptable to the Engineer.

Control fuses shall be furnished where indicated in the schematics.

The magnetic contactors shall not be smaller than the size indicated on the Plans. Starters shall be sized to handle motors furnished even if motors should be larger than indicated on the Plans.

The minimum size starter shall be NEMA Size 1.

161200.10. MANUAL STARTERS

Manual starters as indicated on the Plans shall be across-the-line manual motor starters for motors up to one horsepower, 600V, having the electrical characteristics indicated on the Plans.

Manual starters shall have: NEMA 12 enclosures indoor and NEMA 4 outside (or as indicated on the Plans), handles that clearly indicate the ON, OFF with lockout, and TRIPPED positions, pilot light, and positive, quick-make, quick-break mechanisms. Overload heaters sized and installed by the Contractor, shall be provided except where shown otherwise on the Drawings.

The manual starters shall be Square D, Westinghouse Electric Corporation, or equal.

161210.20 MAGNETIC STARTERS

161210.21. FULL VOLTAGE

Across-the-line full voltage magnetic starters for up to 600V shall have electrical characteristics as indicated herein and as indicated on the Plans.

Magnetic starters shall have: NEMA 12 enclosures unless otherwise noted; positive, quick-make, quick-break mechanisms; padlockable enclosure doors; three overload relays ±15 percent adjustment from nominal heater rating on the overload relay; amber colored overload alarm indicating light and cover mounted reset button; at least three reversible contacts in addition to the hold-in contact; and motor running time meter.

Magnetic starters shall be built in accordance with the latest NEMA Standards and shall be manufactured by Westinghouse Electric, General Electric, or equal.

161210.25. OVERLOAD RELAYS

Overload relays shall have additional control or monitoring relays, as required and as shown on the Drawings.

163100 LIGHTING

163100.1. GENERAL

Lighting fixtures shall be as described below and as indicated on the Plans. Coordinate outlet placement with process equipment and HVAC.

Fixtures shall include lamps, ballasts, poles, mounting hardware, etc. to provide complete operating units.

163100.10. LIGHTING FIXTURE SCHEDULE

LIGHTING FIXTURE "A": Shall be 100 watt HPS, pole mounted fixture, with a clear polycarbonate refractor, Type IV IES reflector, with photoelectric cell, and tilt fitter, and shall operate from 120V ac. The pole shall be square straight aluminum, 15 feet high, with hinge, with receptacle where shown on the Plans. Fixture and pole shall have dark bronze finish. Sterner Cat. No. MQ-12-E-10-4-PTF-100S-120-C-SSA17-EC, Holophane equivalent or equal.

LIGHTING FIXTURE "A1": Shall be the same as Fixture "A", except it shall be a wall mount, Style M. No pole shall be included.

LIGHTING FIXTURE "B": Shall be a 2-tube, 4 foot fluorescent with porcelain reflector and embossed apertures to provide 10 percent uplight. Fixture shall be Daybrite Catalog No. 40211-4 or equal.

LIGHTING FIXTURE "C": Shall be suitable for wet locations and shall be a 100 watt HPS ceiling mount fixture, with symmetrical distribution. The fixture shall be Holophane Bantam Prismtite, with glass refractor, Catalog No. BANT100HP12A685.

LIGHTING FIXTURE "D": Shall be niche-mounted underwater light, with a 500 watt, PAR-56 120V tungsten halogen lamp, and shall be designed for a wall mount application. The fixture shall be Imperial Bronze Lite Catalog No. SW-500 Kim equivalent or equal. Cable shall be supplied with fixtures and lengths shall be verified prior to ordering.

LIGHTING FIXTURE "E": Shall be an emergency lighting fixture with number or remote heads as shown on the Plans. Batteries shall be sealed lead calcium type housed in a 20-gauge steel cabinet. Fixture shall have low voltage battery cutoff, three-rate charge for controlled automatic recharge, ammeter, charge indicator lights and test switch. Lighting fixture shall be as manufactured by Teledyne Big Beam Catalog No. H2TC12S50TD 120V, or equal. Remote lamp assembly shall be a Par 36 sealed beam with satin chrome finish as manufactured by Teledyne Big Beam Model No. H59F12, or equal. Outdoor lamps shall be a neoprene weatherproof Par 36 lamp assembly with Lexan Lens as manufactured by Teledyne Big Beam Model No. H36WP1212.

LIGHTING FIXTURE "F": Shall be a 70-watt HPS fixture, wall mounted. The fixture shall have a bronze finish. Light distribution shall be wide-spread. Fixture shall be Holophane wall packette, with glass refractor. Catalog No. WP-2-A-070HP-12-BZ, or equal.

LIGHTING FIXTURE "G": Shall be 250-watt HPS, pole mounted fixture, with a clear polycarbonate refractor, Type IV IES reflector, with photoelectric cell, and tilt fitter, and shall operate from 120V ac. The pole shall be square straight aluminum, 20 feet high, with hinge. Fixture and pole shall have dark bronze finish. Sterner Catalog No. MQ-19-E-10-4-PTF-250S-120-C-SSA25-EC, Holophane equivalent or equal.

163100.3. INSTALLATION

Surface and flush mounted fixtures shall be solidly connected to a junction box. Suspended fixtures shall be hung utilizing pendant mounting or stainless steel chains and hooks. Plugs and receptacles shall be as manufactured by Hubbell, General Electric Company, or equal.

Underwater lighting fixture shall have cord terminated in brass junction box, Imperial Bronzelite or equal. Junction box shall be mounted flush with wall of basin.

Pole mounted fixtures shall be mounted on aluminum poles as designated in the fixture schedule. All metal poles shall be bonded to the plant ground system. Poles shall have adequate handholes and weatherproof receptacles where indicated. All anchor bolts and nuts shall be stainless steel.

163100.4. BALLASTS

A. Ballasts shall be:

1. Energy saving type, suitable for use with energy saving lamps.

2. High power factor type, with a power factor not less than 90 percent.

B. Ballasts for fluorescent lamps:

1. Shall bear CBM and ETL labels certifying that the ballasts meet the pertinent requirements of such organizations.

2. Shall have a built-in thermal protector or fuse that disconnects the ballast permanently prior to failure.

3. Shall be high efficiency and constant wattage type.

4. Shall be of two windings where required by applicable codes.

5. Shall be manufactured by Advance, Universal, or equal.

C. Ballasts for high intensity discharge, HID, lamps:

1. Shall meet requirements of UL 1029 Standard for High-Intensity Discharge Lamp Ballasts.

2. Shall be either UL listed or UL recognized.

3. Shall have copper winding.

4. Shall be fused.

5. Shall be manufactured by Advance, Holophane, Sylvania, or equal.

166010. VARIABLE FREQUENCY/VARIABLE VOLTAGE MOTOR CONTROL

166010.10. GENERAL

The Contractor shall furnish and install solid-state variable frequency/ variable voltage (VFD) motor drive speed control system(s), including but not limited to inverter power unit, motor starting and switching equipment, sequence control, auxiliary control and alarms.

Motors shall be properly matched to accommodate the type controller provided, and furnished with the controller to provide a properly coordinated system. VFD's shall be open chassis type and be mounted in an industrial type enclosure as indicated on the Plans and specified elsewhere in this Section.

Front panel mounted devices, such as push buttons, pilot lights and internal equipment such as relays, circuit breakers, shall conform to equipment specifications elsewhere in these documents.

Submittals shall be as outlined in Section 161000.70 of this Specification. The manufacturer shall have been producing the equipment specified for a minimum of 5 years. The manufacturer shall also furnish factory test data on the proposed equipment. Total VFD/motor combination shall have a mean time before failure (MTBF) of 20,000 hours minimum. All VFD controllers shall have a minimum of 4 hours burn-in time prior to delivery, at rated motor full load torque. The manufacturer shall also furnish a spare parts list for each drive type according to H.P. rating. VFD's shall be as manufactured by Emerson, Toshiba, Reliance Electric, or equal.

166010.11. FUNCTION

The VFD system shall be an all solid-state AC to DC converter utilizing silicone type or transistor type semiconductors in the power switching circuits to produce variable voltage inverter control. The phase control rectifier shall convert the AC line voltage into DC voltage proportional to the desired speed. This output shall be filtered prior to use as the input to the inverter. The VFD unit shall restrict reflected harmonic distortion to 5 percent maximum per IEEE 519 standard. Manufacturer shall correct harmonic voltage distortion with line reactor and/or filter at his cost, to stay within distortion limit. Upon completion of installation, submit documented testing data with harmonics profile. The inverter shall convert this signal into an AC voltage at a frequency which shall be proportional to the desired speed. The frequency and voltage shall both vary simultaneously, to provide a constant ratio and to provide volt/cycle necessary to operate AC motor(s) at the desired variable speed.

The VFD systems shall be for an input voltage as indicated on the Plans, 3 phase short circuit current 42,000 A with an output to operate matched NEMA Design B induction motors.

VFD shall have the following characteristics as a minimum requirement:

1. "Soft start" control circuitry shall limit in-rush current to 150 percent of full load current under automatic and manual operating conditions. The VFD shall be capable of developing 150 percent starting torque.

2. The VFD shall have 3 to 1 speed ranges, or as given elsewhere in these Specifications, with less than 3 percent slip at rated speed and an inverter efficiency of 95 percent at rated horsepower.

3. No external heat exchange equipment shall be required, unless specifically accepted by the Engineer.

4. The basic subassemblies of the drives shall be modular.

5. Maintenance and repair shall be accomplished by removing and installing circuit boards.

6. Components employed in the drives shall be industry standard devices available from commercial sources.

7. Drive options not called for in this Specification shall be capable of being installed at a future time without factory assistance.

8. Speed adjustment shall be accomplished on each controller.

9. Each drive shall be furnished with an input circuit breaker.

10. These circuit breakers shall serve as the primary short circuit interrupting and safety disconnect devices.

11. Circuit breakers shall comply with Section 161100.

12. Drives shall be capable of being manually disconnected and "locked out" for maintenance.

13. The drive shall also have a built-in interface module. This interface module shall be used to interface the drive with the remote control and monitoring devices. The drive shall be controlled by a local or remote speed/start/stop control. The interface module shall be capable of accepting a 4-20 mA speed control signal and contact closures for input control.

14. The interface module shall include all devices and signals indicated on the Electrical and Process and Instrumentation Drawings, including a 4-20 mA speed indication output signal.

166010.12 ENVIRONMENTAL CONDITIONS

The VFD system shall be designed to operate in the following environmental conditions:

Ambient temperature	0-50°C
Relative humidity	to 95%
Altitude	2,000 feet MSL

166010.13. CURRENT CONTROL

The inverter shall provide current limit control to shut down the drive whenever the load reaches a preset point. The current at maximum speed shall be field adjustable from 100 percent to 75 percent of drive rated full load current. The inverter shall have the capability of starting, stopping, and running with stable operation throughout the voltage and frequency range under no load conditions.

The drive shall have a built-in ground fault sensor that shall "trip" the drive if there is a ground fault condition in the drive, motor circuit conductors or motor. Ground fault settings shall limit the amount of ground fault current to 150 percent or less of the full load rating of the drive.

A ground fault sensor system with shunt trip on the drive input power breaker or control circuit interlock shall be used to interrupt the ground fault if adequate interrupting capacity is not available through the drive.

The control circuit also shall be designed so as to protect the drive whenever the supply voltage to the drive exceeds 10 percent above the nominal voltage or goes lower than 10 percent below the nominal voltage.

In the event the protective circuits of the drive are activated due to either undervoltage, overvoltage, overcurrent, short circuit or excessive dissipation, or improper function of the power output modules, the drive shall give clear indication as to the cause that activated the protective circuit, and shall remain annunciated until they are manually reset by an operator at the drive.

166010.14. CHARACTERISTICS

The VFD system(s) shall include, as minimum, the following, and devices as indicated on the Plans:

1. Main circuit breaker
2. Manual speed control
3. Test card(s)
4. Input and output instantaneous overcurrent protection
5. Input protection from: single phasing, power failure, phase sequence, power dips, voltage transients
6. Torque/current limit alarms - after set time delay
7. Controlled linear acceleration and deceleration, each adjustable up to 2 minutes
8. Inverter faults
9. Soft start
10. Radio interference protection
11. Controls, as shown on the Plans and described herein
12. Frequency and voltage regulation - ±1 percent
13. Operating frequency range - 0.5-60 hertz
14. Minimum incoming line power factor throughout the load and speed range of 0.95.
15. Running time meter
16. Internal 120-volt control power
17. PID control capability
18. Bypass starter

19. The drive shall be of the PWM design
20. Manual/process follow speed control selection switch
21. Volts/hertz adjustment
22. Timers

AUXILIARY CONTACTS: The following (NO, NC) contacts are to be provided for the following logic conditions:

a. Fault
b. Ready
c. Run
d. Drive bypass
e. Control mode status

For other required contacts, see Drawings.

166010.15. ENCLOSURES

The VFD enclosures shall be dead-front with front accessibility. All metal surfaces and structural parts shall be given a phosphatizing, or equal, treatment prior to painting. The enclosures shall then be given a gun-metal gray undercoat which is equal to zinc chromate. The exterior of the enclosures shall be furnished in ANSI 61 gray. Interiors shall be white enamel. The doors shall have full length piano type hinges. Each door shall be braced to prevent sag when fully open.

A forced air exhaust ventilation system, powered from an integral 120-volt transformer in the VFD cabinet, shall be included if required for adequate heat dissipation inside the cabinets. All control pilot devices called for in schematics shall be capable of being mounted on the door in front of the controller. Each section shall have its own separate front access door.

All wiring within the VFD shall have identification tags as described in Section 160112. No glue on wire fasteners shall be used, see 160116.

A complete set of record drawings shall be installed in a clear plastic cover in each VFD unit.

TRAINING: A two day, sixteen hour training for Owner's technicians shall be included. Training session to be conducted by the manufacturer's technical staff.

166010.16. SPARE PARTS

As a minimum, the following spare parts shall be supplied with each complete VFD system:

1. One set of all power and control fuses.

167000. CONTROL PANELS

Control panel(s), unless otherwise indicated, shall be vertical rack type with full length hinged doors to open as shown on the Plans. The panel dimensions shall be as indicated on the Plans and as required for the equipment furnished. Sufficient working space shall be provided around all

installed equipment. The panels shall be formed of not less than 10-gauge cold-rolled steel. The framework shall be made of not less than 2-inch by 2-inch by 3/16-inch thick steel angle.

The following control panels shall be furnished, designed, shop painted, assembled and wired, field tested, and placed in satisfactory operation under DIVISION 16 of specifications:

1. Chemical control panel "CV".

2. Bar screen control panel.

3. Sludge collector control panel.

The panels shall be complete with instruments, meters, switches, controls, indicating lights, wires, wireways, grounding, nameplates, and all other accessories and appurtenances required for complete panels. The controls and components to be included on the panels are as shown.

The following drawings of each panel shall be supplied by the panel manufacturer for acceptance before fabrication:

A. Panel front view showing equipment arrangement and dimensional information.

B. Panel floor plan and side view showing dimensions, doors, and equipment layout inside the panel.

C. Drawing showing structural details.

D. Diagrams showing all external devices connected to the panel.

E. Wiring diagrams.

F. Panel bill of material with detailed description of components.

Instruments, as specified in DIVISION 17 and shown on drawings shall be securely braced and secured by a supporting framework such that a minimum load is put on the panel face.

Joints shall be welded and ground smooth. All hardware shall be noncorrodible metal. All anchor bolts, nuts, and washers required for secure anchorage to steel channel bases shall be provided. Panel enclosures shall be shipped with nameplates mounted, and all equipment mounted and wired.

The exterior of the panels shall be selected by the Engineer and the interior shall be white. Both finishes shall be applied over bonderizing.

The fabrication of the enclosures shall be subject to the Engineer's acceptance. Proposed panel layouts are, in general, shown on the Plans; however, these shall be modified as required to facilitate equipment furnished. Enclosures shall be NEMA 4X or as indicated on the Plans.

All punching, reaming, cutting, and other fabricating work shall be done before the finish is applied. All electrical connections shall terminate at terminal strips, which shall be labeled with appropriate identifying data.

All terminal strips shall be provided with a minimum of 25 percent spare terminals. Panels shall be delivered with all instruments and controls installed and completely wired and piped. Panels shall be shipped with complete wiring and piping diagrams and instructions to identify instrumentation inside the panel, as well as internal wiring and piping diagrams.

Each device requiring power or neutral connection shall be arranged so that when the wires are removed from any unit, no other shall be interfered with.

All electrical wiring within the panels shall be color coded, bundled, and bound with plastic strip lock straps and terminated on numbered terminal strips. All external connections shall be properly identified by function and number in accordance with ISA standards. Power to the panel shall be 120 volts, 60 Hertz, single phase, or as shown on the Plans.

If the instruments are series wired, only one receiver in the loop shall be grounded while the others shall accept a floating input. Also, current-to-current converters shall be provided as required for load boosting in order to accommodate the appropriate number of instruments. If the instruments are parallel wired, all receivers shall be referenced to the same common.

All signal connections for outgoing 4-20 mA DC signals shall be equipped with adequate signal retransmission devices. For parallel wired systems, voltage-to-current transducers shall be provided and shall be referenced to the same common as all other receiving instruments. For series wired systems, fully isolated current-to-current transducers shall be provided to maintain loop continuity and eliminate grounding problems.

All lights, instruments, push buttons, and other equipment mounted in or on the panels shall have engraved identification and function nameplates. The nameplates shall be black lamicoid plastic with white letters and shall be fastened with round head brass screws. Equipment mounted inside the panels shall be labeled with identification which correlates with Plan identification.

* * * END OF DIVISION 16 * * *

DIVISION 17

INSTRUMENTATION

170000 GENERAL

The work included in Part B of this project that is covered in the following Sections of the Specifications shall be as specified in the Part A Specification Sections as follows:

	PART B		PART A
170000.10	Requirements:	SEE	Section 17010 - General Provisions
170000.15	Submittals:	SEE	Section 17010 - General Provisions
170000.16	General:	SEE	Section 17010 - General Provisions
170000.17	Engineering Data Catalog	SEE	Section 17010 - General Provisions
170000.18	Operation and Maint. Manuals	SEE	Section 17010 - General Provisions
170000.19	I and C Schedule of Work	SEE	Section 17010 - General Provisions

The general panel design requirements specified in Part B shall apply to control panels furnished in Part B.

It is the intent of the Engineer that panel devices be furnished by a single manufacturer for all control panels furnished under Parts A, B, and C. The attached partial cross-reference table indicates where major devices of a given type are specified in more than one part of the specifications.

In providing devices of a single type from a single manufacturer, the I and C subcontractor shall review all specification requirements shown.

Wherever possible, it is the intent of the Engineer that field devices of a comparable type be furnished by an identical manufacturer. The attached partial cross-reference table indicates where major field devices of a given type are specified in more than one part of the specification.

In providing devices of a single type from a single manufacturer, the I & C subcontractor shall review all specification requirements shown.

PARTIAL CROSS REFERENCE TABLE - PANEL DEVICES

ITEM DESCRIPTION	PART A	PART B	PART C
Interfacing/Control Relays	17020.2.2		
Time Delay Relays	17020.2.3		
Switches and Pilot Lights	17020.2.4		
DC Power Supplies	17020.2.5		
Power Conditioner - Cont. Panels	17020.2.6		17130
PID Controller	17020.2.7		17274
Ratio Control Module	17020.2.8		
Process Indicators	17020.2.9B		17275-3
Current Trip	17020.2.10	170314.10	
Current Isolator	17020.2.11	170201.20	17271
Analog Summation Module	17020.2.11B		
Totalizer	17020.2.12	170307.10	
Prog. Logic Controller	17020.2.13		17310
Time Clock - Programmable	17020.2.14		
Duration Timer (Repeat)	17020.2.15		
Duration Timer	17020.2.16		
Adj. Preset Counter	17020.2.17		
Single/Multipen Recorders	17020.2.18		
Annunciator	17020.2.19		17120

PARTIAL CROSS REFERENCE TABLE - PANEL DEVICES (Continued)

ITEM DESCRIPTION	PART A	PART B	PART C
Time Clock (Chronometer)	17020.2.20		
Potentiometer Converter			17271
Auto/Man Loading Sta.			17274
Man. Loading Station			17274
Concentric Scale Indicator			17275-4
Video Graphic Recorder			17275-5

PARTIAL CROSS REFERENCE TABLE - FIELD INSTRUMENTS

ITEM DESCRIPTION	PART A	PART B	PART C
2.1 Level Transmitter-Admittance	17025.2.1		
2.2 Not Used	17025.2.2		
Level Sw.-Single Point	17025.2.3		
Level Sw.- Float Type	17025.2.4		17216-6
Liquid Level Indicator/Level Sw.	17025.2.5		
Magnetic Flow Tubes and Transmitters	17025.2.6	170013	17212-4
Annular Flow Elements/Transmitters	17025.2.7		
Turbine Flow Meters	17025.2.8		
Rotameters	17025.2.9	170017	
Pressure Transmitters	17025.2.10		
Pressure Switches	17025.2.11	170315	17216-4
Pressure Gauges	17025.2.12		17211-5
Diaphragm Seals	17025.2.13		
Temperature Switches	17025.2.14		
Not Used			
Temperature Gauges	17025.2.16		
Flow Sensor/Transmitter Parshall Flume Adm. Type	17025.2.17		
pH Sensor and Transmitter	17025.2.18	170018	
Load Cell and Transmitter	17025.2.19		

PARTIAL CROSS REFERENCE TABLE - FIELD INSTRUMENTS (Continued)

ITEM DESCRIPTION	PART A	PART B	PART C
Flow Switches-Reed Sw. Type	17025.2.20		
Propeller Meter Modifications	17025.2.20B		
Flow Switch-Thermal Dispersion Type	17025.2.20C		
Process Taps, Sending Lines, Accessories	17025.2.21		17211-1
Sludge Blanket Level Detection System			17212-7
Radio Freq. Level Transmitter			17212-9
Ultrasonic Level Transmitter		170012	17212-11
Radio Freq. Level Switch			17216-7
Surface Scatter Turbidimeter		170019	

170000.15. SUBMITTALS

170000.16. GENERAL

170000.20. CONTROL AND INSTRUMENTATION DEVICES

Control mechanisms shall be standard devices constructed of corrosion-resistant materials, enclosed in a dustproof case and mounted as specified in the individual application. Instruments to be mounted outdoors or in basements shall be in weatherproof cases. Corrosion resistant cases shall be furnished where indicated. Cases shall be finished in manufacturer's standard colors except as otherwise specified. All instrument wires or cables shall be enclosed and not exposed or within reach of the public.

Each meter, indicator, totalizer, controller, recorder or other device shall have an identifying engraved lamicoid nameplate. This includes all primary elements, such as flow meters. The nameplate shall be mounted on the case so that it will identify the equipment as specified on the drawings. Brass or stainless steel mounting screws shall be used.

Each receiver and each transmitter shall have an individual cutout, switch and/or fuse to disconnect the receiver from all sources of electricity, including both power and signal sources.

Surge suppression devices shall be installed at each outdoor field instrument or field analyzer.

170000.30 INTERCOMPONENT WIRING AND TUBING

Intercomponent wiring shall be run in conduit. Minimum permissible signal wiring insulation voltage is 600 volts, with the exception of special cable as required by the manufacturer and accepted by the Engineer.

Pneumatic systems control tubing and fittings internally used for panels fabrication and externally used for interconnection of components shall be (1/4-inch OD) aluminum. All tubing and fittings shall be designed and installed for a minimum of 150 psi.

170001.10. INSTRUMENTATION CLASS CABLE

(Refer to Section 160203.30.)

170002.10 TERMINATIONS AND SPLICES (600 VOLT AND LESS)

Terminations shall be terminal board type with set-screw pressure connectors. Splicing shall join conductors mechanically and electrically to provide a complete circuit prior to installation of insulation. Conductors, including grounding conductors, of different sizes shall be spliced and then soldered or welded. Splices in wet locations and all splices below grade shall be waterproof heat shrink type as manufactured by Elastimold, Thomas-Betts, or equal.

170003.10 CONDUIT

Conduit shall be as shown on the Plans and as specified in DIVISION 16.

170010 PRIMARY ELEMENTS

170010.10 GENERAL

Primary elements shall be complete and ready for operation. Elements consisting of more than one unit, such as sensor, signal converter, and transmitter, shall include all conductors and conduit furnished and installed to interconnect each component.

170012. ULTRASONIC

The ultrasonic sensors shall be of the noncontact type for continuous measurement of liquid levels. The units shall include a front panel mounted level indicator scaled in engineering units and shall provide a 4-20 mA DC analog output signal which is proportional to liquid level.

The units shall include ultrasonic sensor(s), interconnecting cable and microprocessor based transmitter. Military grade connectors shall be supplied to enable quick disconnect of the sensor from the interconnecting cable and the cable from the transmitter unit. The sensor shall be encapsulated in chemical and corrosion resistant material such as Kynar and Teflon and capable of operating from -20 degrees F to +150 degrees F. The system shall be ambient temperature compensated which automatically compensates for errors due to large temperature changes.

The system shall be variable span with maximum range of 15 feet. The span and range shall be easily set in the field. No external calibration equipment shall be required. Accuracy shall be ±1 percent of full scale of minimum span and ±0.6 percent of full scale of maximum span. The unit shall be self calibrating for ambient changes of temperature, humidity, and wind. Zero drift shall not be acceptable. Sensor mounted outdoors shall have separate temperature element for required temperature compensation and shall be provided with sun and wind shield. The manufacturer shall be responsible to ascertain that the application and mounting of the unit, for the specific use, is functional.

The system shall include an indication of echo strength and if the echo is momentarily lost, the system shall hold the last valid signal until the echo returns.

The transmitter with indicator and all electronic controls shall be in a NEMA 4 enclosure and shall operate from A 115 VAC power source.

170012.10. BAR SCREENS

The ultrasonic level measuring system supplied at each of the bar screens shall operate using two transducers. The transmitter shall display level or volume from each, as well as the differential of the two. The system shall feature four SPDT alarm/control relays, and shall output analog signals of 4-20 mA. All values shall be key pad programmable. The level differential indicating transmitter shall be installed on the bar screen control panel.

The system shall be Milltronics Multi Ranger Plus, panel-mount type, or equal.

170012.20 PRESEDIMENTATION BASINS

The ultrasonic level device at the presedimentation basins shall display single point level measurement. The system shall feature two SPDT relays.

The transmitter shall output 4-20 mA. All values shall be keypad programmable.

The system shall be Milltronics MicroRanger II, or equal.

170013. MAGNETIC FLOWMETERS

The magnetic flowmeter shall be of the low frequency electromagnetic induction type and shall produce a pulsed DC signal directly proportional to and linear with the liquid flow rate. The meter shall be designed for operation on 120 VAC ±10 percent, 60 Hz ±5 percent.

The signal converter portion of the magnetic flowmeter shall include both the magnet driver to power the magnet coils and the signal converter electronics. The signal converter shall be integrally or remotely mounted within 500 feet of the flowmeter. It shall be housed in the NEMA 4 die cast aluminum case. When remotely mounted, the interconnecting cable shall be supplied with the meter. Signal converters shall be identical and interchangeable for all meter sizes. When integrally mounted the converter shall include a separate customer connection section to isolate the electronics compartment and protect the electronics from the environment. A separate terminal strip for power connection shall be supplied.

The electronics shall be solid state, utilize integrated circuitry and be microprocessor based. It shall have push-button programming and an integral LCD to allow for change of rate and/or pulse width. There shall be no trim pots, jumpers, DIP switches, or external devices to calibrate the instrument. Programmed flow ranges shall be entered directly in engineering units. The microprocessor shall safeguard against entering of invalid flow rate data for the particular line size. The LCD shall display programmed values, flow rate, totalized flow, and error codes as required. All data shall be stored in nonvolatile memory without battery back-up.

The system shall be self-standardizing with automatic data integrity checking to maintain the system accuracy within its performance specifications. Manual secondary calibration checks shall not be required.

The calibrated analog and digital output accuracy of the flowmeters, not including panel readouts shall be ±1/2 percent of rate in 10 to 100 percent of flow range for all metered velocities between 1 and 30 feet per second. The meters shall give no "ghost readings" under a condition of zero flow and shall have an output of 4 mA DC at zero flow. The repeatability of the scale reading shall be ±0.25 percent of rate in 10 to 100 percent of flow range and shall not be affected by fluctuations of line voltages of ±10 percent or frequency of ±1 percent.

170013.10 MAGNETIC FLOW HEAD

The metering tubes for sizes 1/10-inch through 12-inch shall be constructed of stainless steel. For sizes 14-inch and larger, the tubes shall be constructed of 304 stainless steel. All magnetic flowmeters shall be designed to mount directly in the pipe between ANSI Class 150 flanges through 24-inch, and AWWA Class D flanges in sizes 30-inch and larger. Meters 1/10-inch through 4-inch shall be wafer design. Sizes 6-inch and larger shall consist of a flanged pipe spool piece. Laying length of meters 14-inch and larger shall be 1-1/2 times the nominal meter size. Meters 4-inch and smaller shall be lined with Tefzel and be supplied with zirconium electrodes. Meter sizes 6-inch and larger shall have Neoprene liners and 316 stainless steel electrodes. The meter(s) shall be sized in accordance with the flow ranges specified in DIVISION 18.

The flow head shall be splashproof and shall be able to withstand continual submergence in water to 30 feet. The electrodes shall be field replaceable without affecting calibration. Electrodes, electrode field leads and coils shall be field replaceable without having to take the piping system out of service. Outer surface of the meter body, except flange faces, shall be coated as per DIVISION 9. Splash and dustproof terminal box (NEMA 4) with watertight cable entrance seals shall be provided on the main body of the meter.

The output of the flow head shall be linear and directly proportional to the average velocity of the fluid flowing through the meter tube. Neither turbulence nor variation in velocity profile within the flowing fluid shall affect the accuracy of the flow head in its ability to measure the average flow, when operating within its guaranteed temperature and velocity ranges.

Each magnetic flow head shall be grounded to a 10-foot long by 5/8 inch diameter copper clad ground rod, or an individual concrete encased ground electrode.

The operating temperature range of flow head shall be from +5 degrees F to +150 degrees F, minimum.

All necessary hardware for the installation of the flow heads in the process pipelines shall be provided. This hardware shall include flange gaskets manufactured from neoprene or rubber; grounding probes or 1/8 inch thick grounding rings with internal diameter 1/4 inch smaller than process pipeline I.D.; and all necessary grounding straps and fasteners to complete the installation of the flow head.

Ultrasonic electrode cleaner systems shall be installed based upon manufacturer's recommendation for both the raw water and presedimentation sludge application.

The flow head shall be Krohne America M460, Fischer & Porter Series 10D1435, or equal.

170013.20. MAGNETIC FLOWMETER REMOTE ELECTRONICS

The magmeter manufacturer shall provide a transmitter for each meter as specified:

1. Design: Microprocessor based solid state. Incorporate automatic zero stability without flow interruption.

2. Mounting: Integral mounted or wall mounted within 100 feet of the flowmeter.

3. Enclosure: Splash, water and dustproof NEMA 4X die cast aluminum case or manufacturer's standard.

4. Electrical: Provide power and signal wire between the flowmeter and the transmitter. Cable and conduit shall be installed in accordance with Electrical Section, DIVISION 16. The size and type of cable and conduit shall also be in accordance with the meter manufacturer's recommendation. Fittings to be moisture and watertight.

5. Power Requirements: 120 Vac, 60 Hz.

6. Flow Indicator: Flush mounted in the transmitter enclosure. Digital display of flow rates/totalized flow in engineering units, with an accuracy of ±2.0 percent.

7. Output Signals: (1) 4-20 mA DC into 800 ohms load and scaled frequency 0-10 Hz at 15 mS pulse width minimum or 0-10 KHZ at 50 uS pulse width minimum. (2) Reverse flow digital output contact, normally open, set to close on adjustable reverse flow setting. The analog output shall have an adjustable response time. The scaled pulse outputs shall be designed to operate a remote totalizer. Scaling factors shall be field adjustable to provide totalizer multiplier of a power of 10.

8. Low Flow Cutoff Limit: Drive the output to zero when the measured flow rate is 2 percent or less of full scale.

9. Operating Temperature: -20 to 130 degrees F (-30 to 55 degrees C).

10. Humidity: 10 to 90 percent noncondensing.

Factory calibration certificates shall be submitted for the flowmeter. An ISA data sheet shall be submitted for approval.

The flowmeter remote electronics shall be Fischer & Porter Series 50XM1000, Krohne America SC-100, or equal.

A calibration procedure for the flowmeter shall be supplied by the meter manufacturer for use with the manufacturer-furnished calibrator.

170013.30. MAGNETIC FLOWMETER SECONDARY CALIBRATOR

One portable secondary calibrator shall be furnished.

The magnetic flowmeter secondary calibrator shall be a passive, high accuracy device designed to simulate output signals and reference voltages from low frequency type magnetic flowmeters. The magnetic flowmeter secondary calibrator shall be furnished by the magmeter manufacturer.

The instrument shall precisely simulate a process flow signal to accomplish dynamic performance testing of the electronic circuitry without the meter being in service, and to simulate specific flow velocities between 0 and 9.99 m/sec.

Accuracy of the calibrator shall be ±0.15 percent of setting at reference conditions. It shall be capable of operating in a temperature range of -40 to +65 degrees C. The unit shall be housed in NEMA 1 case.

170017. VARIABLE AREA FLOW METERS (ROTAMETERS)

Variable area flow meters shall be the straight through flow design suited for the service described below. Each unit shall be of the full view type with viton O-ring seals suitable for pipeline or panel mounting as indicated on the Plans. The flow range shall be as per DIVISION 18 with a minimum rangeability of 10:1 and a minimum accuracy of plus or minus 2 percent maximum flow rate from 100 percent to 10 percent full range.

All wetted materials shall be Type 316 stainless steel. The meter shall have either direct etched or detachable flow scales. All meters supplied shall have the same flow scale design. Scale length shall be 250 mm plus or minus. Connections to the meter shall be rotatable through 360 degrees in 90-degree intervals. Full safety shielding shall be required in the front only with the rear of the meter equipped with dark colored backing plate. The float shall be constructed of Type 316 stainless steel and shall be designed for the specific service and flow rates stated below. The meters shall be Wallace and Tiernan, Fischer & Porter, or equal.

170018. pH ANALYZER

The pH sensor, analyzer and indicating transmitter shall be products of the same manufacturer. The cable between the sensor and the transmitter shall be provided by the manufacturer. The sensor shall consist of a corrosion-resistant PVC or polypropylene plastic electrode housing which contains a glass pH electrode and a fouling-resistant reference electrode. The reference electrode shall be self-contained and shall not require an external electrolyte reservoir. The sensor shall have automatic temperature compensation.

Flow-through type sensors shall have 3/4 or 1 inch NPT process connections and shall be suitable for a working pressure of 50 psig at 140 degrees F.

Each sensor assembly shall be provided with two maintenance kits which shall include a spare pH electrode, a spare reference electrode, and other spare parts as recommended by the manufacturer.

The transmitter shall be enclosed in a cast aluminum or fiberglass NEMA 4 housing. The transmitter shall be suitable for ambient temperatures of -30 degrees C to +50 degrees C with relative humidity of 0 to 100 percent. The transmitter shall have an isolated 4-20 mA DC output which is linearly proportional to the measured pH range with an accuracy of plus or minus 0.5 percent of scale.

The transmitter shall contain a 3-1/2 digit LCD display with engraved pH units. Transmitter range shall be as indicated on the Instrument Index. The transmitter shall have automatic temperature compensation over a range of 0 to +50 degrees C. The local indicator shall be scaled in Engineering pH units. The transmitter shall be powered from 120 volts AC.

The pH analyzer shall be Fischer & Porter, Rosemount-Xertec, Foxboro, or equal.

170019. SURFACE SCATTER TURBIDIMETERS

The turbidimeter shall be a continuous reading, on-line instrument using the nephelometric method of turbidity measurement. It shall use a silicon photodiode to detect scattered light from a tungsten filament light source through the sample in the measuring tube. There shall be no contact between the photocell and the liquid sample. An auto ranging display shall read from 0-9999 NTU with automatic decimal positioning eliminating range setting. Accuracy shall be ±5 percent from 0 to 2000 NTU, ±10 percent from 2000 to 9999 NTU. Repeatability shall be ±1.0 percent or ±0.04 NTU, whichever is greater. Resolution shall be 0.01 NTU below 100 NTU, 0.1 NTU between 100-999.9 NTU and 1.0 NTU over 1000 NTU. The unit shall be suitable for operation in temperatures from 33 degrees F to 122 degrees F.

Calibration of the meter shall be based on formazin, the primary turbidity standard. Routine calibration shall be via comparison to laboratory turbidimeter or with furnished secondary reflectance rods.

The turbidimeter shall consist of a turbidimeter body and a control unit. All optical and hydraulic components shall be housed in the body. The body shall also incorporate a built-in trap to purge the sample of entrapped air prior to measurement. The body shall be constructed as a NEMA 12 rated plastic enclosure. The control unit shall be constructed as a NEMA 12 rated plastic enclosure with clear polycarbonate cover. Units shall be wall mounted.

The control unit shall provide a digital LED display with 4 digits and auto decimal positioning. It shall provide a linear 4-20 mA output signal which can be programmed to span all or a portion of the 0-9999 NTU range. It shall provide two set point alarms adjustable over the entire range and actuate SPDT relays with contacts rated for 5A resistive load at 230 VAC. The unit shall have a bubble rejection circuit to eliminate spikes due to transient conditions. Power requirement shall be selectable 120 VAC, 60 hertz.

Surface scatter turbidimeters shall be Hach, or equal.

170201.20. CURRENT-TO-CURRENT CONVERTER

Current-to-current converters shall provide electrical isolation between the input and output. Current-to-current converters shall be supplied where shown and wherever the circuit impedance exceeds the capability of a transmitter. The converter shall receive a 4-20 mA DC analog current input signal and produce an identical 4-20 mA DC output signal into a 0-1,000 ohm load. Accuracy shall be plus or minus 0.25 percent of span. The converter shall be provided with NEMA 1 enclosure suitable for back of panel mounting.

170307.10 TOTALIZERS (GENERAL)

They shall be Fischer & Porter, Foxboro, or equal.

170314.10 SET POINT RELAYS

The set point relays shall be solid state device and shall provide a contact closure or opening output from a 4-20 mA current input upon reaching a preselected set point. The set point shall be continuously adjustable over the entire span. The dead band shall also be adjustable from at least 1 percent to 20 percent. The output relay shall be DPDT with contacts rated 5 amps at 120 volts AC resistive load. The output contacts shall be isolated. Power requirements shall be 120 volts AC, 60 Hertz.

The unit shall be housed in a general purpose, dead front, type housing.

The set point relays shall be Fischer & Porter Type 55PA, Foxboro 63 Series, or equal.

170315. PRESSURE SWITCHES

Pressure switches shall have snap action type, single-pole, double-throw switching elements with an electrical rating of at least 10 amperes at 120 volts AC. Switches shall be enclosed in NEMA 12 housings for interior installation, and NEMA 4 housings for exterior. Set points shall be fully adjustable and shall be in the middle of the working range. Pressure switches shall be accurate to within 1/2 percent of set point. Pressure switches for pressures up to 80 psig shall be of the diaphragm or bellows type and shall have a proof pressure of at least twice the maximum working pressure. Diaphragms and bellows shall be Type 316 stainless steel.

Pressure switches for pressures greater than 80 psig shall be of the bourdon tube or bellows type and shall have a proof pressure of at least 50 percent greater than the maximum working pressure. Bourdon tubes and bellows shall be Type 316 stainless steel.

Pressure switches shall be as manufactured by Barksdale Controls, United Electric Controls Company, or Mercoid. The Contractor shall review the application and determine the set points prior to submitting the recommended products to the Engineer for acceptance.

170405.10. CONTROL PANELS

Refer to specific requirements for equipment in other sections of the Specifications for control panels for sludge collectors, bar screens, conveyor, and chemical valves.

170410.10. PROGRAMMABLE CONTROLLERS

Programmable controller shall be supplied for control and monitoring as shown on the Drawings. The field inputs and outputs shall be connected to the programmable controller (PLC). The programmable controller shall be located inside the MCC and shall be of the same manufacturer as the MCC. See DIVISION 16 of these Specifications.

All input and output shall be modular. Light emitting diodes shall be supplied with each modular input and output device that shall indicate malfunction. All ladder logic and control diagrams shown on the Plans as PLC software shall be fully implemented by the Contractor.

Input and output modules shall be furnished and installed plus 50 percent spare for each type of input or output. The I/O count shall be obtained from both the electrical and instrumentation drawings. However, as a minimum the implemented input and output complement shall be:

64 discrete inputs (dry contact type)
64 discrete outputs (relay emulation)
8 analog inputs (4-20 milliamperes D.C.)
2 analog outputs (4-20 milliamperes D.C.)
2 pulse inputs (0 to 20 pulses per second)

PLC shall be manufactured by Allen Bradley, Westinghouse, General Electric, or equal.

170410.20. PROGRAMMABLE CONTROLLER PROCESSOR

The programmable controller (PLC) shall be a microprocessor based industrial controller with a temperature rating of 0 to 60 degrees C and a humidity rating of 5 to 95 percent noncondensing, minimum. A local face plate programming terminal shall be installed on the PLC. A data table access module shall be installed on the PLC enclosure for set point adjustment access.

It shall contain programmable CMOS circuitry to store user-programmed instructions. The memory capacity shall be sufficient to fully implement implement the control algorithms shown on the plans and described in these Contract Documents plus 100 percent spare programming space for each PLC. However, in no case shall the fully implemented programming capacity be less than 2,000 8-bit bytes.

The PLC shall be supplied with register memory which shall retain information on power failure for a minimum of 48 hours. Each location shall be capable of storing 16 bits of data. The numerical information storable shall be binary, 2's complement, or binary coded decimal. This information shall represent process set points, times, counter presets, accumulated values, positions, or other measured process variables. Register and auxiliary status tables shall be supplied for the PLC.

The PLC shall be supplied with logic memory. Logic memory shall be retentive on power failure. Program control and logic functions shall be solved sequentially during each CPU scan. The scanning mechanism shall additionally perform PLC system tasks to include:

1. Update of time reference from a built-in clock.

2. Diagnostic self-test of PLC to include input and output.

3. Reset watchdog timer which shall be used to verify correct functioning of the PLC and which shall be preset to 100 to 250 milliseconds.

In the event of DC input power failure the PLC shall complete an executing, pending function and go to a safe state.

After power is restored and during power-up, the physical PLC outputs shall be disabled until the PLC shall read all inputs, solve all logic, perform preliminary input-output, and verify all other functions of the PLC. The PLC shall be configurable to allow the system supplier to program which digital outputs should resume control after power failure, which digital outputs should remain set in their last position before power failure until manually reset, and which digital outputs shall be de-energized until manually reset.

The PLC shall be clock driven with a resolution of plus or minus 10 milliseconds or better.

Twelve bit minimum analog inputs and outputs shall be available with the following ranges:

1 to 5 volts DC
4 to 20 mA DC

Each discrete output shall have a fuse, with fuse blown indicators on each module. Indicator lights shall also be provided on each I/O point to indicate status of each input or output signal. Each individual input or output point shall be opto-isolated to protect the controller I/O circuitry from user input and output high voltage transients. The I/O modules and structures shall be universal in design and be compatible with all of the processors available from the selected supplier. All external wiring shall be made to removable wiring arms or swing arms to allow simple quick installation or extractions of I/O modules. Labels shall be provided on modules and wiring arms for user to mark data. Wire terminals on I/O shall accept a maximum 12-gauge stranded wire.

The power supply shall provide power for the processor, I/O modules, and meter receiver/transmitters. It shall have built-in overvoltage and undervoltage detection circuitry, protection against overcurrent conditions, and automatic power-up sequence which enable outputs only when proper operating tolerances are reached. The power supply shall accept 24-volt direct current input.

A surge suppression shall be included for PLC protection.

170410.30. INPUT/OUTPUT STRUCTURE

The Input/Output (I/O) Structure shall consist of a rack or racks of input/output modules which shall interface between the processor and control devices. The I/O structure shall be field expandable to the maximum capacity without modifications of the processor. I/O modules shall be available as listed.

D.C. (12 to 24-volt)	Input or Output
AC/DC Isolated (120-volt)	Input or Output
Dry Contact	Input

The programmable controller shall be supplied with extended functions that shall include 3 mode, proportional, derivative, and integral control algorithms and communication interface. Programmable controller shall not be accepted unless the programmable controller supplier can document, to the satisfaction of the Engineer, that the supplier has communication interfaces, along with the required software; all of which shall be the PLC manufacturers' standard, cataloged, product.

The programmable controller shall have reset counters, repeat cycle timer and reset timer, and the system supplier shall review the specific project requirements to implement the counter/timer requirements.

170410.40. UPS

A micro-UPS such as Best FERRUPS shall be sized based upon the PLC requirements, including spare I/O, with a submittal of calculated load. The UPS shall be within the MCC enclosure with a status light on the panel face indicating alarm or running status.

* * * END OF DIVISION 17 * * *

DIVISION 18

OPERATIONS

1808000 GENERAL

The requirements set forth in this section, in general, shall apply, but are not limited to all instrumentation equipment furnished under DIVISION 11, DIVISION 15, DIVISION 17 and as indicated elsewhere in the Plans and/or Specifications. They shall supplement the Detailed Equipment Specifications, but in case of conflict, the Detailed Equipment Specifications take precedence.

This section of the Specifications provides the units of measure and the limits of measure for design operation of the instrumentation equipment used in each of the design areas of this project. This information is presented in tabular form for each of the instruments which includes the description, instrumentation drawing where shown, units of measurement, lower limit of measure, upper limit of measure, other limit of measure and any relevant comments for each instrument. The significant figures used to define each of the limits shall represent the interval or increment of measure which the instrument will provide at the display. This is also the description of the term readability used in the comments column.

The purpose of this Section is to establish the control and/or monitoring criteria that each unit of instrumentation equipment is designed to provide.

Abbreviations List

(BW)	Backwash Mode
CFM	Cubic Feet per Minute
C.L.	Confidence Level
DEGREES (F)	Degrees - Fahrenheit
Ø	Diameter
DO	Dissolved Oxygen
EXP.	Expanded
(F)	Filter Mode
F.E.	Flow Element
FT.	(See Plans for Reference Elevation)
FT.(AMSL)	Feet Above Mean Sea Level (Elevation)
FLOC.	Flocculator
GALS.	Gallons
GPM	Gallons per Minute
IN.	Inch
LB	Pounds
LB/IN^2	Pounds per Square Inch
LB/MN	Pounds per Minute
LVL	Level
MFG.	Manufacturer
MG	Million Gallons
MGD	Million Gallons per Day
MG/L	Milligrams per Liter
MN	Minute

MIN.	Minimum
M.S.	Microscreens
MMHO'S	Unit of Measure for Conductivity (milli-MHO's)
NO.	Number
NTU	Nephelometric Turbidity Units
OPER.	Operating
PART/ML	Particles per Milliliter
PRESED.	Presedimentation
pH	Hydrogen Ion Concentration
PPM	Parts per million
PRESS.	Pressure
PSI	Pounds per Square Inch
% SOLIDS	Percent Solids
STA.	Station
STOR.	Storage
M	Micrometer (Micron)

FIELD INSTRUMENTS

DESCRIPTION	DRAWING(S)	ENGINEERING UNITS	RANGE LOWER LIMIT	RANGE UPPER LIMIT	RANGE OTHER LIMIT	COMMENTS
BAR SCREEN CHANNEL 1 LEVEL SENSOR A	N-2	FT (AMSL)	1231.0	1243.0	--	
BAR SCREEN CHANNEL 1 LEVEL SENSOR B	N-2	FT (AMSL)	1231.0	1243.0	--	
BAR SCREEN CHANNEL 2 LEVEL SENSOR A	N-2	FT (AMSL)	1231.0	1243.0	--	
BAR SCREEN CHANNEL 2 LEVEL SENSOR B	N-2	FT (AMSL)	1231.0	1243.0	--	
BAR SCREEN CHANNEL 3 LEVEL SENSOR A	N-2	FT (AMSL)	1231.0	1243.0	--	
BAR SCREEN CHANNEL 3 LEVEL SENSOR B	N-2	FT (AMSL)	1231.0	1243.0	--	
BAR SCREEN CHANNEL 1 HIGH DIFFERENTIAL	N-2	FT	--	--	0.4	HIGH DIFFERENTIAL START (BAR SCREEN
BAR SCREEN CHANNEL 1 HIGH DIFFERENTIAL	N-2	FT	--	--	0.6	HIGH DIFFERENTIAL ALARM
BAR SCREEN CHANNEL 2 HIGH DIFFERENTIAL	N-2	FT	--	--	0.4	HIGH DIFFERENTIAL START (BAR SCREEN
BAR SCREEN CHANNEL 2 HIGH DIFFERENTIAL	N-2	FT	--	--	0.6	HIGH DIFFERENTIAL ALARM
BAR SCREEN CHANNEL 3 HIGH DIFFERENTIAL	N-2	FT	--	--	0.4	HIGH DIFFERENTIAL START (BAR SCREEN
BAR SCREEN CHANNEL 3 HIGH DIFFERENTIAL	N-2	FT	--	--	0.6	HIGH DIFFERENTIAL ALARM
RAW WATER TURBIDITY ROTOMETER	N-2	GPM	0.0	1.0	--	
RAW WATER TURBIDITY	N-2	NTU	0.0	999.9	--	READABILITY = 0.1
RAW WATER PH ROTOMETER	N-2	GPM	0.0	20.0	--	
RAW WATER PH	N-2	PH	2.0	12.0	--	READABILITY = 0.1
RAW WATER POST CHEMICAL ADDITION PH ROTOMETER	N-2	GPM	0.0	20.0	--	
RAW WATER POST CHEMICAL ADDITION PH	N-2	PH	2.0	12.0	--	READABILITY = 0.1
SAMPLE PUMP NO. 1 HIGH DISCHARGE PRESSURE SWITCH	N-2	PSI	0	100	*	VARIABLE SETTING, * SET PER PUMP MANUFACTURER'S REQUIREMENTS
SAMPLE PUMP NO. 2 HIGH DISCHARGE PRESSURE SWITCH	N-2	PSI	0	100	*	VARIABLE SETTING, * SET PER PUMP MANUFACTURER'S REQUIREMENTS
RAW WATER FLOW METER NO. 1	N-2	MGD	0.0	140.0	--	READABILITY = 0.1, BIDIRECTIONAL
RAW WATER FLOW METER NO. 2	N-2	MGD	0.0	140.0	--	READABILITY = 0.1, BIDIRECTIONAL
PRESEDIMENTATION SLUDGE PUMP STATION SUMP FLOAT SWITCH NO. 1	N-4	FT (AMSL)	--	--	1220.5	

FIELD INSTRUMENTS

DESCRIPTION	DRAWING(S)	ENGINEERING UNITS	RANGE LOWER LIMIT	RANGE UPPER LIMIT	RANGE OTHER LIMIT	COMMENTS
PRESEDIMENTATION SLUDGE PUMP STATION SUMP FLOAT SWITCH NO. 2	N-4	FT (AMSL)	--	--	1220.0	
PRESEDIMENTATION SLUDGE PUMP STATION SUMP FLOAT SWITCH NO. 3	N-4	FT (AMSL)	--	--	1223.5	
PRESEDIMENTATION SLUDGE PUMP STATION SUMP FLOAT SWITCH NO. 4	N-4	FT (AMSL)	--	--	1224.0	
PRESEDIMENTATION BASIN EFFLUENT LEVEL	N-5	FT (AMSL)	--	--	--	
PRESEDIMENTATION SLUDGE PUMP NO. 1 SEAL WATER PRESSURE INDICATOR	N-6	PSI	0	100	--	
PRESEDIMENTATION SLUDGE PUMP NO. 1 DISCHARGE PRESSURE INDICATOR	N-6	PSI	0	100	--	
PRESEDIMENTATION SLUDGE PUMP NO. 1 DISCHARGE LOW PRESSURE SWITCH	N-6	PSI	0	100	*	VARIABLE SETTING, * SET PER PUMP MANUFACTURER'S REQUIREMENTS
PRESEDIMENTATION SLUDGE PUMP NO. 1 DISCHARGE HIGH PRESSURE SWITCH	N-6	PSI	0	100	*	VARIABLE SETTING, * SET PER PUMP MANUFACTURER'S REQUIREMENTS
PRESEDIMENTATION SLUDGE PUMP NO. 1 FLOW METER	N-6	GPM	0	1000	--	
PRESEDIMENTATION SLUDGE PUMP NO. 2 SEAL WATER PRESSURE INDICATOR	N-6	PSI	0	100	--	
PRESEDIMENTATION SLUDGE PUMP NO. 2 DISCHARGE PRESSURE INDICATOR	N-6	PSI	0	100	--	
PRESEDIMENTATION SLUDGE PUMP NO. 2 DISCHARGE LOW PRESSURE SWITCH	N-6	PSI	0	100	*	VARIABLE SETTING, * SET PER PUMP MANUFACTURER'S REQUIREMENTS
PRESEDIMENTATION SLUDGE PUMP NO. 2 DISCHARGE HIGH PRESSURE SWITCH	N-6	PSI	0	100	*	VARIABLE SETTING, * SET PER PUMP MANUFACTURER'S REQUIREMENTS

FIELD INSTRUMENTS

DESCRIPTION	DRAWING(S)	ENGINEERING UNITS	RANGE LOWER LIMIT	RANGE UPPER LIMIT	RANGE OTHER LIMIT	COMMENTS
PRESEDIMENTATION SLUDGE PUMP NO. 2 FLOW METER	N-6	GPM	0	1000	--	
PRESEDIMENTATION SLUDGE PUMP NO. 3 SEAL WATER PRESSURE INDICATOR	N-6	PSI	0	100	--	
PRESEDIMENTATION SLUDGE PUMP NO. 3 DISCHARGE PRESSURE INDICATOR	N-6	PSI	0	100	--	
PRESEDIMENTATION SLUDGE PUMP NO. 3 DISCHARGE LOW PRESSURE SWITCH	N-6	PSI	0	100	*	VARIABLE SETTING, * SET PER PUMP MANUFACTURER'S REQUIREMENTS
PRESEDIMENTATION SLUDGE PUMP NO. 3 DISCHARGE HIGH PRESSURE SWITCH	N-6	PSI	0	100	*	VARIABLE SETTING, * SET PER PUMP MANUFACTURER'S REQUIREMENTS
PRESEDIMENTATION SLUDGE PUMP NO. 3 FLOW METER	N-6	GPM	0	1000	--	

* * * END OF DIVISION 18 * * *

STANDARD DETAILS

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STANDARD DETAILS

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STANDARD DETAILS

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GENERAL:

1. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS BEFORE STARTING WORK AND SHALL IMMEDIATELY NOTIFY THE ENGINEER OF ANY DISCREPANCIES.

2. UNLESS DETAILED, SPECIFIED, OR INDICATED OTHERWISE, CONSTRUCTION SHALL BE AS INDICATED IN THE APPLICABLE TYPICAL DETAILS AND GENERAL NOTES. TYPICAL DETAILS ARE MEANT TO APPLY EVEN THOUGH NOT REFERENCED AT SPECIFIC LOCATIONS ON DRAWINGS.

3. WHERE NO CONSTRUCTION DETAILS ARE SHOWN OR NOTED FOR ANY PART OF WORK, DETAILS SHALL BE THE SAME AS FOR OTHER SIMILAR WORK.

REINFORCED CONCRETE:

1. ALL CONCRETE CONSTRUCTION, INCLUDING BENDING OF BARS, SHALL COMPLY WITH ACI "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE" (ACI 318).

2. UNLESS INDICATED OTHERWISE ON THE PLANS, MINIMUM REINFORCEMENT OF CONCRETE WALLS OR SLABS SHALL BE:

   8" THICK OR LESS – USE #5 @ 12" EW
   9" THICK OR MORE – USE #5 @ 12" EWEF

3. ALL WALL REINFORCEMENT AT CORNERS OR JUNCTIONS OF WALLS SHALL BE CONTINUOUS, LAPPED, OR TERMINATED IN A STANDARD 90 DEGREE HOOK. LAP SPLICES SHALL CONFORM WITH NOTE 5.

4. UNLESS INDICATED OTHERWISE, ALL BARS SHALL BE DOWELED. DOWELS SHALL BE THE SAME SIZE AND SPACING AS THE REINFORCEMENT WHICH IS SPLICED TO THE DOWELS.

5. UNLESS INDICATED OTHERWISE ON THE PLANS, THE LENGTH OF LAP SPLICES SHALL BE CLASS "B" WHERE NO MORE THAN HALF THE BARS ARE LAP SPLICED WITHIN THE LENGTH TABULATED BELOW. ALL SPLICE LENGTHS SHALL BE IN ACCORDANCE WITH APPLICABLE TABULATED VALUES. LENGTHS SHOWN ARE IN INCHES. FOR BARS SPACED 6 INCHES ON CENTER, OR FARTHER APART, WITH AT LEAST 3 INCHES CLEAR FROM FACE OF MEMBER TO EDGE OF BAR, MEASURED IN DIRECTION OF SPACING, THE SPLICE LENGTH MAY BE REDUCED BY 20 PERCENT.

   THE SPLICE LENGTH TABLE IS BASED ON FY = 60,000 PSI AND F'C = 3500 PSI

		#4	#5	#6	#7	#8	#9	#10	#11
TOP BARS*	(CLASS "B")	22	27	33	44	58	74	94	115
	(CLASS "C")	29	36	43	58	76	97	123	151
OTHER BARS	(CLASS "B")	16	20	23	32	42	53	67	82
	(CLASS "C")	20	26	31	41	54	69	88	108

*TOP BARS ARE ALL HORIZONTAL REINFORCEMENT SO PLACED THAT MORE THAN 12 INCHES OF FRESH CONCRETE IS CAST IN THE MEMBER BELOW THE BAR.

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6. ALL SLABS, BEAMS AND COLUMN REINFORCING BARS SHALL HAVE A MINIMUM EXTENSION OR ANCHORAGE INTO SUPPORTS IN ACCORDANCE WITH ACI 318.

7. STIRRUP SUPPORT BARS SHALL BE PROVIDED BETWEEN ENDS OF TOP BARS AS REQUIRED.

8. UNLESS INDICATED OTHERWISE, CONCRETE COVER OVER REINFORCEMENT SHALL BE AS FOLLOWS:

   A. SURFACES NOT EXPOSED DIRECTLY TO THE GROUND, WATER, OR WEATHER AFTER FORM REMOVAL:
      CONCRETE SLABS IN BUILDINGS ..... 3/4"
      CONCRETE SLABS OVER WATER BEARING STRUCTURES ..... 1"
      CONCRETE BEAMS, GIRDERS, COLUMNS, AND WALLS .... 1 1/2"
   B. SURFACES EXPOSED DIRECTLY TO THE GROUND, WATER OR WEATHER AFTER FORM REMOVAL:
      FOR #5 BARS OR SMALLER ..... 1 1/2"
      FOR #6 BARS OR LARGER ..... 2"
   C. CONCRETE PLACED DIRECTLY AGAINST THE GROUND ..... 3"
   D. REINFORCEMENT SHALL BE PLACED WITHIN A TOLERANCE OF ±1/4" OF POSITION SPECIFIED.

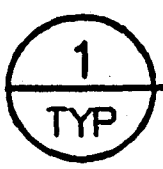
9. KEYWAYS AND WATER STOP SHALL END 3" BELOW THE TOP OF WALLS, UNLESS THERE IS A SLAB ON TOP OF THE WALL, IN WHICH CASE IT SHALL END AT THE BOTTOM OF THE SLAB. IN JOINTS WHERE WATERSTOP TERMINATES AT ADJOINING SLAB OR WALL, WATER STOP SHALL BE EMBEDDED IN ADJOINING SLAB OR WALL A MINIMUM OF 6".

10. CONCRETE CURING SHALL BE IN ACCORDANCE WITH THE CONTRACT DOCUMENTS. SOME CONCRETE WORK REQUIRES WATER CURING, AS SPRAYED MEMBRANE CURING IS NOT ALLOWED. THE CONTRACTOR IS WARNED THAT WATER CURING IS DIFFICULT AT TIMES DUE TO WIND AND DRY CONDITIONS. THE CONTRACTOR SHALL STUDY REQUIREMENTS AND SHALL FURNISH ADEQUATE SYSTEMS TO PROVIDE WATER CURING WHERE REQUIRED. TOP OF WALLS SHALL BE KEPT VISIBLY MOIST AT ALL TIMES AND SHALL BE FLOODED NOT LESS THAN THREE TIMES DAILY.

11. WATERSTOP SHALL BE PLACED IN ALL CONSTRUCTION, CONTRACTION, AND EXPANSION JOINTS IN ALL WATERBEARING SLABS AND WALLS UNLESS INDICATED OTHERWISE ON THE PLANS, AND IN ALL WALLS AND SLABS SUBJECTED TO GROUNDWATER. WATERSTOP IN THE WALLS SHALL BE CARRIED INTO SLABS AND SHALL BE SPLICED WITH THE WATERSTOP IN THE SLABS.

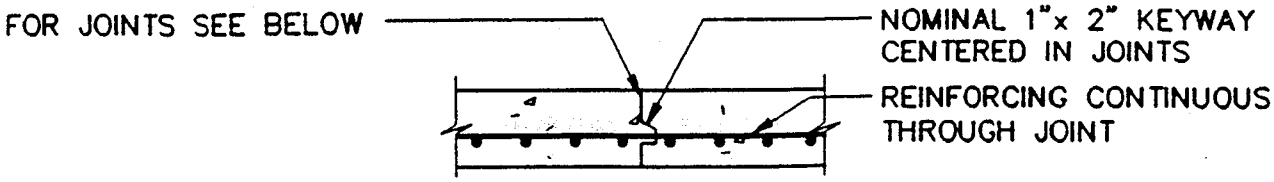
12. NO BACKFILL SHALL BE PLACED AGAINST WALLS UNTIL CONCRETE HAS REACHED 85 PERCENT OF THE SPECIFIED STRENGTH AND THE CONNECTING SLABS AND BEAMS HAVE BEEN CAST AND HAVE REACHED 85 PERCENT OF THE SPECIFIED STRENGTH.

13. PROVIDE A 3/4" CHAMFER ON ALL EXPOSED CONCRETE CORNERS, UNLESS NOTED OTHERWISE.

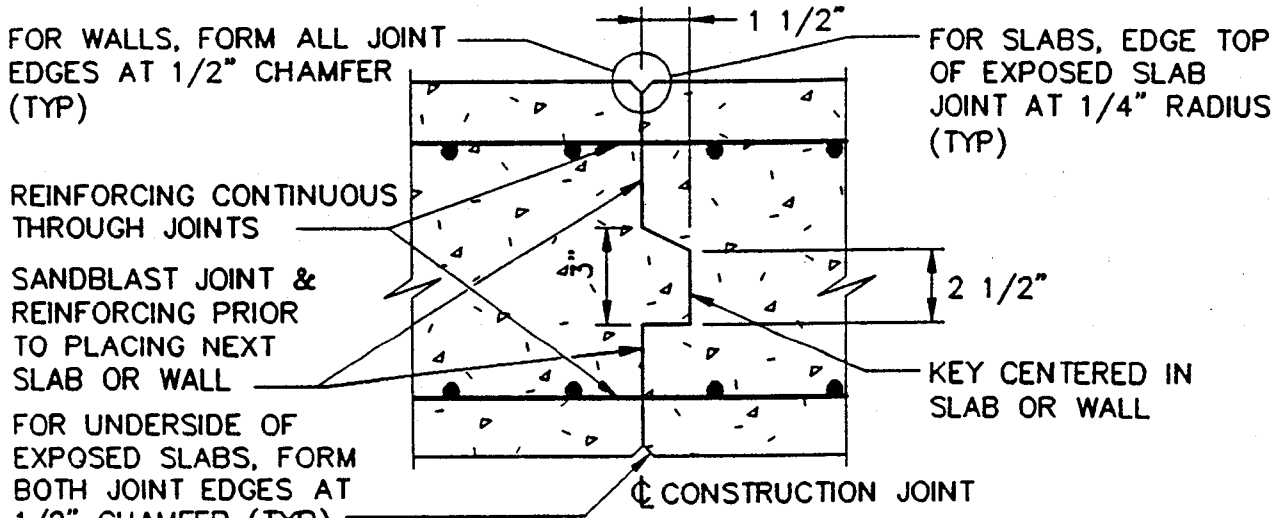


STRUCTURAL NOTES

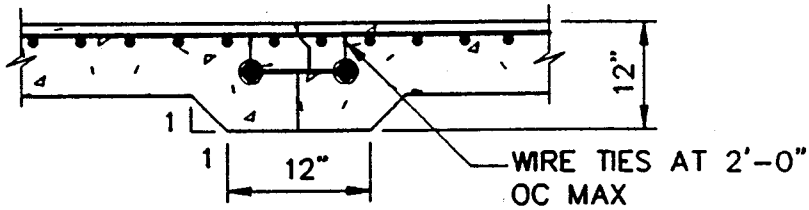
S



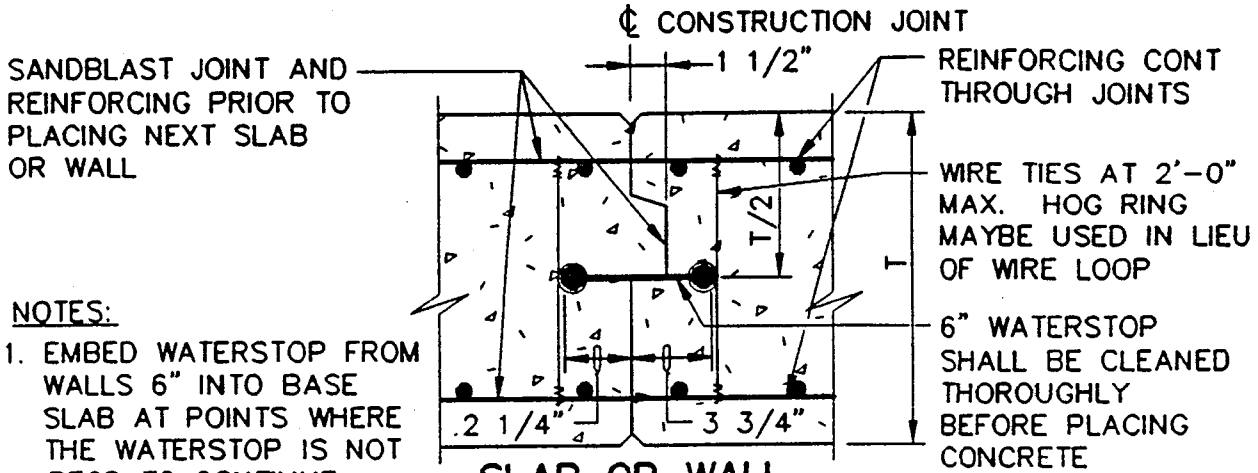
WALL OR SLAB WITH SINGLE CURTAIN REINFORCING



SLAB OR WALL
(NON-WATER BEARING)



SLAB THICKENING DETAILS
(WATER BEARING LESS THAN 12" THICK)



NOTES:

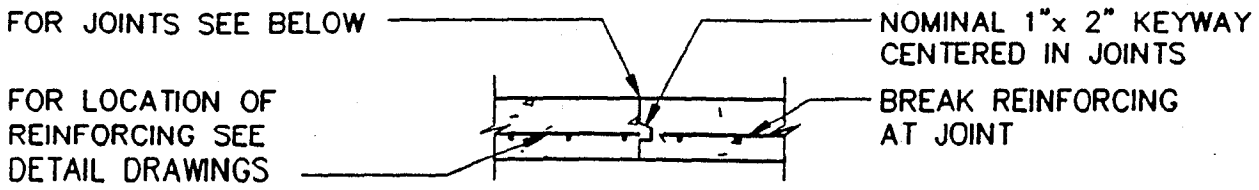
1. EMBED WATERSTOP FROM WALLS 6" INTO BASE SLAB AT POINTS WHERE THE WATERSTOP IS NOT REQD TO CONTINUE THROUGH SLAB.

SLAB OR WALL
(WATER BEARING)

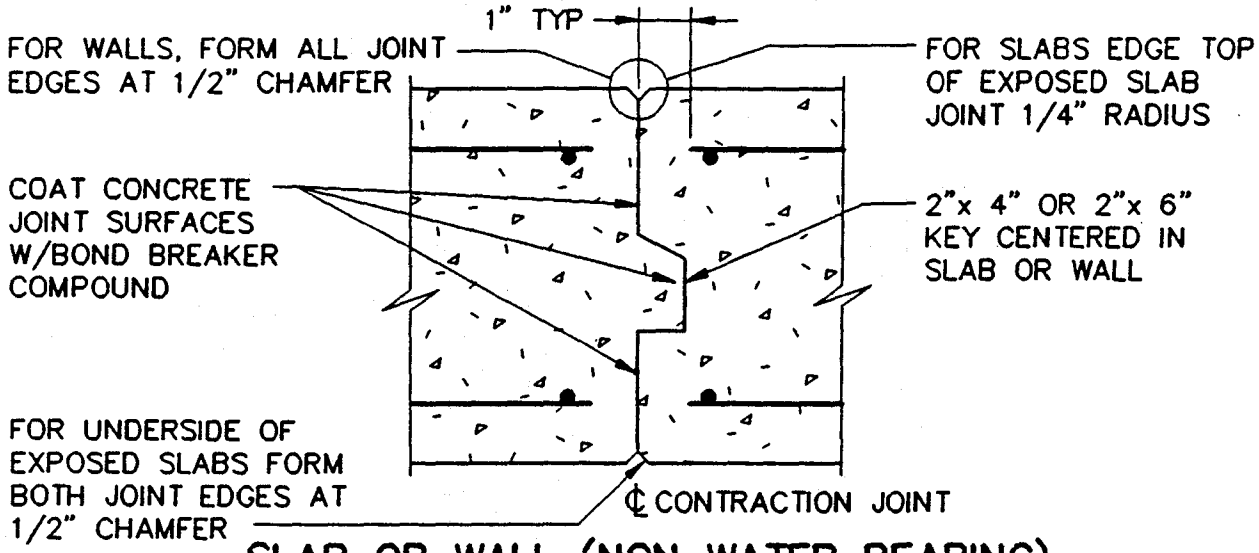
20 TYP

CONSTRUCTION JOINT

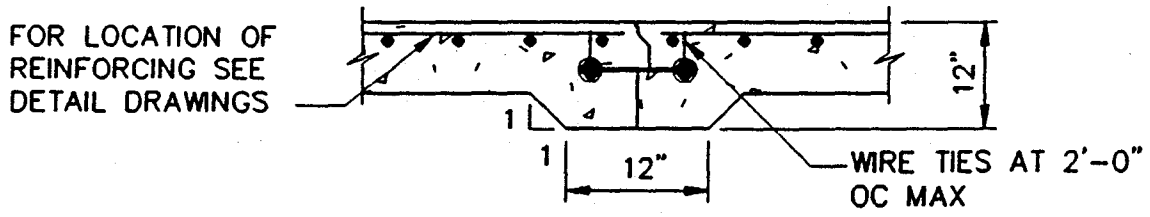
S



WALL OR SLAB WITH SINGLE CURTAIN REINFORCING

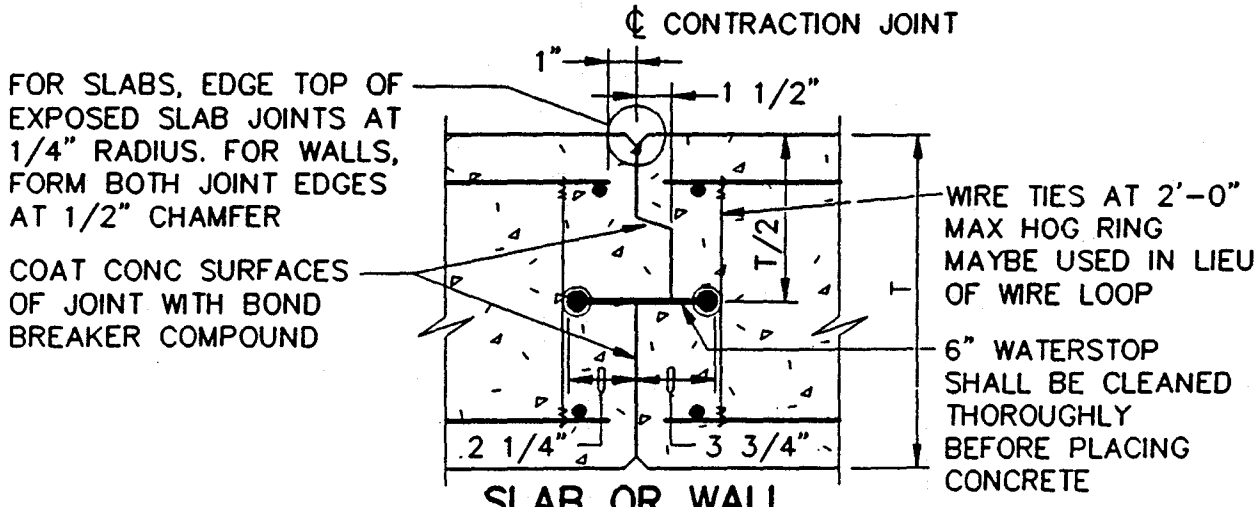


SLAB OR WALL (NON WATER BEARING)



SLAB THICKENING DETAILS

(WATER BEARING LESS THAN 12" THICK)



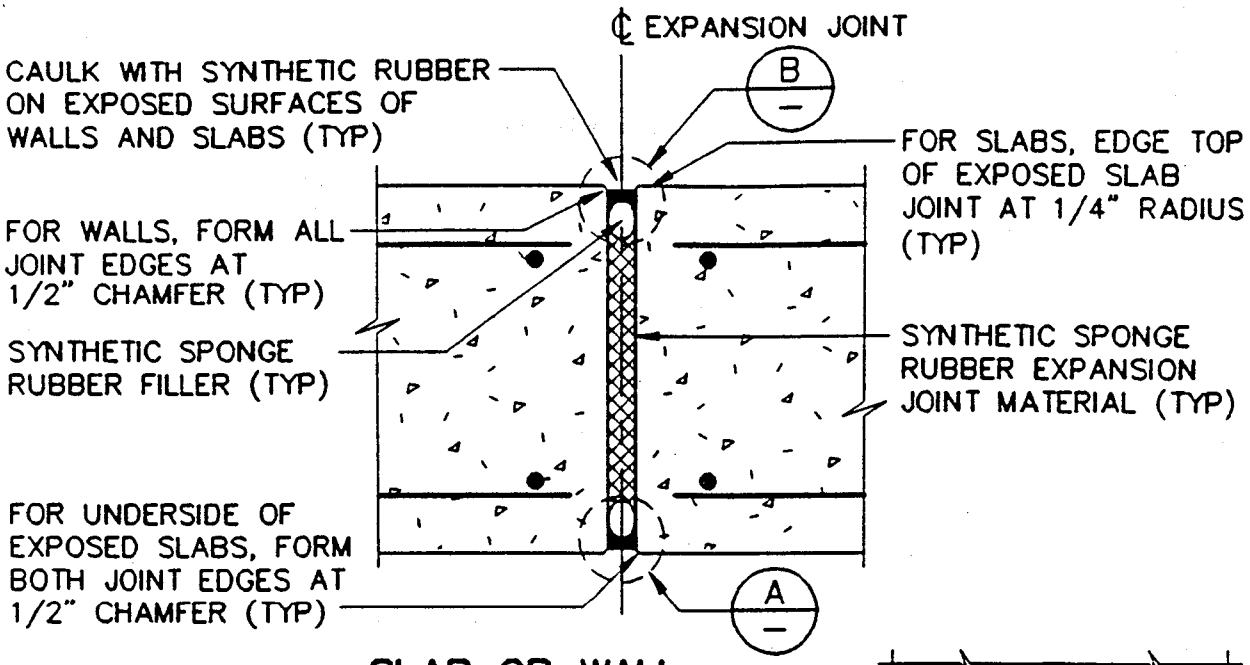
SLAB OR WALL

(WATER BEARING)

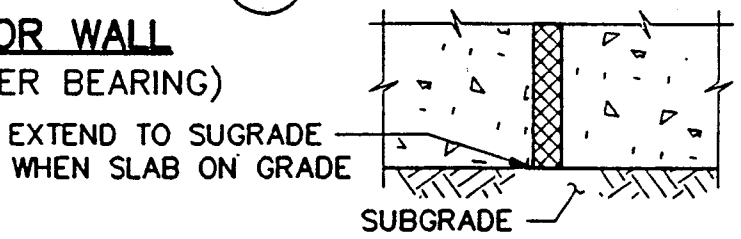
21 TYP

CONTRACTION JOINT

TYP021 5-14-91

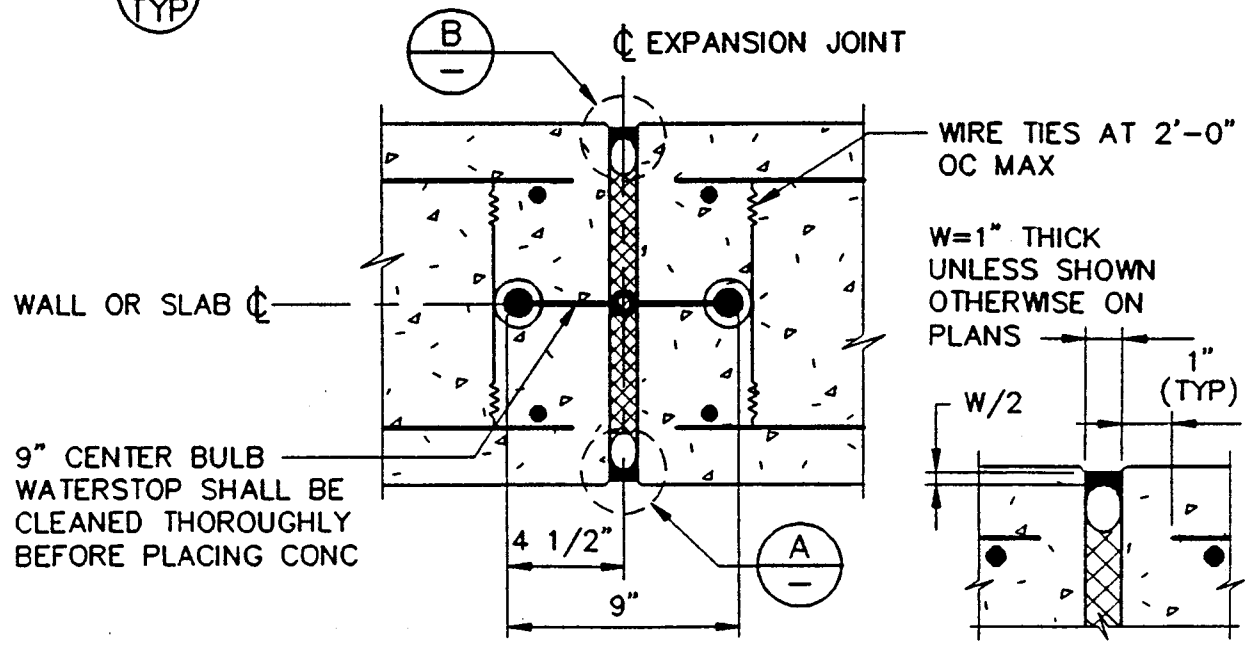


SLAB OR WALL
(NON-WATER BEARING)



NOTE:
1. SLABS ON GRADE SHALL BE THICKENED AT JOINT PER 20 TYP

A — DETAIL – SLAB ON GRADE

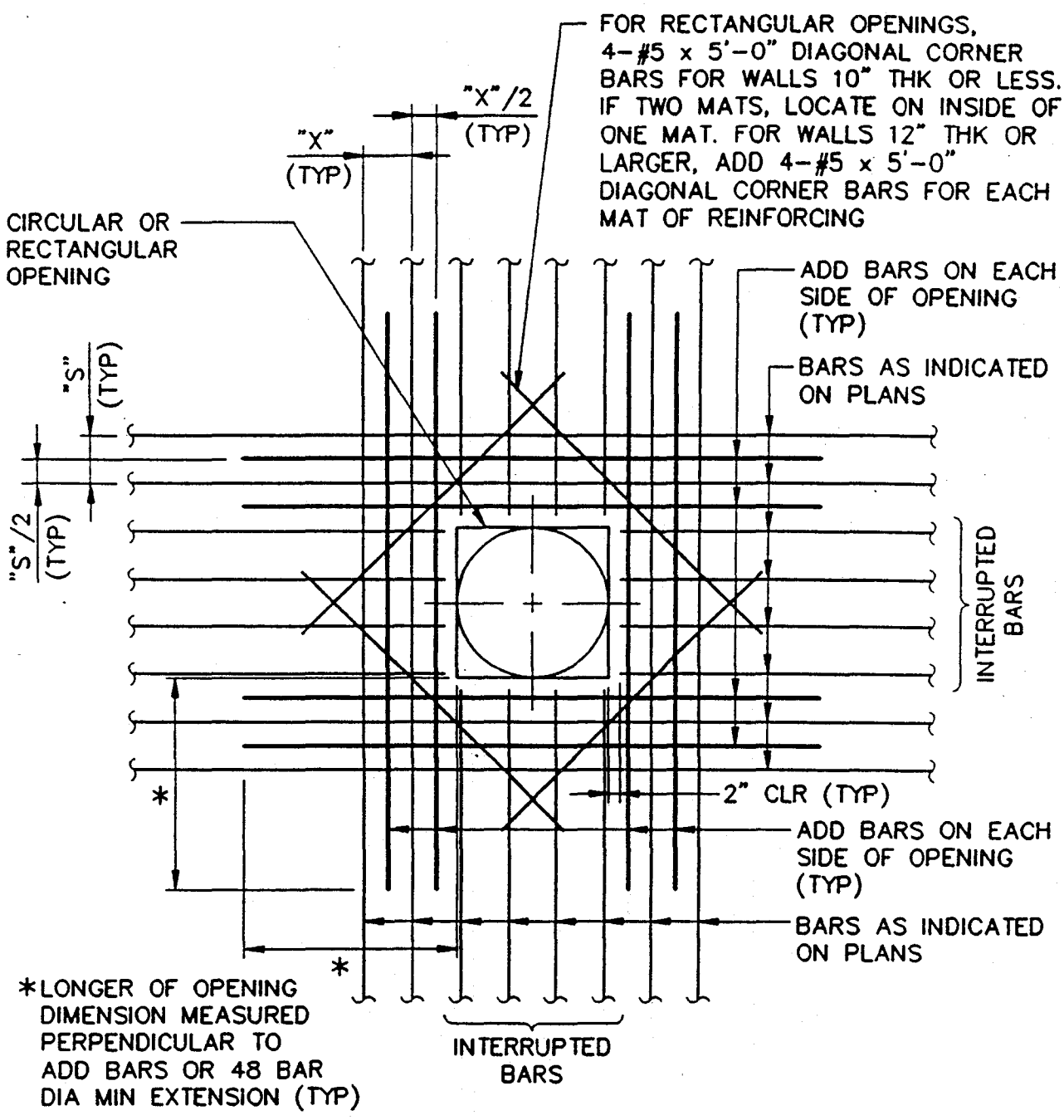


SLAB OR WALL
(WATER BEARING)

B — DETAIL

22 TYP S EXPANSION JOINT

TYP022 5-14-91



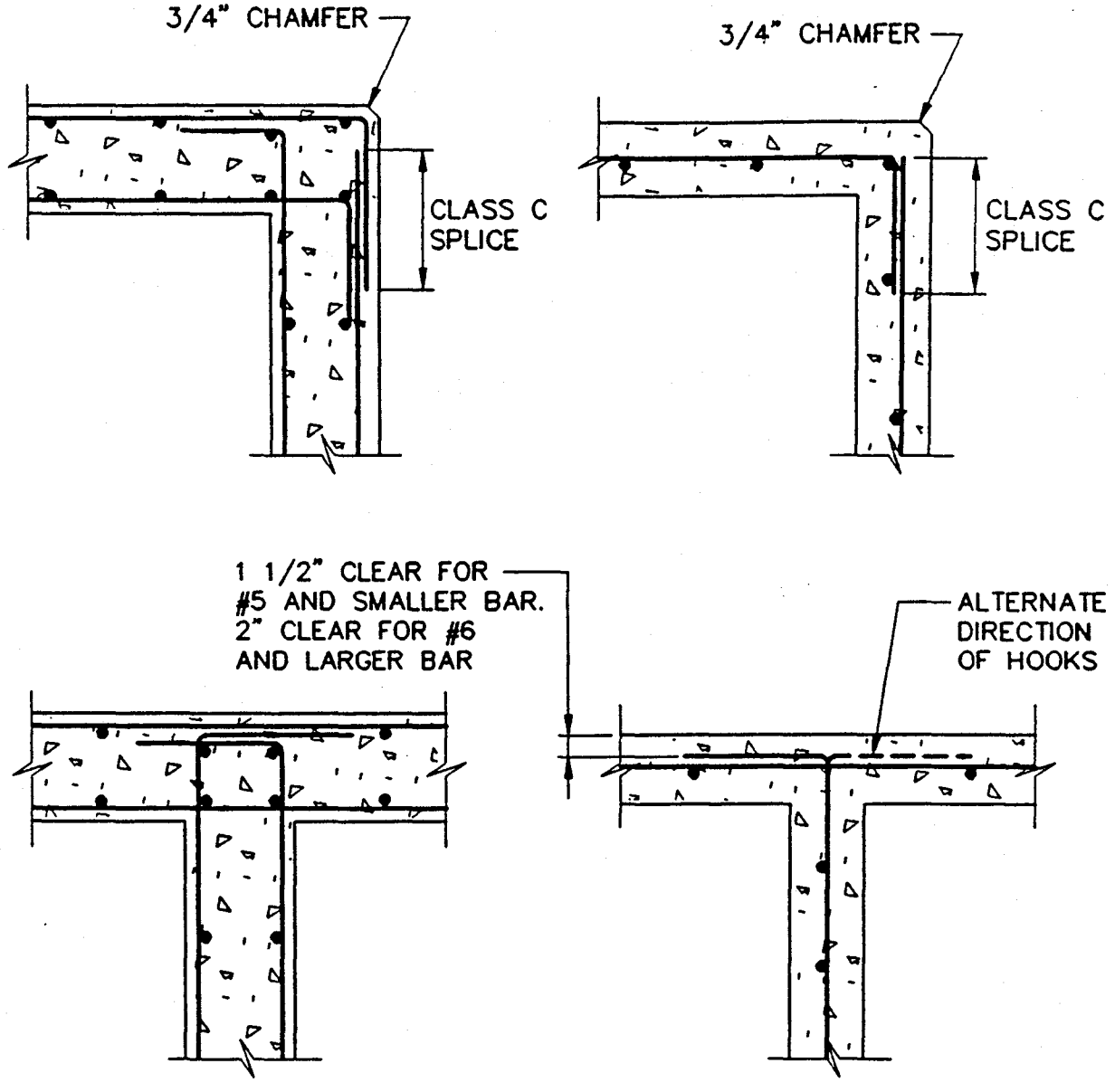
NOTES:

1. AREA OF ADD BARS AT EACH EDGE OF OPENING IN EACH DIRECTION SHALL MATCH 1/2 THE CROSS SECTIONAL AREA OF THE INTERRUPTED BARS.
2. PROVIDE STANDARD ACI HOOKS ON BARS IF STRAIGHT EXTENSION, PAST THE OPENING, CANNOT BE ACHIEVED.
3. PLACE ADD BARS IN SAME PLANES AS INDICATED REINFORCING.
4. PLACE #5 DIAGONAL BARS UNDER INDICATED REINFORCING.

25 TYP S

ADDITIONAL REINFORCING AT OPENINGS IN CONCRETE SLABS OR WALLS

TYP025 5-14-91



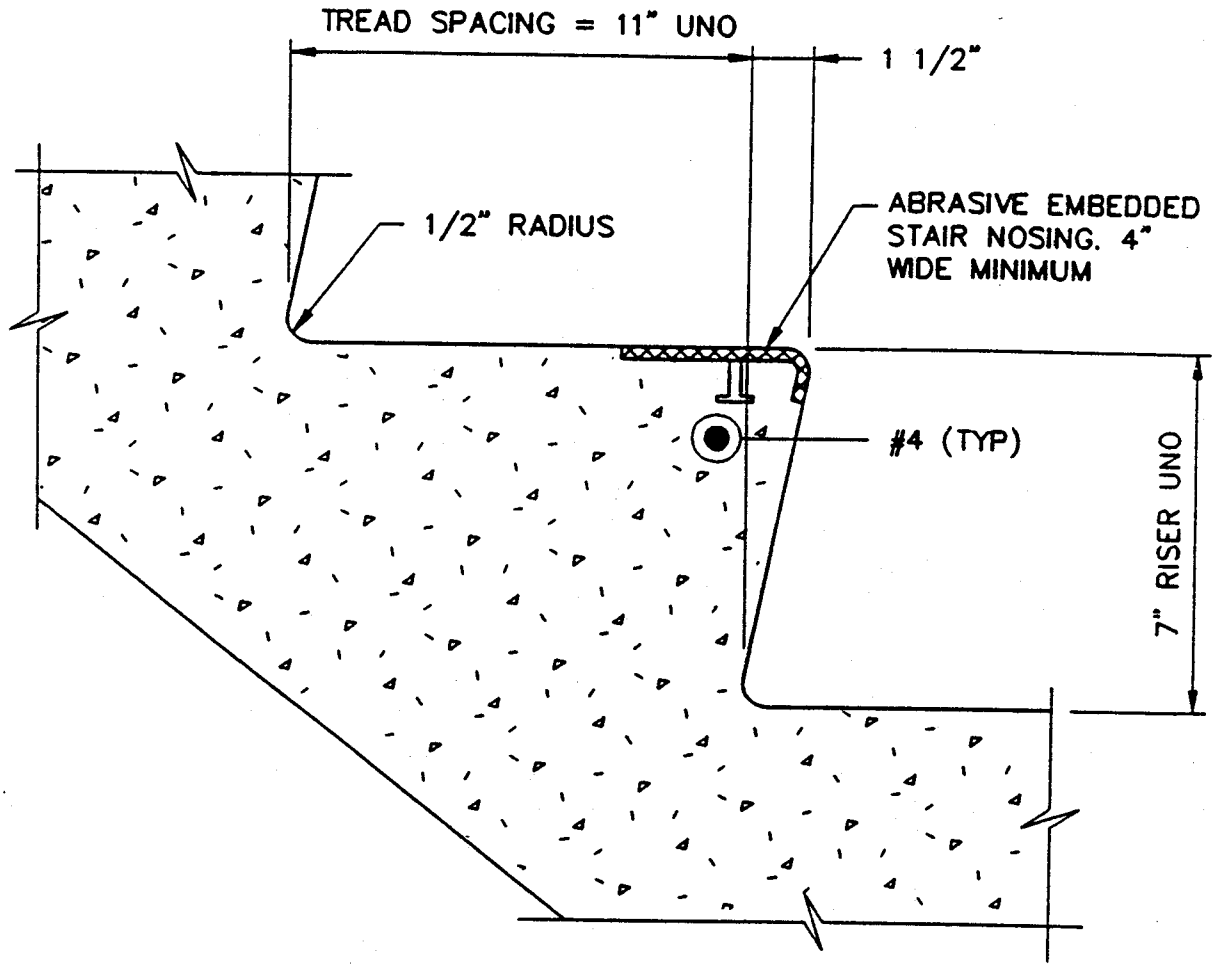
NOTES:

1. ALL HOOKS. SHALL BE ACI STD 90 DEGREE HOOKS.

26 TYP S

REINFORCEMENT AT CORNERS AND JUNCTIONS

TYP026 5-14-91

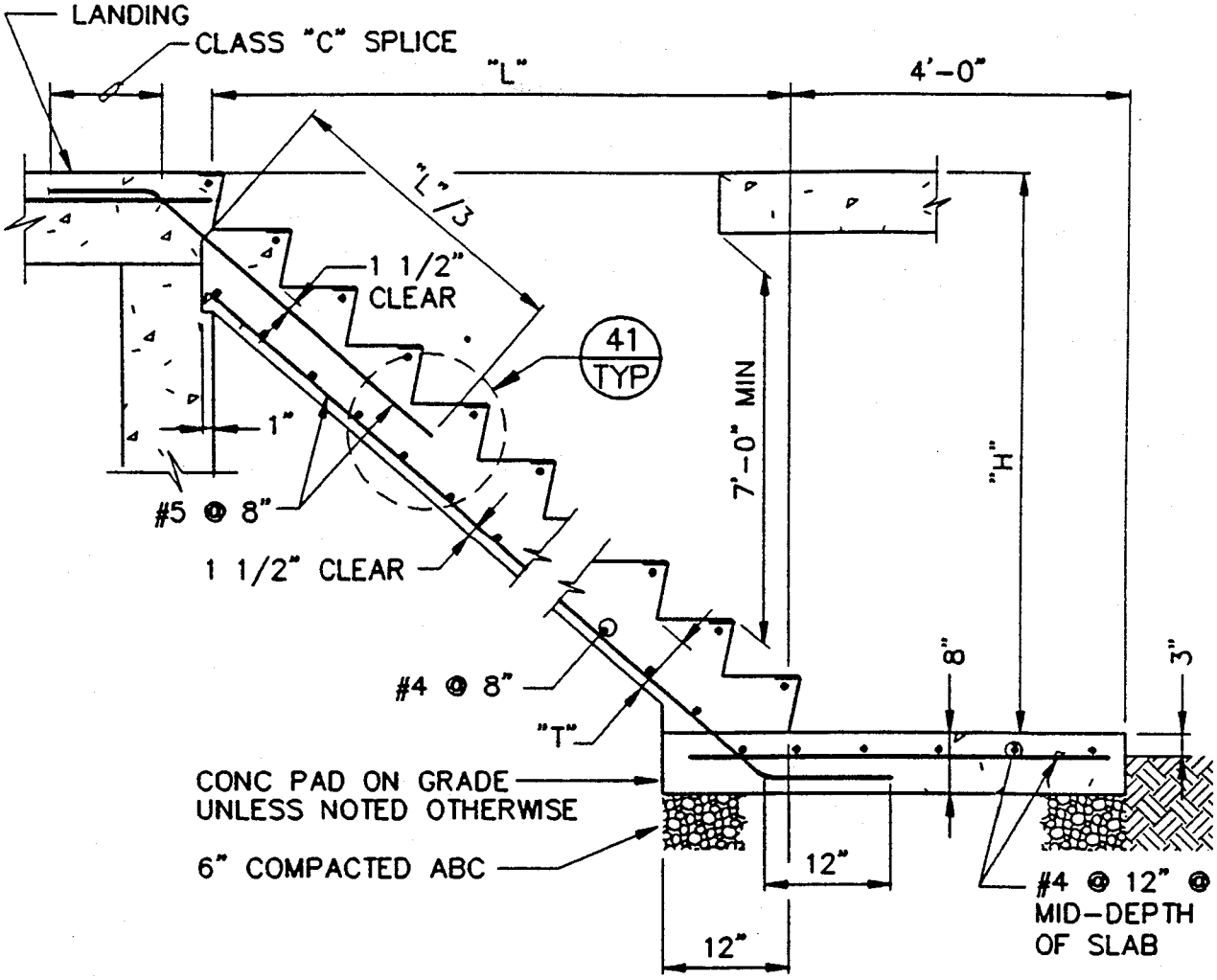


NOTE:

1. ANY FASTENERS IN THE STAIR NOSING SHALL BE TYPE 304 OR 316 ST STL.

41 TYP S **CONCRETE STEP**

TYP041 5-14-91



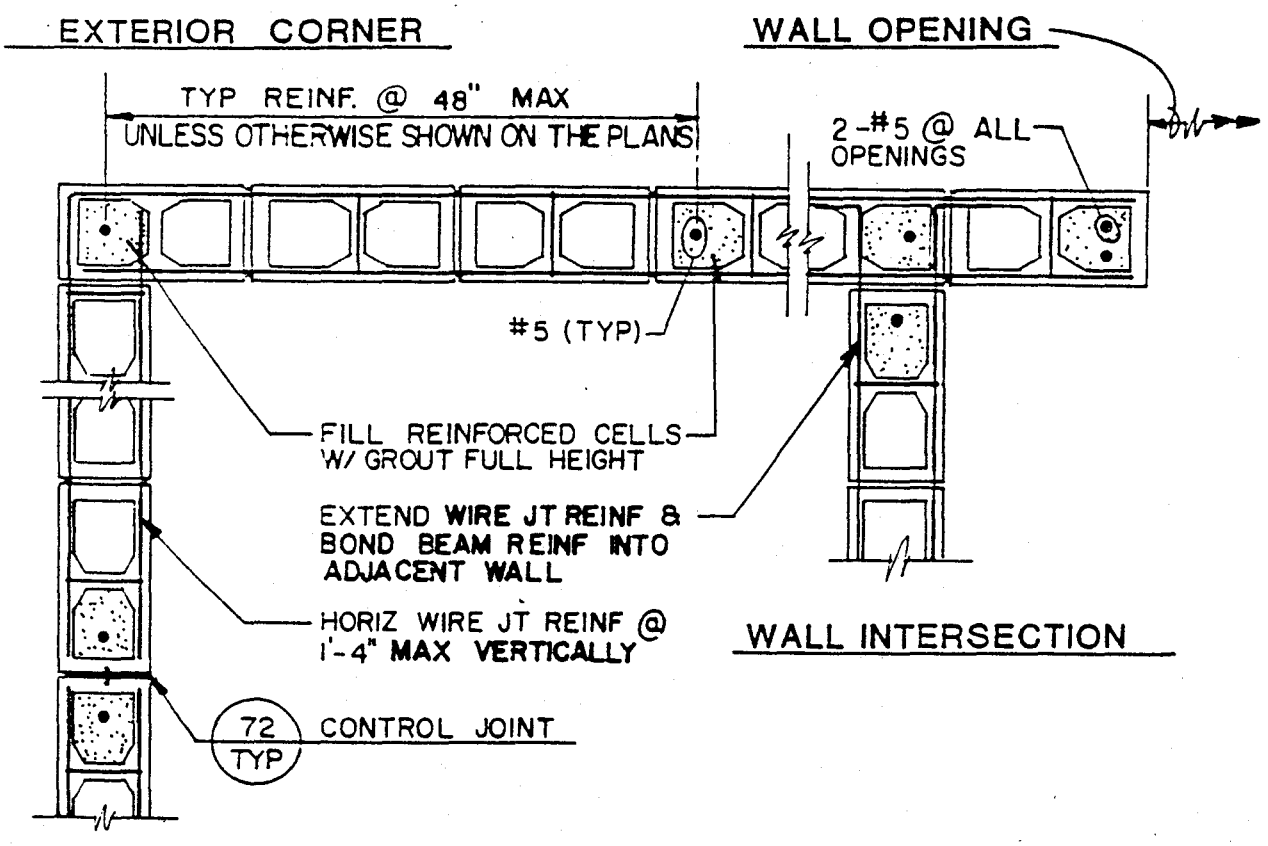
SPAN "L"	"T"
0' TO 8'	6"
8' TO 10'	8"
10' TO 12'	12"
12' TO 14'	16"

NOTES:

1. SEE PLANS FOR DIMENSIONS "H", "L" AND STAIR WIDTH "W".
2. ALL STAIRS SHALL HAVE HANDRAILS ON EACH SIDE.

43 TYP **CONCRETE STAIR**s

TYP043 5-14-91

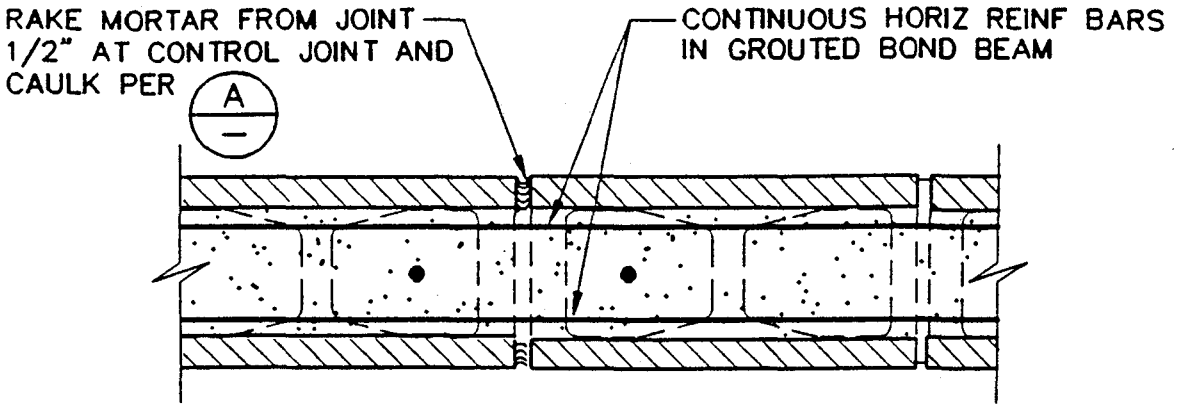


MASONRY NOTES:

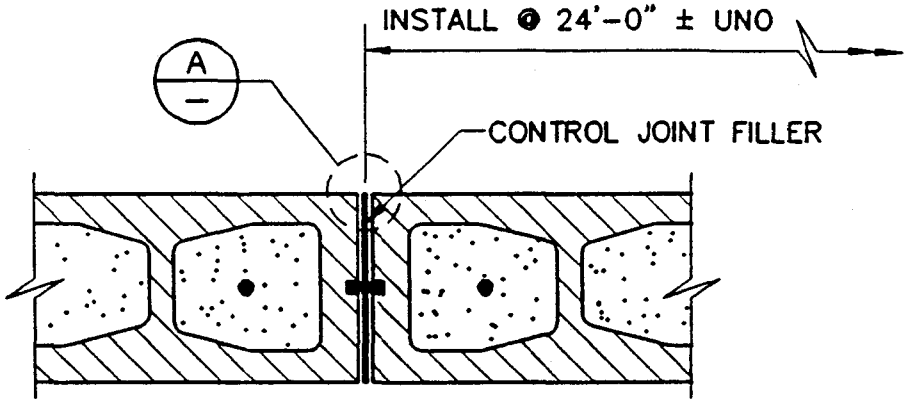
1. WALL REINFORCEMENT SHALL BE PLACED AND GROUTED AS DESCRIBED IN THE SPECIFICATIONS.
2. UNLESS INDICATED OTHERWISE ON THE PLANS, ALL WALLS SHALL BE REINFORCED WITH A MINIMUM OF NO. 5 VERTICAL REINFORCING BARS GROUTED AT 4'-0" OC AND HORIZONTAL WIRE JOINT REINFORCEMENT SPACED AT 1'-4" MAX. OC SEE PLANS FOR WALL REINFORCEMENT. SEE NOTE 5 FOR ADDITIONAL VERTICAL REINFORCEMENT ADJACENT TO WALL OPENINGS.
3. ALL VERTICAL REINFORCING SHALL EXTEND TO TOP OF WALL OR SHALL BE WELDED TO ANCHOR IN SLAB ABOVE AND SHALL BE DOWELED TO THE FOOTING WITH MATCHING DOWELS.
4. ALL DOWELS SHALL LAP WALL REINFORCING BARS 62 DIA AND SHALL BE DEVELOPED INTO FOOTING IN ACCORDANCE WITH ACI 318.
5. A NO. 5 VERTICAL BAR SHALL BE PLACED AND GROUTED AT ALL WALL CORNERS AND WALL INTERSECTIONS AND TWO NO. 5 VERTICAL BARS SHALL BE PLACED AT JAMBS OF WALL OPENINGS AND SUCH BARS SHALL EXTEND THE FULL HEIGHT OF WALL AND BE ANCHORED IN THE FOOTING AS INDICATED IN NOTE 4.
6. LINTELS FOR ALL OPENINGS SHALL BE 75 TYP UNLESS INDICATED OTHERWISE ON THE PLAN.
7. ALL HORIZONTAL AND VERTICAL JOINTS IN MASONRY UNITS SHALL BE CONCAVE ON BOTH FACES UNLESS INDICATED ON THE PLANS OR SPECIFIED OTHERWISE.
8. MASONRY CONTROL JOINTS IN WALLS SHALL BE INSTALLED AT 24'-0" ± SPACING UNLESS INDICATED OTHERWISE ON THE PLANS.
9. EXTERIOR WALL CELLS NOT FILLED WITH GROUT SHALL BE FILLED WITH INSULATION.

70 TYP MASONRY WALL REINFORCING

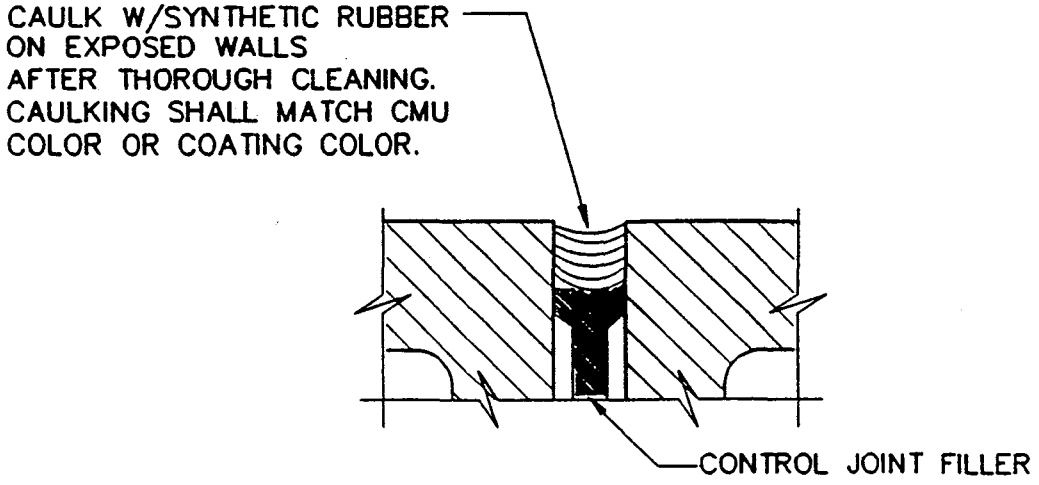
S 387



SECTION AT BOND BEAM



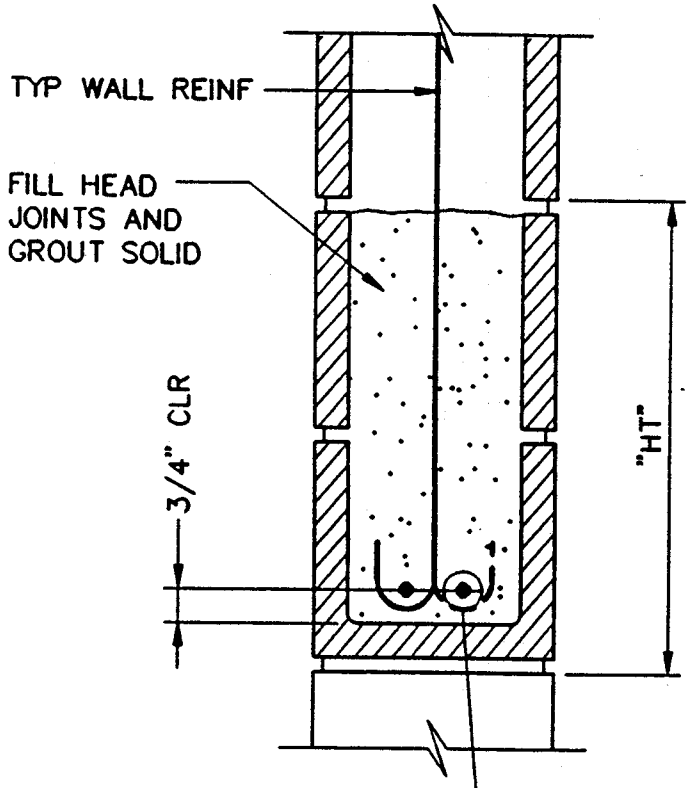
SECTION ABOVE OR BELOW BOND BEAM



A — DETAIL

72 TYP S MASONRY CONTROL JOINT

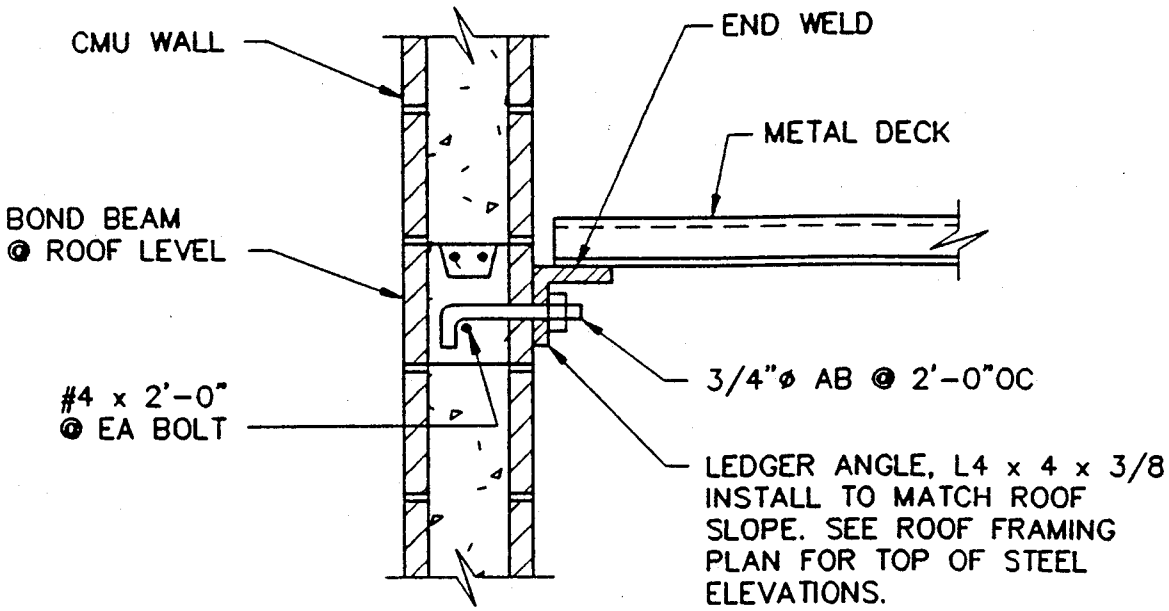
TYP072 5-14-91



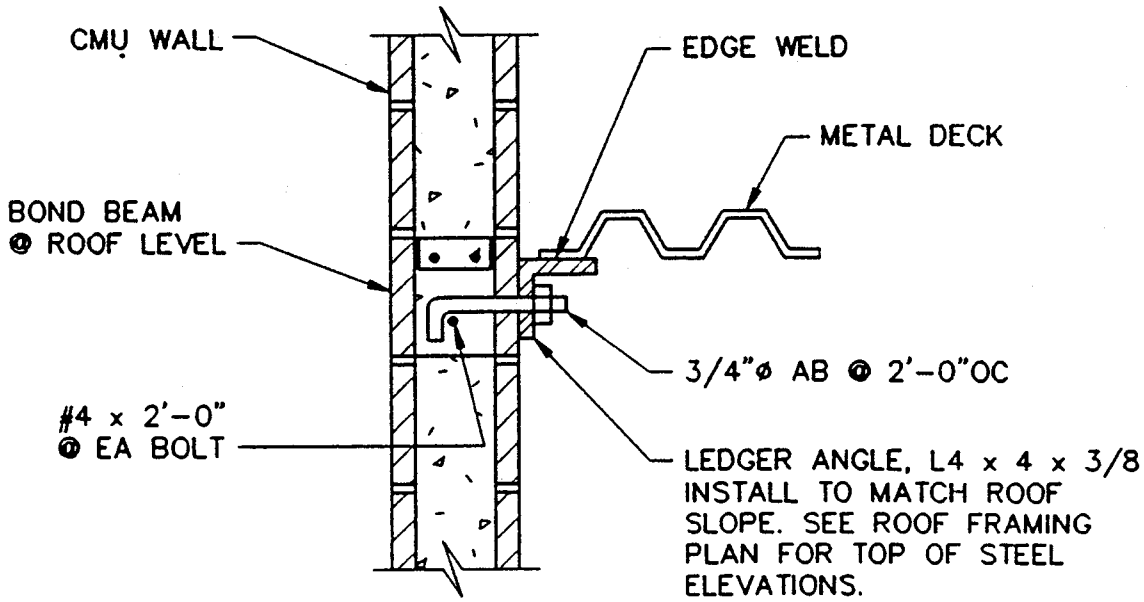
HT	CLEAR OPENING
16"	0'-0" - 8'-0"
32"	8'-1" - 12'-0"

75 TYP S LINTEL AT WALL OPENINGS IN MASONRY WALLS

TYP075 5-14-91



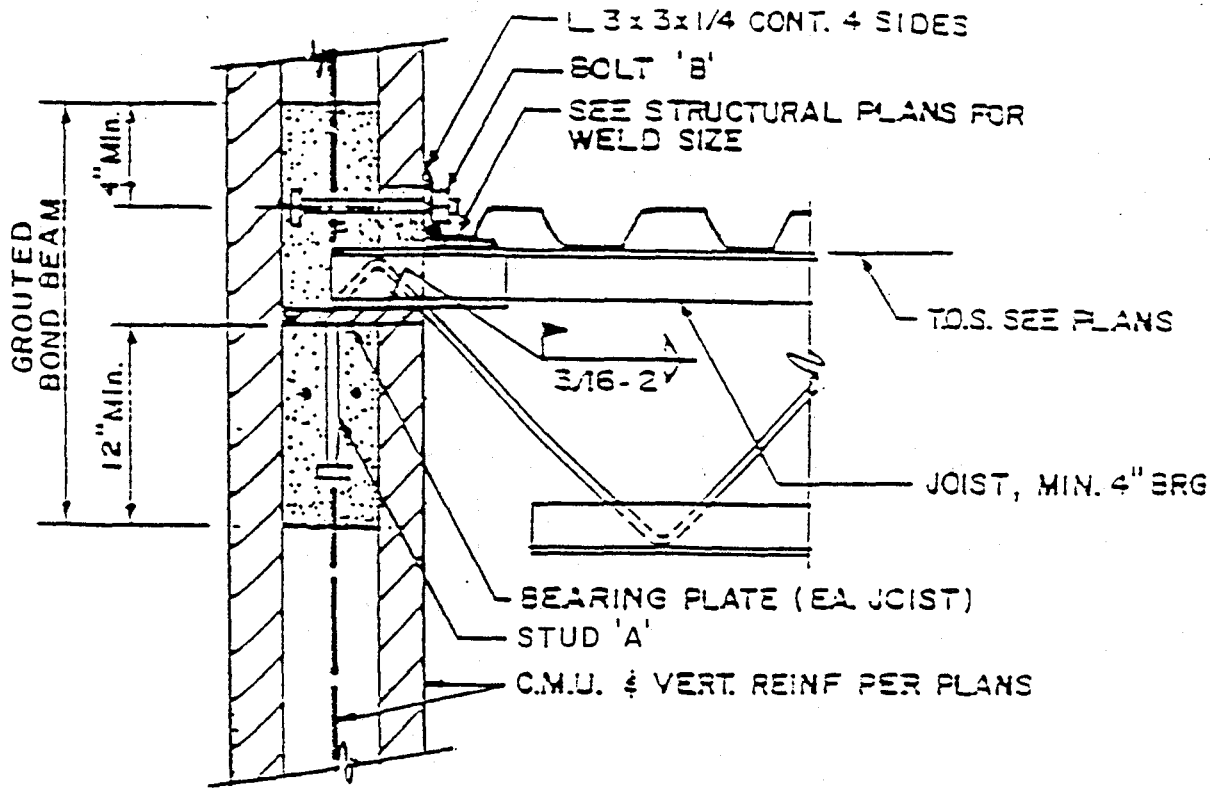
RIBS PERPENDICULAR TO WALL



RIBS PARALLEL TO WALL

104 TYP ROOF DECK TO WALL CONNECTION

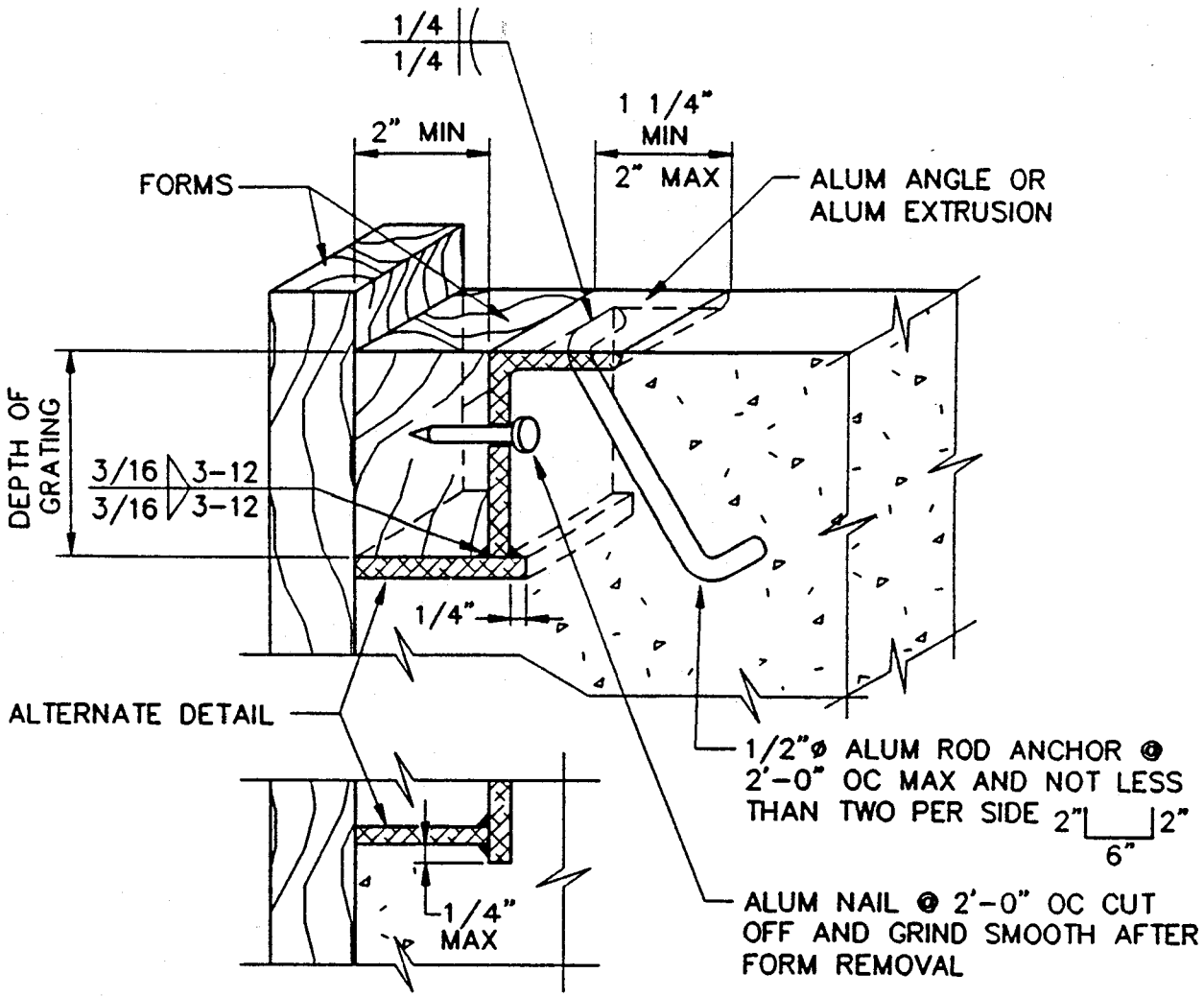
TYP104 5-14-91



JOIST TYPE	BEARING PLATE	STUD 'A'	BOLT 'B'	BOND BEAM REINFORCING
———	Thick x Width x Length	No. - Dia. x Length	Dia. x Length x Spacing	No. - Size x Length
14 K 3	1/2" x 6" x 0'-9"	(2) 1/2" x 6 9/16"	3/4" x 8" @ 2'-0"	2 - #5 x CONT.

108. TYP

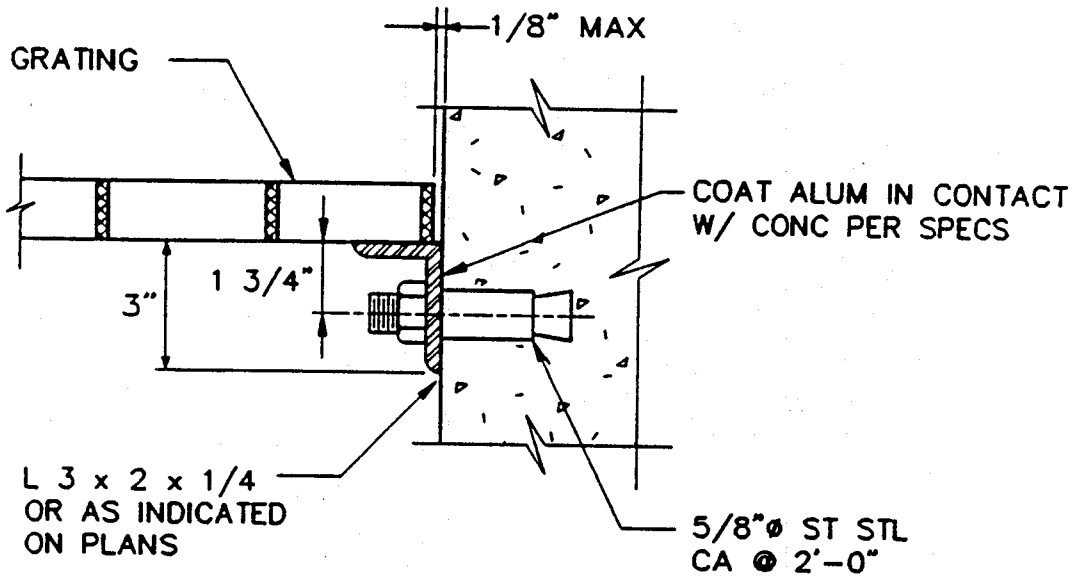
JOIST SUPPORT



NOTES:

1. FOR GRATING SEE SPECIFICATIONS.
2. REBATE ANGLE TO BE CONTINUOUS AROUND ENTIRE OPENING.
3. ALUM ANGLE AND BEARING PLATE SHALL BE 1/4" MIN THICK.
4. REBATE MAY BE EXTRUDED, SUBJECT TO ENGINEER'S APPROVAL.
5. COAT ALL ALUMINUM IN CONTACT WITH CONCRETE PER SPECIFICATIONS.

120 TYP S GRATING REBATE

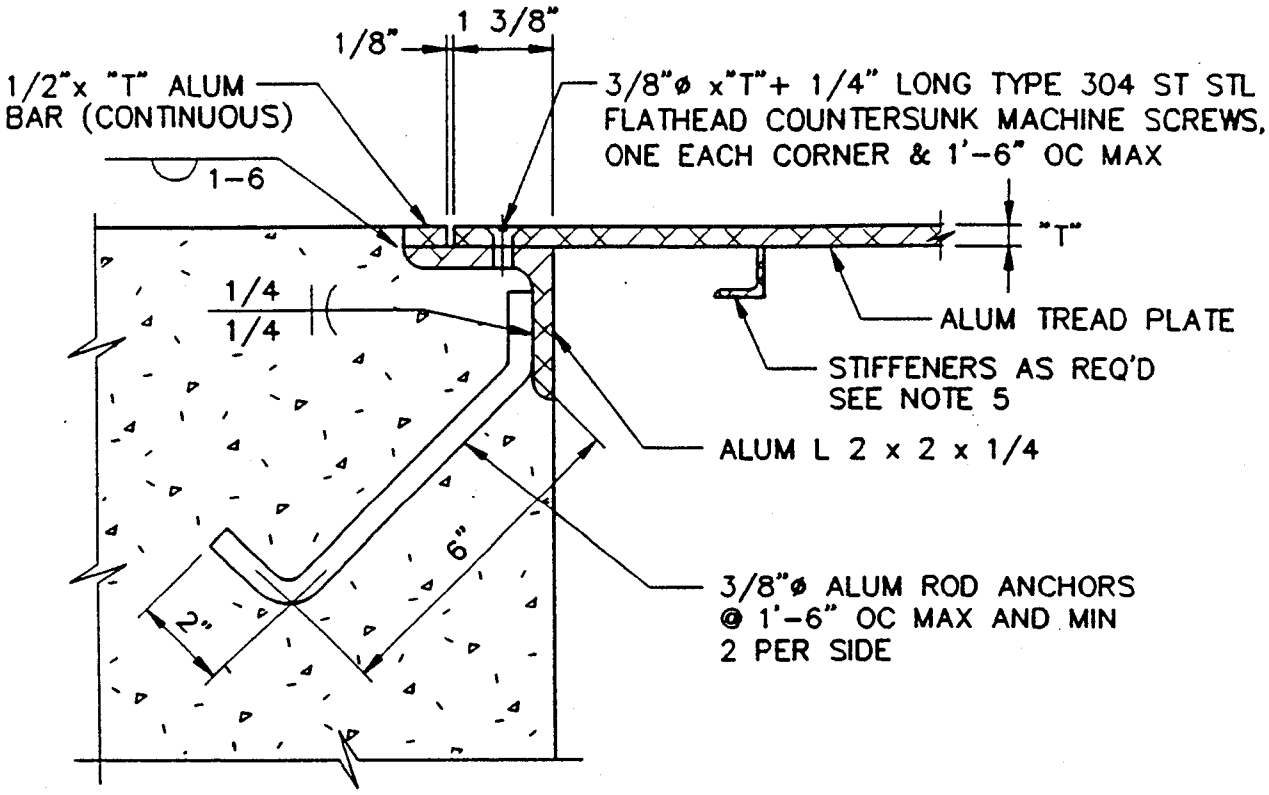


NOTE:

UNLESS OTHERWISE SHOWN ON THE PLANS, ANGLE SHALL BE ALUMINUM FOR ALUMINUM GRATING, TYPE 304 OR 316 ST STL FOR FRP GRATING.

121 TYP S **GRATING SEAT**

TYP121 5-14-91

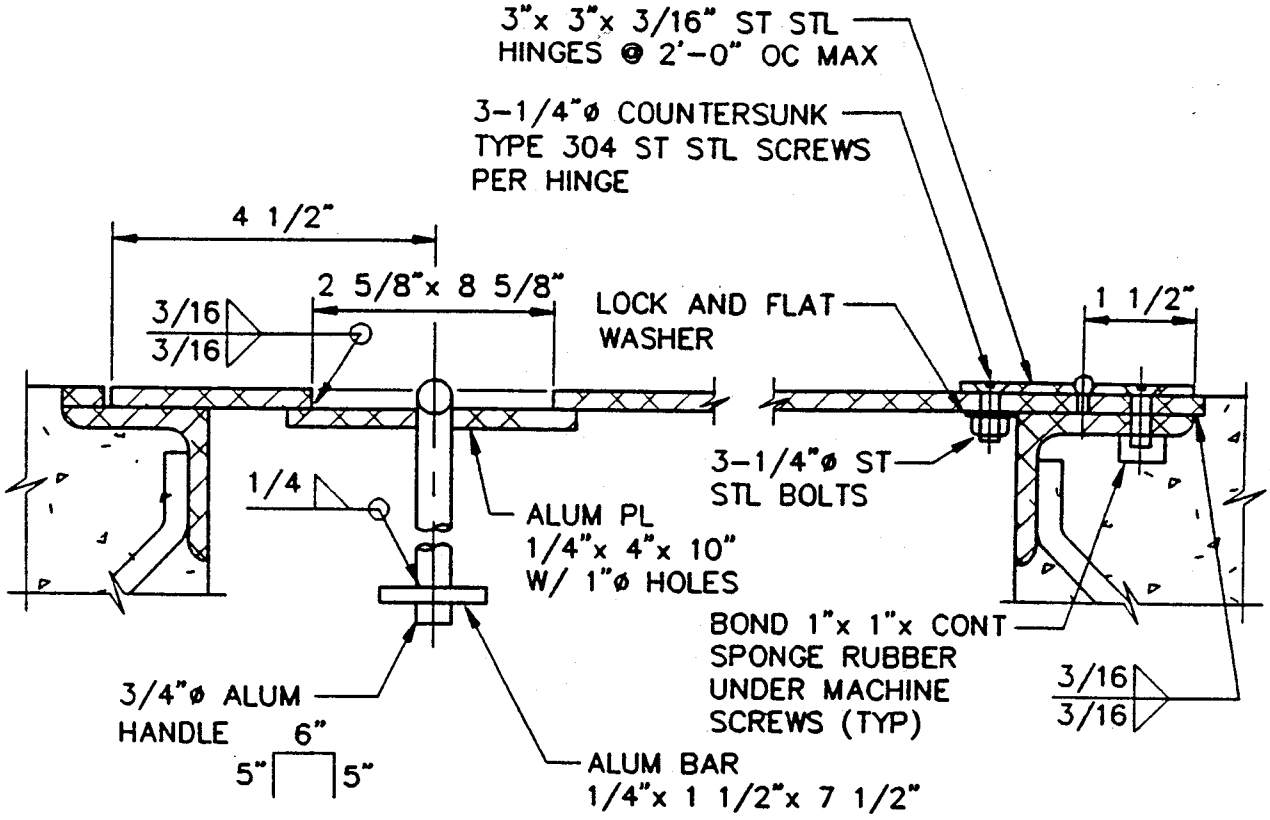


NOTES:

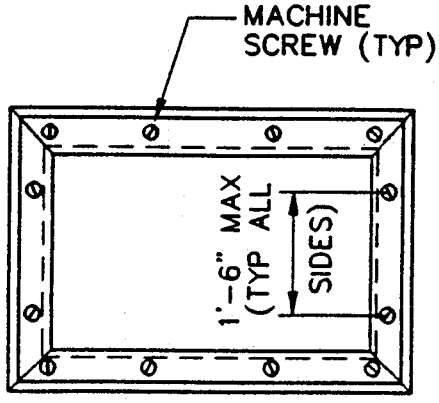
1. ALUMINUM ANGLE AND BAR MAY BE EXTRUDED.
2. COAT ALUMINUM SURFACE IN CONTACT WITH CONRETE IN ACCORDANCE WITH THE SPECIFICATIONS.
3. OMIT PERIMETER MACHINE SCREWS WHERE HINGE IS SPECIFIED.
4. HINGE AND HANDLE DETAIL SHALL APPLY WHERE SHOWN ON PLANS.
5. TREAD PLATE THICKNESS AND STIFFENERS PER MANUFACTURER. MAXIMUM DEAD PLUS LIVE LOAD DEFLECTION NOT TO EXCEED L/240, FOR 180 PSF LIVE LOAD PLUS DEAD LOAD.

125 TYP S **TREAD PLATE**

SHEET 1 OF 2



HINGE & HANDLE DETAIL

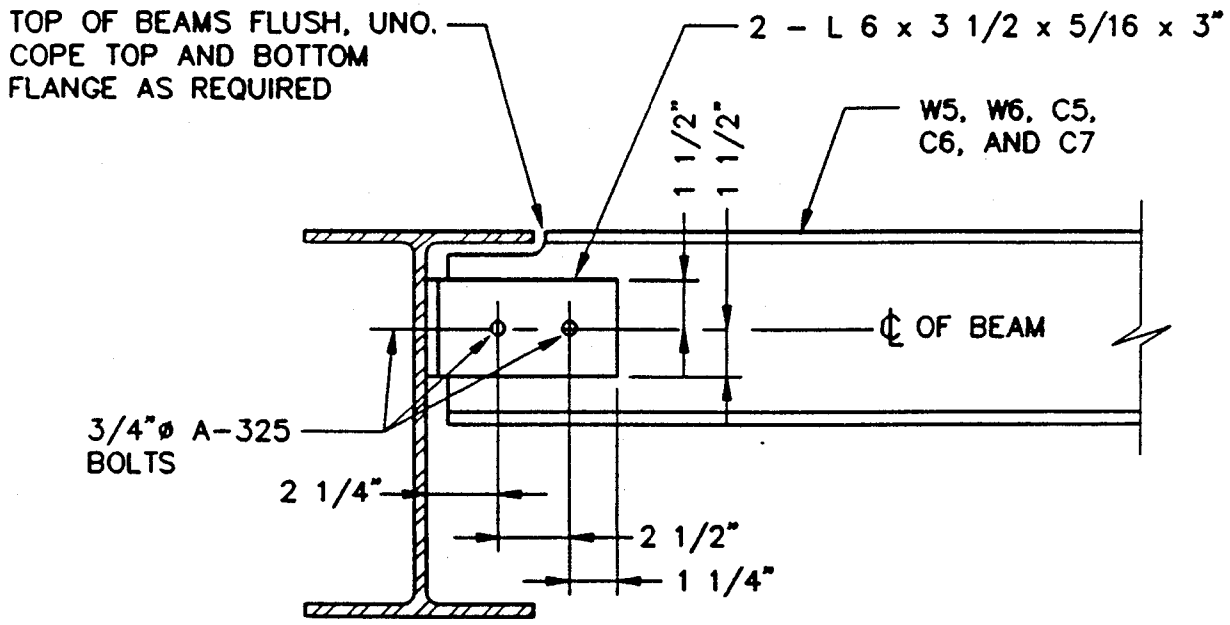


SEAT PLAN

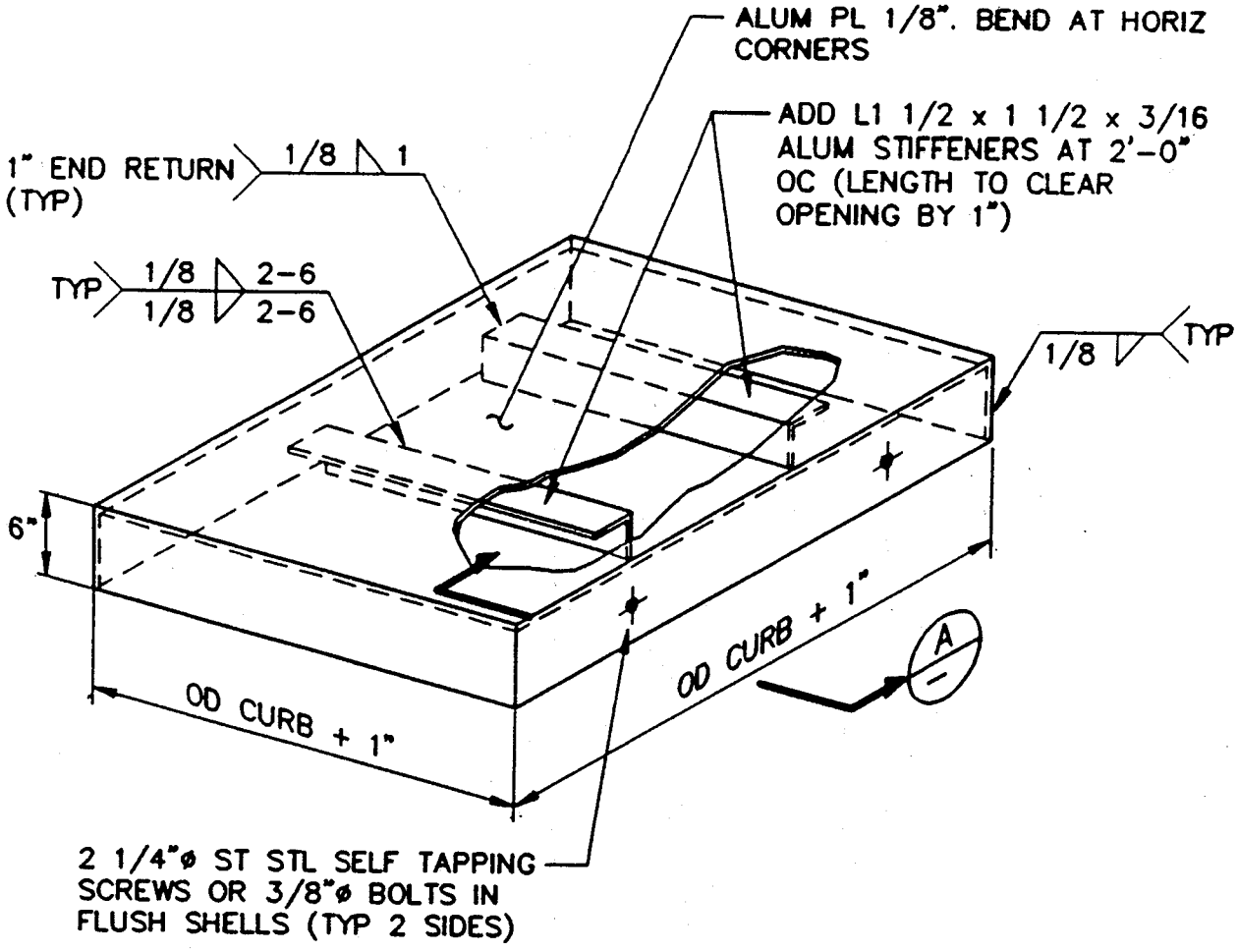
125 TYP

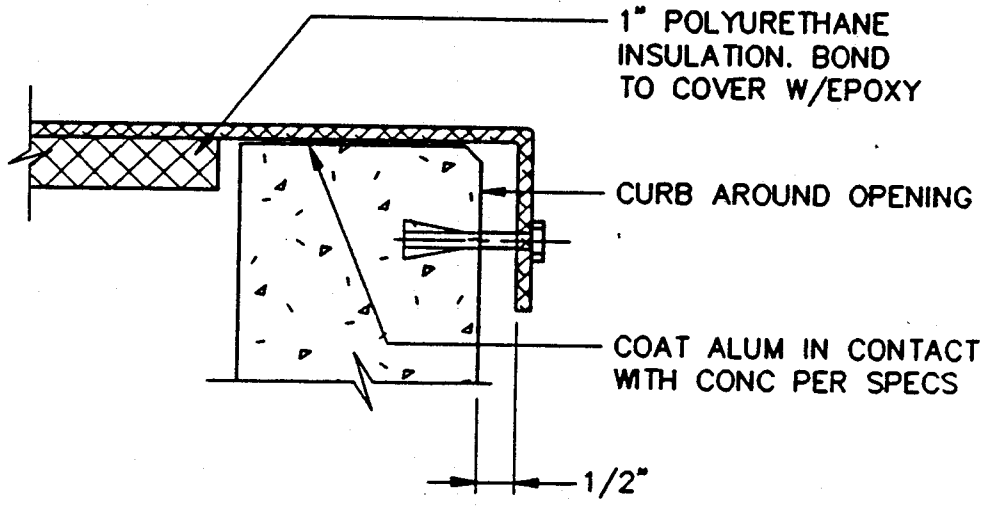
TREAD PLATE

S SHEET 2 OF 2



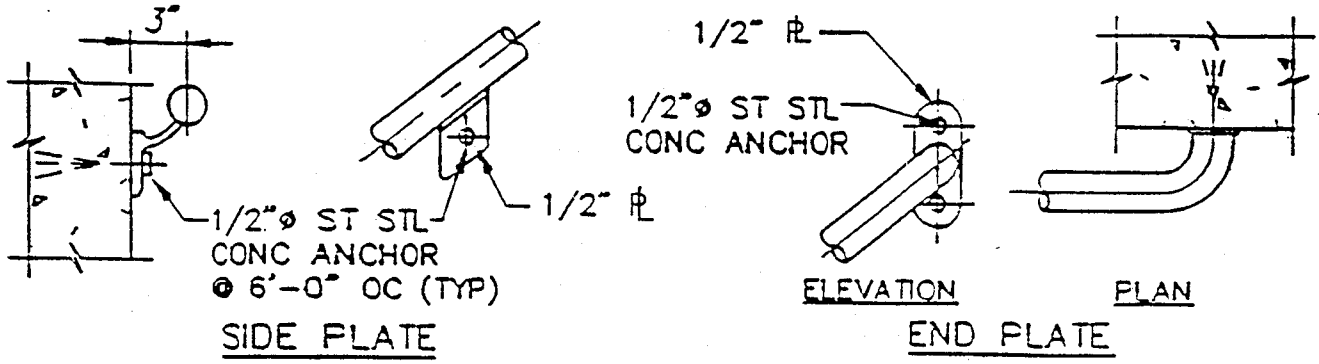
133 TYP BOLTED CONNECTION





A — SECTION

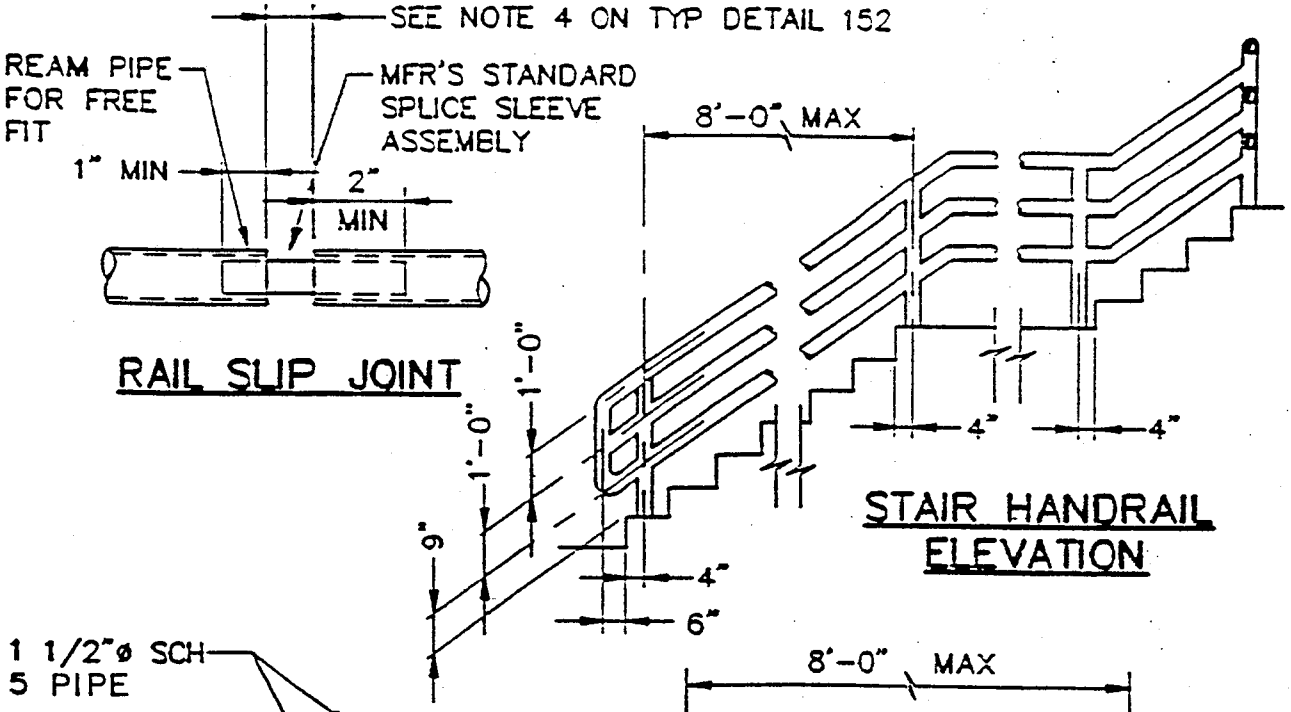
146 TYP ROOF OPENING COVER



SIDE PLATE

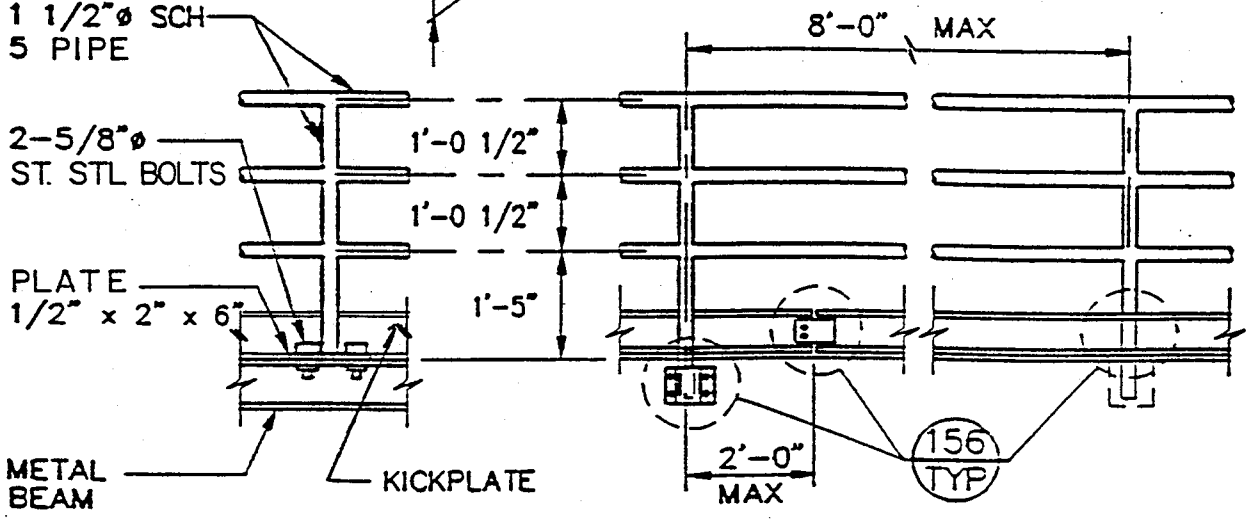
END PLATE

SINGLE RAIL BRACKETS



RAIL SLIP JOINT

STAIR HANDRAIL ELEVATION



HANDRAIL ELEVATION

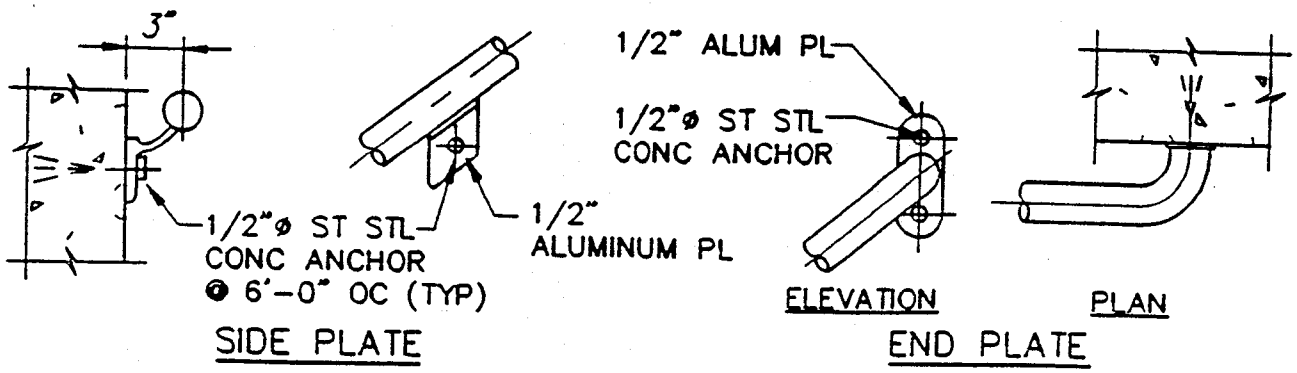
NOTES:

1. SEE SPECIFICATIONS AND TYPICAL DETAIL 152 FOR ADDITIONAL REQUIREMENTS.

149. TYP

STEEL HANDRAIL

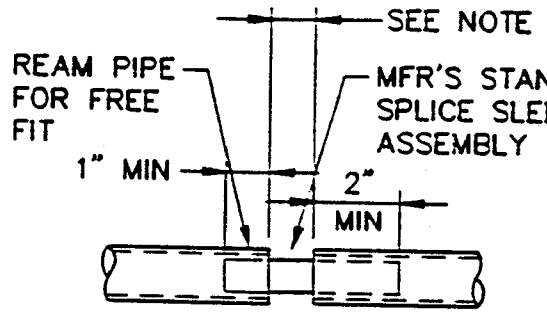
S



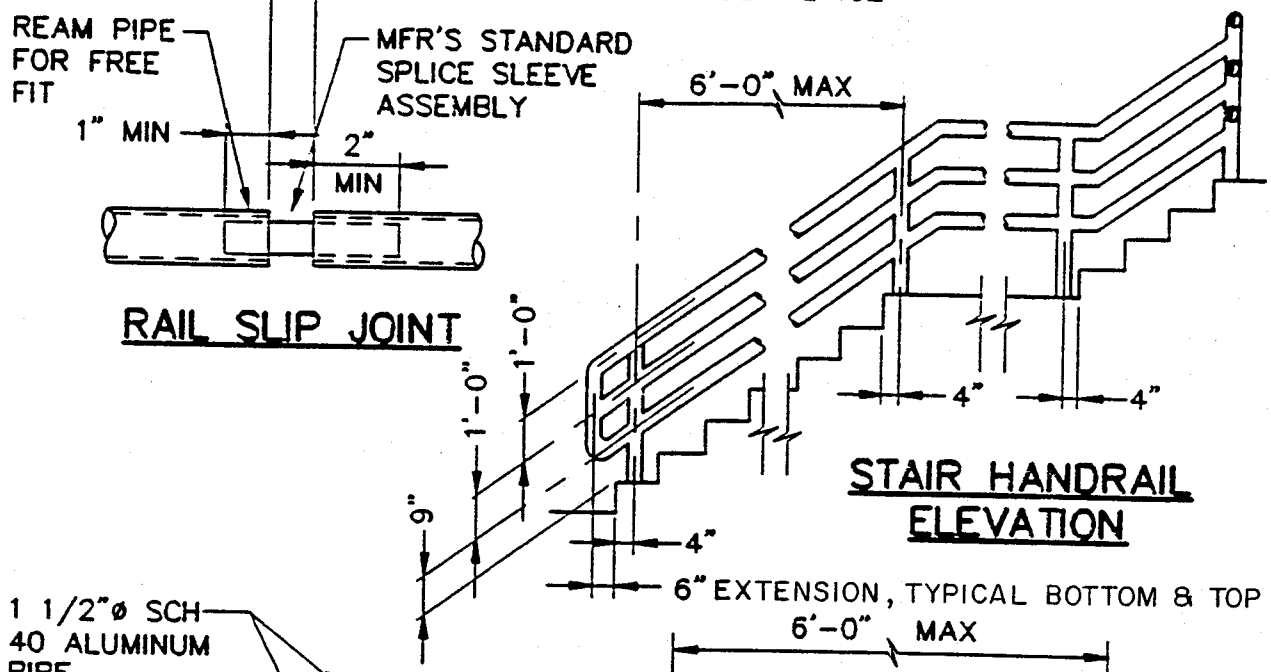
SIDE PLATE

END PLATE

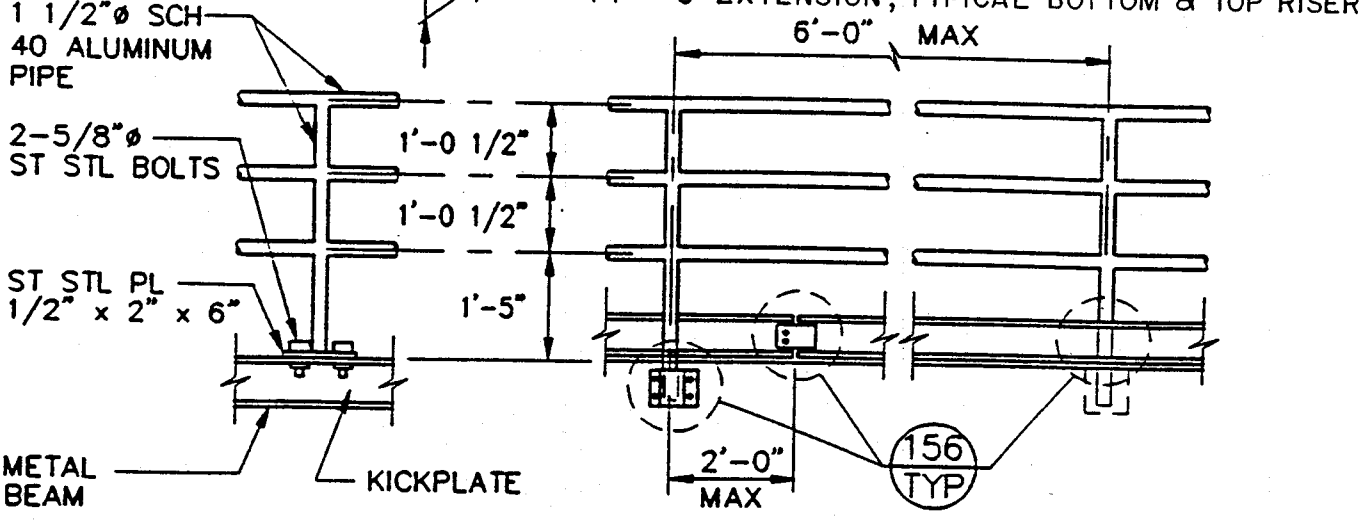
SINGLE RAIL BRACKETS



RAIL SLIP JOINT



STAIR HANDRAIL ELEVATION



HANDRAIL ELEVATION

NOTES:

1. SEE SPECIFICATIONS AND TYPICAL DETAIL 152 FOR ADDITIONAL REQUIREMENTS.

151. ALUMINUM HANDRAIL

TYP S

1. PLACE CENTER OF HANDRAIL 4" FROM EDGE OF CONCRETE UNLESS OTHERWISE NOTED ON PLANS.

2. PLACE HANDRAIL POSTS OPPOSITE EACH OTHER WHERE HANDRAILS ARE PARALLEL.

3. COAT ALL SURFACES OF ALUM THAT COME IN CONTACT WITH CONCRETE IN ACCORDANCE WITH SPECIFICATIONS. PLACE NEOPRENE GASKET BETWEEN ALUM AND STEEL.

4. PROVIDE SLIP JOINT AT 24' MAX CENTERS FOR EXPANSION OF RAILS AND KICKPLATE. GAP AT TIME OF INSTALLATION SHALL BE BASED ON TEMPERATURE OF HANDRAIL (3/8" GAP AT 25° F, 0" GAP AT 100° F). AT CONCRETE EXPANSION JOINTS, PROVIDE 1" GAP IN SLIP JOINT. INSERT SLEEVES SHALL BE LONG ENOUGH TO ALLOW FOR THE FULL RANGE OF MOVEMENT.

5. KICKPLATE MAY BE EXTRUDED OR BENT PLATE AND SHALL BE ATTACHED WITH ST STL BOLTS IN 5/16" X 3/4" SLOTTED HOLES. BOLT KICKPLATE TO POST WITH BOTTOM 1/4" CLEAR FROM SURFACE. FOR SIDE MOUNTED HANDRAIL, PROVIDE STANDARD SPACER BLOCK BETWEEN POST AND KICKPLATE TO MAINTAIN 1/4" MAX CLEAR SPACING. PROVIDE KICKPLATE AT ALL PLACES WHERE DROP FROM ONE LEVEL TO ANOTHER EXCEEDS 4'-0" AND WHERE SHOWN ON PLANS OR DETAILS. HAND TIGHTEN AND CENTER PUNCH BOLT TO LOCK. SPLICES SHALL ACCOMMODATE TEMPERATURE EXPANSION PER NOTE 4. DELETE KICKPLATE WHERE HANDRAIL IS MOUNTED ON 6" MIN CURB.

6. STAIR RAILS ALONG WALLS SHALL BE FASTENED WITH STANDARD WALL BRACKET AT 5'-0" OC MAXIMUM. END OF RAILS SHALL HAVE CLOSURES. STAIR RAILS SHALL BE OFFSET TO PROVIDE 3" MIN CLEARANCE FROM ALL OBSTRUCTIONS.

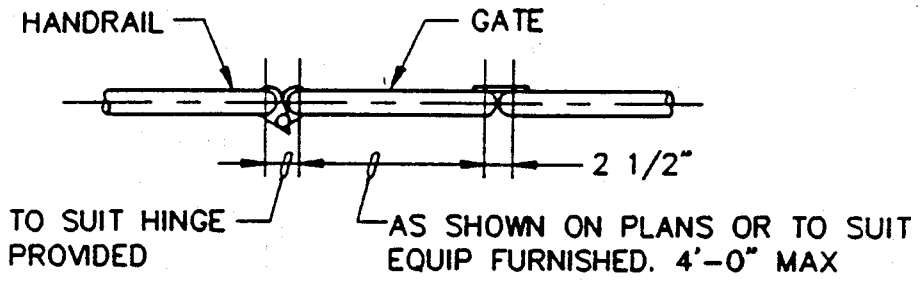
7. ALL HANDRAILS SHALL BE FIXED UNLESS OTHERWISE NOTED.

8. HANDRAILS ALONG WALLS SHALL BE SINGLE RAIL AT 3'-6" HEIGHT, OR TO MATCH TOP RAIL ON OPPOSITE SIDE.

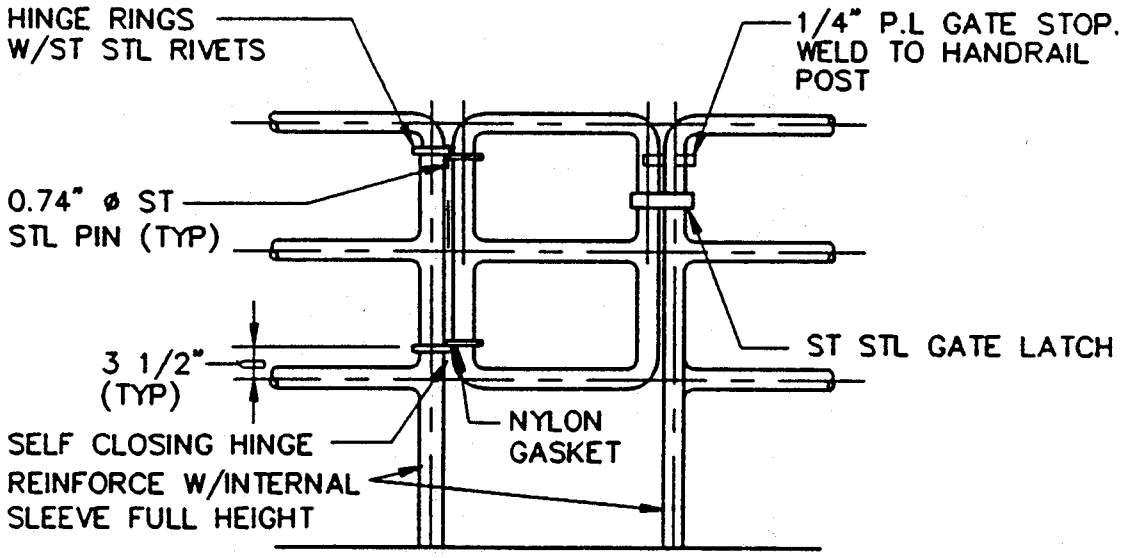
9. ALL JOINTS FOR STAINLESS STEEL HANDRAIL SHALL BE COPED, WELDED, AND GROUND SMOOTH.

10. FOR HANDRAIL MOUNTED TO BEAM OR STAIR CHANNEL, PROVIDE MANUFACTURERS REINFORCED CONNECTION FROM PIPE RAIL TO PLATE. PLATE AND REINFORCED INSERTS SHALL BE ALUMINUM OR STAINLESS STEEL.

11. MATERIAL FOR SLIP JOINT PLATE AND KICKPLATE CHANNEL SHALL BE OF THE SAME MATERIAL AS THE HANDRAIL.



PLAN

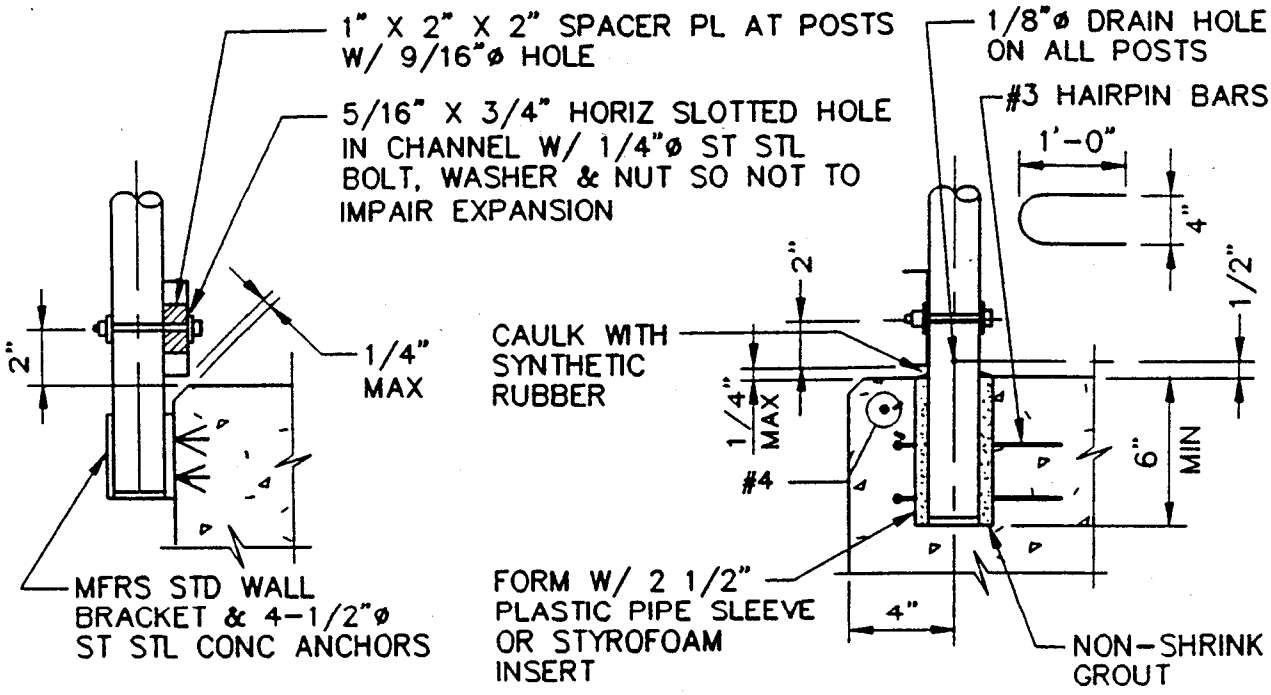


ELEVATION

NOTES:

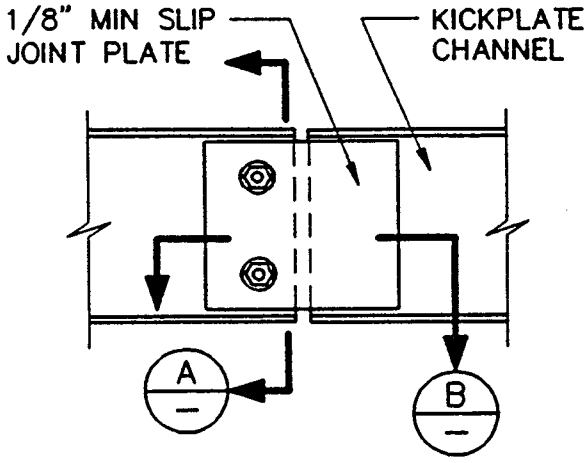
1. GATE MATERIAL AND FINISH SHALL MATCH HANDRAIL.
2. GATE SHALL OPEN TOWARD THE WALKWAY.

154 TYP S GATE AT HANDRAIL

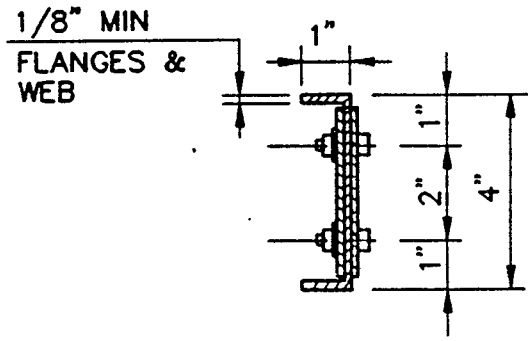


SIDE MOUNTED POST

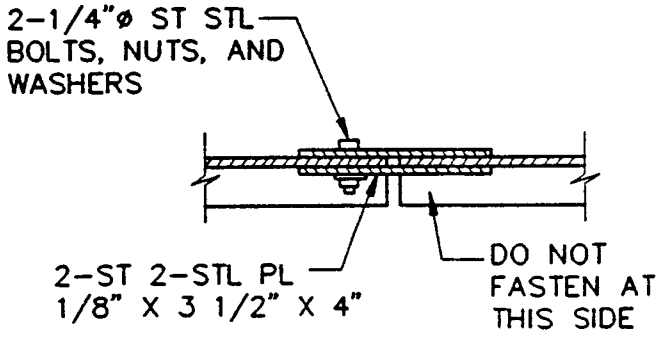
EMBEDDED POST



KICKPLATE JOINT



A SECTION

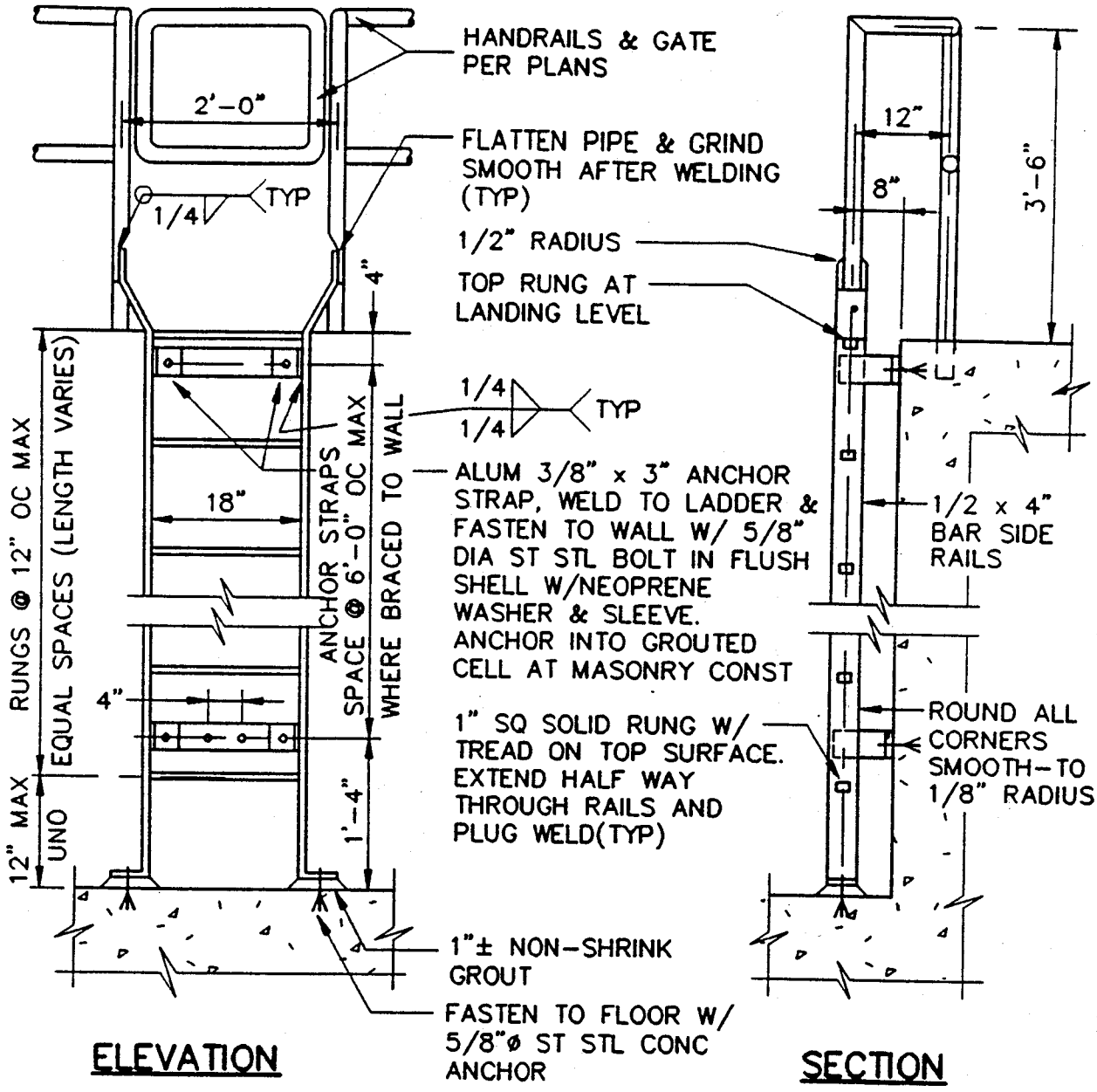


B SECTIONAL PLAN

156 TYP HANDRAIL KICKPLATE

S

TYP156 5-14-91



NOTES:

1. INSTALL FALL PREVENTION SYSTEM, OR SAFETY CAGE, WHERE HEIGHT OF LADDER EXCEEDS 20'-0". SEE TYPICAL DETAIL 170.

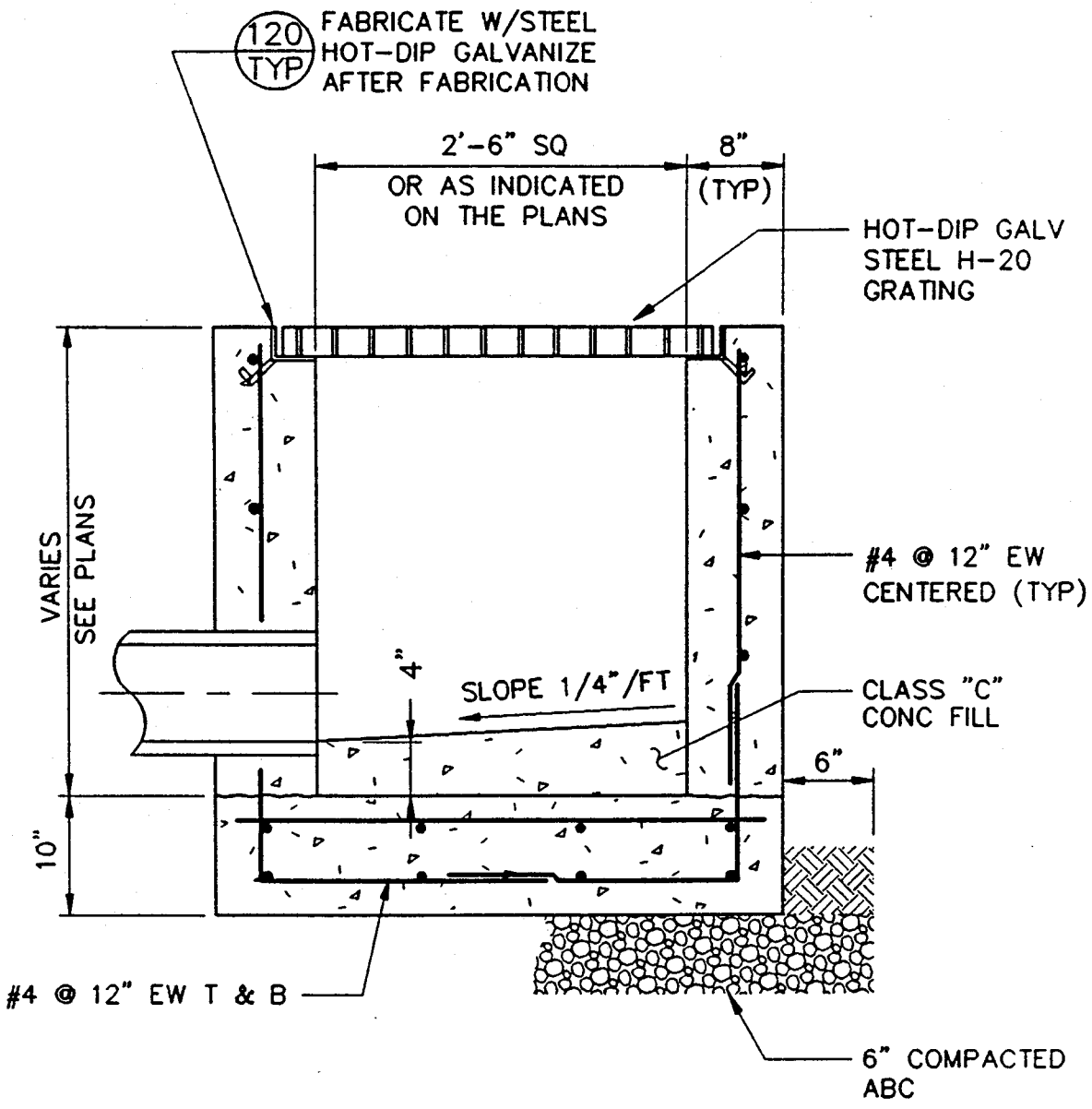
2. MINIMUM CLEARANCE TO ANY OBSTRUCTION ADJACENT TO LADDER:
   2'-6" AT CLIMBING SIDE (2'-3" AT SMOOTH WALL)
   1'-3" EACH SIDE OF CENTER LINE, AT SIDES OF LADDER.

3. COAT ALL ALUM SURFACES IN CONTACT WITH CONCRETE OR MASONRY, IN ACCORDANCE WITH THE SPECIFICATIONS.

4. WHERE HANDRAIL IS STAINLESS STEEL, BOLT PIPE TO RAIL W/ 2-1/2"ø STAINLESS STEEL BOLTS.

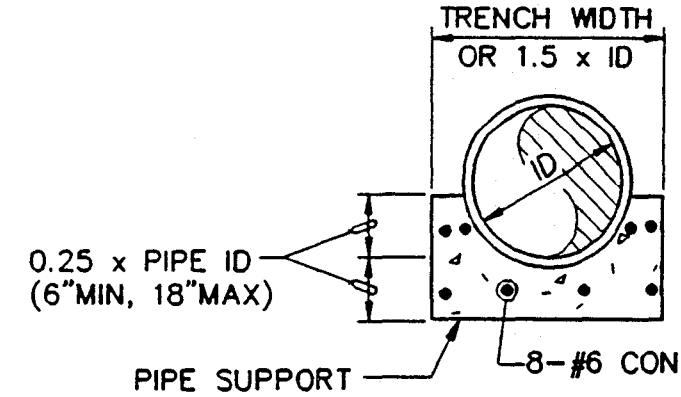
169 TYP LADDER (ALUMINUM)

S



212 TYP CATCH BASIN

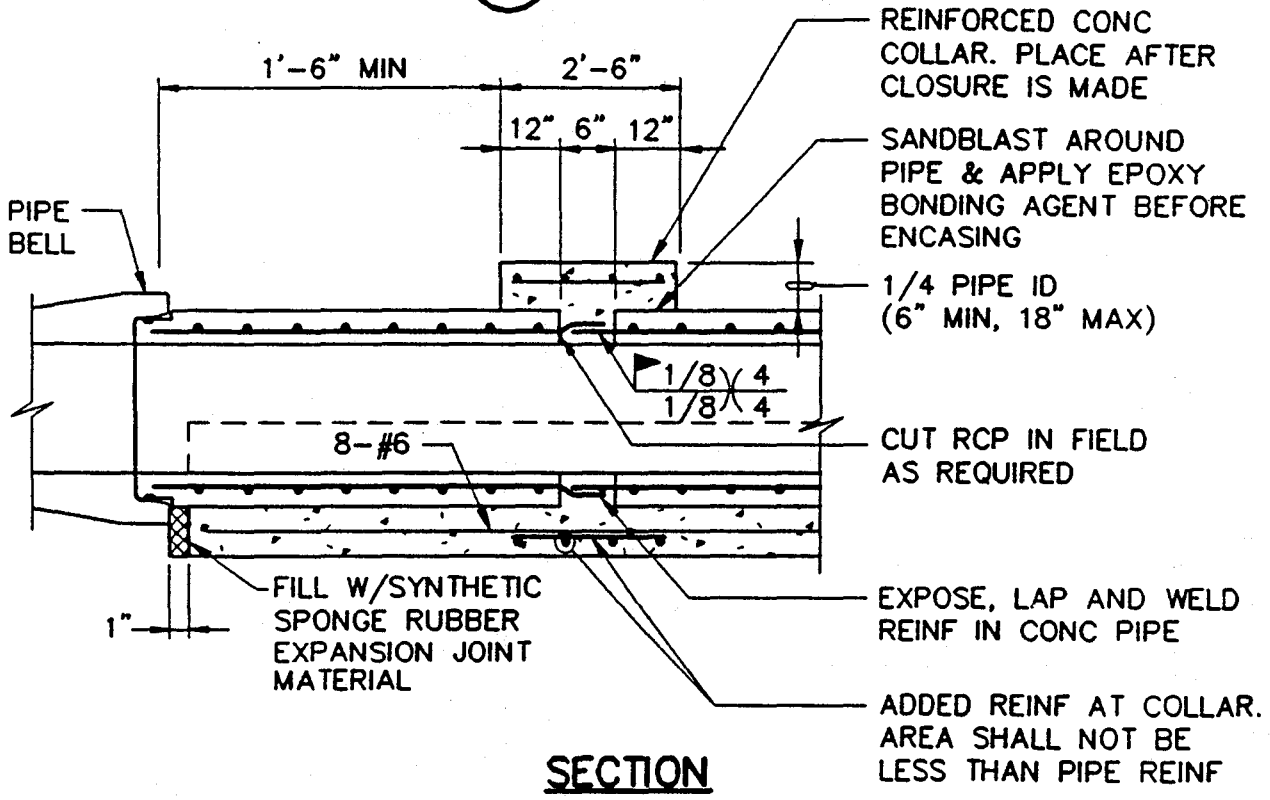
TYP212 5-14-91



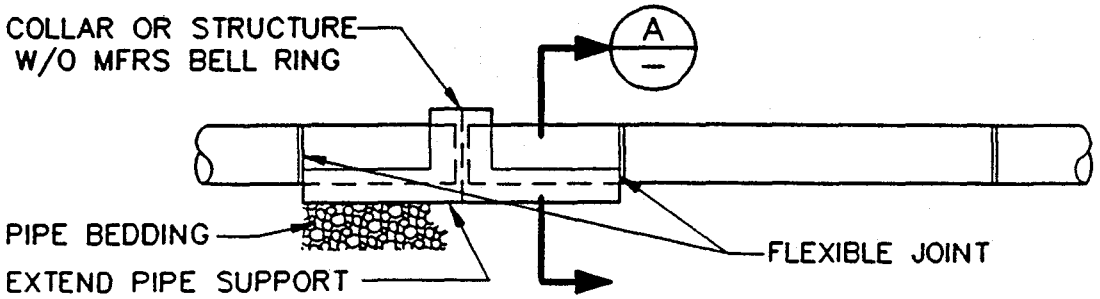
NOTES:

1. EXCEPT WHERE INDICATED ON PLANS, FIELD CLOSURE SHALL BE USED ONLY AS APPROVED BY ENGINEER. THE SAME TYPE AND DEPTH OF BEDDING USED UNDER THE PIPE SHALL BE USED UNDER THE FIELD CLOSURE.

A — SECTION



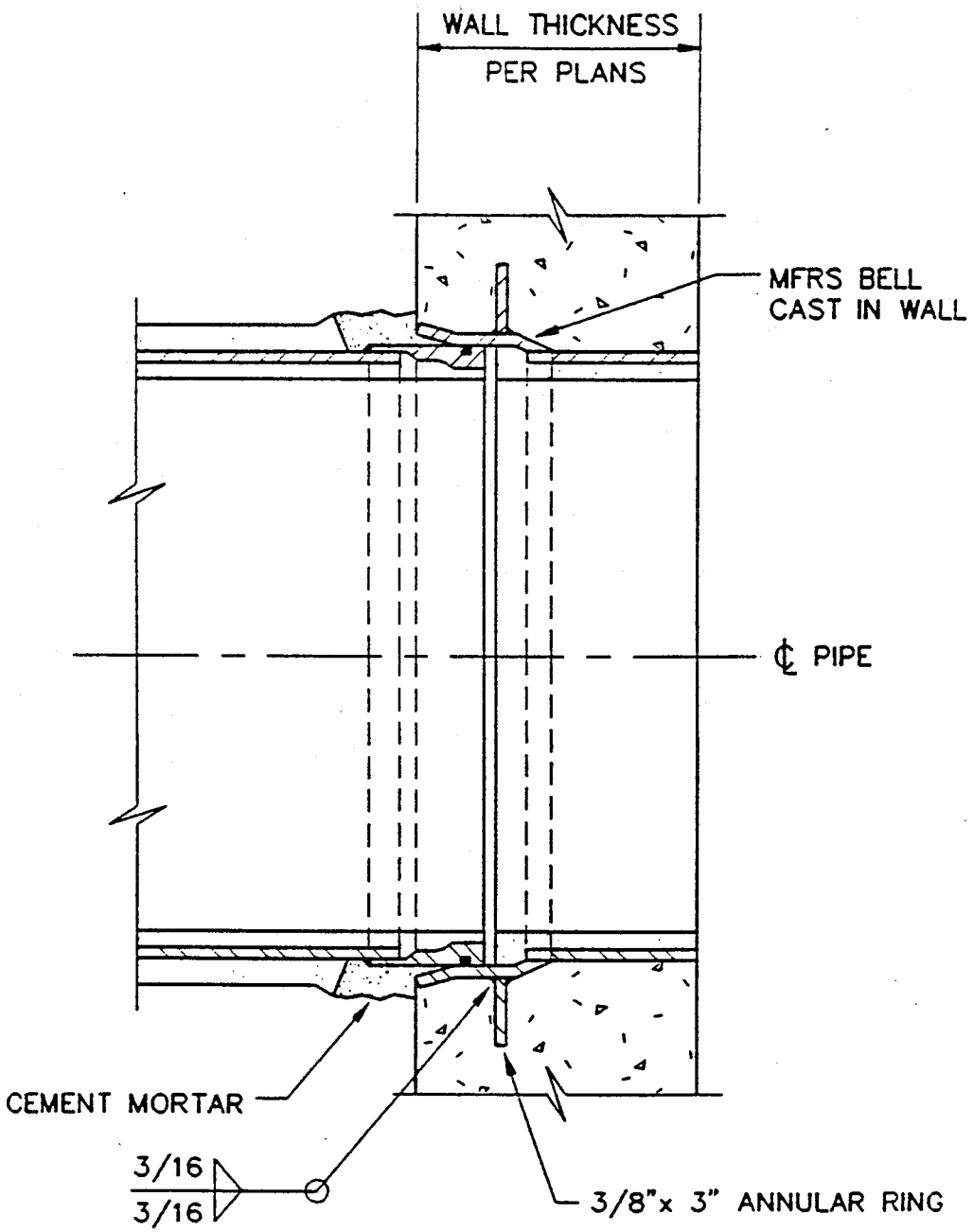
SECTION



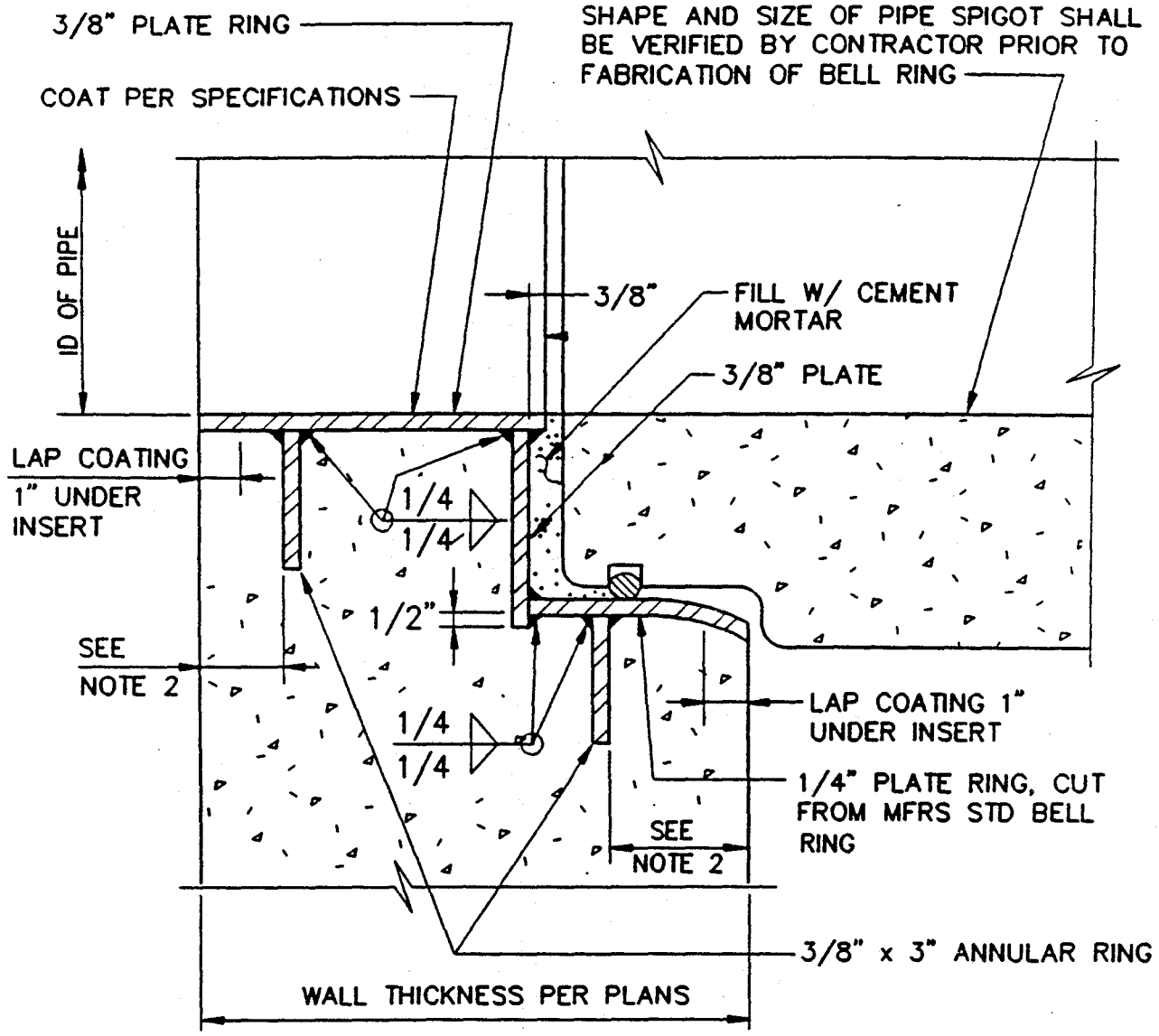
ELEVATION

221 TYP RCP FIELD CLOSURE S

TYP221 5-14-91



222 TYP BELL RING INSERT FOR STEEL PIPE

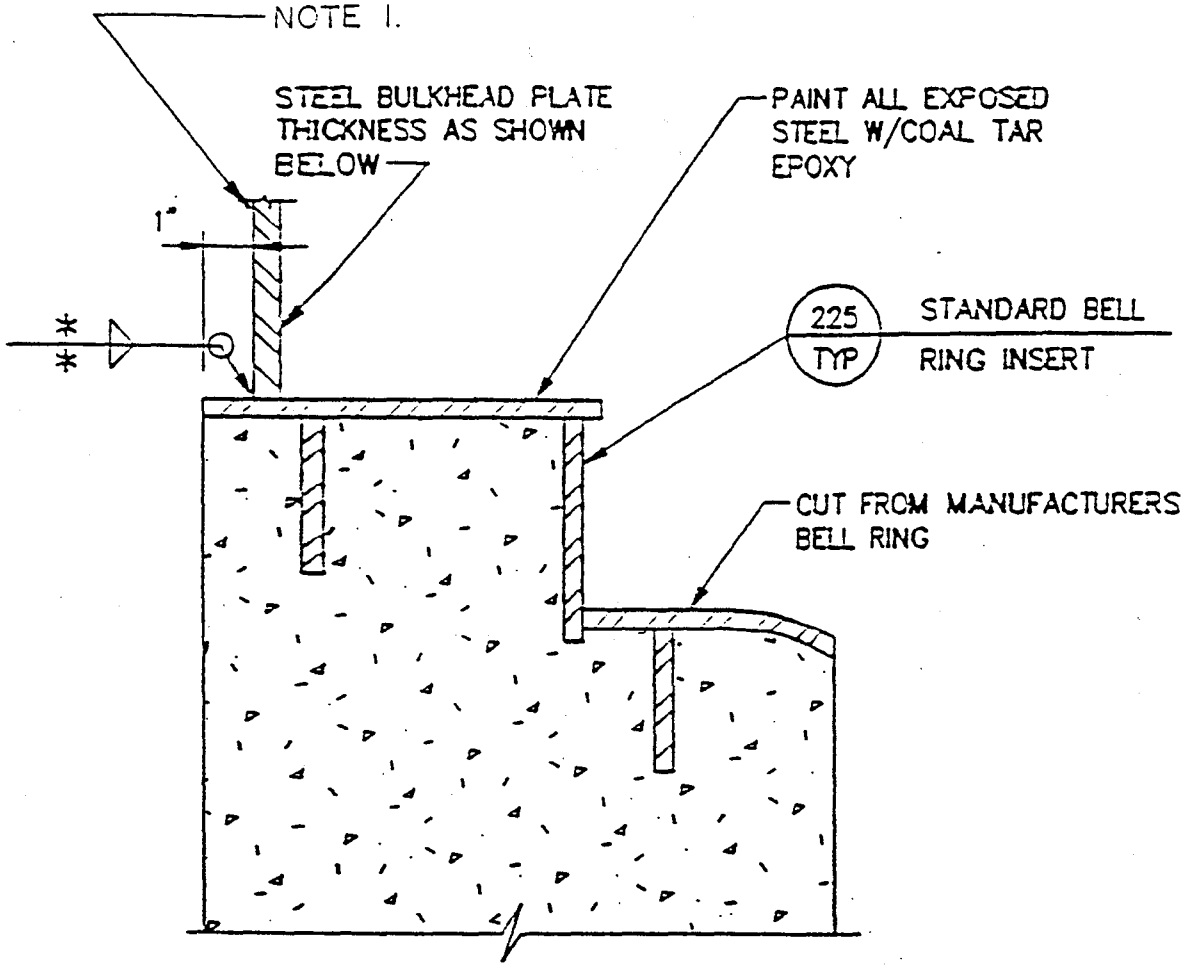


NOTES:

1. WELD ALL CUT REINFORCING BARS TO ANNULAR RING FOR PIPES GREATER THAN 48" DIAMETER. USE LOW HYDROGEN WELDING.
2. REINFORCING STEEL CLEAR COVER PLUS DIAMETER OF OUTSIDE BARS.
3. GRIND SMOOTH ALL METAL EDGES IN AREAS TO BE COATED AND ALL SURFACES IN PIPE SEATING AREA.
4. RING SHALL HAVE SPIDER BRACING INSTALLED AT POINT OF MANUFACTURE.

225 TYP S STANDARD BELL RING INSERT

TYP225 5-14-91

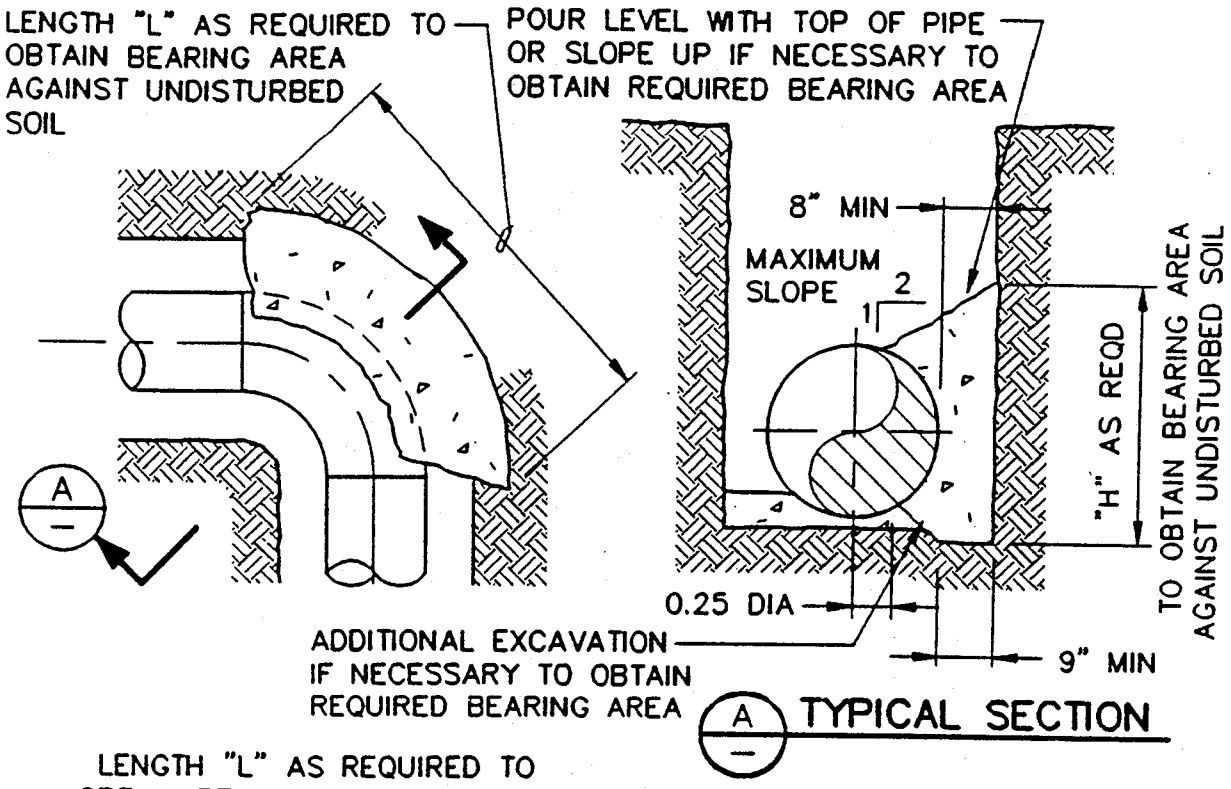


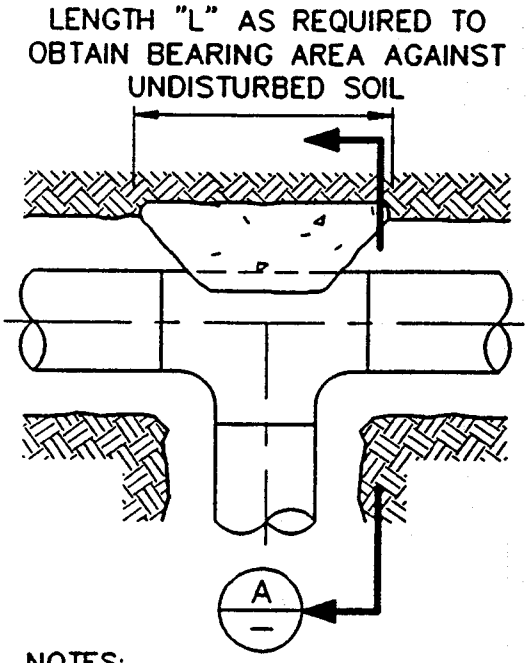
NOTES:

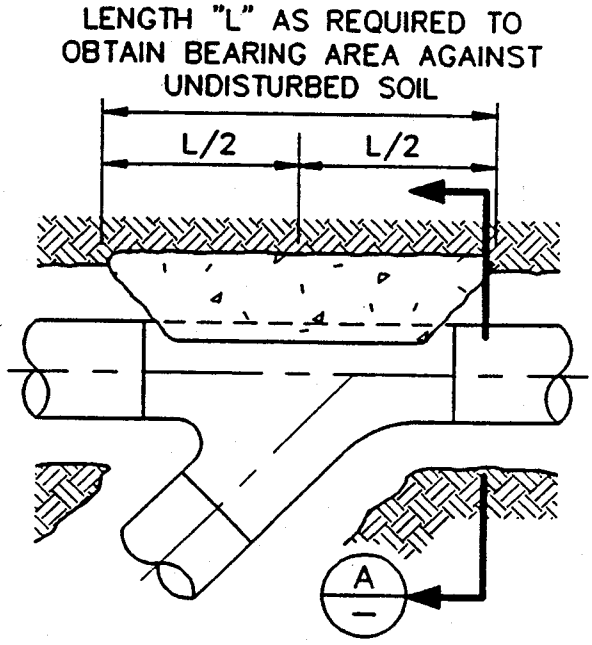
1. PAINT ALL STEEL WITHIN INFLUENT CHANNEL W/ EPOXY POLYAMIDE

BULKHEAD PLATE			
MARK NO	PIPE DIAMETER	PLATE THICKNESS	* WELD SIZE
1	96"	5/8"	3/8"

227 TYP STEEL BULKHEAD



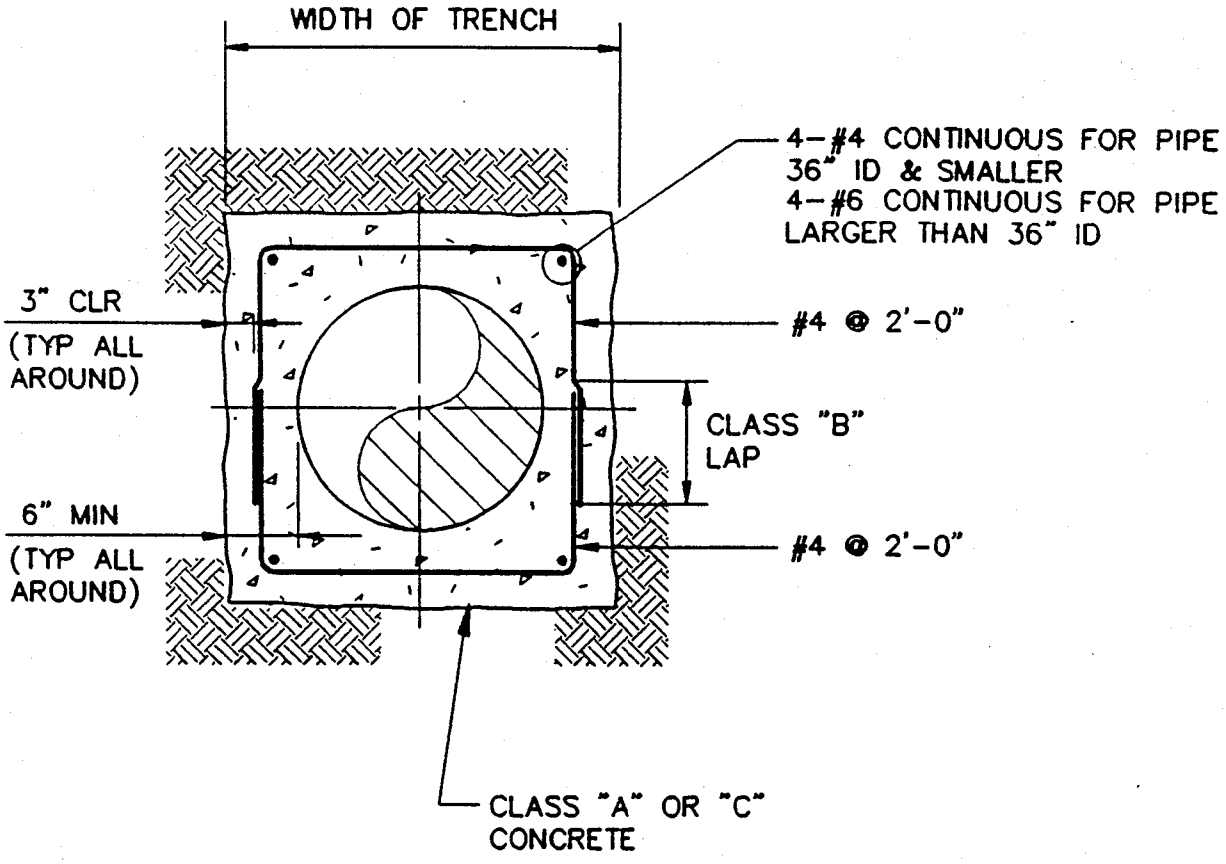




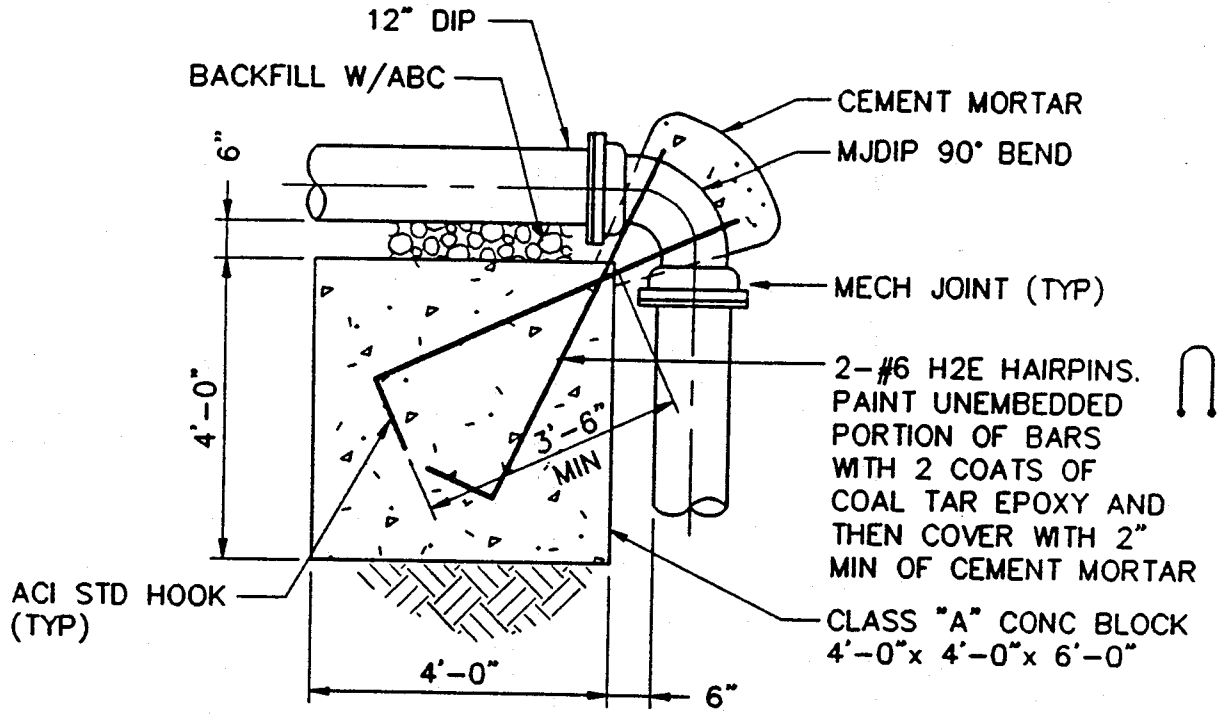
NOTES:

1. BEARING AREA IS THE AREA REQUIRED TO OBTAIN A MAXIMUM SOIL LOADING OF 200 PSF PER FOOT OF DEPTH TO A MAXIMUM VALUE OF 1500 PSF WHEN THE PIPE IS SUBJECTED TO ITS TEST PRESSURE, OR BEARING AREA SHOWN ON PLANS. AREA MAY BE DECREASED IF SUBSTANTIATED BY SOIL BEARING TESTS.
2. CONCRETE SHALL BE CLASS "A" OR "C".
3. THRUST BLOCK IS TO EXTEND TO UNDISTURBED SOIL.

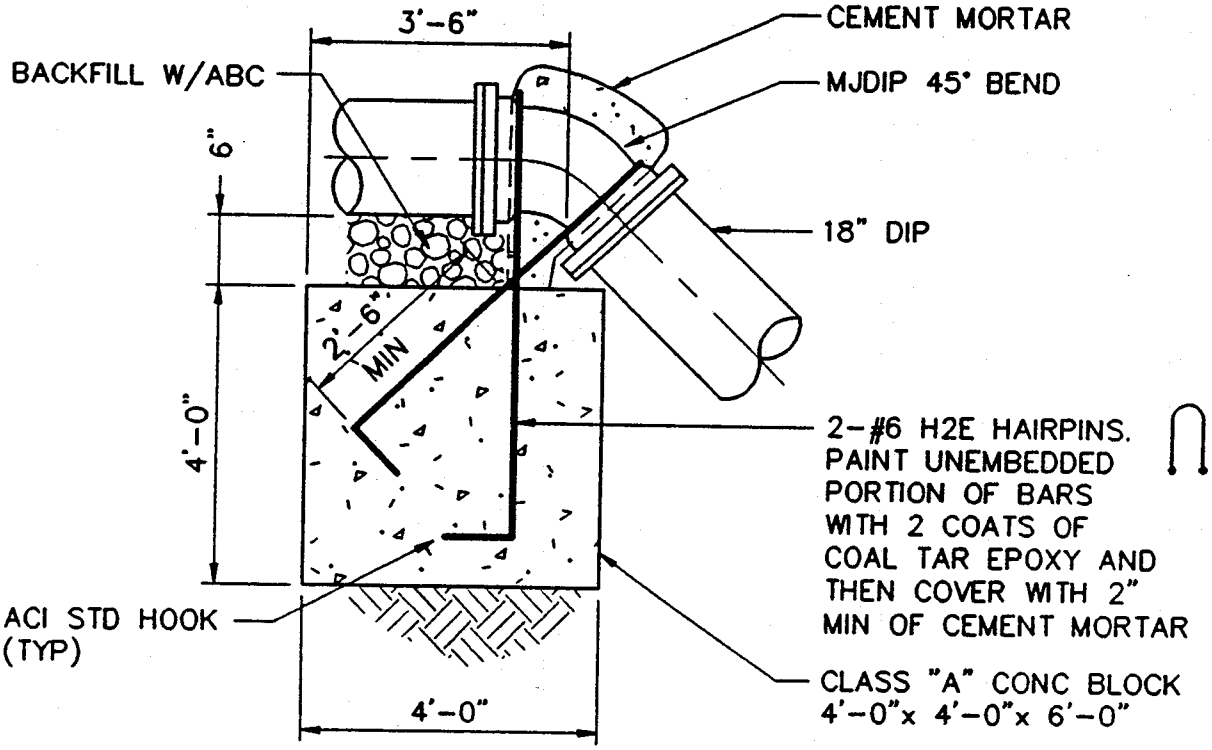
230 TYP PIPE THRUST BLOCK S



231 TYP S CONCRETE ENCASEMENT OF PIPE

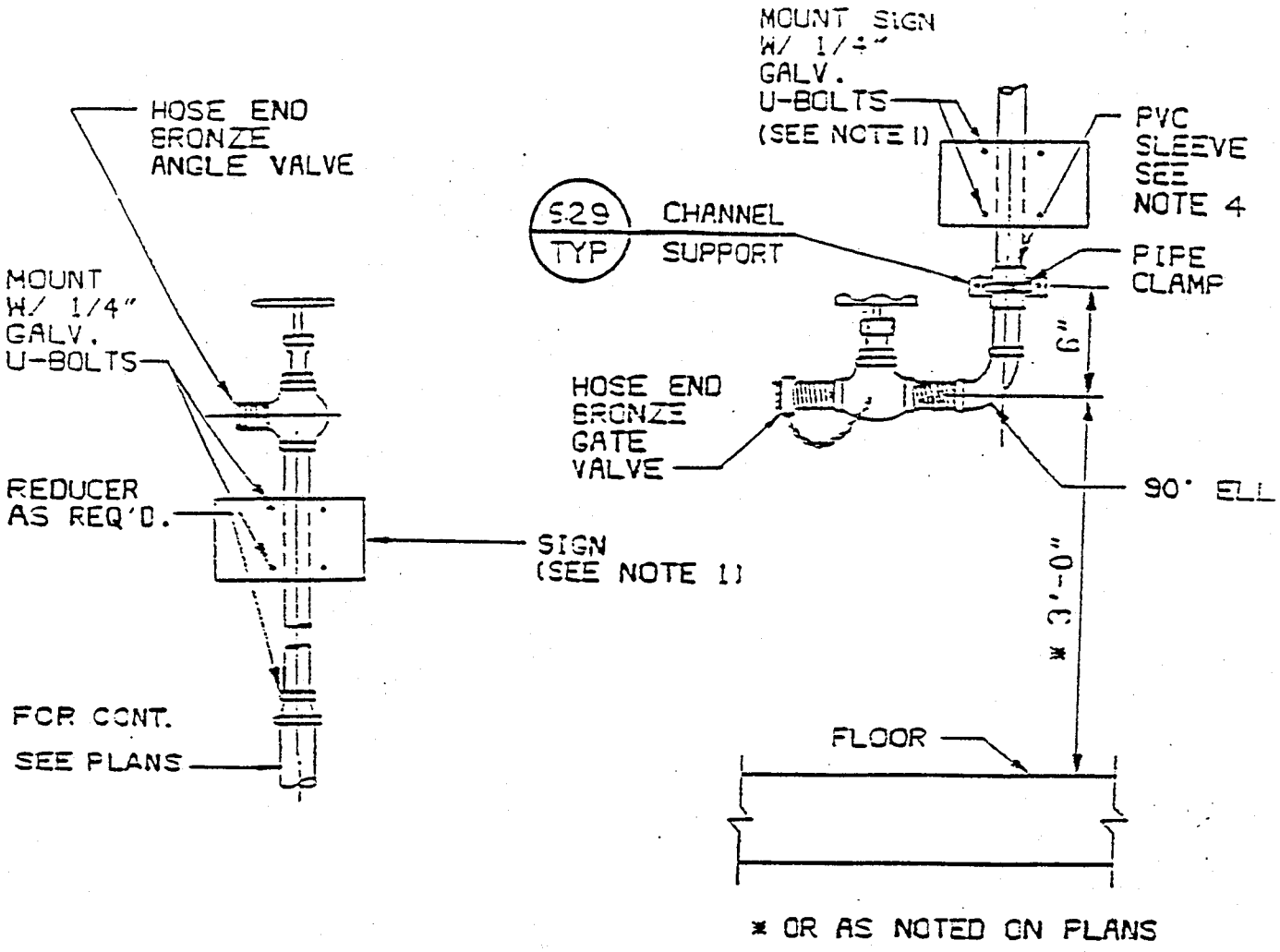


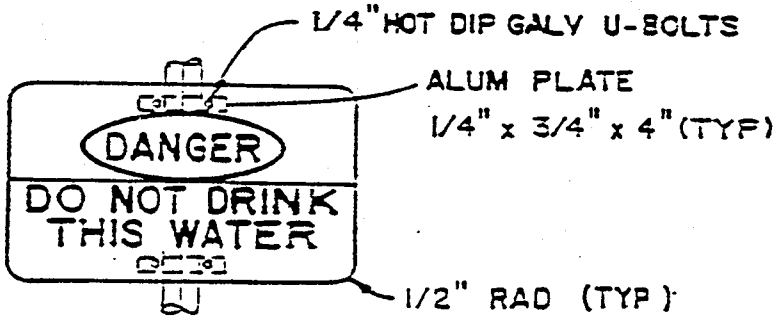
A — SECTION – 90° BEND



B — SECTION – 45° BEND

232 TYP ANCHOR BLOCKS FOR VERTICAL BENDS



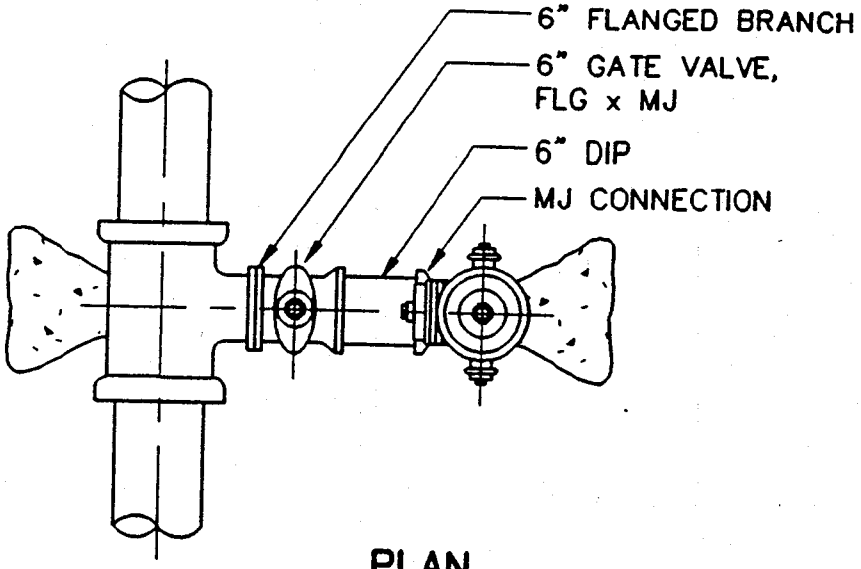


NOTES:

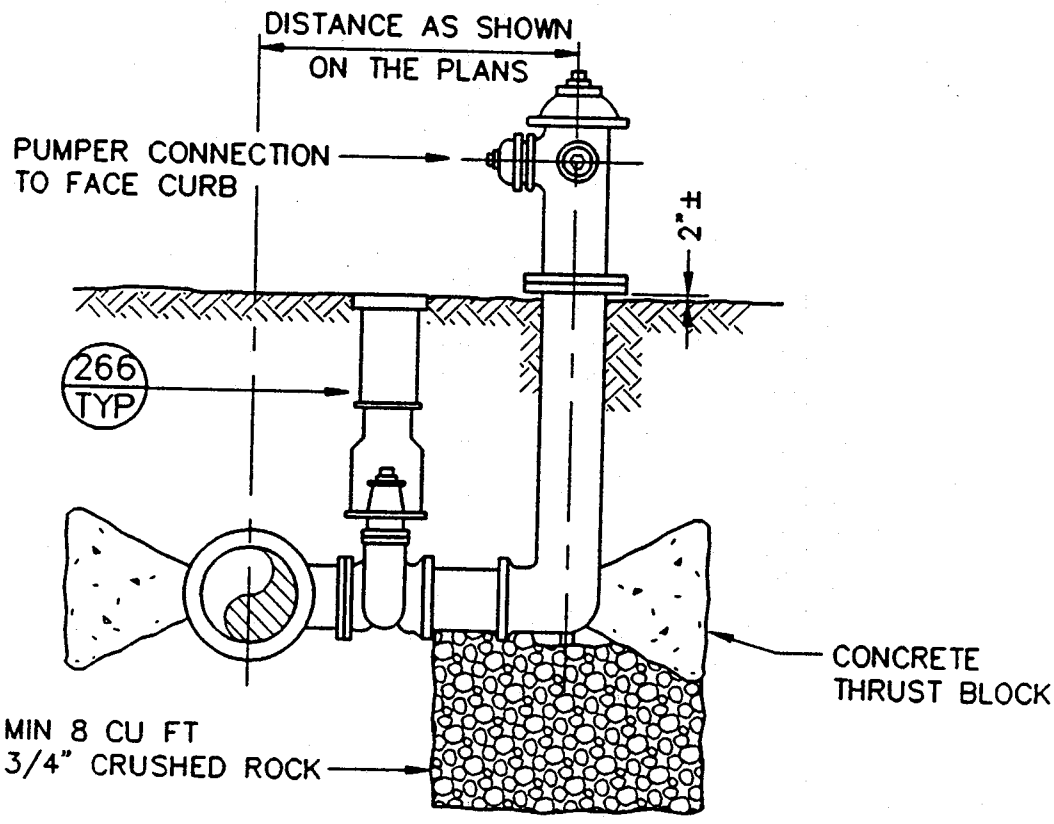
1. SIGN SHALL BE 3/8" THK LAMINATED PLASTIC. PLASTIC SHALL BE TREATED TO RESIST SUNLIGHT (ULTRAVIOLET) DETERIORATION. MOUNTING: FOUR GROMMETED HOLES FOR 1/4" GALV U-BOLTS.
2. SIGN SHALL BE 8" x 5" & SHALL CONFORM TO OSHA REGULATION 1910.145.
3. SIGN AS SHOWN IS ROTATED 90° OFF TRUE POSITION. SIGN SHALL BE MOUNTED TO PERMIT EASY READING.
4. SLEEVE REQUIRED FOR DISSIMILAR METALS.

246 TYP

1 1/2" HOSE VALVE & SIGN DETAIL



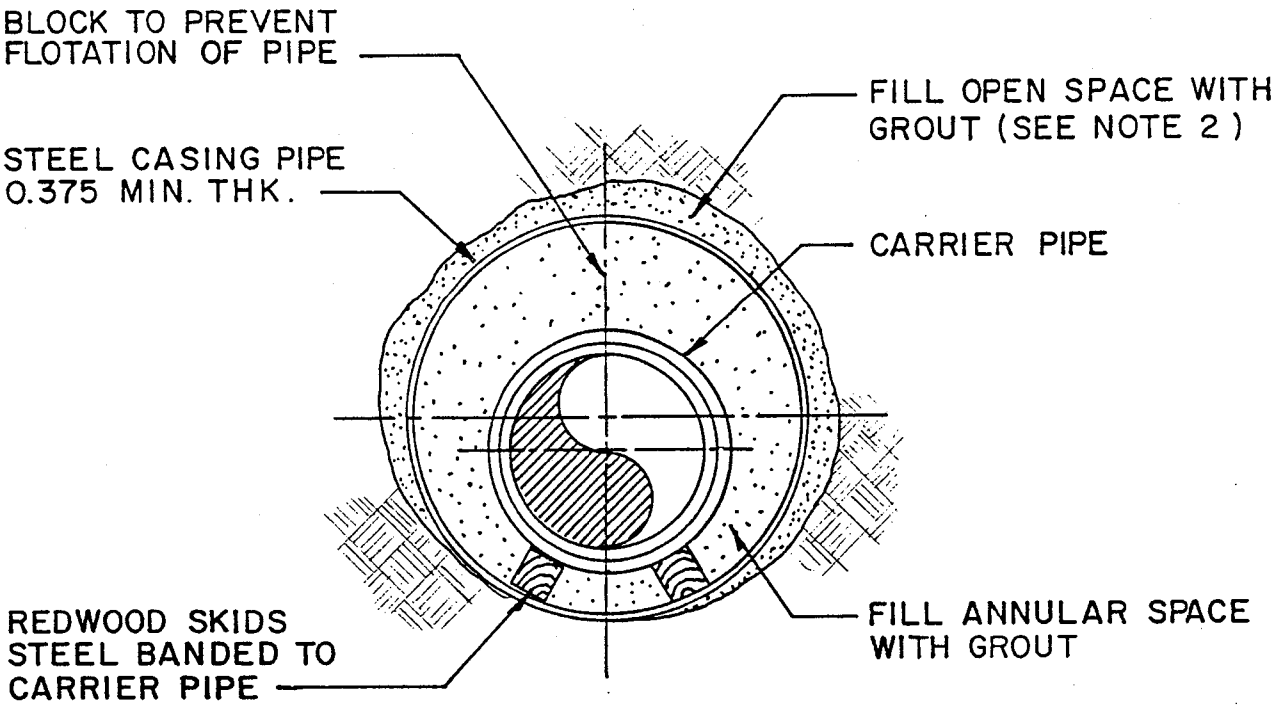
PLAN



ELEVATION

247 TYP FIRE HYDRANT AND VALVE

TYP247 5-14-91



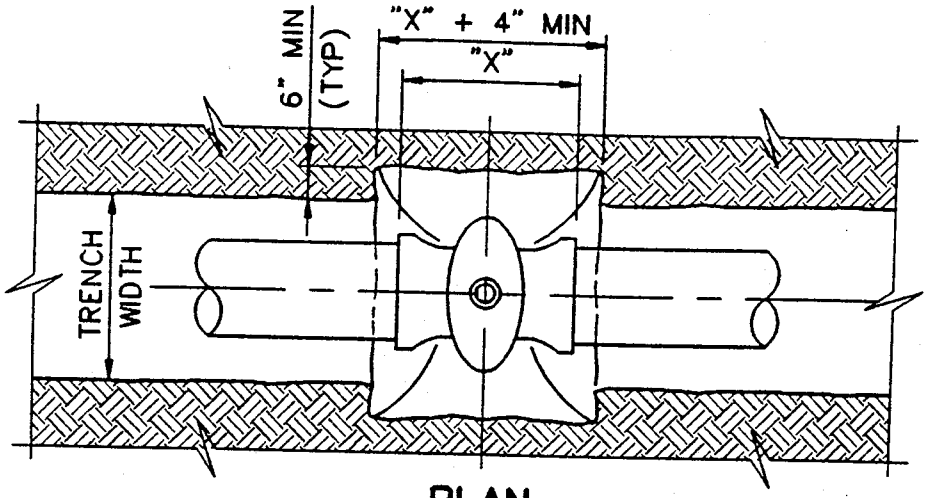
NOTES:

1. PIPE DIAMETERS AS INDICATED ON THE PLANS.

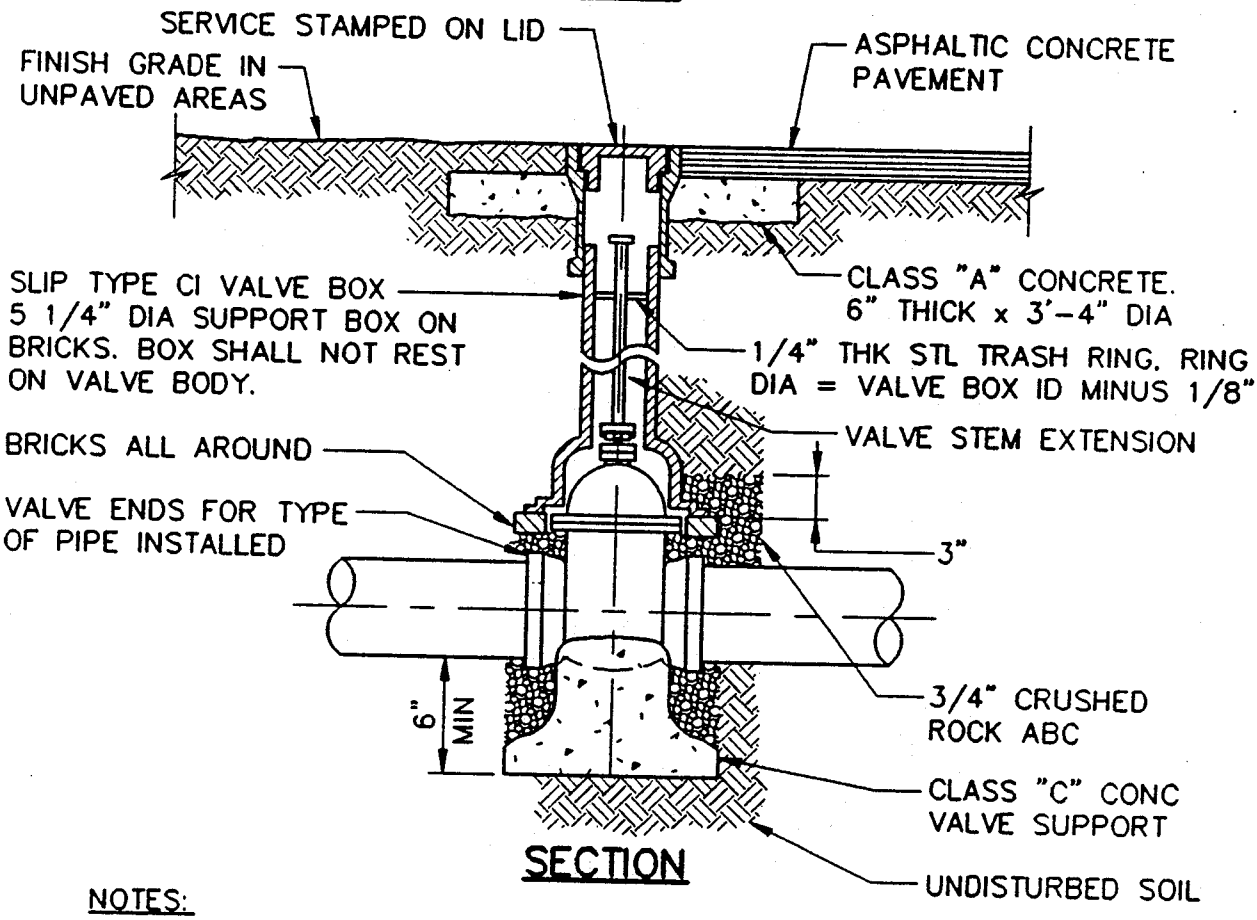
2. PROVIDE OPENINGS IN STEEL CASING TO PUMP GROUT INTO THE VOID FORMED OUTSIDE THE CASING. THE NUMBER OF OPENINGS SHALL BE AS REQUIRED TO COMPLETELY FILL THE VOIDS AROUND THE CASING.

264. TYP

PIPE IN STEEL CASING



PLAN

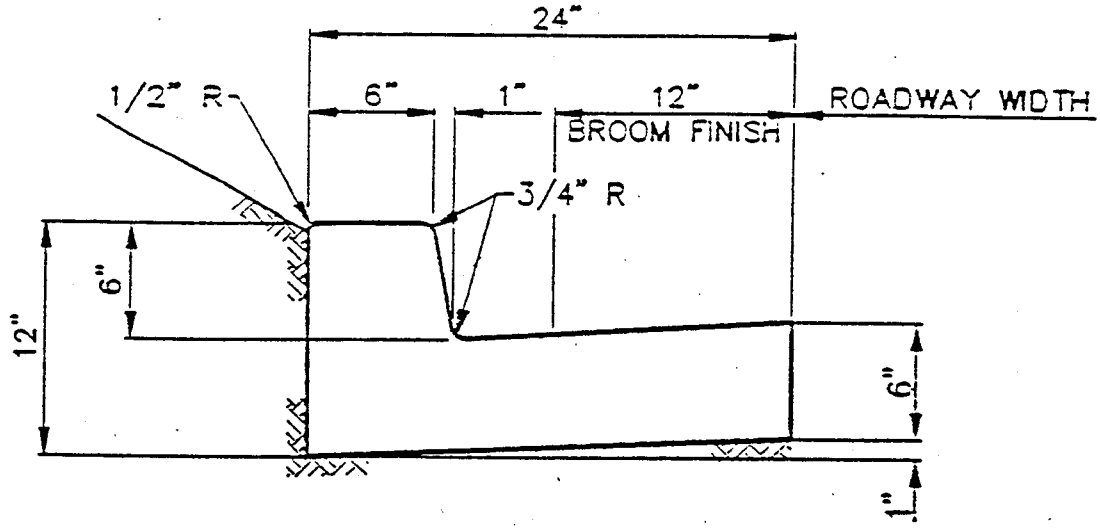


SECTION

NOTES:

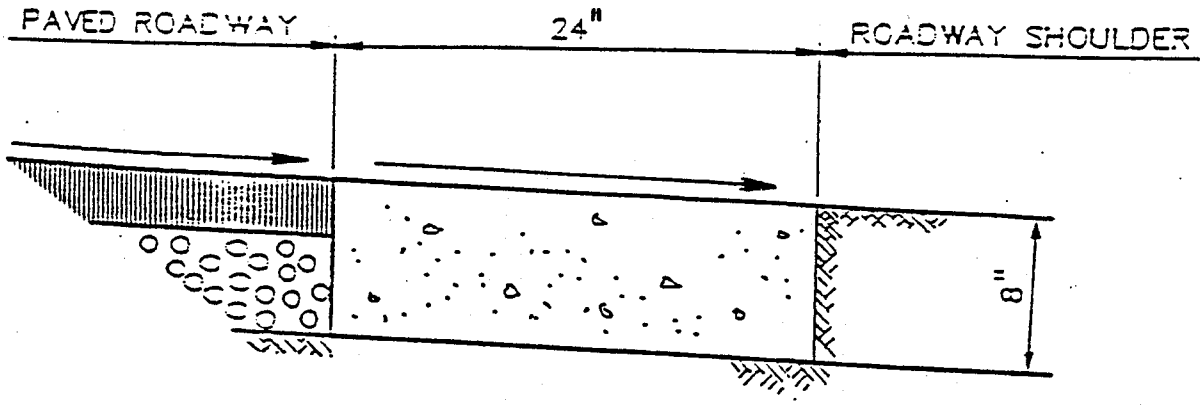
1. ALL BURIED VALVES SHALL BE PROVIDED W/EXTENSION STEM OPERATOR W/2" SQ AWWA NUT WITHIN 36" OF VALVE BOX COVER. NUT IS TO INDICATE DIRECTION OF ROTATION TO OPEN VALVE.
2. COAT BURIED PIPE & VALVE BOX PER SPECIFICATIONS.
3. CLEAN VALVE BOX OF ALL DEBRIS & SOIL.
4. VALVE TYPE AS INDICATED ON THE PLANS.

266 TYP VALVE BOX INSTALLATION



NOTES: 1. ALL EXPOSED SURFACES TO BE TROWELED FINISHED EXCEPT AS SHOWN.

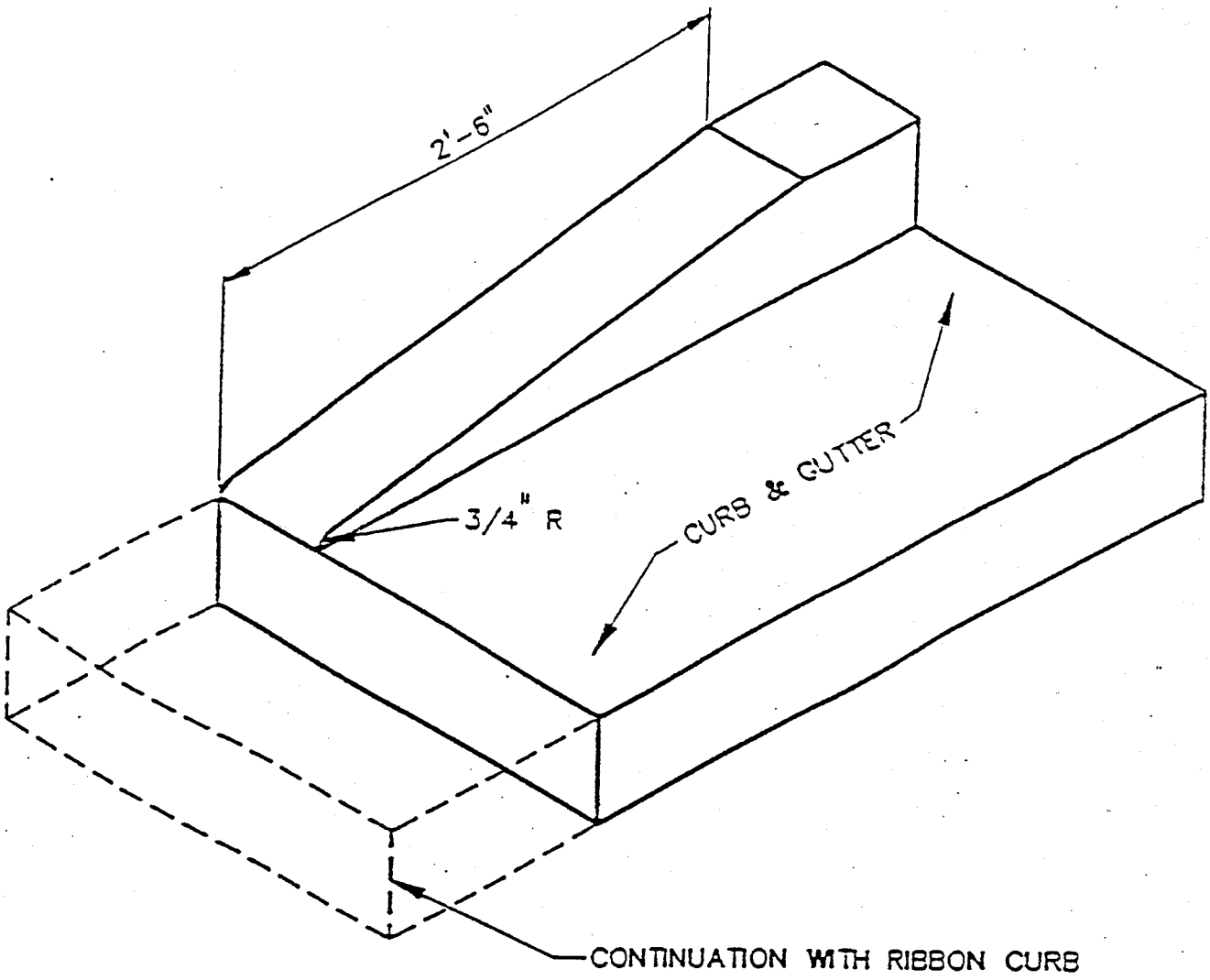
275. TYP VERTICAL CURB & GUTTER



NOTES: 1. SLOPE OF RIBBON CURB TO MATCH ADJACENT ROADWAY SLOPE

2. BROOM FINISH TOP SURFACE

276. TYP RIBBON CURB

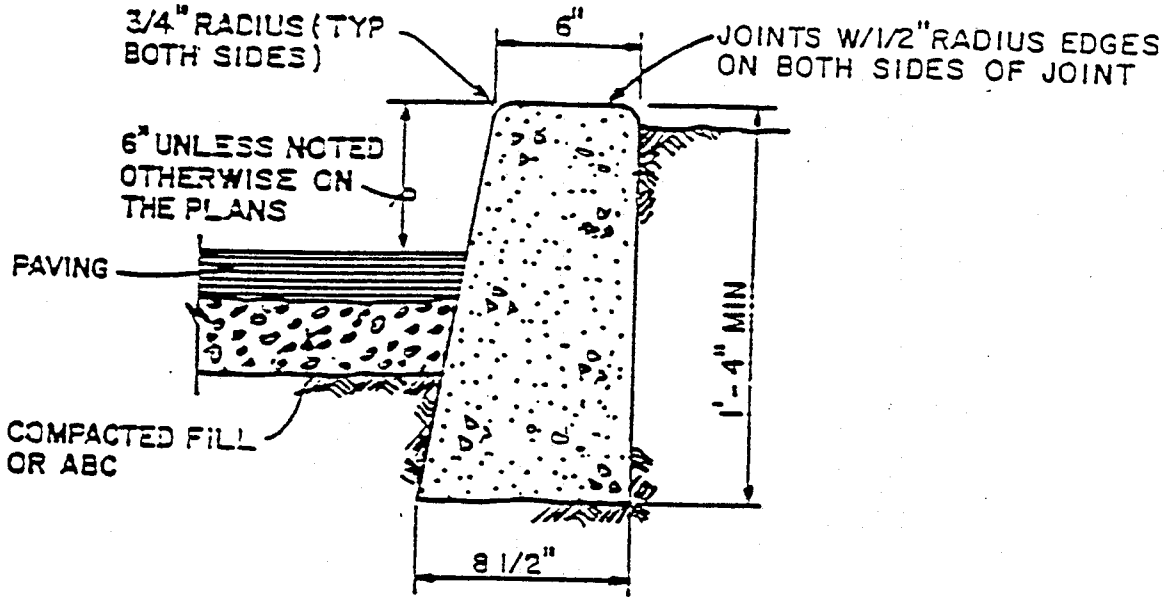


NOTES: 1. CURB & GUTTER PER TYP. DETAIL 275

2. RIBBON CURB PER TYP. DETAIL 276

277. TYP

VERTICAL CURB TERMINATION

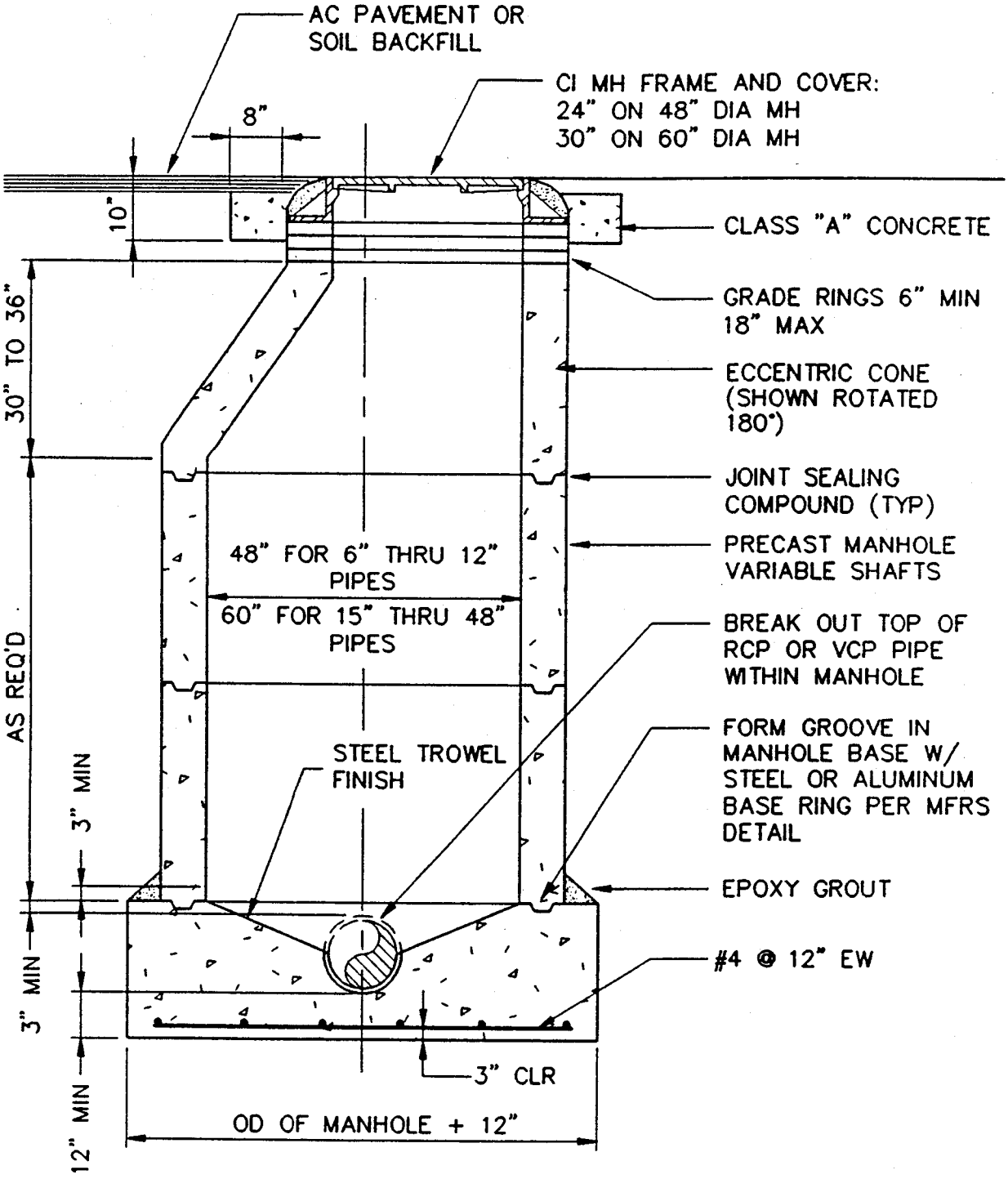


NOTE:

1. CURB TO BE FINISHED AT TOP, 8" DOWN FACE, AND 2" DOWN BACK.

278. TYP

SINGLE VERTICAL CURB



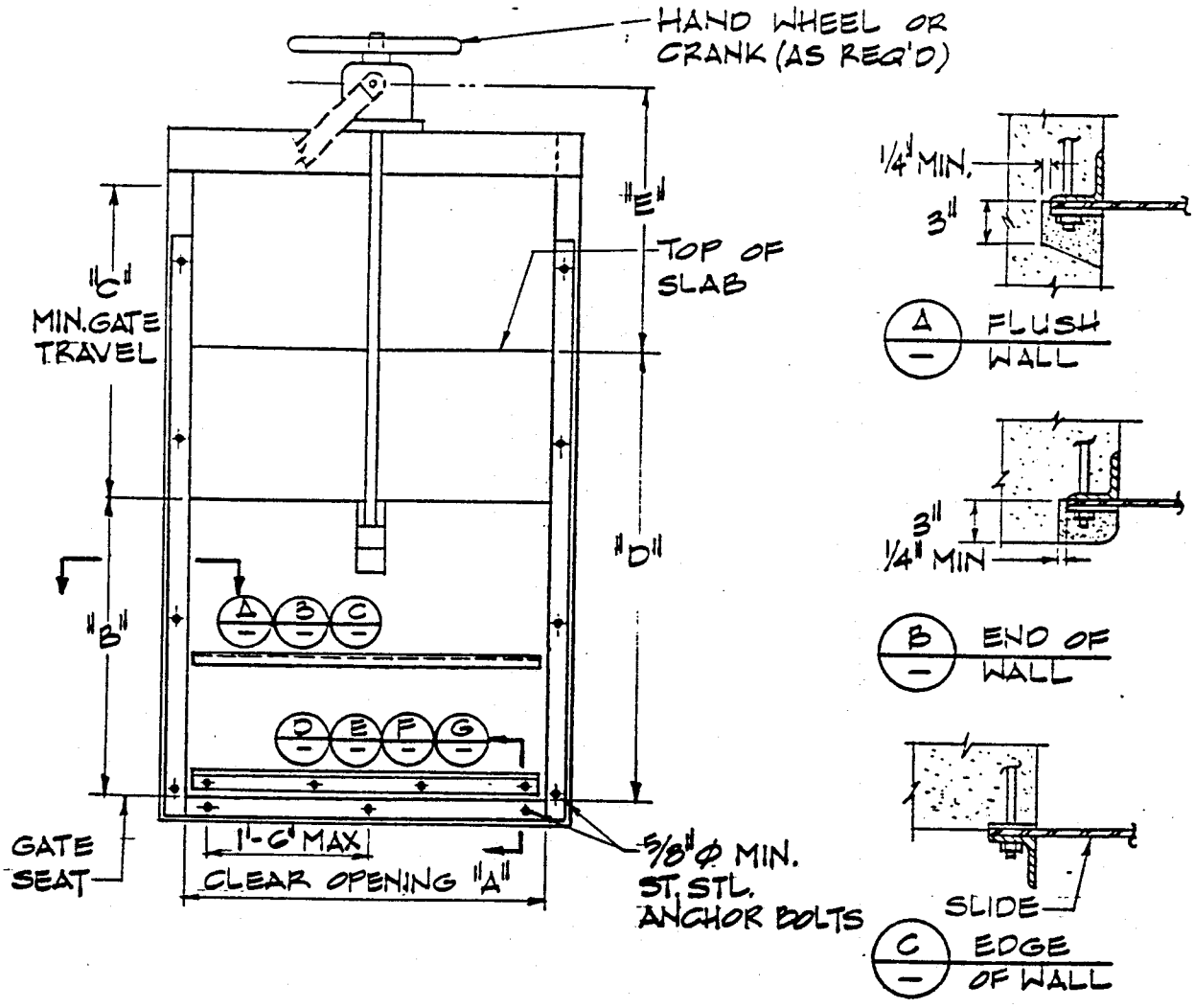
NOTES:

1. LOCATE MANHOLE COVER ON DOWNSTREAM SIDE OF MANHOLE. SET MANHOLE FRAME IN GROUT.

2. JOINT SEALING COMPOUND SHALL BE QUIK-SEAL BY ASSOCIATED CONCRETE PRODUCTS; RAM-NEK BY K.T. SNYDER COMPANY; OR EQUAL.

280 TYP MANHOLE DETAIL

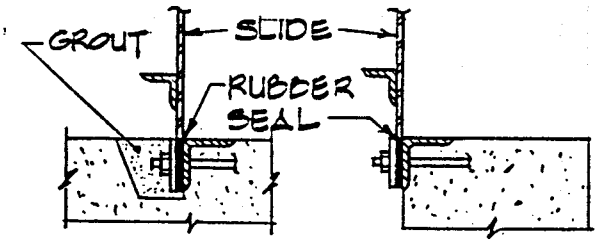
TYP280 5-14-91



A — FLUSH WALL

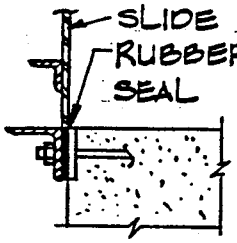
B — END OF WALL

C — EDGE OF WALL

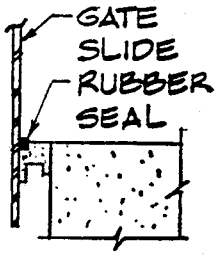


D — FLUSH BOTTOM

E — BOTTOM EDGE OF WALL

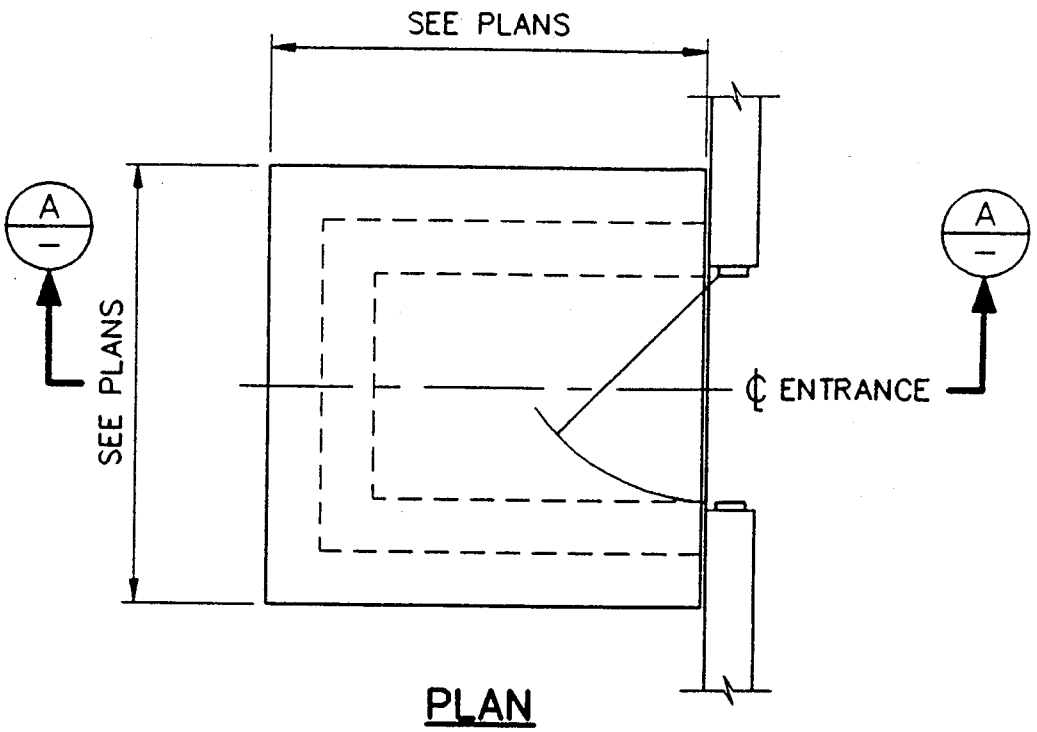


F — BOTTOM EDGE OF WALL

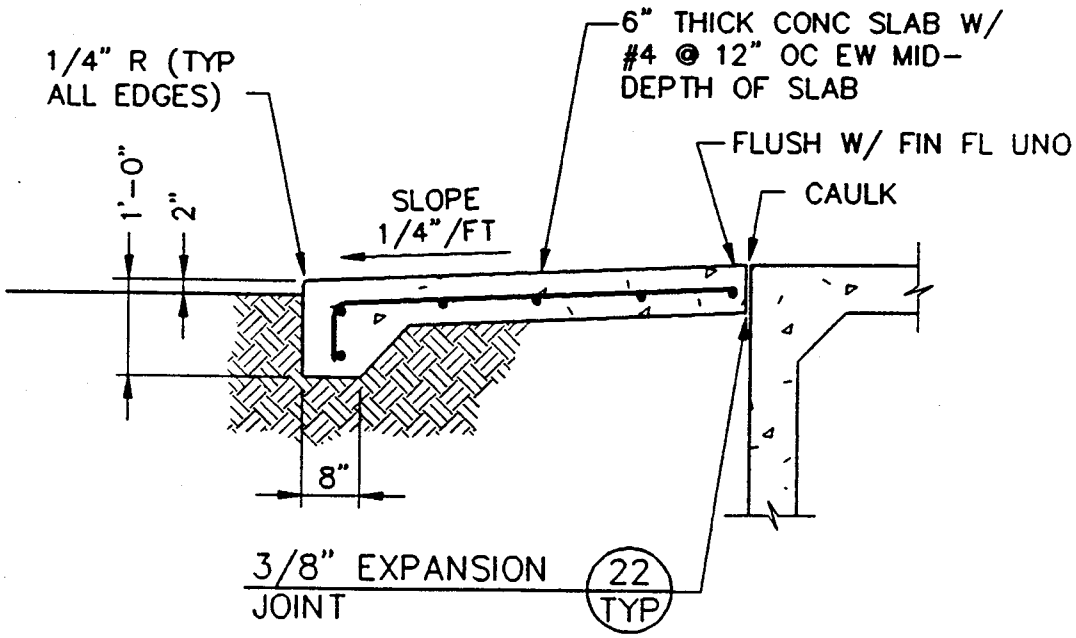


G — SEAT DET. DOWN OPNG. GATE

314 TYP SLIDE GATE DETAILS

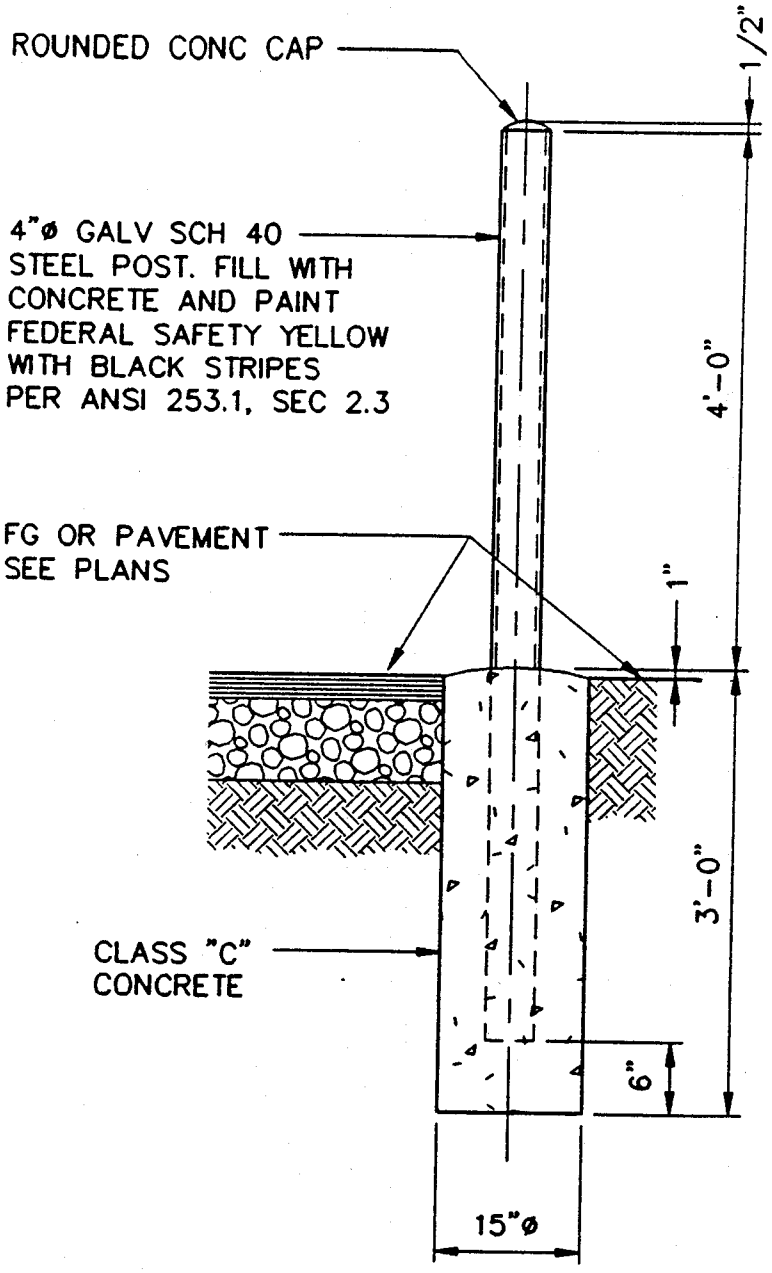


PLAN



A — SECTION

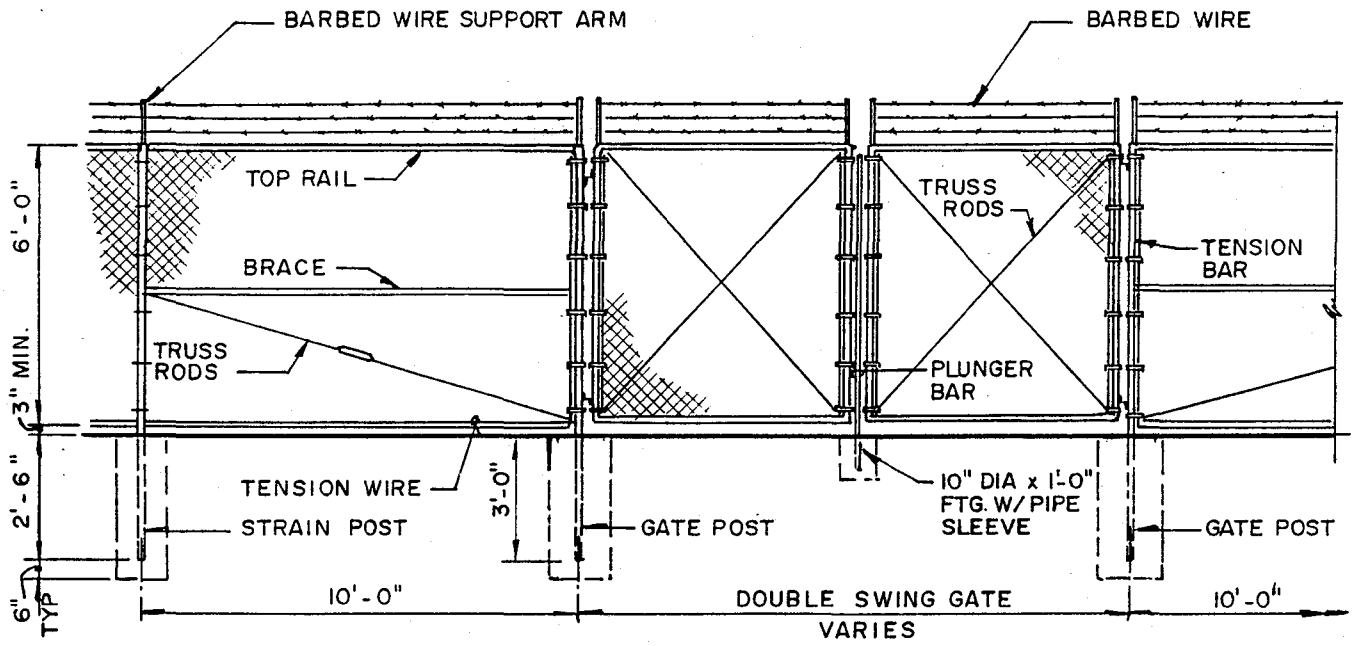
341 TYP ENTRANCE PAD

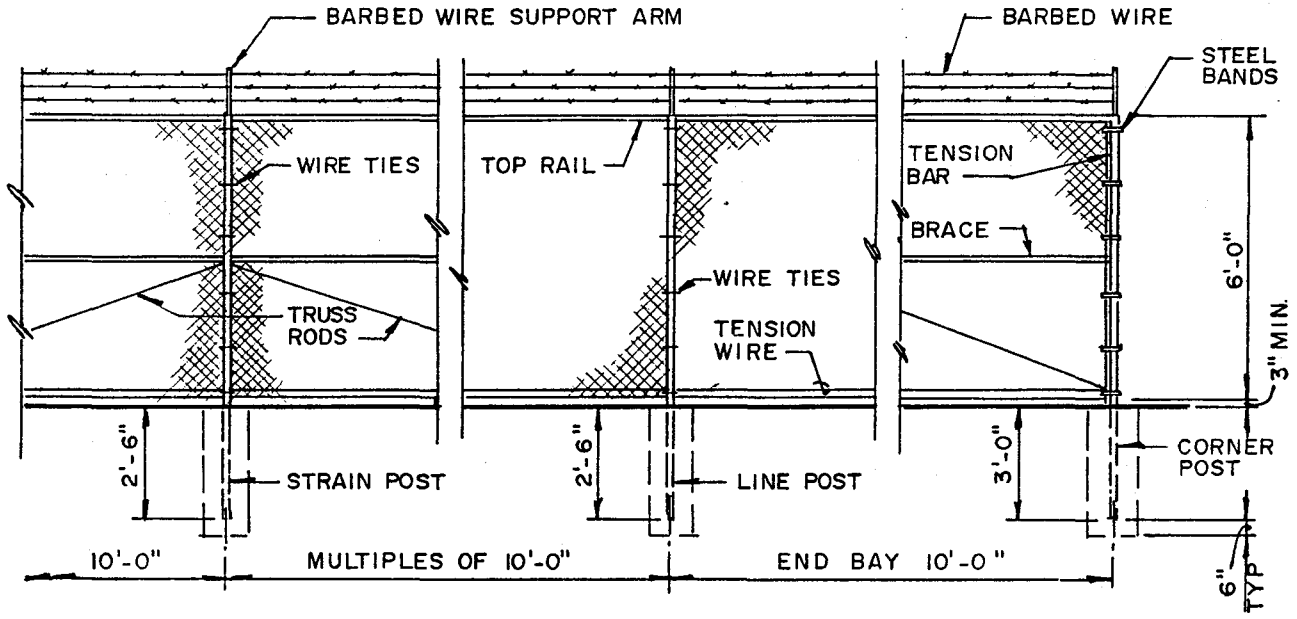


NOTES:

1. PROVIDE 3/8" EJ MATERIAL WHERE INSTALLED IN CONC PAVING

345 TYP GUARD POST



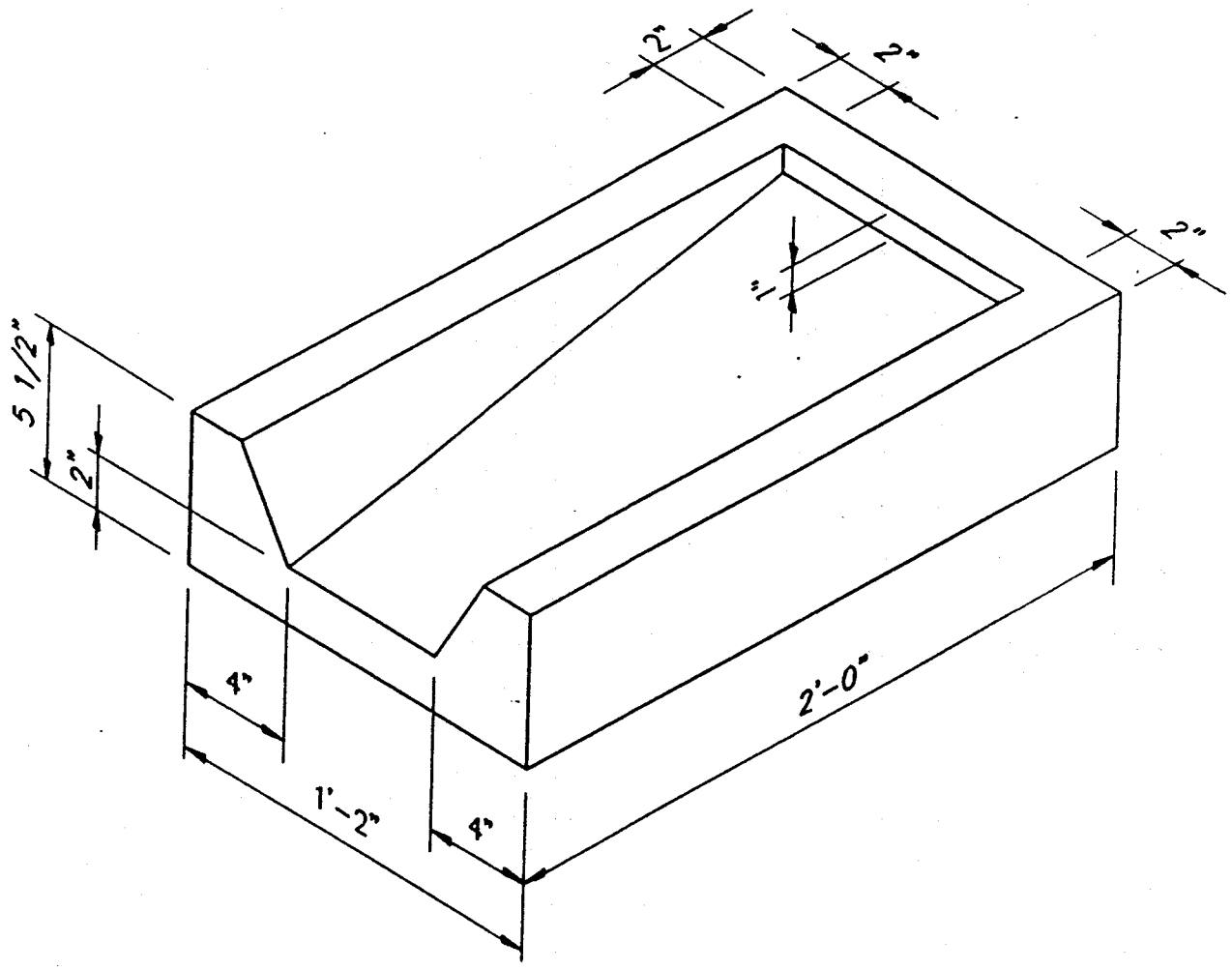


NOTES:

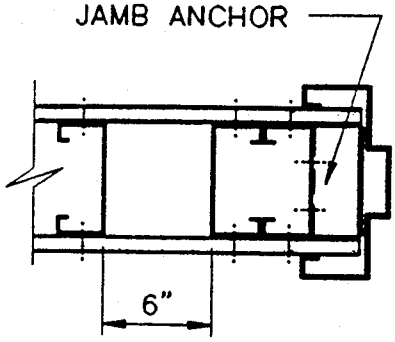
ALL CONCRETE SHALL BE CLASS C. SEE SPECIFICATIONS FOR MEMBER SIZES AND WEIGHTS. FITTINGS NOT SPECIFICALLY DETAILED SHALL BE OF APPROVED HEAVY DUTY DESIGN. STRAIN POSTS SHALL BE SPACED AT 500' MAX. INTERVALS AND BOTH CORNER AND STRAIN POSTS SHALL HAVE STRAIN PANELS EACH SIDE. ALL PIPE POSTS SHALL BE CAPPED.

346. TYP

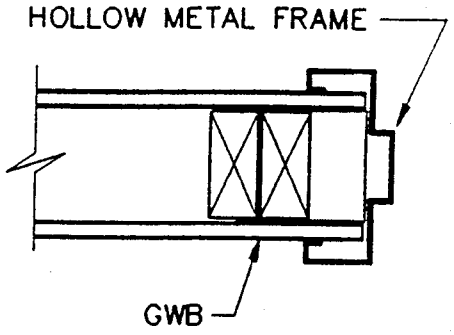
6' CHAIN LINK FENCE & GATE



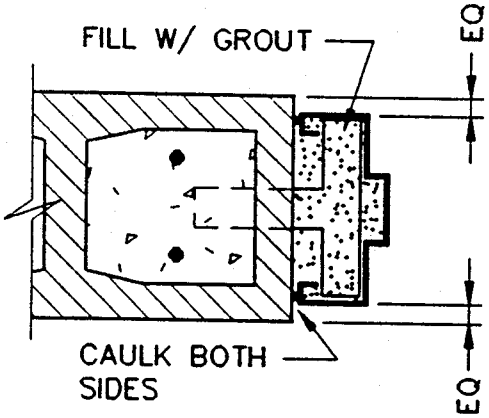
355 TYP CONCRETE SPLASH BOX



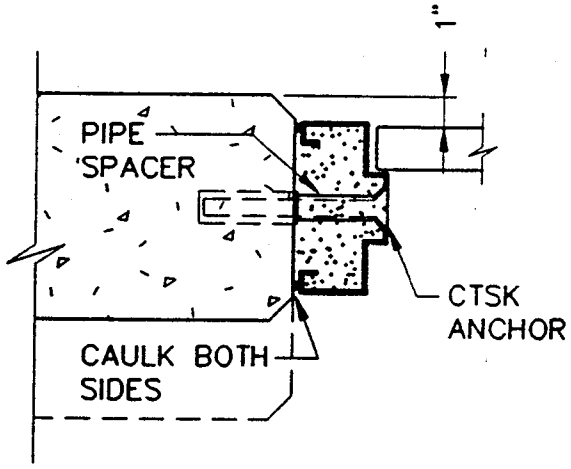
A — NON-LOAD BEARING METAL FRAMING



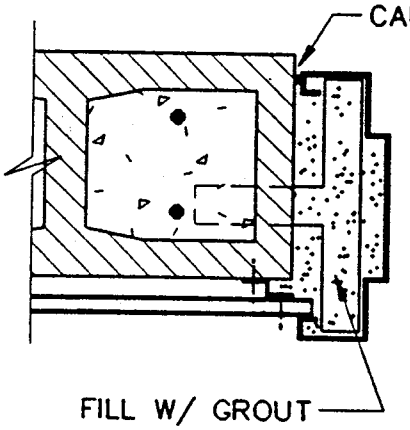
B — NON-LOAD BEARING WOOD FRAMING



C — 8" MASONRY



D — CONCRETE



E — FURRED MASONRY

NOTES:

1. PROVIDE MIN 3 ANCHORS PER JAMB @ MASONRY & 4 ANCHORS PER JAMB @ STUD OR CONCRETE CONSTRUCTION.
2. PROVIDE BACKBEND DIM AS REQD (1/2" ±)

393 TYP — DOOR JAMB DETAILS
HOLLOW METAL FRAME

AIR OR CHEMICAL DIFFUSER

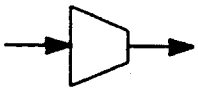
AIR: HIGH PRESSURE QUICK DISCONNECT

BATCHMETER

AIR VENT

BLOWER

CALIBRATION COLUMN



COMPRESSOR/TURBINE

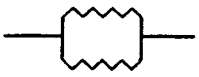
COMPRESSOR: RECIPROCATING

DIAPHRAGM SEAL

DRAIN

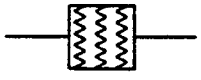
EJECTOR OR EDUCTOR

ELECTRIC MOTOR

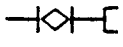


EXPANSION JOINT, FLEXIBLE VIBRATION JOINT

FAN: EXHAUST/SUPPLY



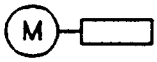
FILTER



FLUSHING CONNECTION

GAUGE: PRESSURE

GAUGE: DIFFERENTIAL PRESSURE

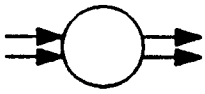


GRINDER

MIXER

OIL OR MOISTURE TRAP AIR SERVICE

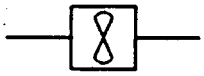
PRIMARY LEVEL ELEMENT: BUBBLER



PRIMARY LEVEL ELEMENT: FLOAT SWITCH

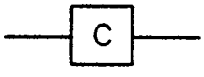
PRIMARY LEVEL ELEMENT: PROBE

PRIMARY LEVEL OR FLOW ELEMENT: ULTRASONIC

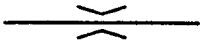


PRIMARY FLOW ELEMENT:
T = TURBINE
P = PROPELLER

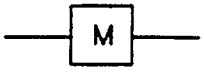
PRIMARY FLOW ELEMENT: AVERAGING PITOT TUBE



PRIMARY FLOW ELEMENT: CORIOLOS



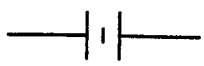
PRIMARY FLOW ELEMENT: FLUME

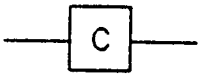


PRIMARY FLOW ELEMENT: MAGNETIC

400 TYP PIPING SYMBOLS

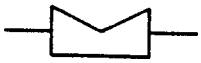
SHEET 1 OF 3


PRIMARY FLOW ELEMENT: ORIFICE PLATE



PRIMARY FLOW ELEMENT: THERMAL

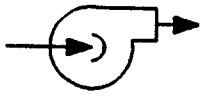

PRIMARY FLOW ELEMENT: VENTURI TUBE

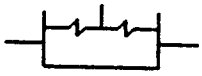

PRIMARY FLOW ELEMENT: WEIR


PRIMARY FLOW ELEMENT: ULTRASONIC

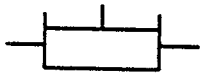

PRIMARY FLOW ELEMENT: ROTAMETER

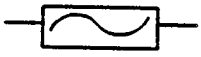

PULSATION DAMPENER


PUMP: CENTRIFUGAL

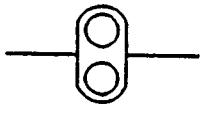

PUMP: DIAPHRAGM


PUMP: METERING

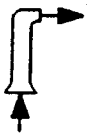

PUMP: PLUNGER


PUMP: PROGRESSIVE CAVITY


PUMP: RECIPROCATING

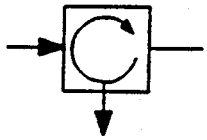

PUMP: ROTARY


PUMP: SCREW


PUMP: VERTICAL LIFT

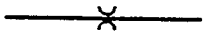

REDUCER: CONCENTRIC


REDUCER: ECCENTRIC


ROTARY CHEMICAL FEEDER

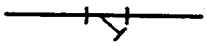

RUPTURE DISK

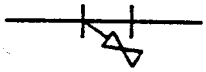
SAMPLE PORT


SIGHT GLASS


SLIDE GATE


SLUICE GATE

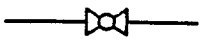

STRAINER: WYE TYPE


STRAINER: WYE TYPE WITH BLOWOFF


THERMOMETER


VALVE: ANGLE (AV)


VALVE: AIR RELIEF (ARV)


VALVE: BALL (BV)

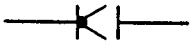
400 TYP S PIPING SYMBOLS

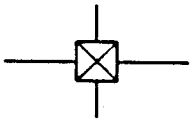
SHEET 2 OF 3


VALVE: BALL CHECK
(BCV)


VALVE: BUTTERFLY
(BV)

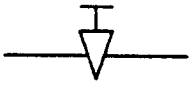

VALVE: DIAPHRAGM
(DV)


VALVE: FLAPPER CHECK
(FCV)


VALVE: FOUR WAY
(4WV)


VALVE: GATE
(GV)

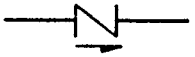

VALVE: GLOBE
(GLV)


VALVE: NEEDLE
(NV)

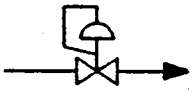

VALVE: PINCH
(PIV)

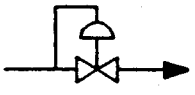

VALVE: PLUG CONCENTRIC
(PV)


VALVE: PLUG ECCENTRIC
(PV)

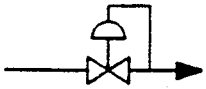

VALVE: SWING CHECK
(SCV)


VALVE: PRESSURE RELIEF
PRESSURE-REDUCING
REGULATOR


BACKPRESSURE REGULATOR
SELF-CONTAINED


BACKPRESSURE REGULATOR
W/EXTERNAL PRESSURE TAP

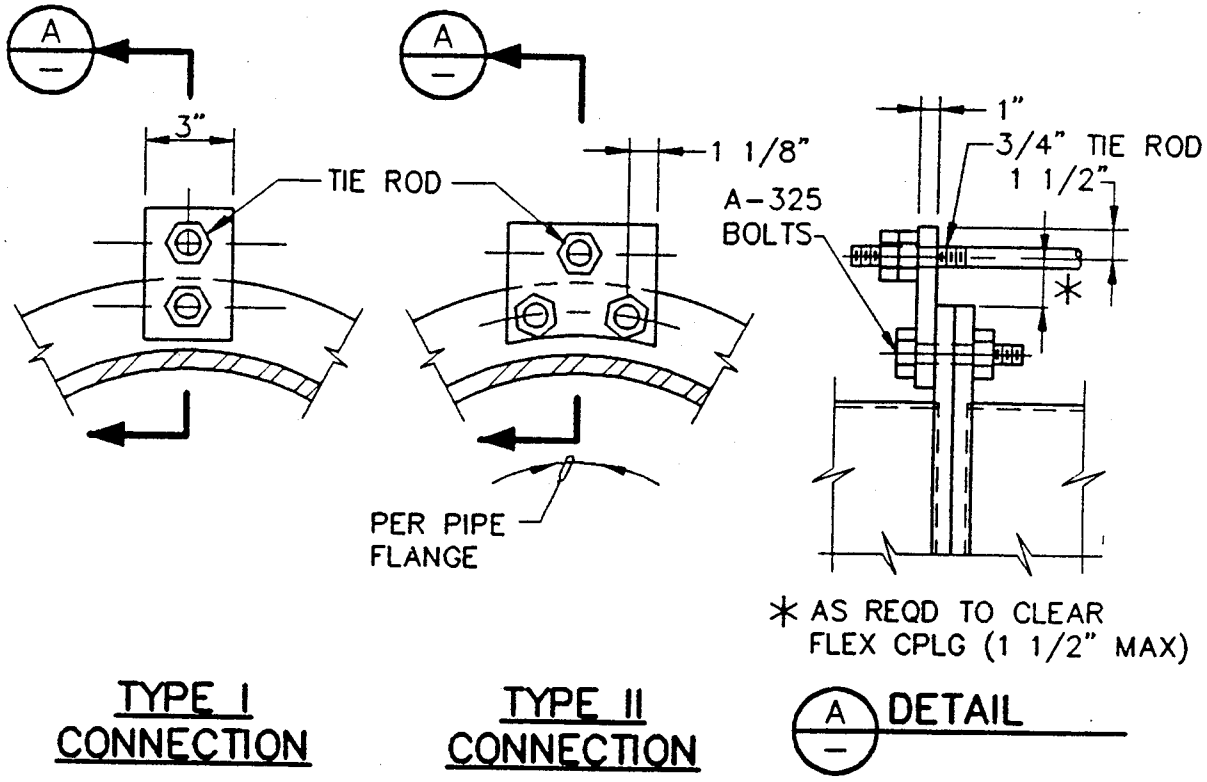

PRESSURE-REDUCING
REGULATOR: SELF
CONTAINED


PRESSURE-REDUCING
REGULATOR W/ EXTERNAL
PRESSURE TAP


VALVE: TELESCOPING


VALVE: THREE WAY

400 TYP S **PIPING SYMBOLS**



TYPE I CONNECTION

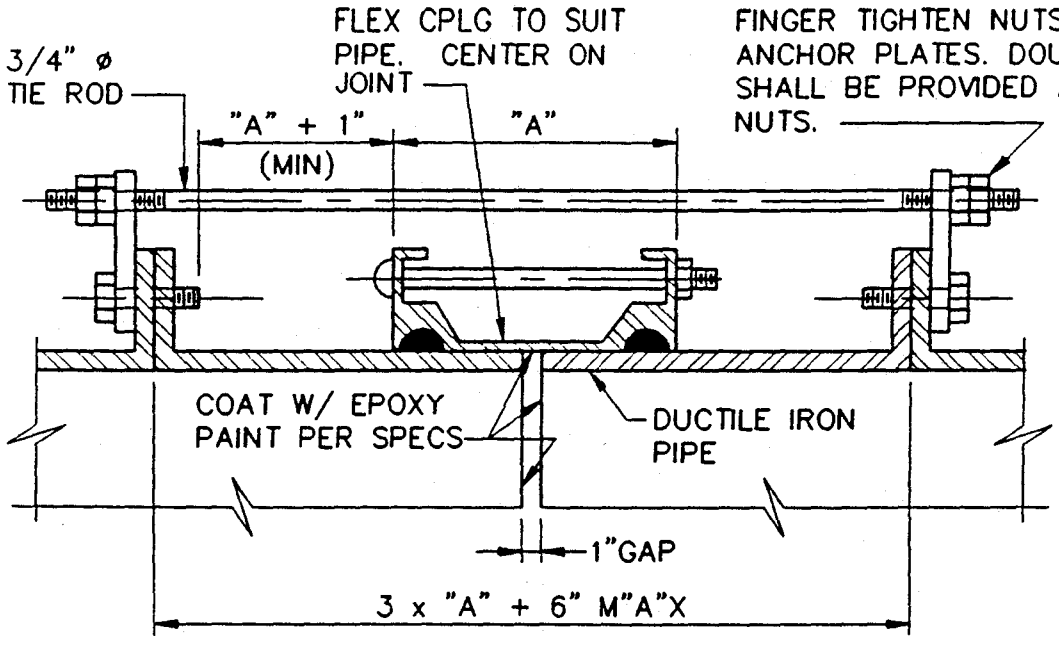
TYPE II CONNECTION

A DETAIL

NOTES:

1. ALL EXPOSED FLEXIBLE COUPLINGS SHALL HAVE TIE RODS UNLESS SPECIFICALLY INDICATED OTHERWISE ON THE PLANS.
2. PIPE THRUST SHALL BE BASED ON TEST PRESSURE.
3. PIPE THRUST = 0.7854 x D^2 x TEST PRESSURE, WHERE D IS PIPE OD.
4. MINIMUM TIE ROD YIELD 48,000 PSI.
5. GRIND ALL CORNERS SMOOTH.

405 TYP DUCTILE IRON PIPE FLEXIBLE COUPLING TIE DOWN

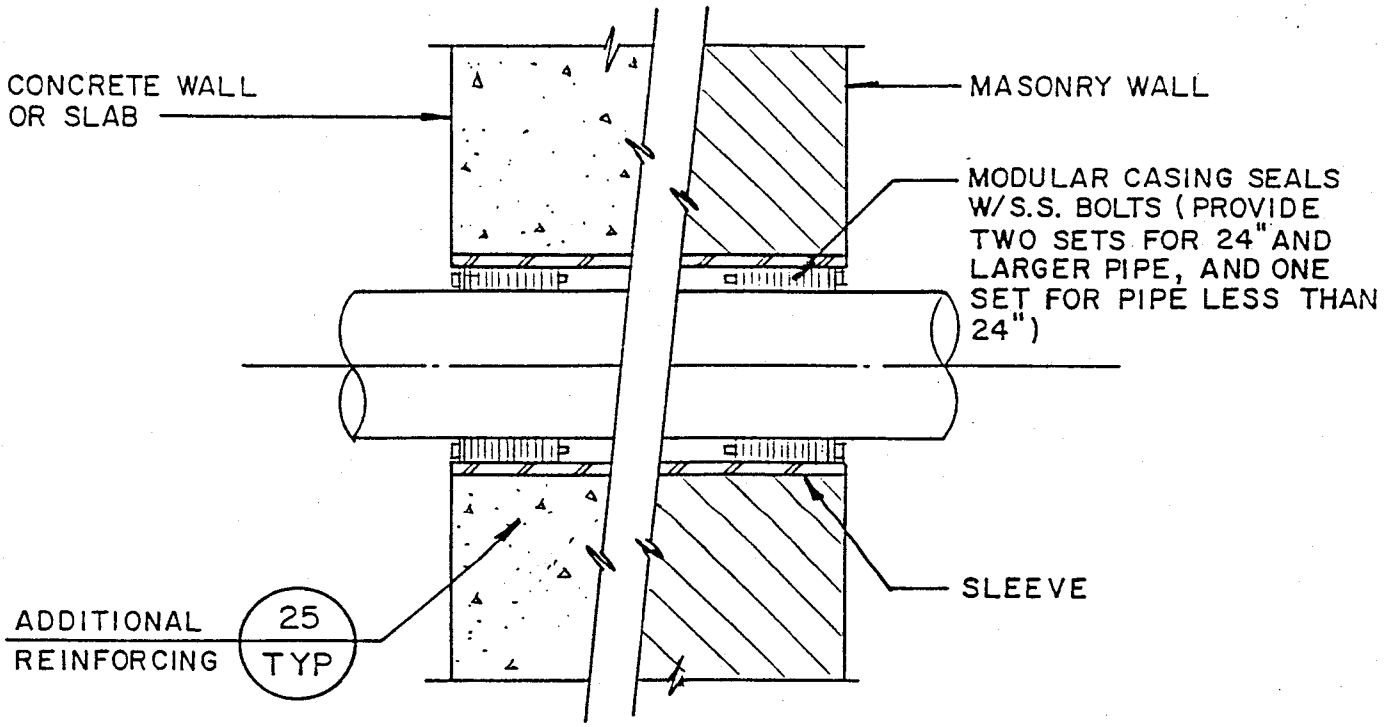


ROD SCHEDULE FOR DIP		
PIPE THRUST SEE NOTE 2	TYPE OF CONNECTION	NO RODS
0–6,000#	I	2
6,001–12,000#	II	2
12,001–18,000#	II	3
18,001–24,000#	II	4
24,001–30,000#	II	5

NOTE:

1. REFER TO NOTES ON SHEET 1 OF 2.

405 TYP **DUCTILE IRON PIPE FLEXIBLE COUPLING TIE DOWN** SHEET 2 OF 2

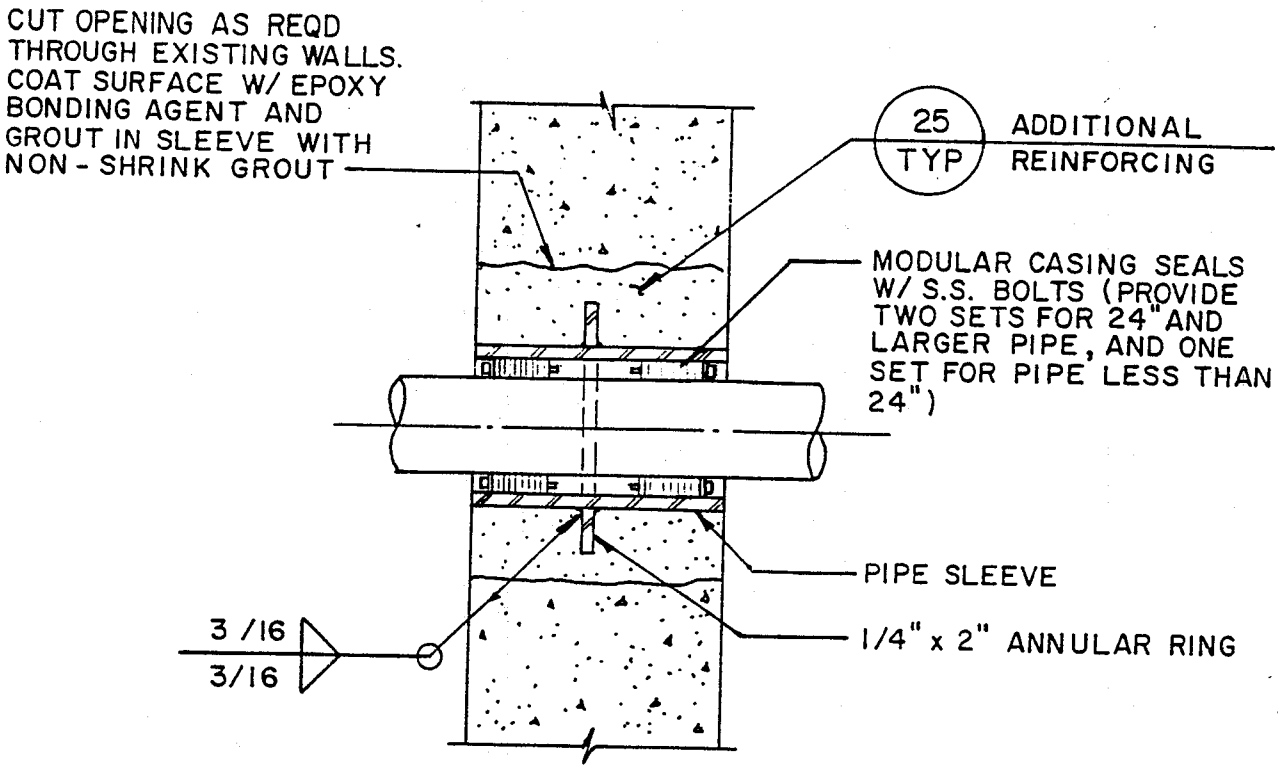


NOTES:

1. SLEEVE DIAMETER SHALL BE PER MODULAR CASING SEAL MANUFACTURE.
2. 6" DIAMETER SLEEVES AND SMALLER: SCHEDULE 40 STEEL PIPE.
3. 8" DIAMETER SLEEVES AND LARGER: 1/4" THICK STEEL PIPE.
4. STEEL SLEEVE SHALL BE HOT-DIP GALVANIZED AFTER FABRICATION.
5. SLEEVES FOR ELECTRICAL CONDUIT SHALL BE SCHEDULE 80 PVC.
6. FOR EXISTING CONCRETE OR MASONRY WALLS, CORE DRILL WALL OPENING IN LIEU OF WALL SLEEVE.

424.
TYP

SLEEVE - INSTALLATION THROUGH DRY WALLS AND FLOOR SLABS



1 SLEEVE DIAMETER SHALL BE PER MODULAR CASING SEAL MANUFACTURE.

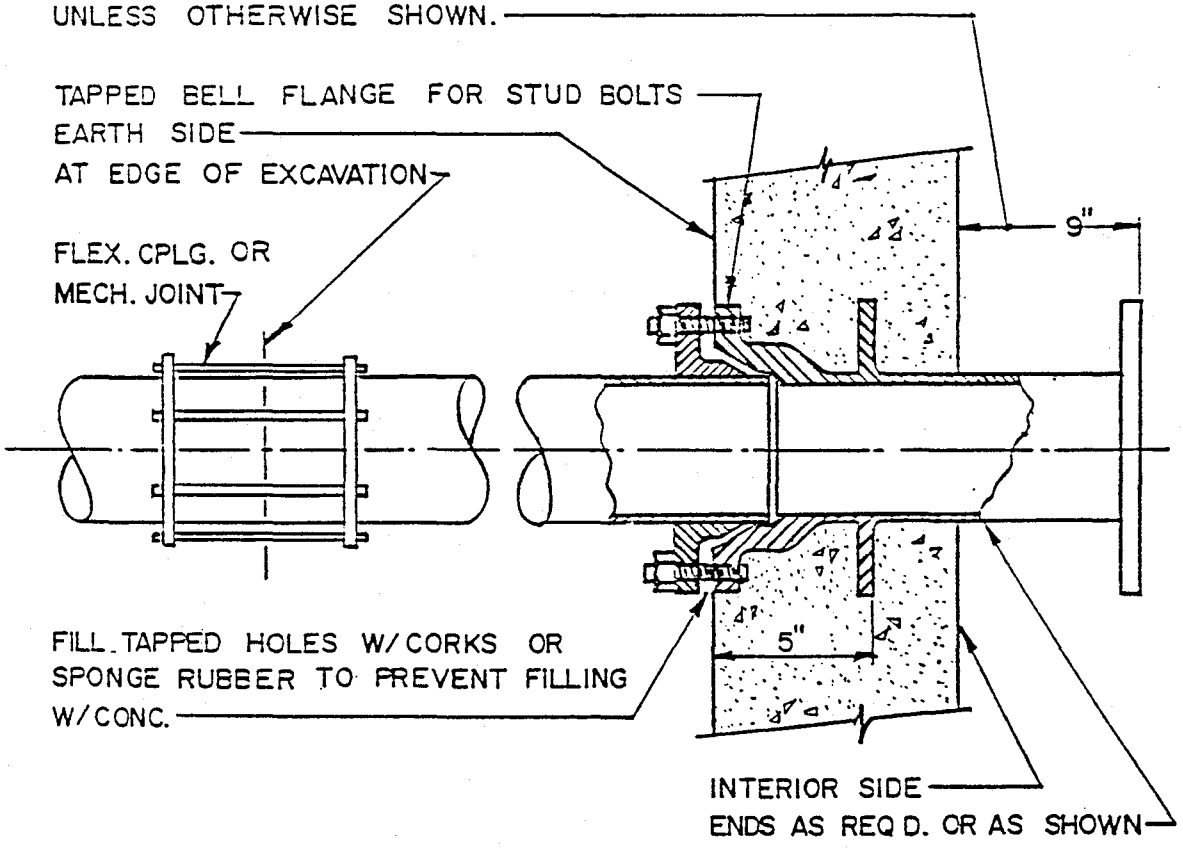
2. FOR NEW CONSTRUCTION, SLEEVES SHALL BE CAST INTO WALL. BLOCKOUTS AND SUBSEQUENT GROUTING IN SLEEVES WILL NOT BE PERMITTED UNLESS A KEYED WATERSTOP JOINT IS PROVIDED.

3. 6" ø SLEEVES AND SMALLER SHALL BE SCH 40 STL PIPE.

4. 8" ø SLEEVES AND LARGER SHALL BE 1/4" THICK STL PIPE.

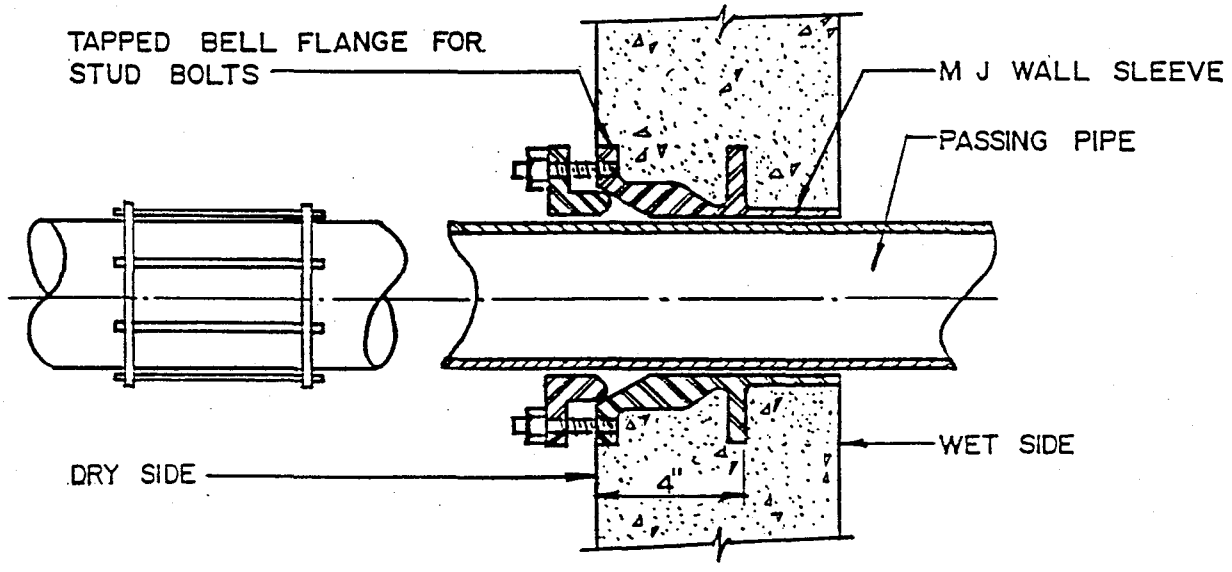
5. SLEEVE SHALL BE HOT-DIP GALVANIZED AFTER FABRICATION.

425. TYP SLEEVE - INSTALLATION THROUGH WALLS AND FLOOR SLABS



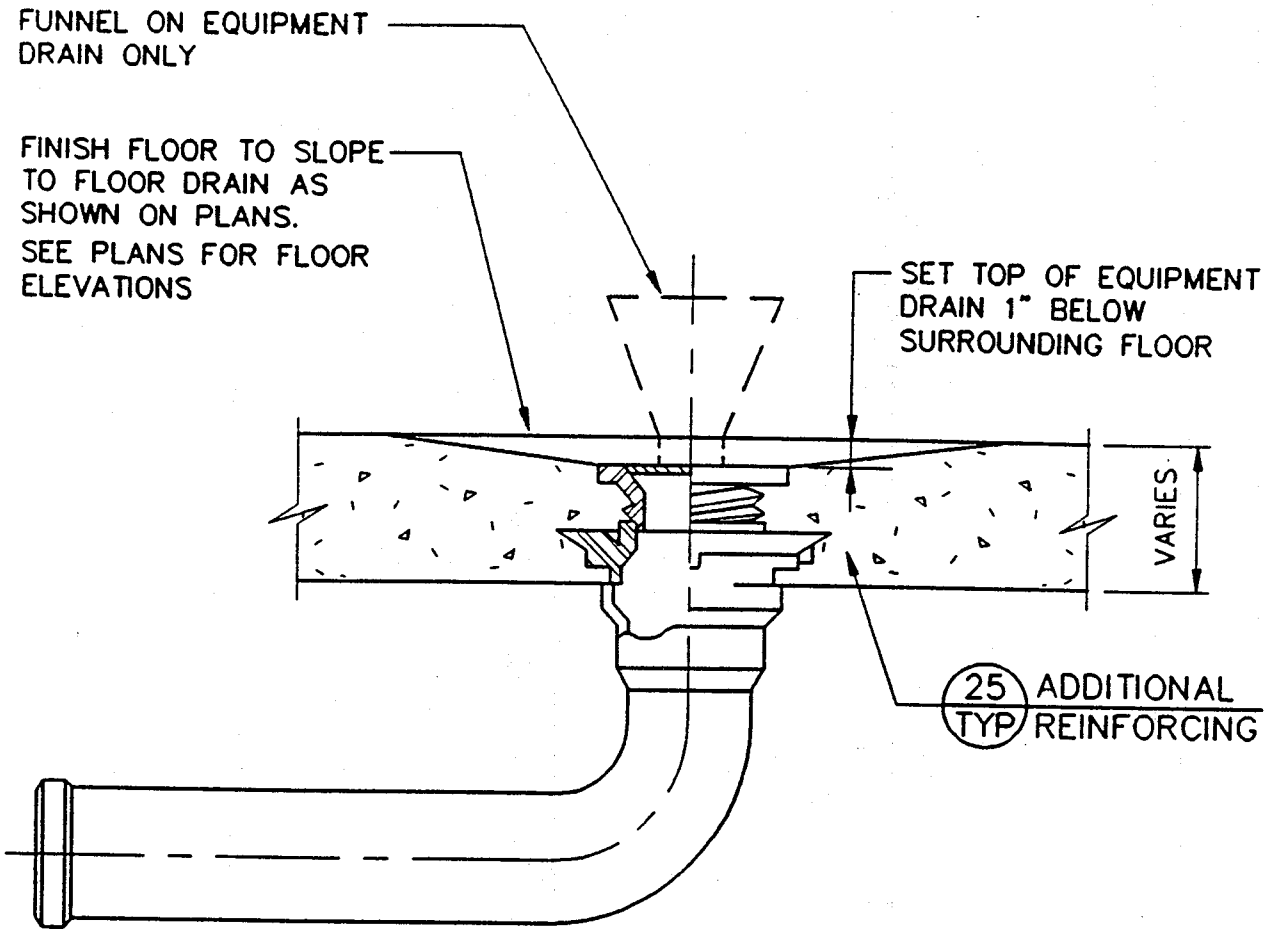
428 TYP

STANDARD WALL PIPE DETAIL



429 TYP

PIPE SLEEVE DETAIL

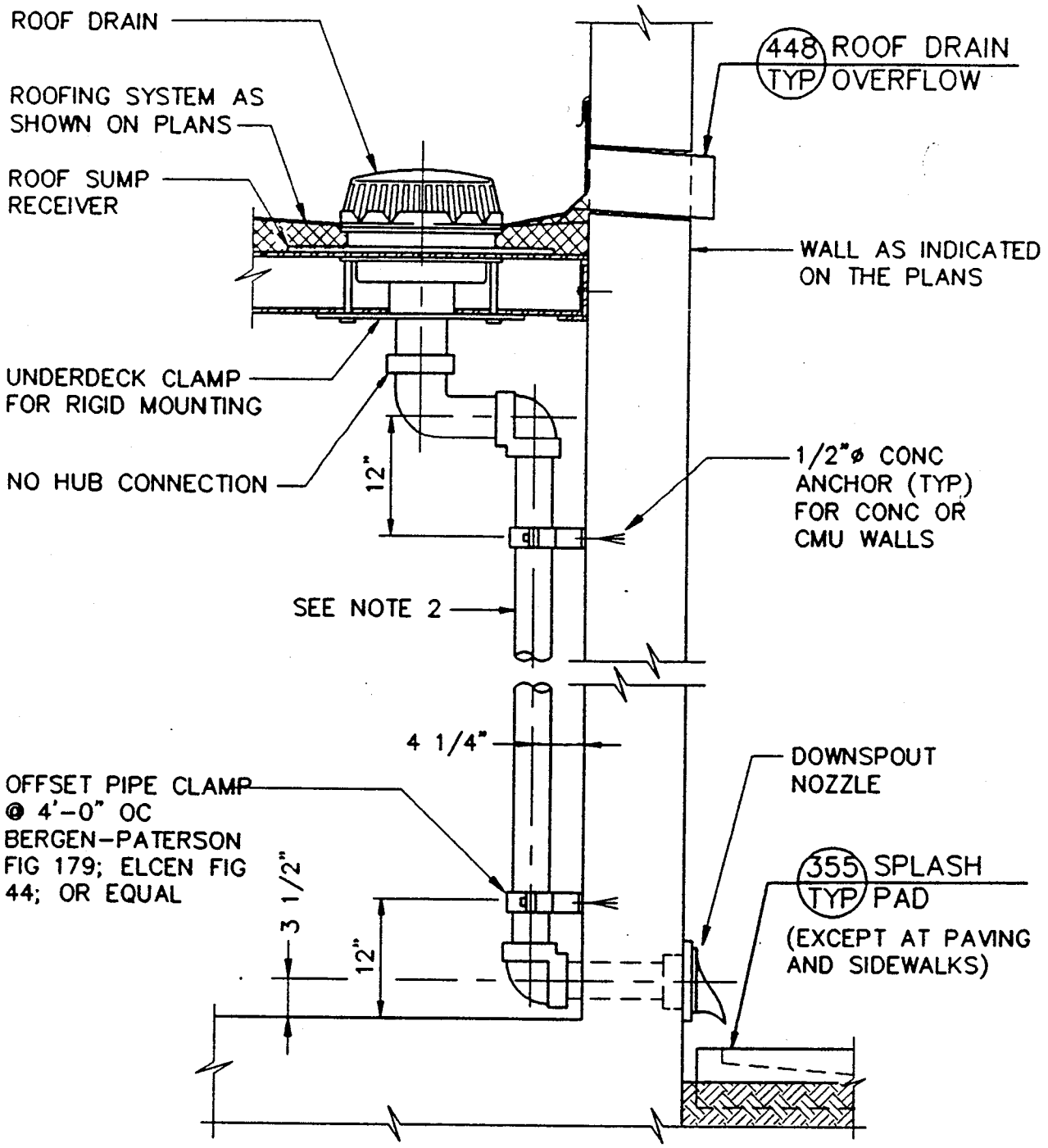


NOTE:

1. PROVIDE 12" RADIUS SLOPE TO EQUIPMENT DRAINS WHERE FLOOR DOES NOT SLOPE TO DRAIN.

442 TYP S FLOOR DRAIN (FD) OR EQUIPMENT DRAIN (ED)

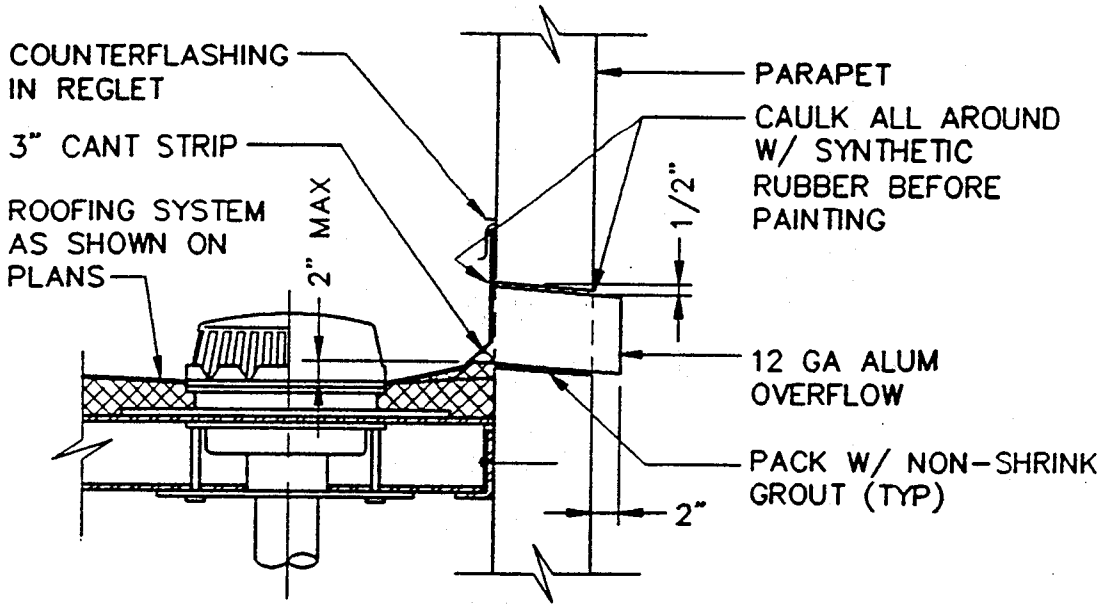
TYP442 5-14-91



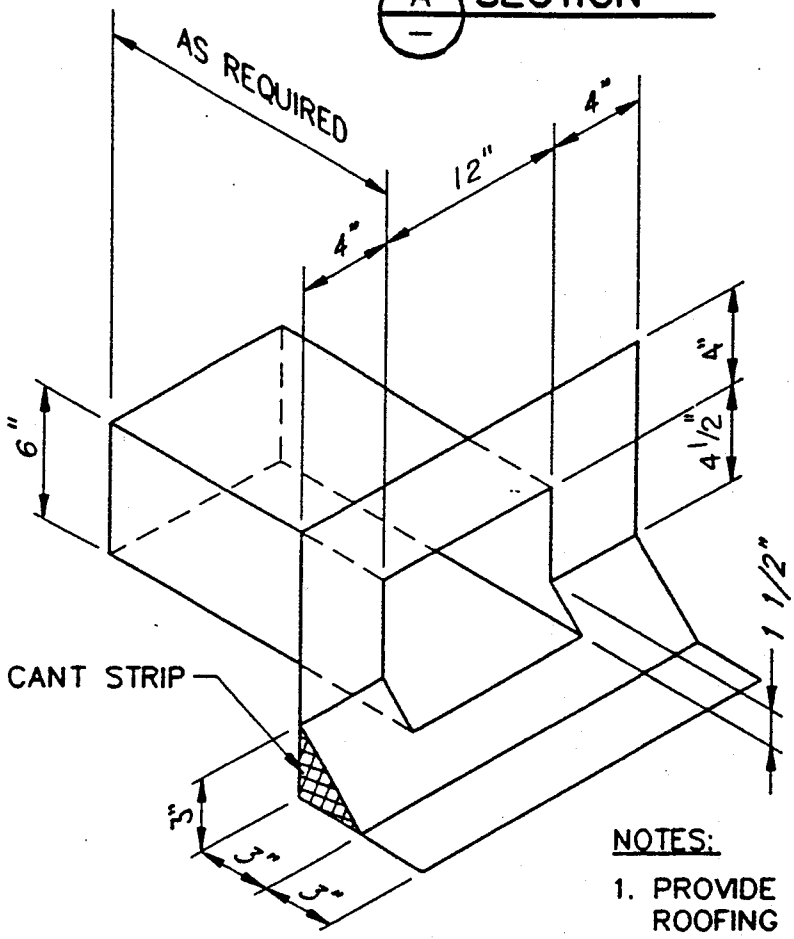
NOTES:

1. OFFSET PIPING AS INDICATED ON THE PLANS.
2. 4"ø GSP UNLESS OTHERWISE INDICATED.

444 TYP ROOF DRAIN PIPING



A — SECTION

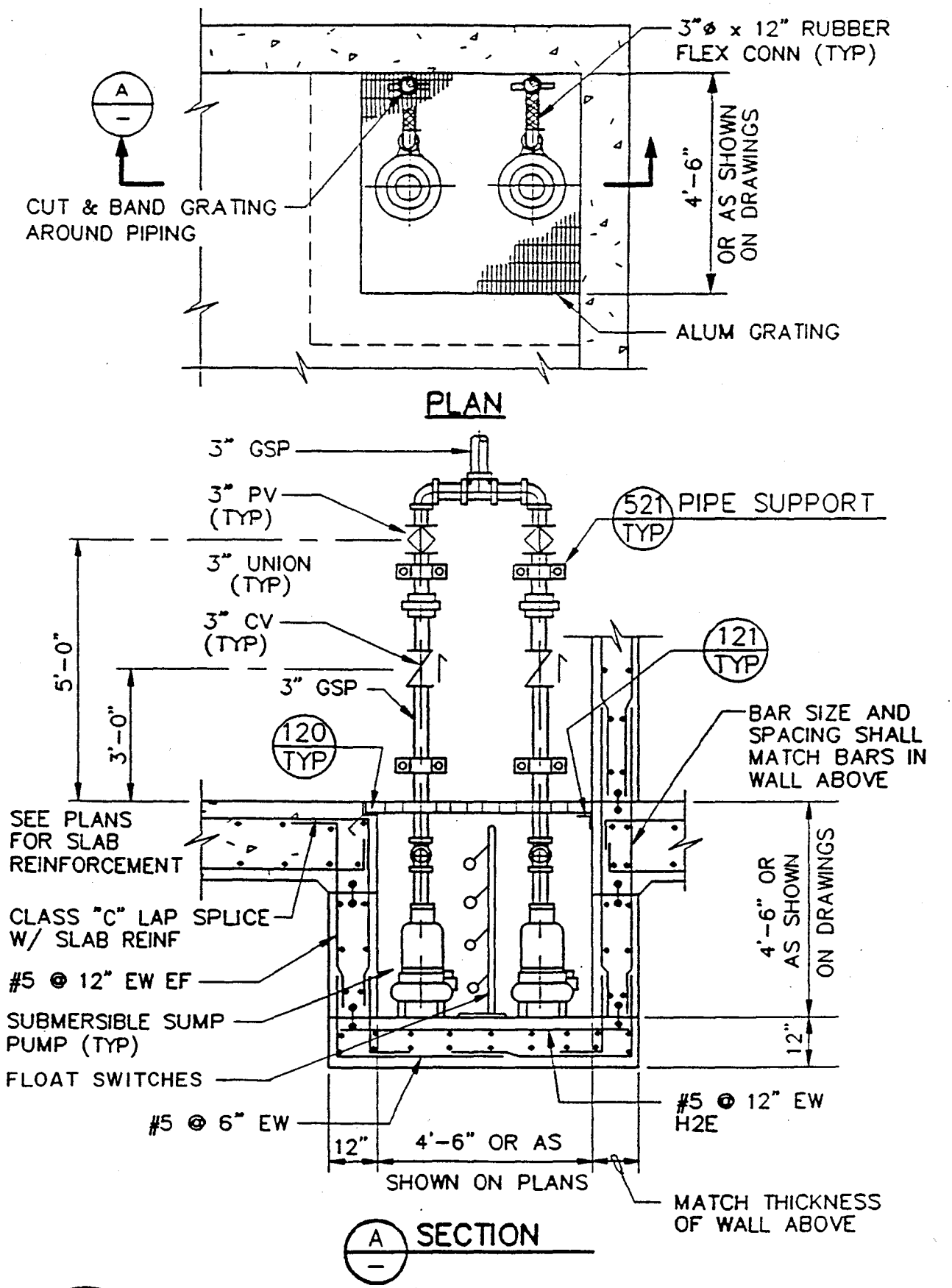


B — ISOMETRIC

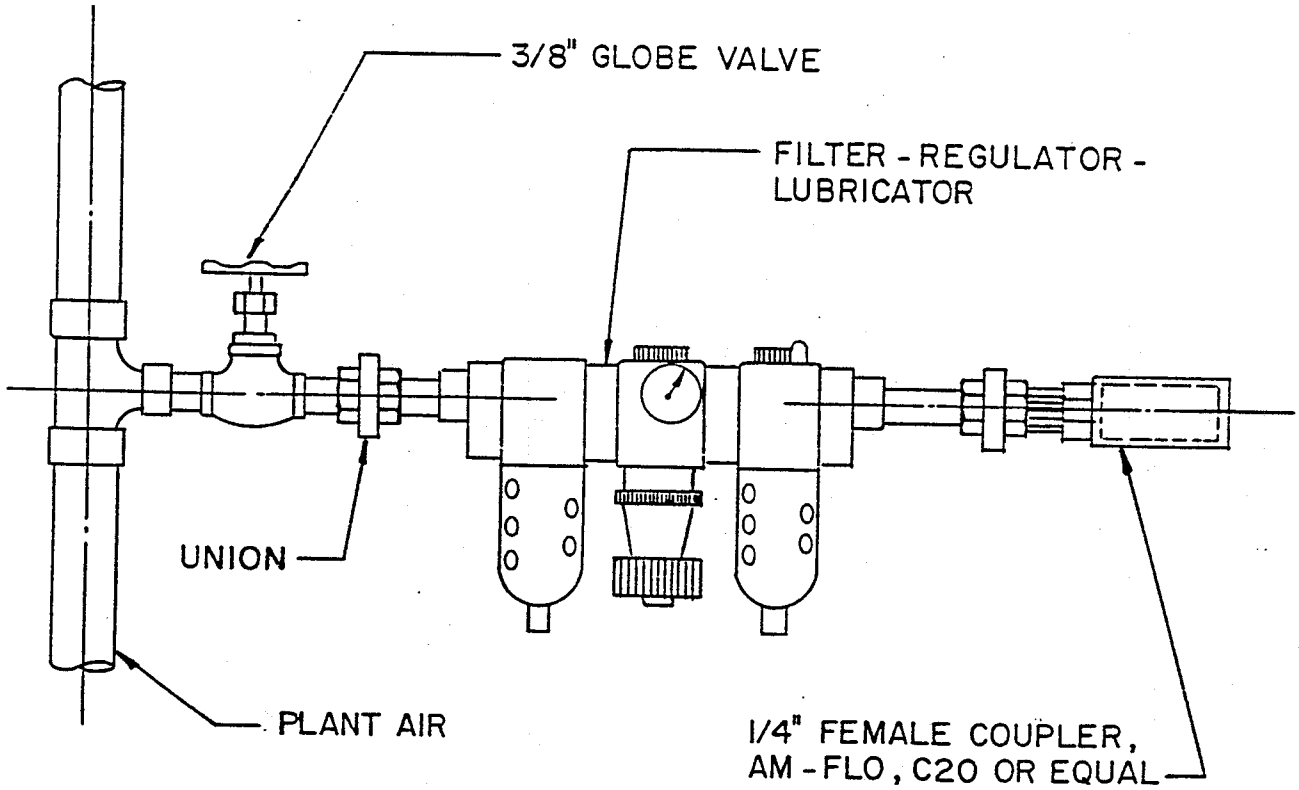
NOTES:

1. PROVIDE FLASHING AS REQUIRED BY ROOFING MANUFACTURER.
2. LOCATE FLOWLINE OF OVERFLOW 2" MAX ABOVE LOW POINT OF ROOF AT ROOF DRAIN.
3. COAT ALUM PER SPECS

448. TYP ROOF DRAIN OVERFLOW

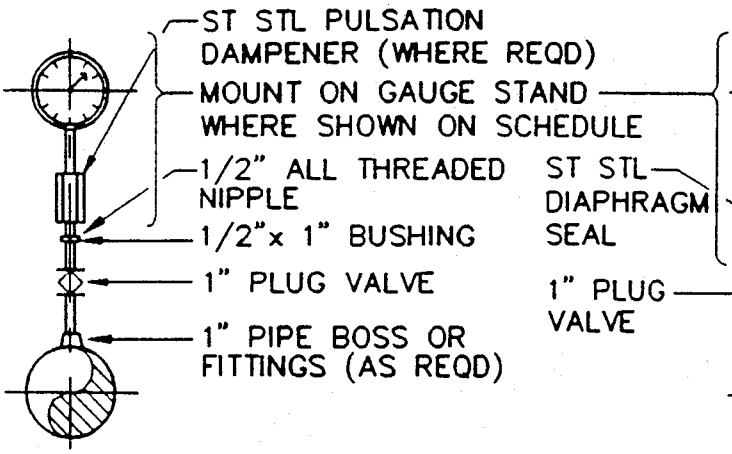


467. TYP SUMP PUMP – DUPLEX SUBMERSIBLE



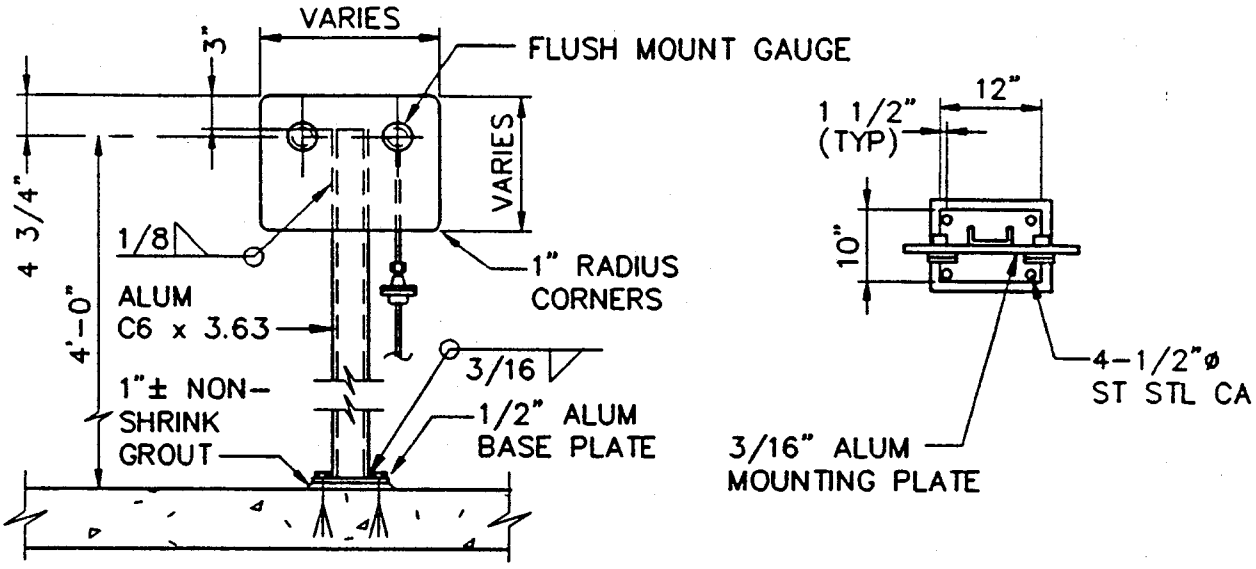
475. TYP

AIR TOOL CONNECTOR



A — DETAIL — AIR AND GAS SERVICE ONLY

B — DETAIL — LIQUID SERVICE



C — ELEVATION

D — PLAN

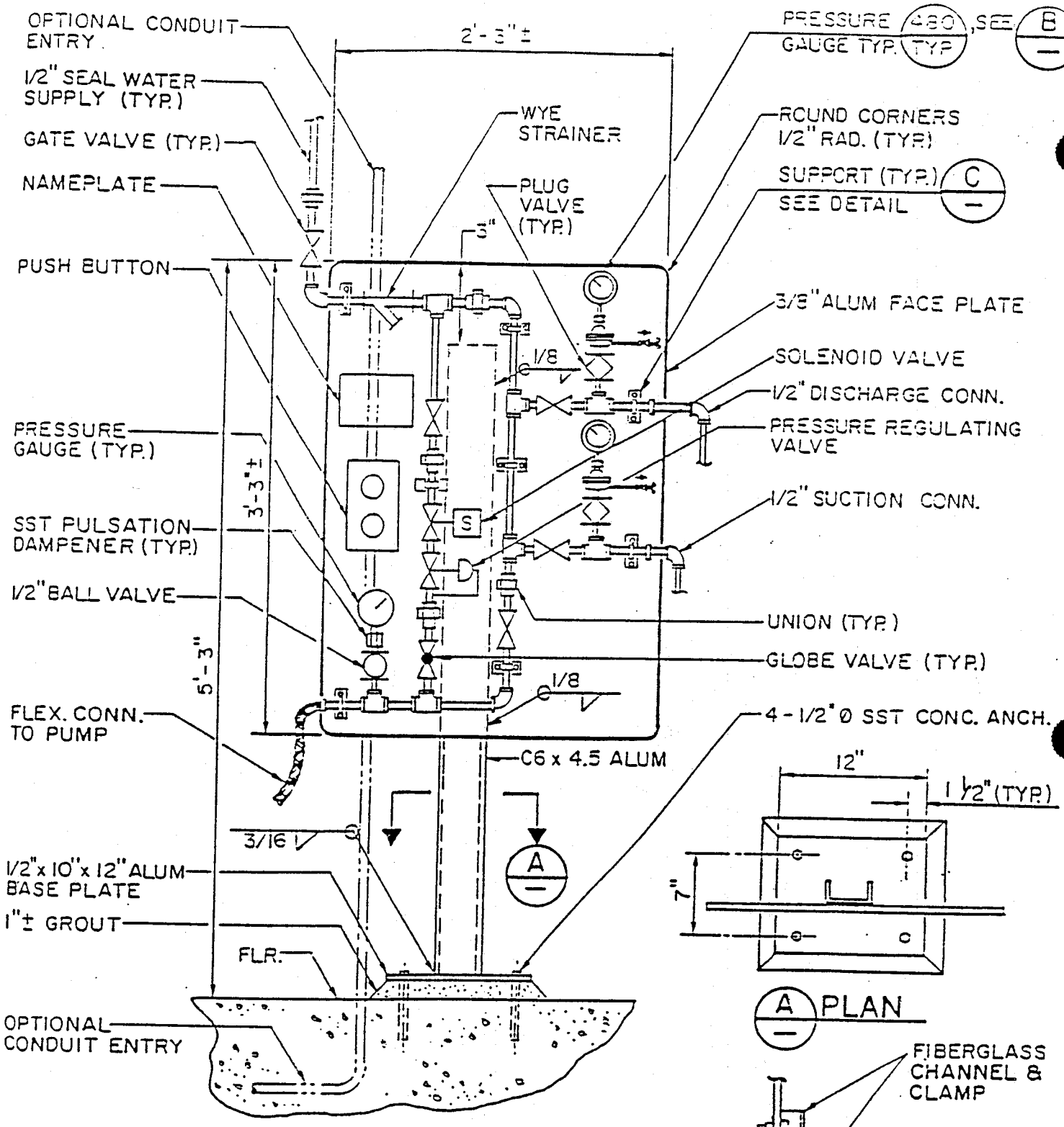
GAUGE STAND

NOTES:

1. ALL GAUGES SHALL BE DUAL SCALE. SCALES ON THE GAUGE FACE SHALL BE MARKED IN PSIG AND FEET OF WATER (FOR POSITIVE READINGS) OR INCHES OF MERCURY (FOR VACUUM READINGS).
2. MOUNTING PLATE DIMENSIONS VARY ACCORDING TO SIZE AND NUMBER OF GAUGES REQUIRED.
3. AT GAUGE STAND, DIAPHRAGM SHALL BE LOCATED BELOW THE MOUNTING PLATE. ONE INCH PIPE SHALL BE ROUTED BETWEEN DIAPHRAGM AND SERVICE PIPE PLUG VALVE. CROSSES WITH THREADED PLUGS SHALL BE USED IN LIEU OF 90° ELBOWS, WITH AT LEAST ONE UNION PER CROSS.
4. COAT ALUMINUM IN CONTACT WITH CONCRETE PER SPECIFICATIONS.

480 TYP — PRESSURE GAUGE DETAIL

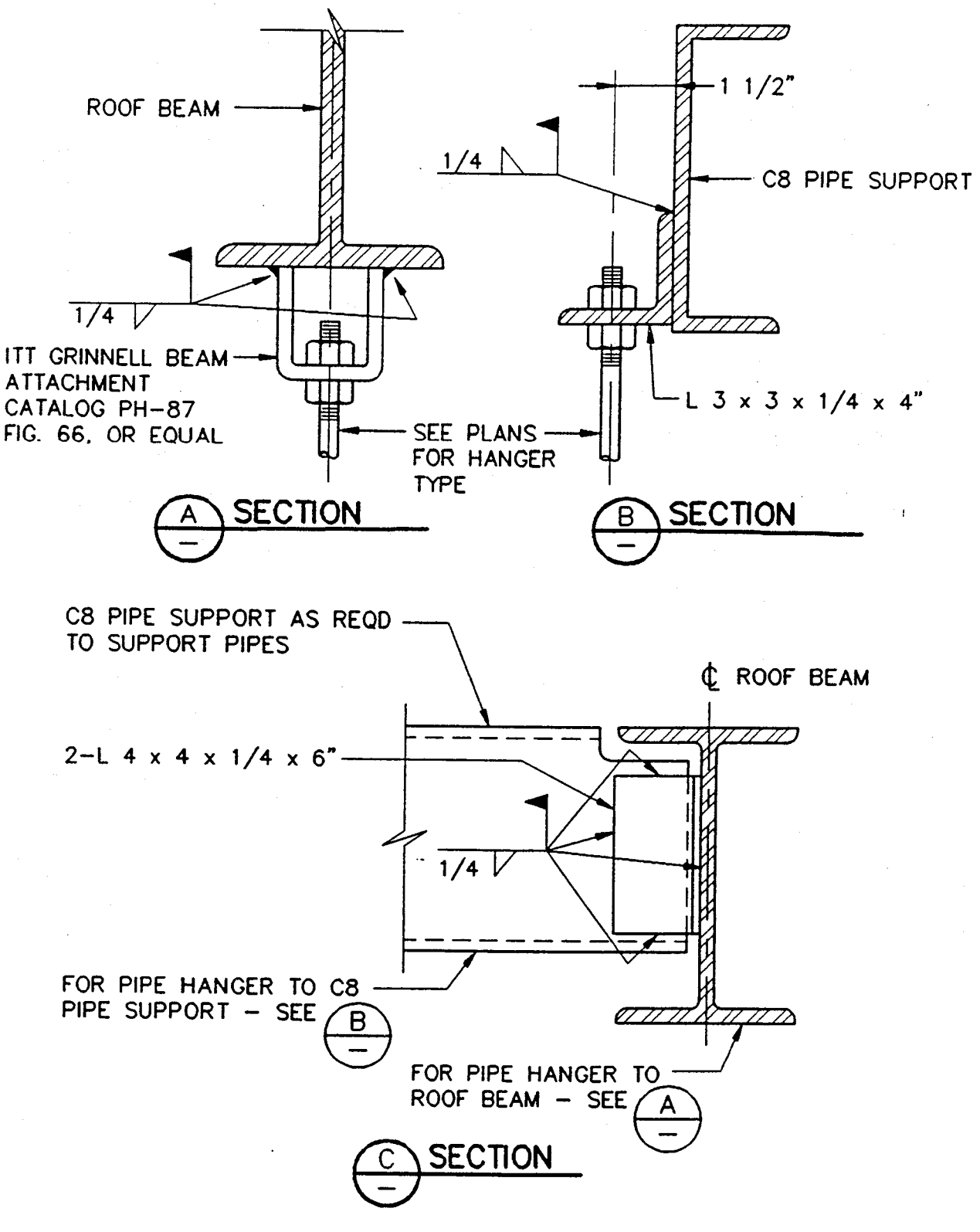
S



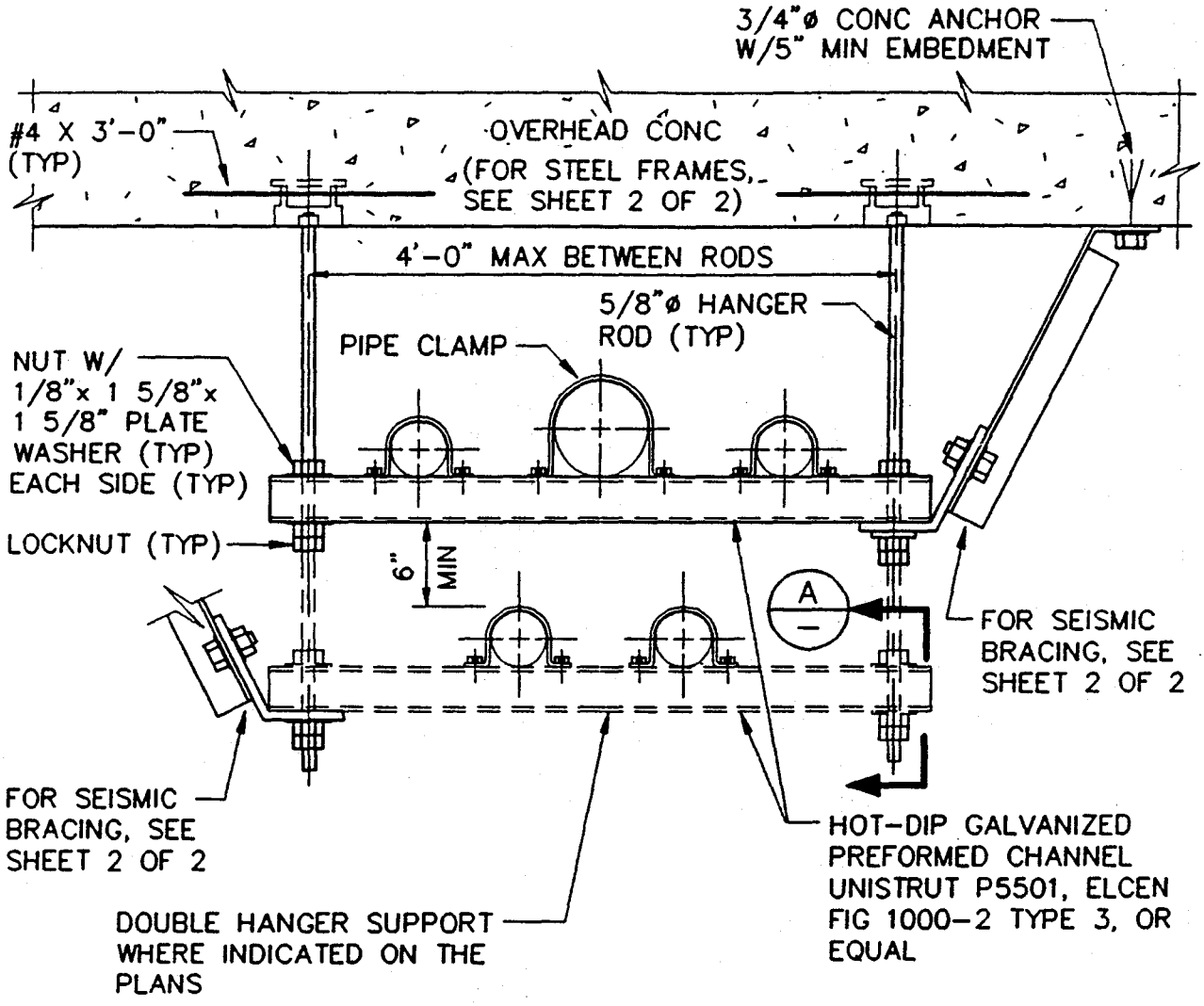
ELEVATION

NOTE: STAND TO BE SUPPLIED BY MECHANICAL CONTRACTOR.

496. TYP SEAL WATER PIPING



501 TYP PIPE HANGER SUPPORT



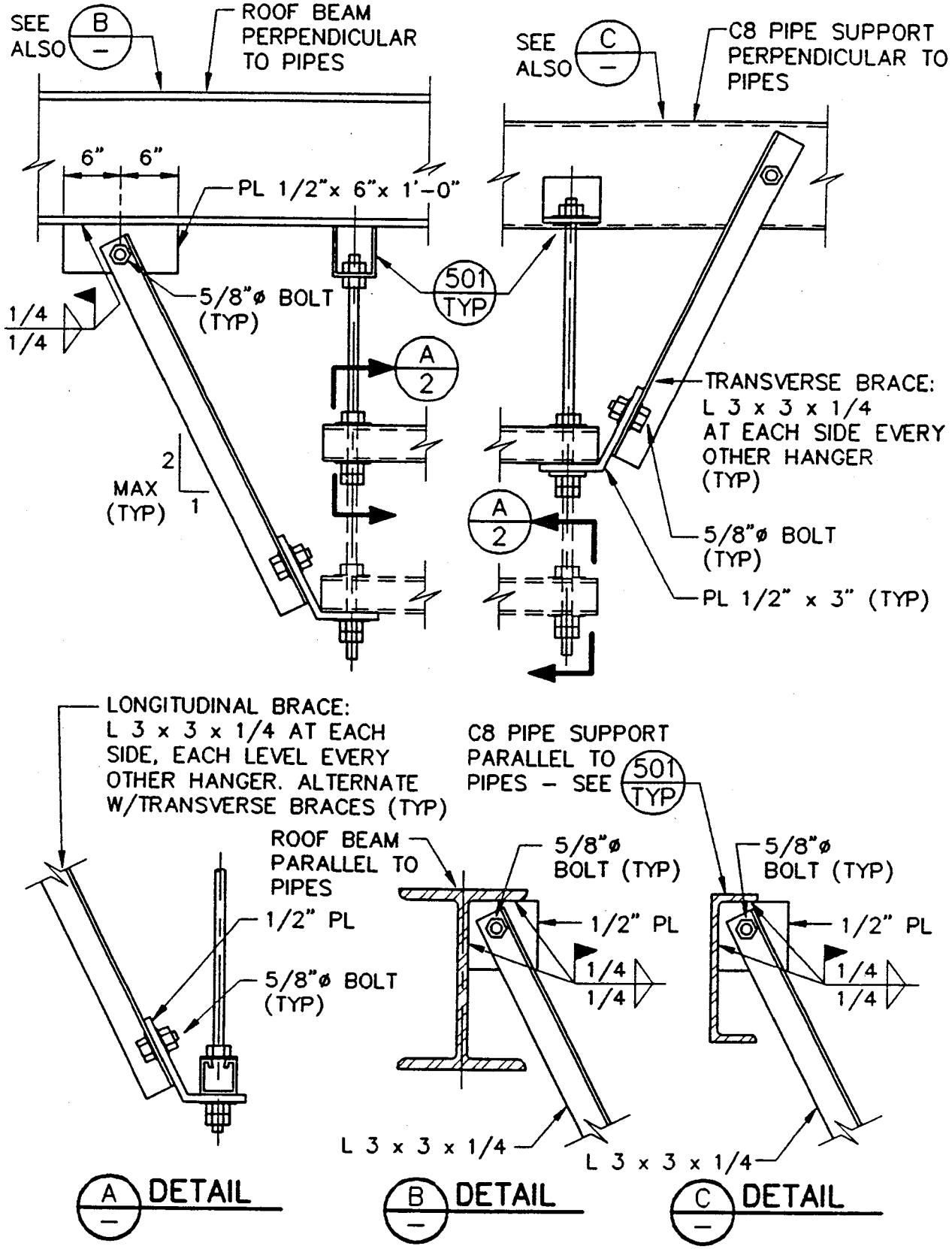
NOTES:

1. MAXIMUM VERTICAL LOAD EQUALS 2000 LBS.
2. HANGER SPACING SHALL BE BASED ON MAXIMUM SPAN ALLOWABLE FOR ANY INDIVIDUAL PIPE AND FOR MAXIMUM LOAD.
3. ALL-THREAD ROD SHALL BE USED ONLY FOR DOUBLE SUPPORTS.
4. ALL MATERIALS SHALL BE HOT-DIP GALVANIZED.
5. ISOLATE ALL COPPER PIPE FROM SUPPORT WITH PVC TAPE.

502 TYP PIPE HANGER – DOUBLE ROD

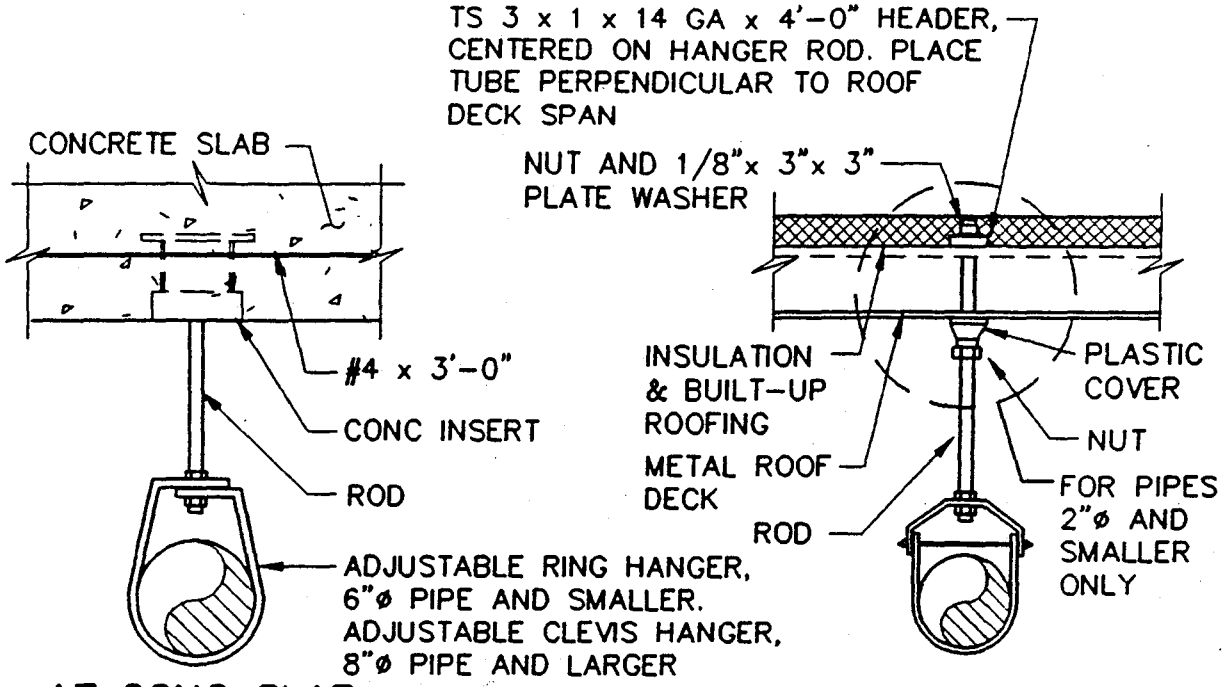
SHEET 1 OF 2

TYP502 5-14-91



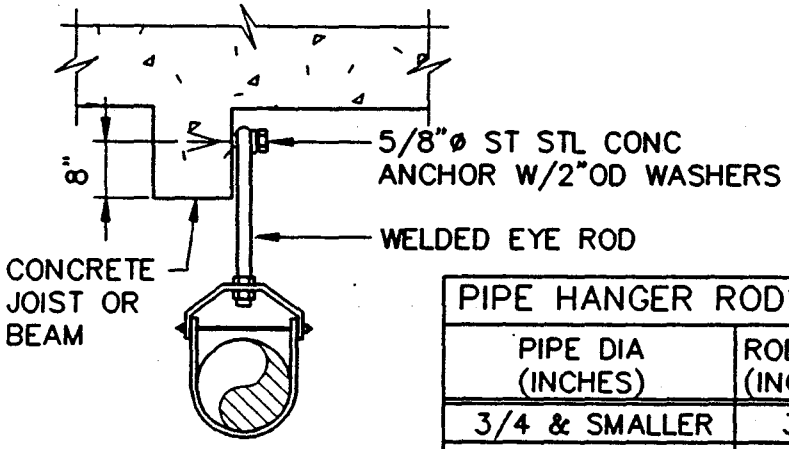
502 TYP PIPE HANGER – DOUBLE ROD

SHEET 2 OF 2



AT CONC SLAB

AT METAL DECK



AT CONC JOIST OR BEAM

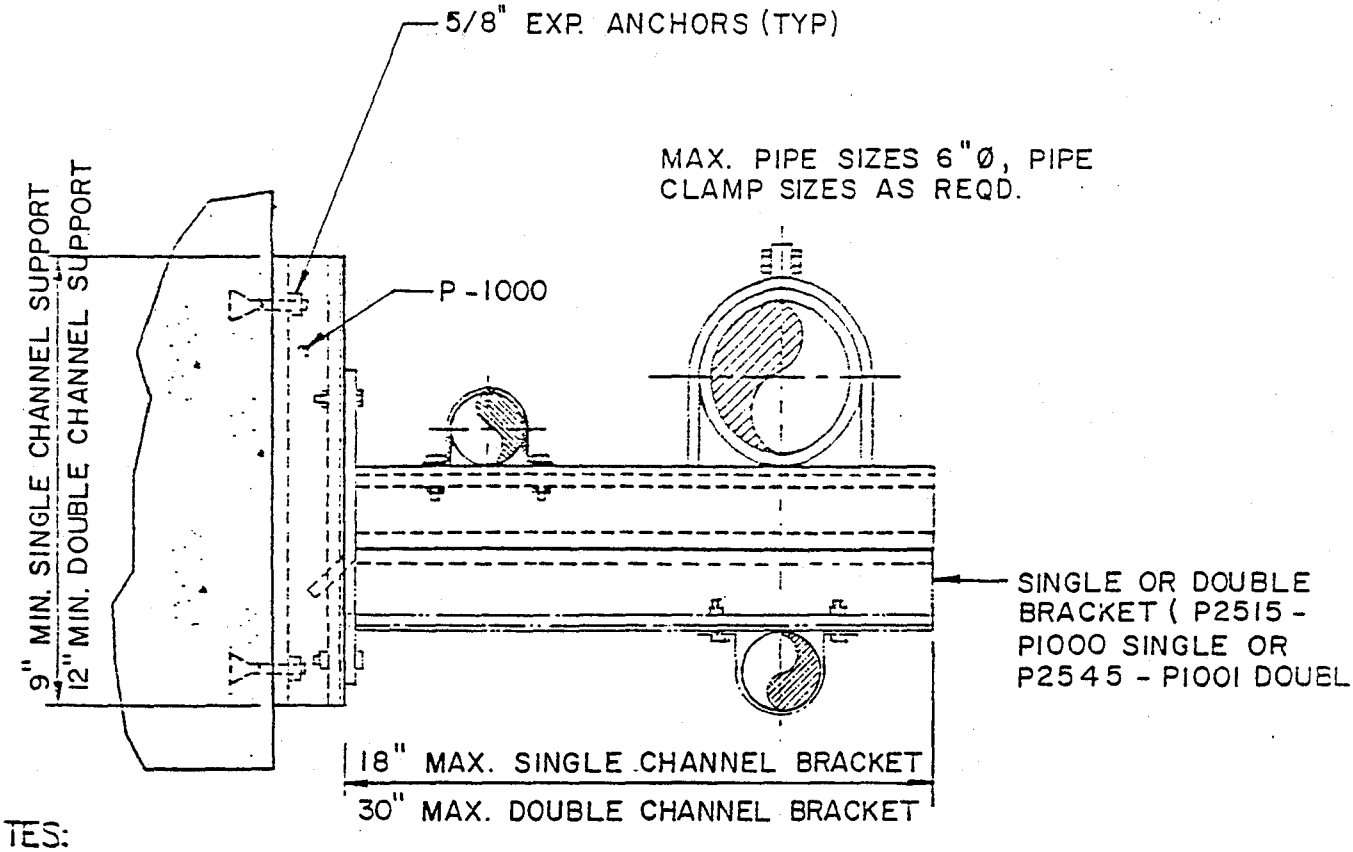
PIPE HANGER RODS AND SUPPORT SPACING			
PIPE DIA (INCHES)	ROD DIA (INCHES)	MAX SUPPORT SPACING	
		STEEL PIPE	CAST IRON
3/4 & SMALLER	3/8	5 FEET	–
1 TO 2	3/8	5 FEET	–
2 1/2 TO 3 1/2	1/2	10 FEET	5 FEET
4 TO 5	5/8	10 FEET	5 FEET
6	3/4	10 FEET	5 FEET
8	7/8	10 FEET	5 FEET
10	7/8	10 FEET	–
12	7/8	10 FEET	–

NOTES:

1. ISOLATE ALL COPPER PIPE FROM SUPPORT WITH PVC TAPE.
2. ALL MATERIALS SHALL BE HOT-DIP GALVANIZED.
3. PROVIDE ADDITIONAL HANGER AT EACH SIDE OF ALL VALVES 4 INCHES AND LARGER.
4. FOR LONGITUDINAL AND LATERAL BRACING OF PIPES, SEE TYPICAL DETAIL 506.

503 TYP PIPE HANGER

TYP503 5-14-91



NOTES:

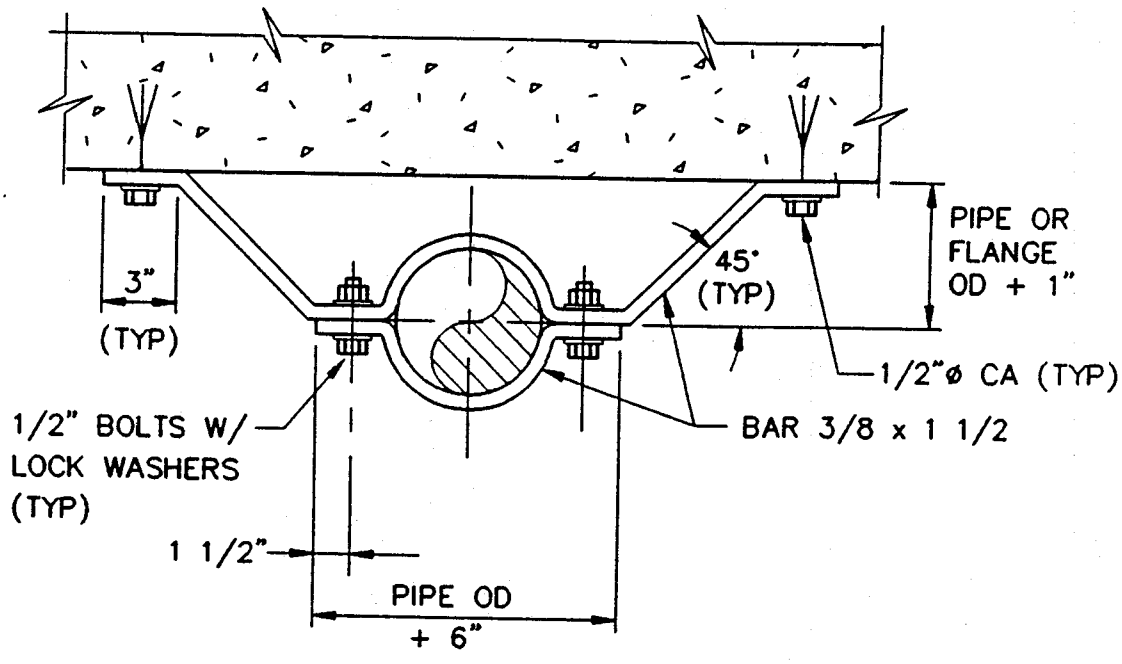
1.) MODEL NUMBERS ARE BASED ON UNISTRUT OR EQUAL.

2.) IF SUPPORT IS SUBMERGED OR BELOW TOP OF WALL OF HYDRAULIC STRUCTURE, ALL MATERIAL SHALL BE STAINLESS STEEL.

3.) FOR COPPER PIPE, WRAP PIPE UNDER "U" CLIP WITH POLYETHYLENE TAPE.

PIPE SIZES	MAX. BRACKET SPACING		
	STEEL	CPVC	PVC
2 – 6" DIA.	5'–0" O.C.	5'–0" O.C.	5'–0" O.C.
2 – 4" DIA.	8'–0" O.C.	5'–0" O.C.	5'–0" O.C.
2 – 3" DIA.	10'–0" O.C.	5'–0" O.C.	5'–0" O.C.
4 – 2" DIA.	-------	4'–0" O.C.	4'–0" O.C.

507. TYP CANTILEVER PIPE SUPPORT

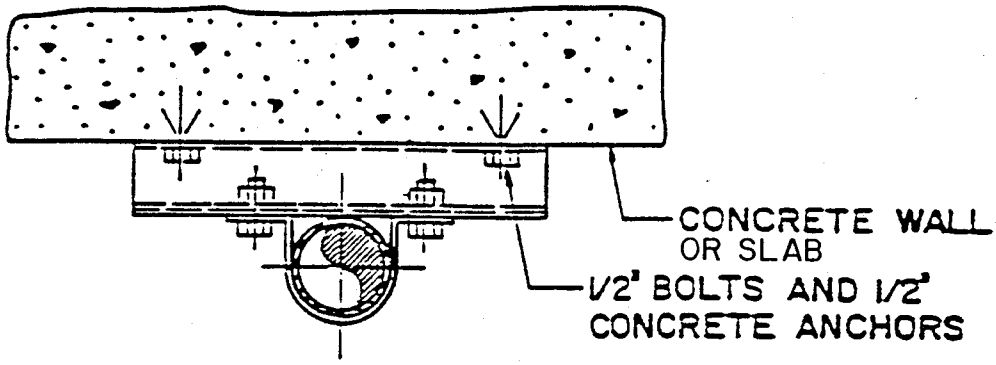


NOTES:

1. SUBMERGED SUPPORTS SHALL BE TYPE 316 ST STL. NON-SUBMERGED SUPPORTS SHALL BE HOT-DIP GALVANIZED.

2. PIPE SUPPORT FOR 8" AND SMALLER PIPE.

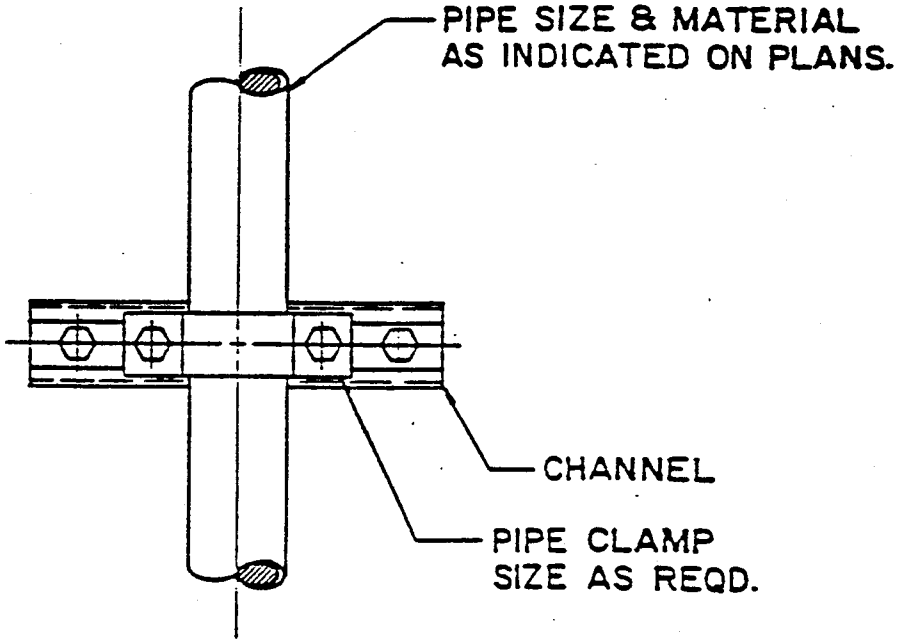
521 TYP PIPE SUPPORT



PLAN

NOTE:

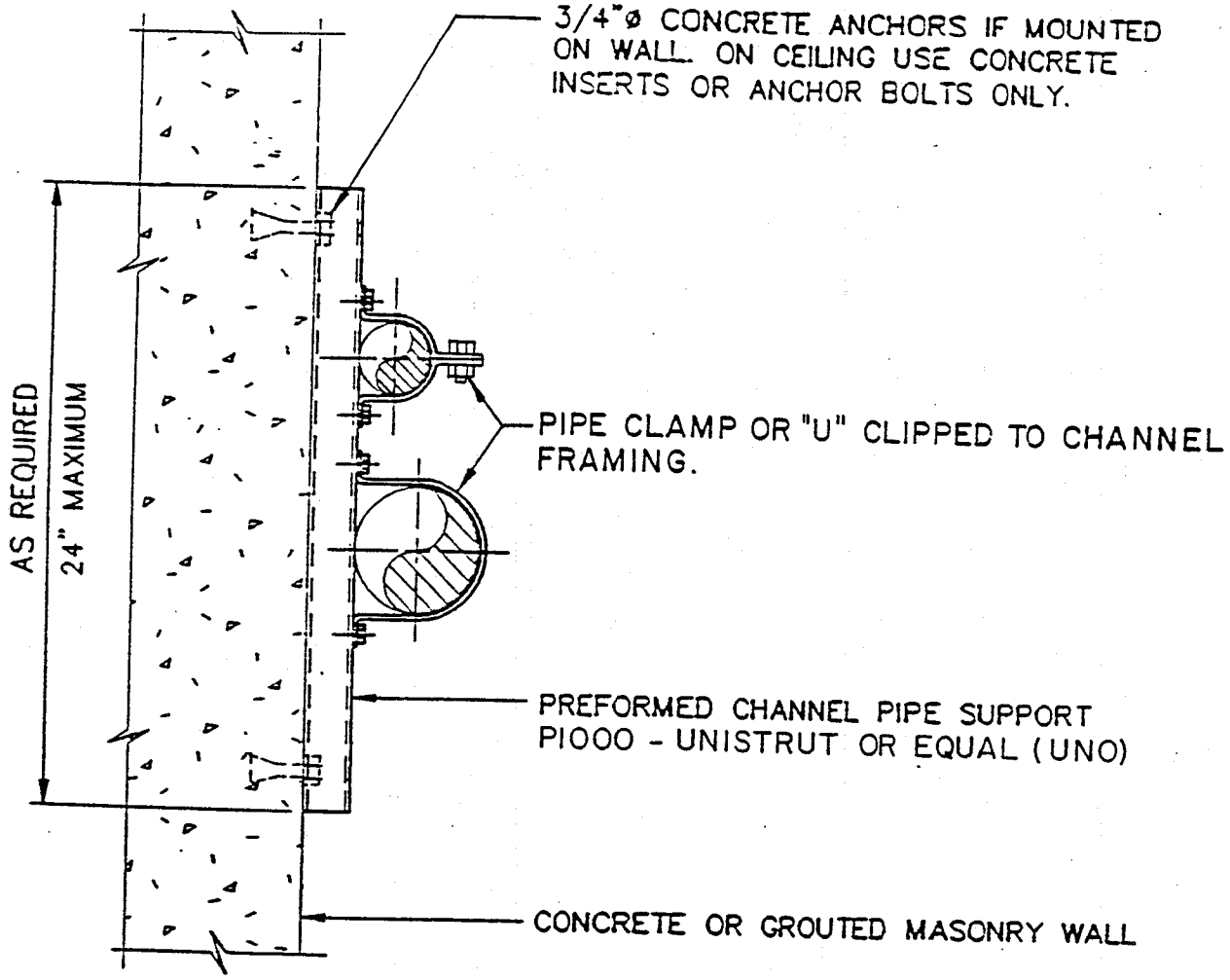
1. INSERTS, BRACKETS AND PIPE CLAMPS SHALL BE UNISTRUT P-1000, ELCEN 600, OR EQUAL.
2. ALL MATERIAL SHALL BE ST. STL. ON ALL SUPPORTS BELOW TOPS OF WALLS ON WATER BEARING STRUCTURES, GALVANIZED STEEL FOR ALL OTHER LOCATIONS.
3. FOR COPPER PIPE, WRAP PIPE UNDER "U" CLIP WITH POLYETHYLENE TAPE



ELEVATION

529. TYP

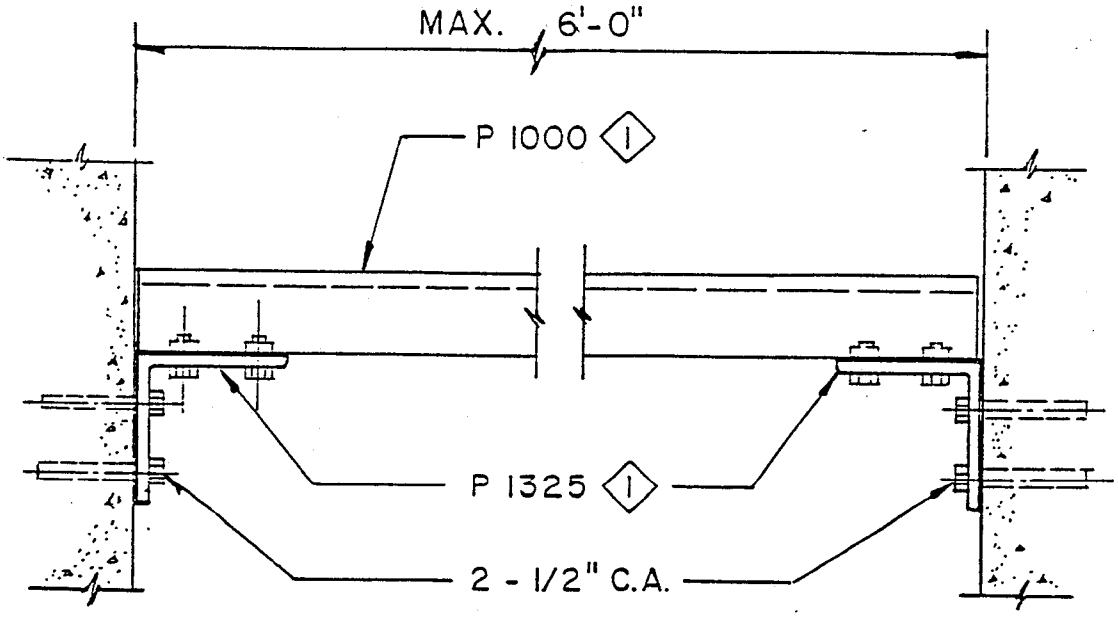
PIPE SUPPORT



NOTES:

1. IF SUPPORT IS SUBMERGED OR BELOW TOP OF WALL OF HYDRAULIC STRUCTURE. ALL MATERIAL SHALL BE STAINLESS STEEL.
2. FOR COPPER PIPE, WRAP PIPE UNDER "U" CLIP WITH POLYETHLENE TAPE.
3. MAXIMUM PIPE SIZE: 4"
4. SPACE FLUSH MOUNT PIPE SUPPORTS AT 5'-0" MAXIMUM.

530. TYP FLUSH MOUNT PIPE SUPPORT



NOTES:

⟨1⟩ BASED ON UNISTRUT OR EQUAL

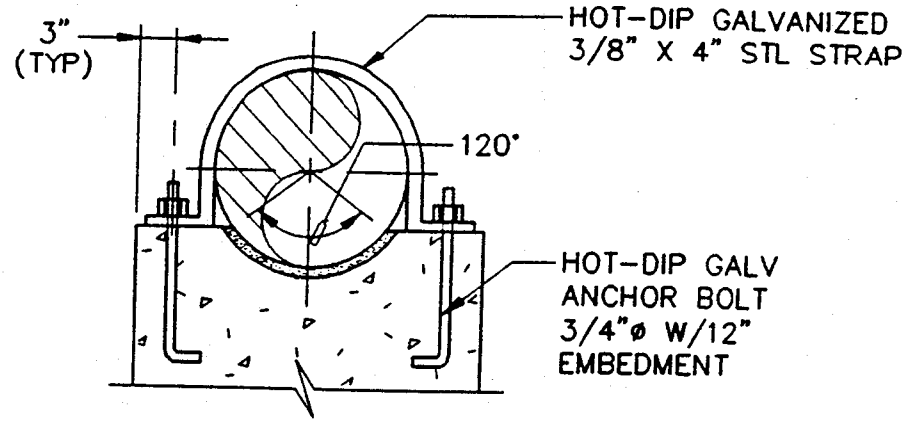
⟨2⟩ IF SUPPORT IS SUBMERGED OR BELOW TOP OF WALL OF HYDRAULIC STRUCTURE. ALL MATERIAL SHALL BE STAINLESS STEEL.

⟨3⟩ FOR COPPER PIPE, WRAP PIPE UNDER "U" CLIP WITH POLYETHLENE TAPE

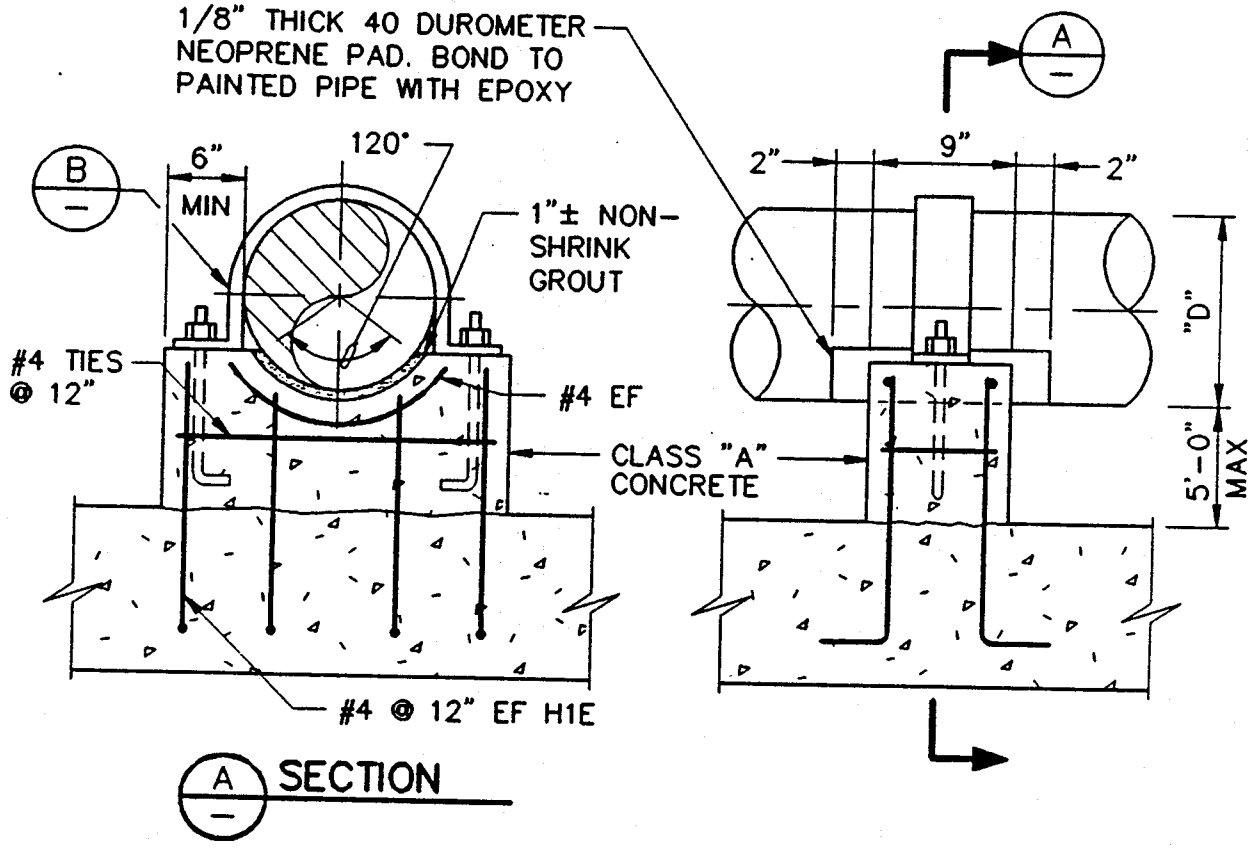
⟨4⟩ MAXIMUM PIPE SIZE: 4"

⟨5⟩ SPACE PIPE SUPPORTS AT 5'-0" MAXIMUM. (U.N.O.)

532. TYP CHANNEL PIPE SUPPORT



B — STRAP DETAIL

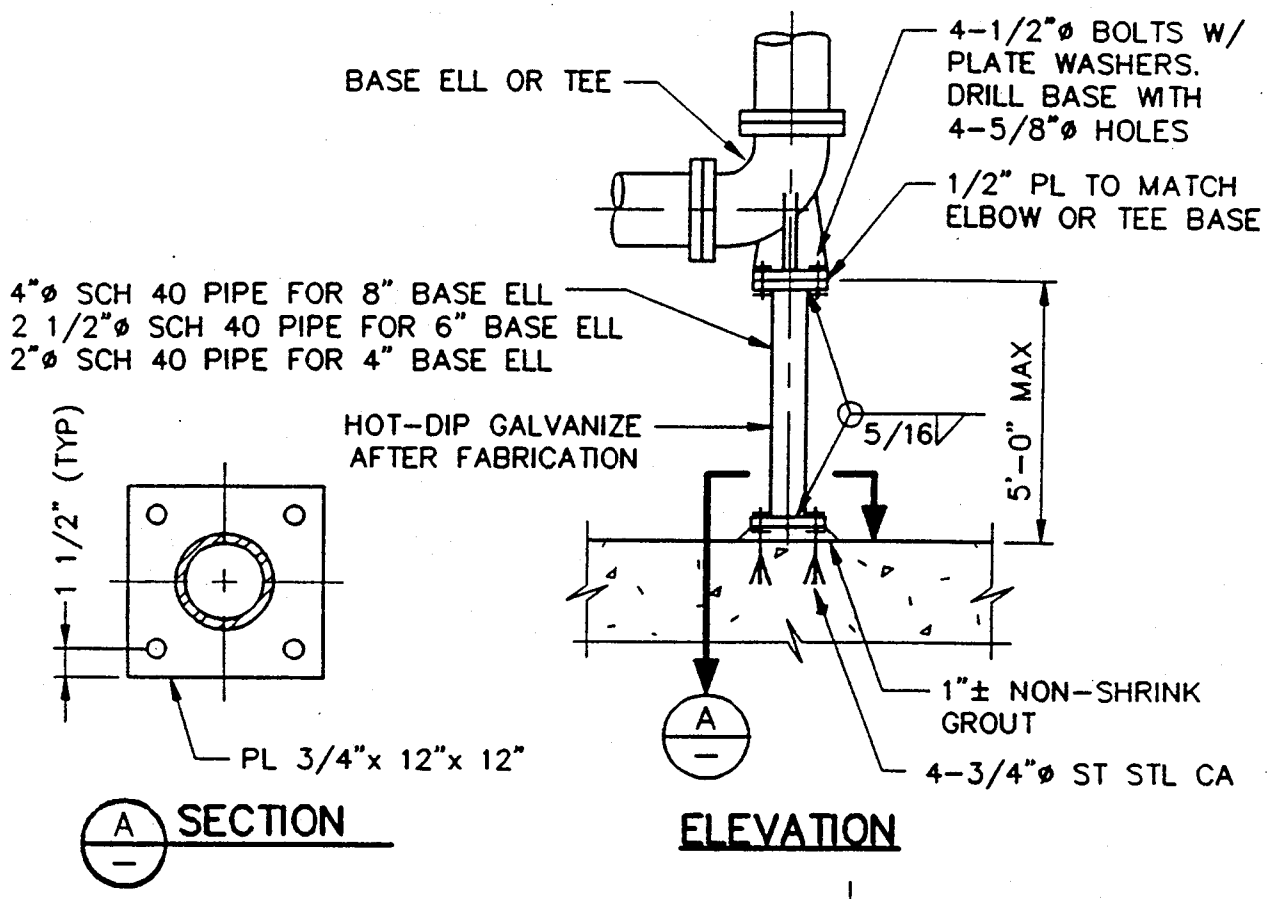


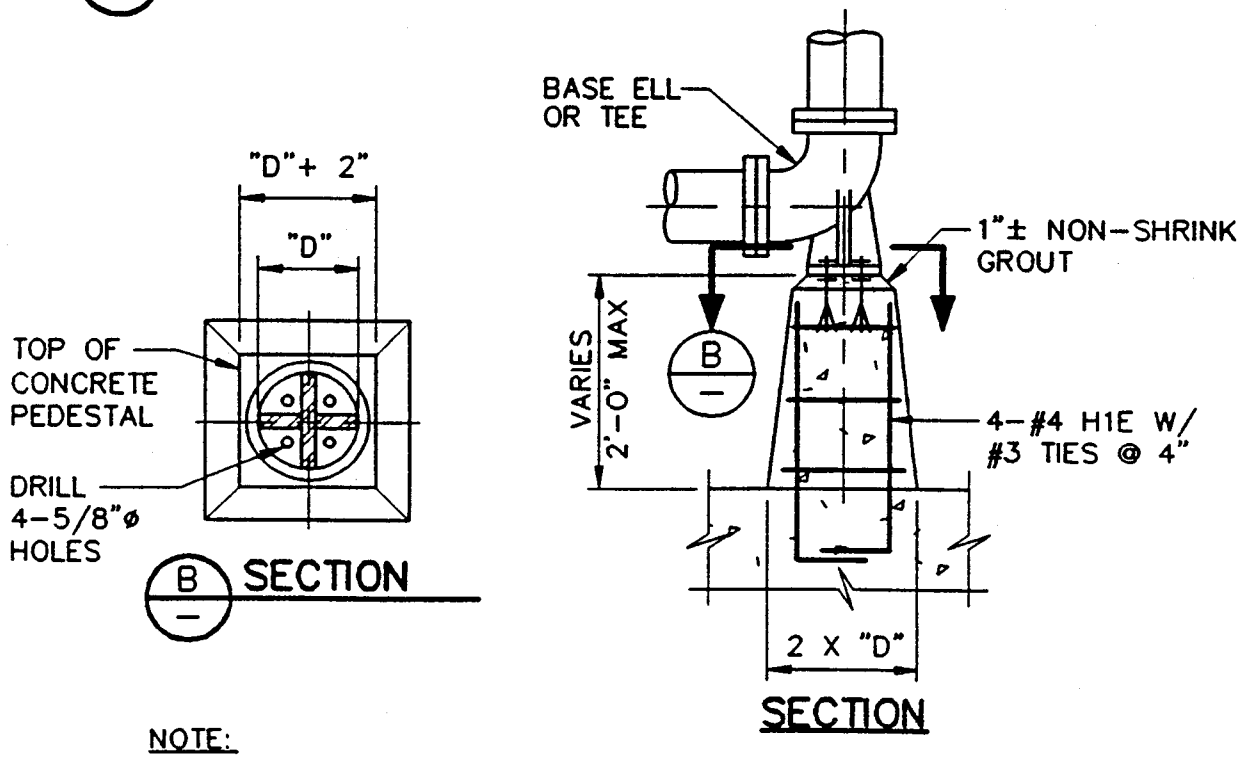
A — SECTION

NOTES:

1. FOR ISOLATED SUPPORTS CONSTRUCT 2'-0"x ("D" + 12") x 12" THICK FOOTING WITH #4 @ 10" EW T&B. SUPPORT SHALL BE ON UNDISTURBED SOIL OR SUBGRADE COMPACTED TO 95%.
2. MAX VERTICAL LOAD = 6000 POUNDS.

541 TYP — CONCRETE PIPE SUPPORT





NOTE:

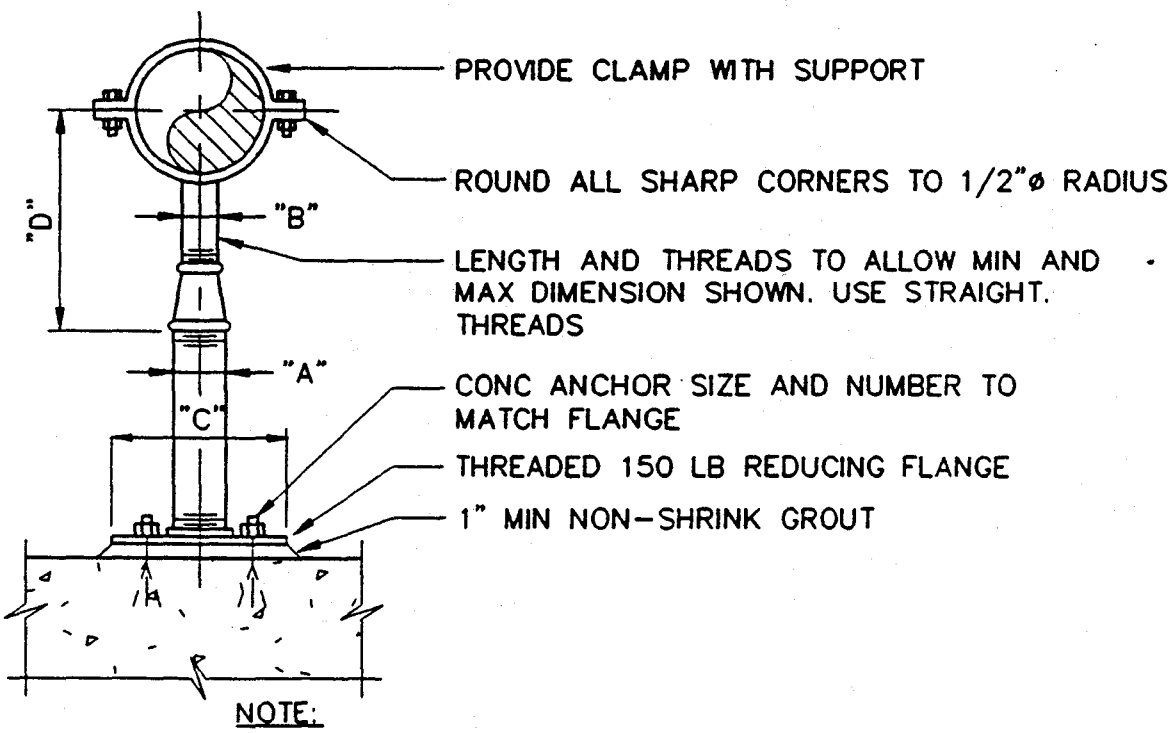
1. SUPPORT TO BE HOT-DIP GALVANIZED AFTER FABRICATION.

542 TYP S PIPE SUPPORT - ELL OR TEE

TYP542 5-14-91

ADJUSTABLE PIPE SADDLE SUPPORT SCHEDULE DIMENSIONS IN INCHES					
PIPE SIZE	A	B	C	D	
				MINIMUM	MAXIMUM
* 2 1/2	2 1/2	1 1/2	9	8	13
3	2 1/2	1 1/2	9	8 1/2	13 1/2
3 1/2	2 1/2	1 1/2	9	8 1/2	13 1/2
4	3	2 1/2	9	9 1/2	14
6	3	2 1/2	9	10 1/2	15 1/2
8	3	2 1/2	9	11 1/2	16 1/2
10	3	2 1/2	9	13 1/2	18 1/2
12	3	2 1/2	9	15	19 1/2
14	4	3	11	16 1/2	20 1/2
16	4	3	11	17 1/2	22 1/2
18	6	3 1/2	13 1/2	19 1/2	24
20	6	3 1/2	13 1/2	21	25 1/2
24	6	4	13 1/2	23 1/2	28 1/2
30	6	4	13 1/2	27	31 1/2
32	6	4	13 1/2	28 1/2	32 1/2
36	6	4	13 1/2	30 1/2	34 1/2

* USE 2 1/2" SUPPORTS FOR PIPES LESS THAN 2 1/2"ø

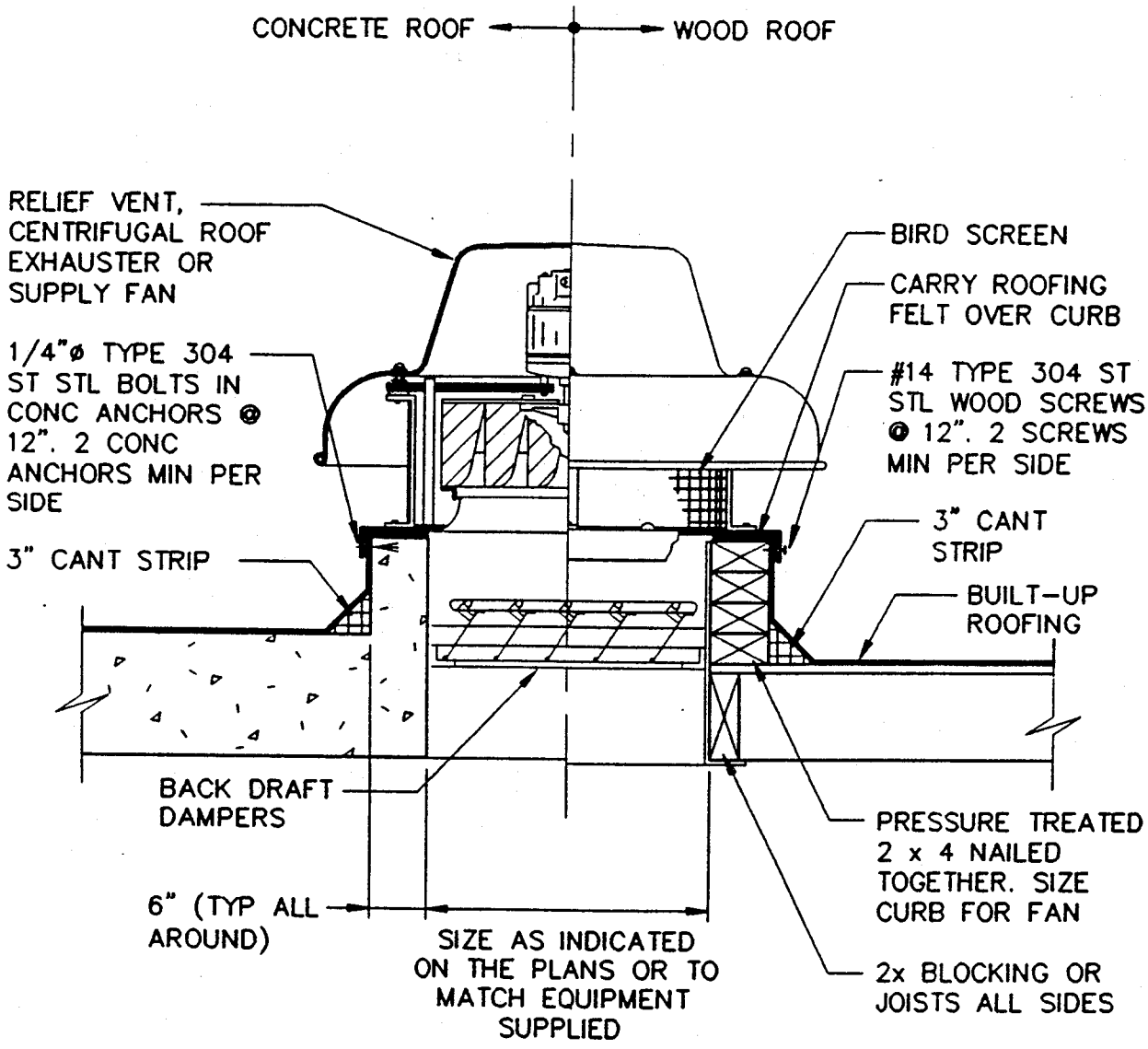


NOTE:

1. HOT DIP GALVANIZE AFTER FABRICATION.
2. PIPE SHALL BE SCHEDULE 40.

545 TYP S ADJUSTABLE PIPE SUPPORT

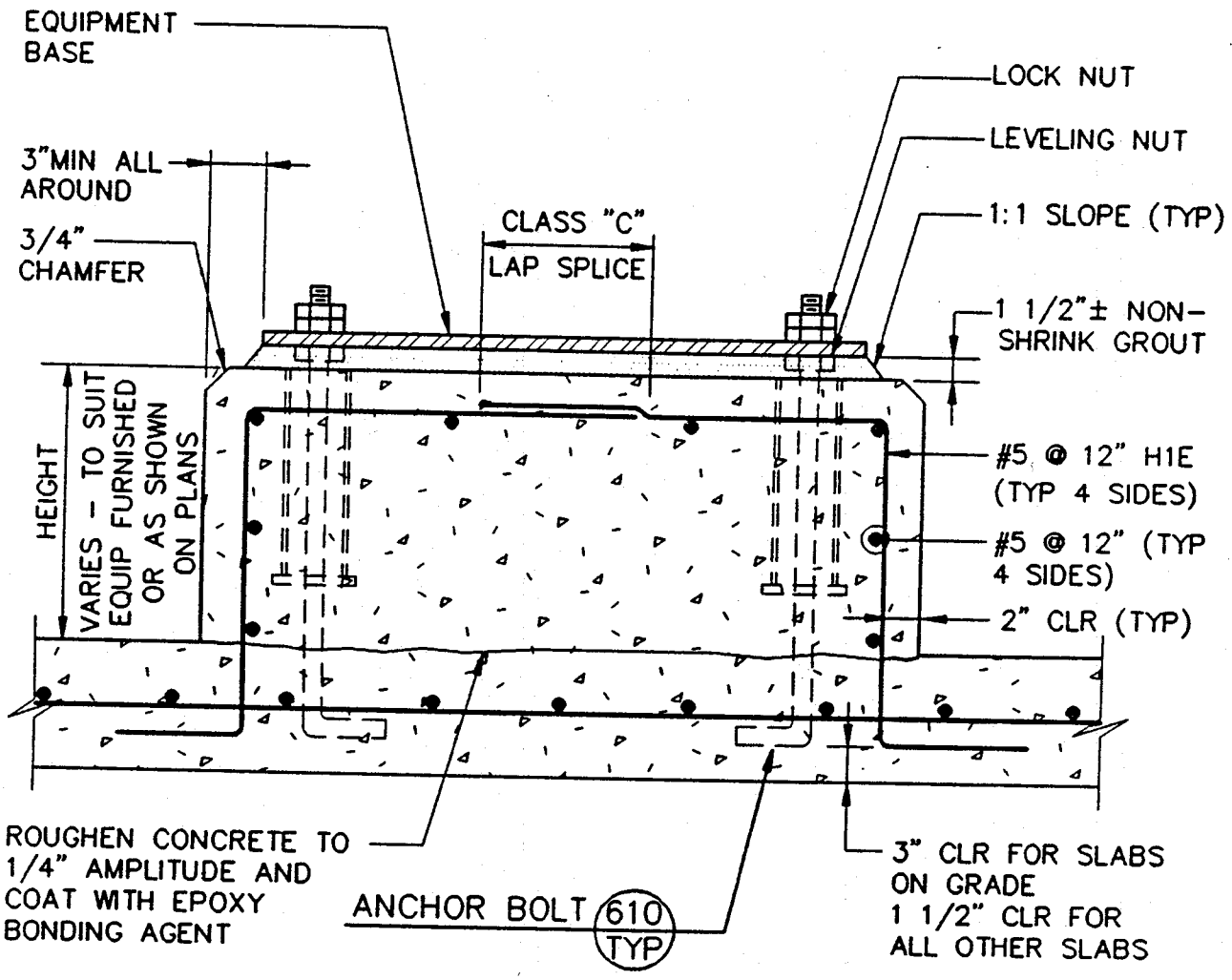
TYP545 5-14-91



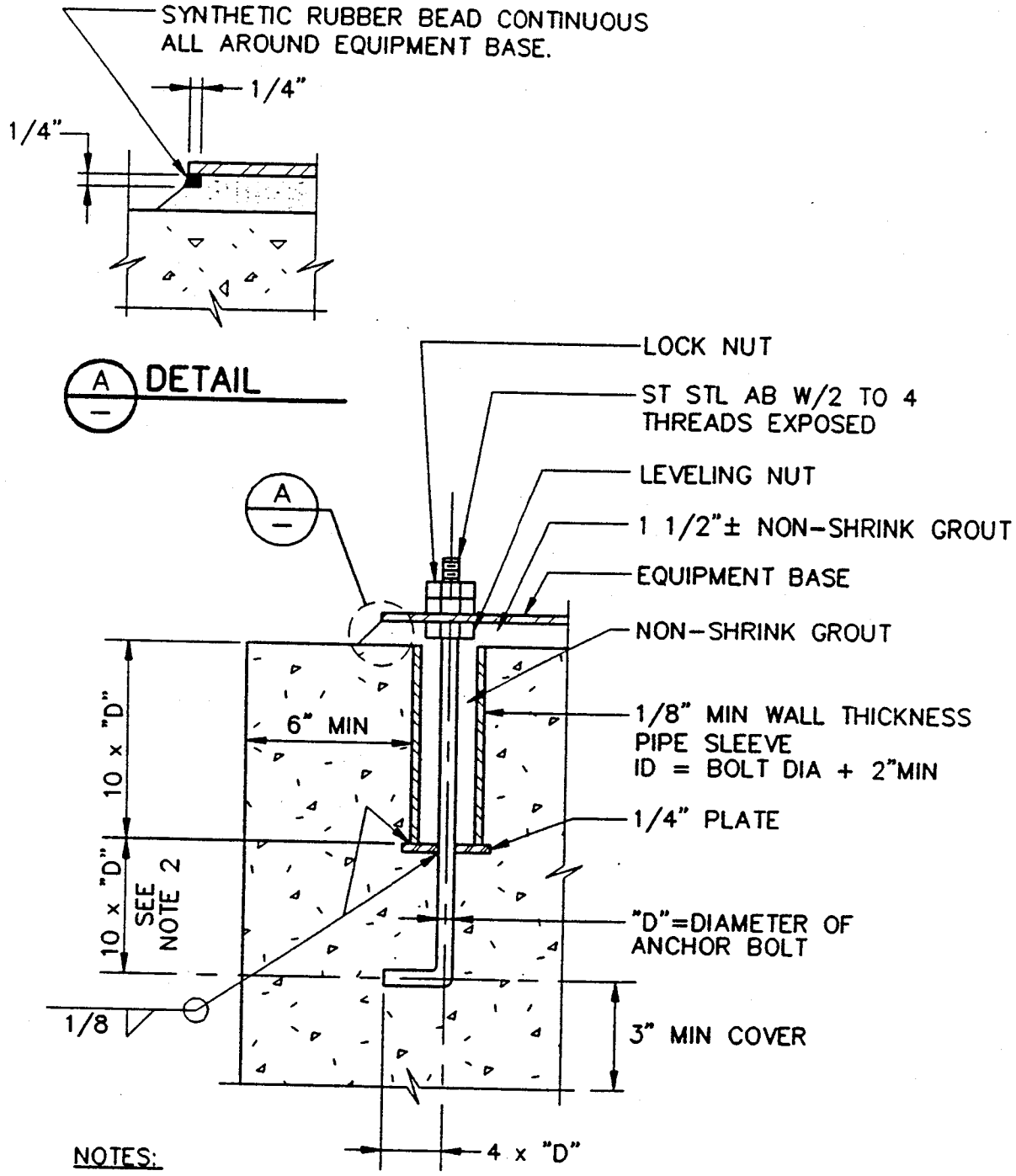
NOTE:

1. TOP OF CURB SHALL BE LEVEL. TAPER WOOD CURB BLOCKING AS REQUIRED.
2. CURB SHALL BE 8" HIGH MINIMUM ABOVE FINISHED ROOF SURFACE.

561 TYP RELIEF, EXHAUST, AND SUPPLY VENT



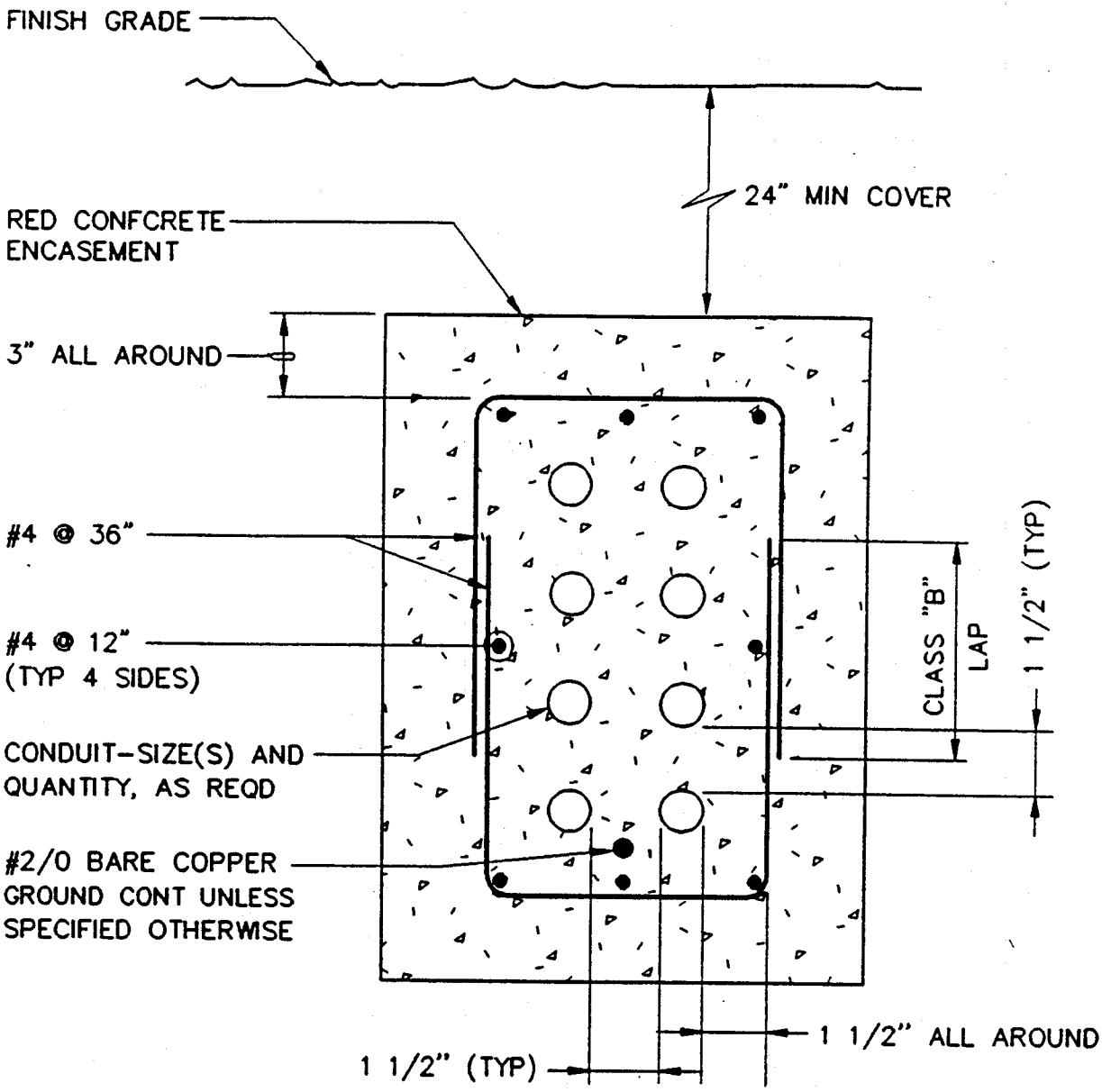
600 TYP EQUIPMENT BASE



NOTES:

1. ANCHOR BOLT SIZE AND LENGTH AS INDICATED ON THE PLANS. IF NOT INDICATED ON THE PLANS, THE ANCHOR BOLT SIZE SHALL BE AS RECOMMENDED BY THE EQUIPMENT MANUFACTURER.
2. WHERE CONCRETE SLAB OR BEAM THICKNESS WILL NOT ACCOMMODATE THE ANCHOR BOLT, PROVIDE EXTRA THICKNESS OF SLAB OR BEAM.
3. PREFABRICATED PLASTIC ANCHOR BOLT SLEEVE OPTIONAL.

610 TYP ANCHOR BOLT

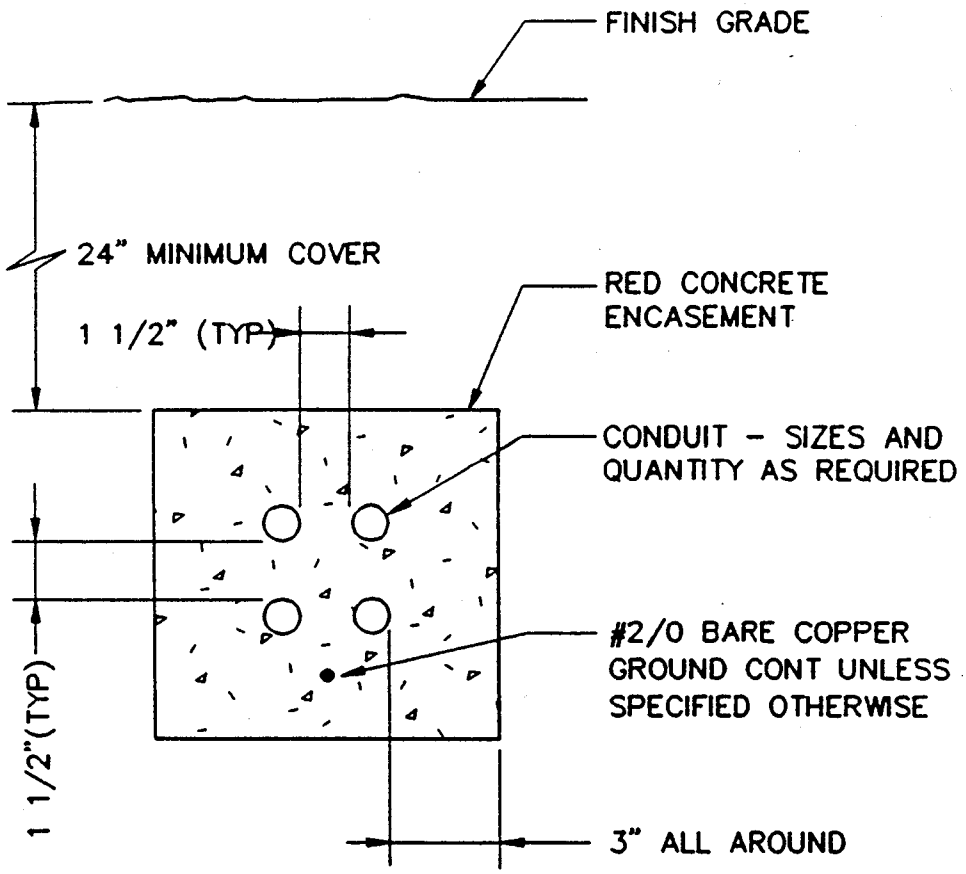


NOTE:

1. ALL DIMENSIONS ARE MINIMUM UNO.

800 TYP S ENCASED ELECTRICAL CONDUITS (REINFORCED)

TYP800 5-14-91



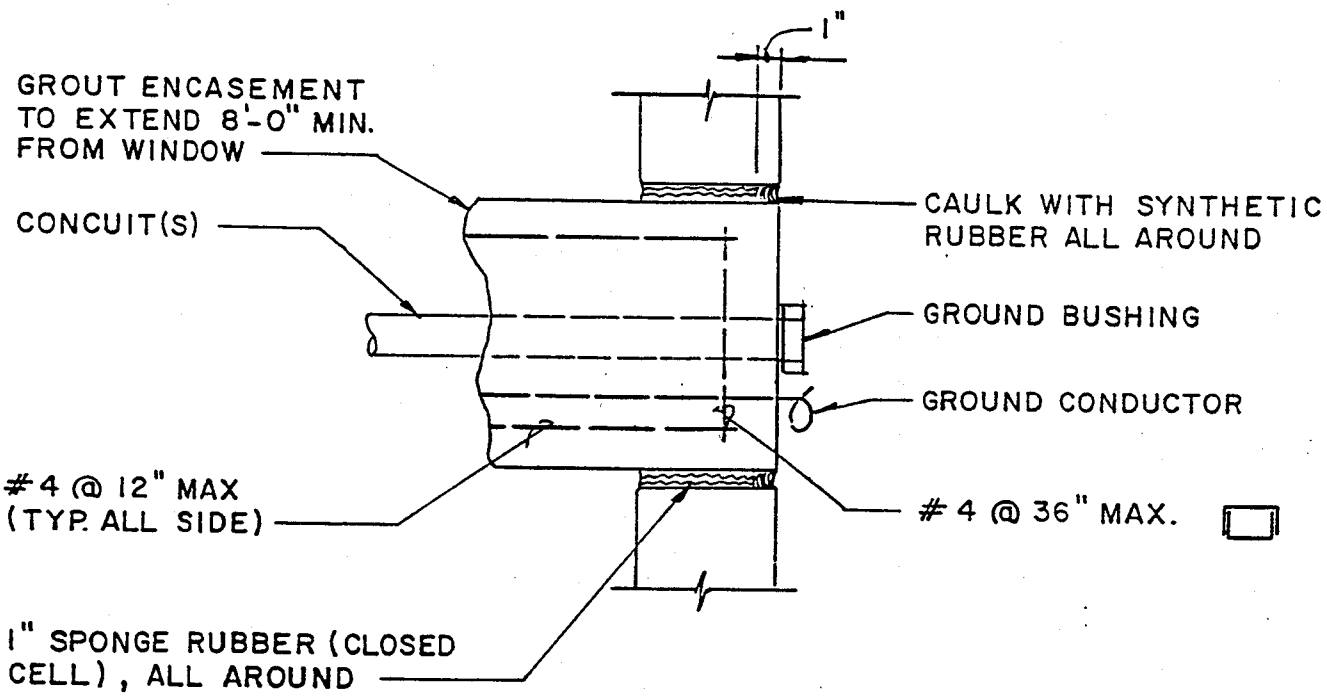
NOTE:

1. ALL DIMENSIONS ARE MINIMUM, UNO.
2. THIS ENCASEMENT FOR NON-TRAFFIC AREAS ONLY.

801 TYP S

ENCASED ELECTRICAL CONDUITS (UNREINFORCED)

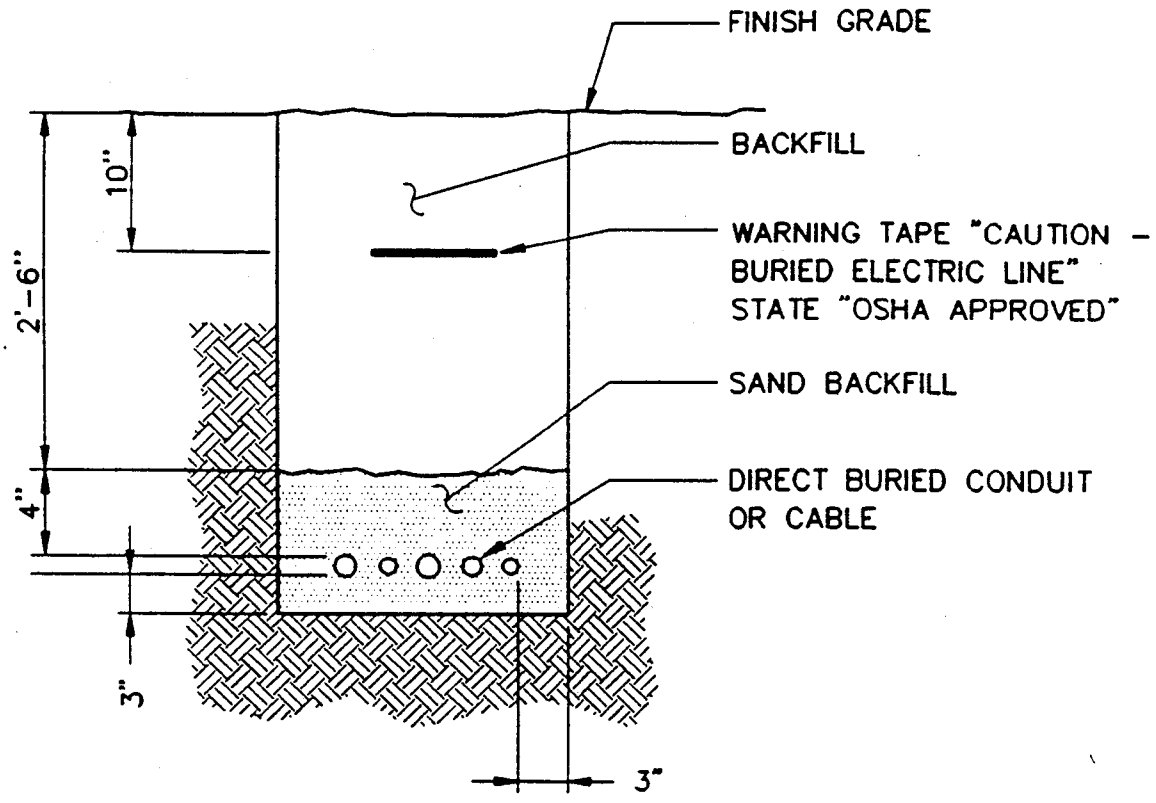
TYP801 5-14-91



802A TYP

ENCASED ELECTRICAL CONDUITS AT MANHOLE OR STRUCTURES

(WITHOUT . WATERSTOP)

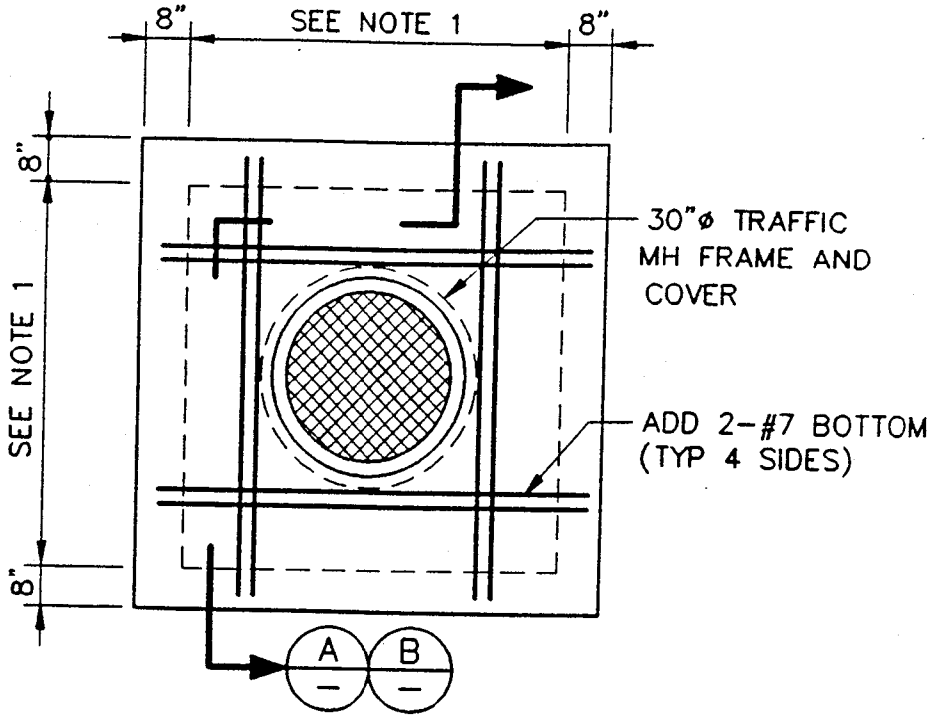


NOTE:

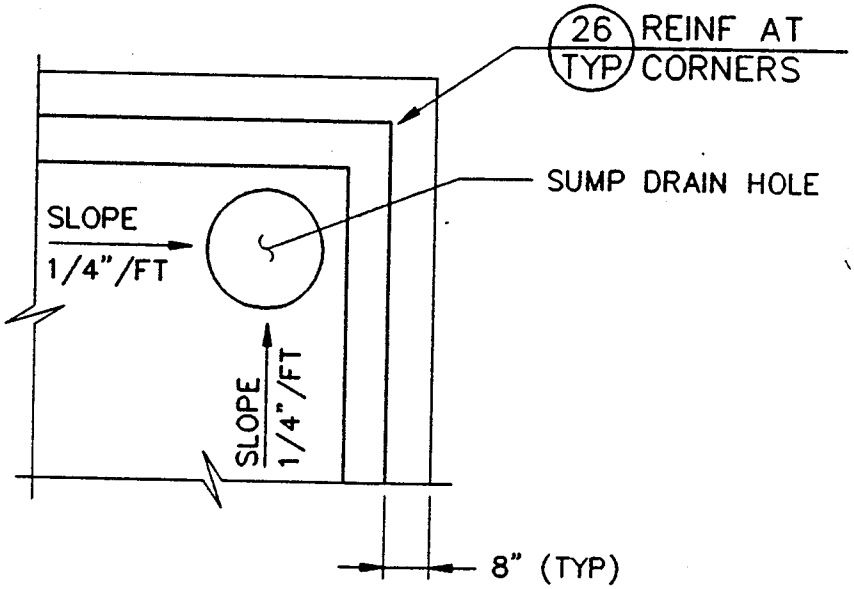
1. ALL DIMENSIONS ARE MINUMUM UNO.

804 TYP DIRECT BURIED CONDUIT OR CABLE

TYP804 5-14-91



TOP PLAN



PARTIAL BOTTOM PLAN

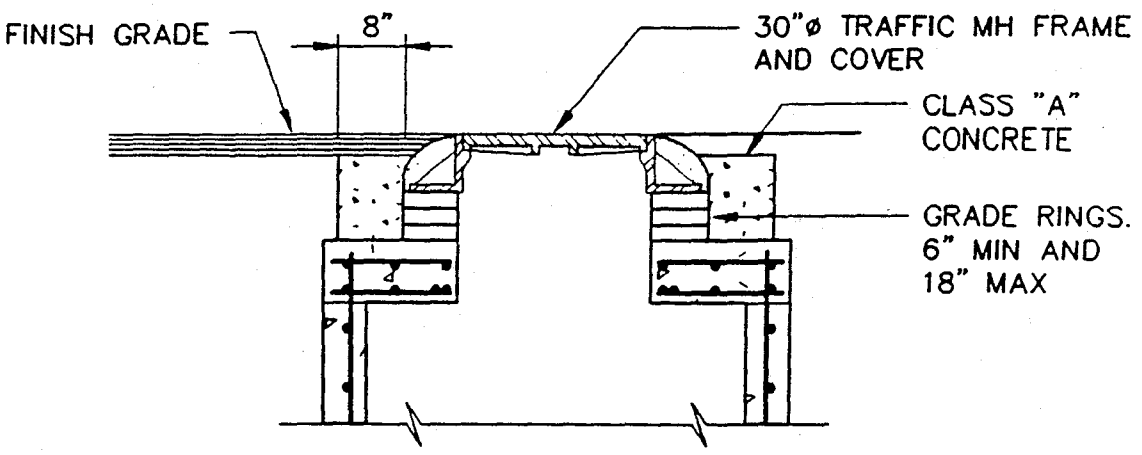
NOTES:

1. SEE PLANS FOR DIMENSIONS.
2. DRAIN HOLE TO BE LOCATED AT A CORNER.

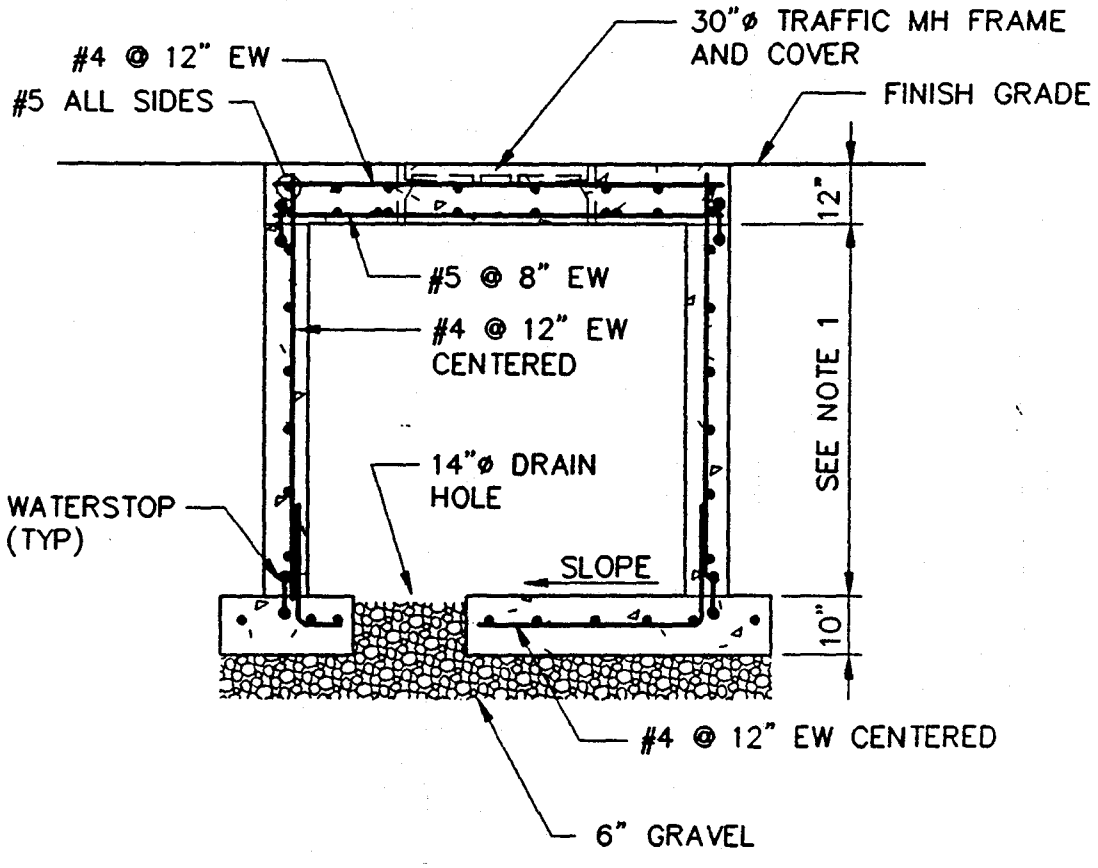
805 TYP ELECTRICAL MANHOLE WITH DRAIN HOLE

SHEET 1 OF 2

TYP805 5-14-91



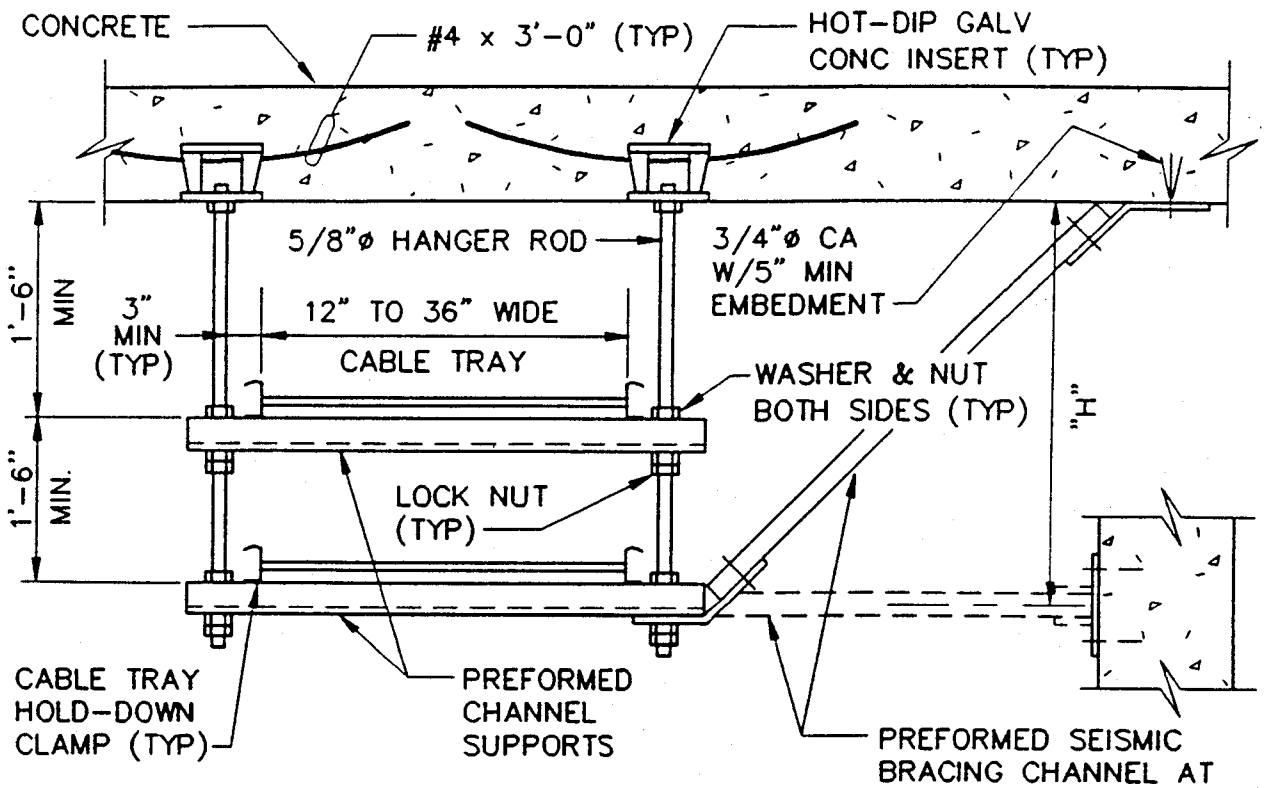
A — SECTION – WITH GRADE RINGS



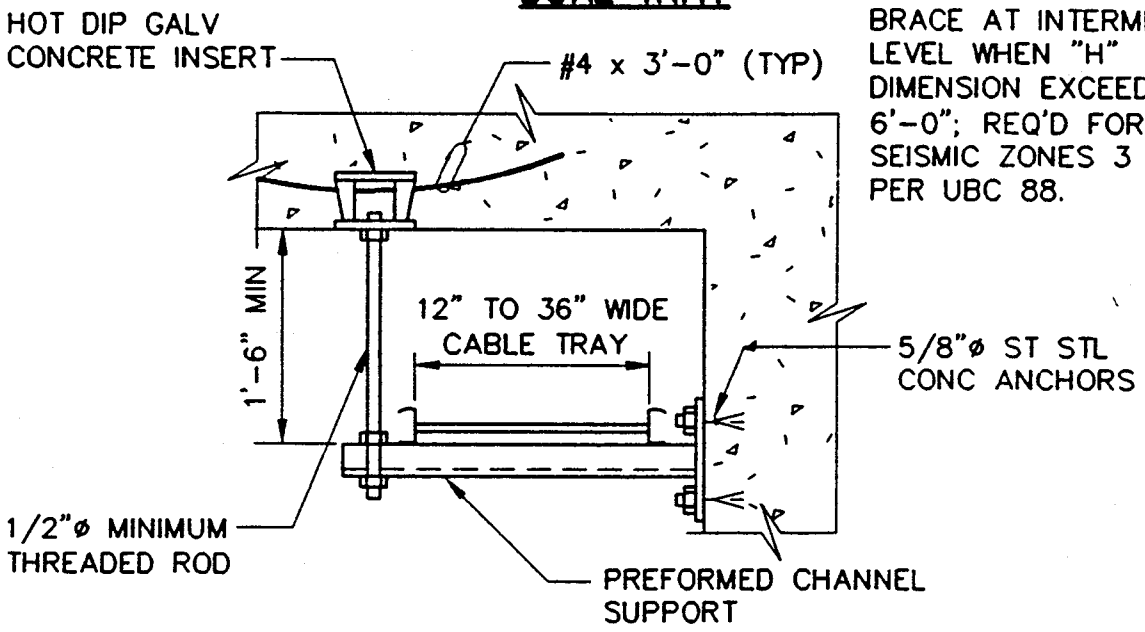
B — SECTION – WITHOUT GRADE RINGS

805 TYP ELECTRICAL MANHOLE WITH DRAIN HOLE

SHEET 2 OF 2



DUAL TRAY

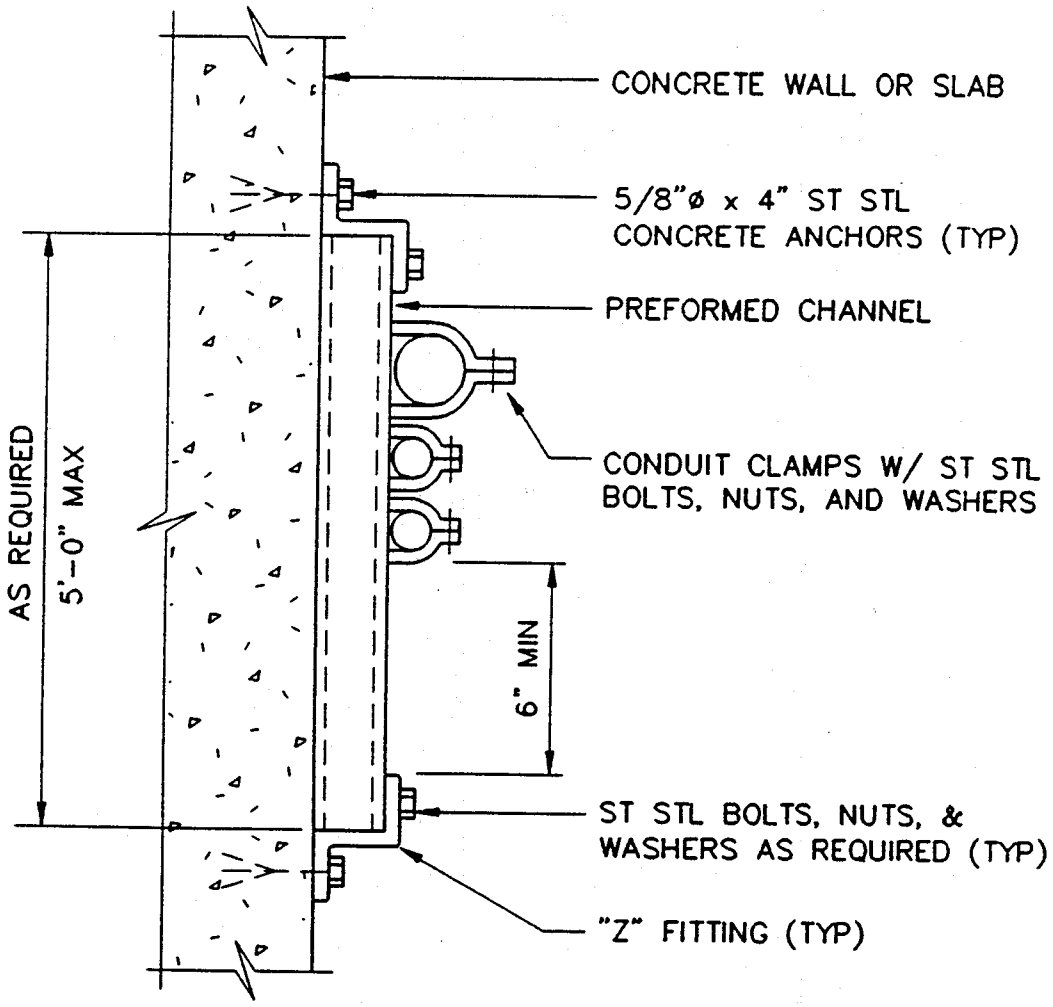


SINGLE TRAY

NOTES:

1. SPACE SUPPORTS AT 5'-0" MAXIMUM. HANGER SPACING SHALL BE BASED ON MAXIMUM LOAD.
2. ALL THREAD ROD SHALL BE USED ONLY FOR DUAL TRAY.
3. ALL MATERIALS SHALL BE HOT-DIP GALVANIZED.

812 TYP CABLE TRAY SUPPORT SYSTEM

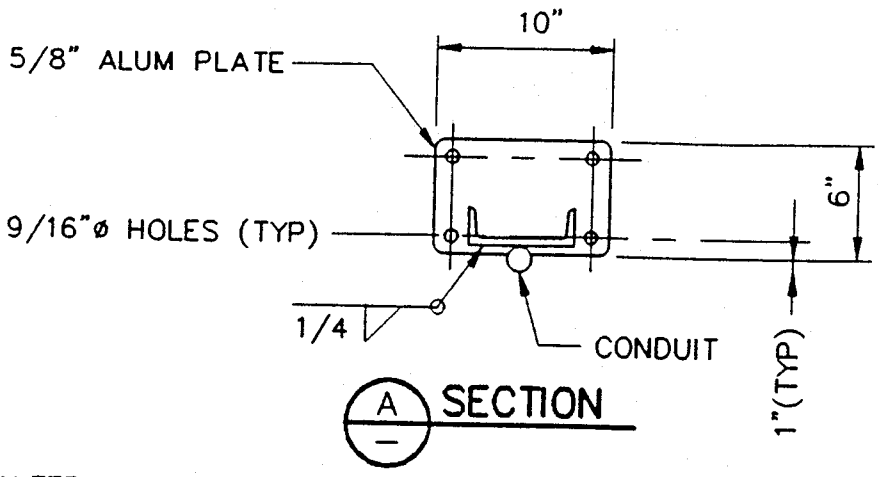


ELEVATION

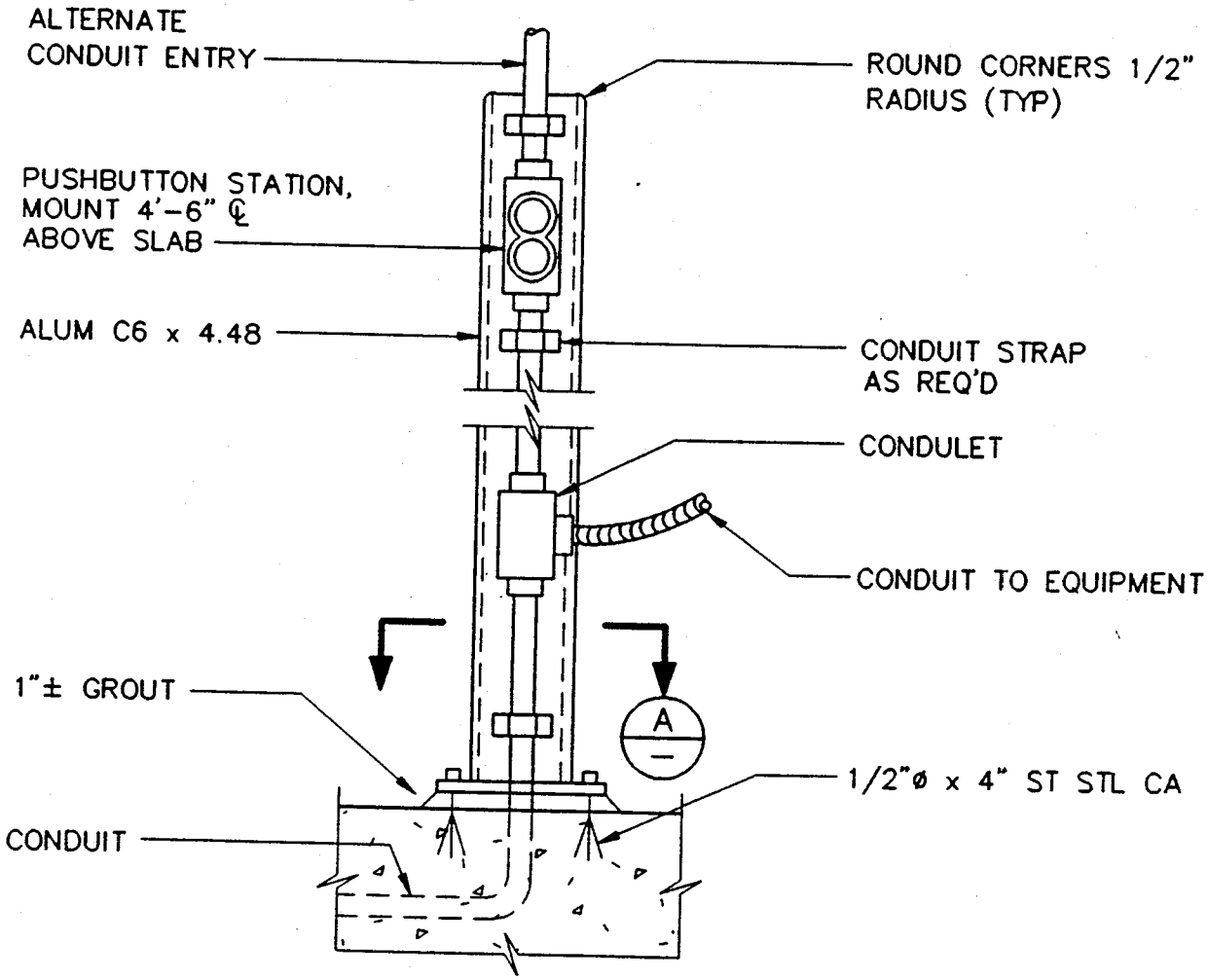
NOTE:

1. THIS DETAIL TYPICAL FOR BOTH VERTICAL AND HORIZONTAL MOUNTING. FOR HORIZONTAL MOUNTING, PLACE 1"± NON-SHRINK GROUT UNDER THE SUPPORT.
2. PREFORMED CHANNEL, FITTINGS AND CLAMPS SHALL BE HOT-DIP GALVANIZED STEEL. FIELD COAT ALL CUTS.
3. CHANNELS TO BE SPACED AT 5'-0" OC MAXIMUM.

813 TYP CONDUIT SUPPORT



A — SECTION

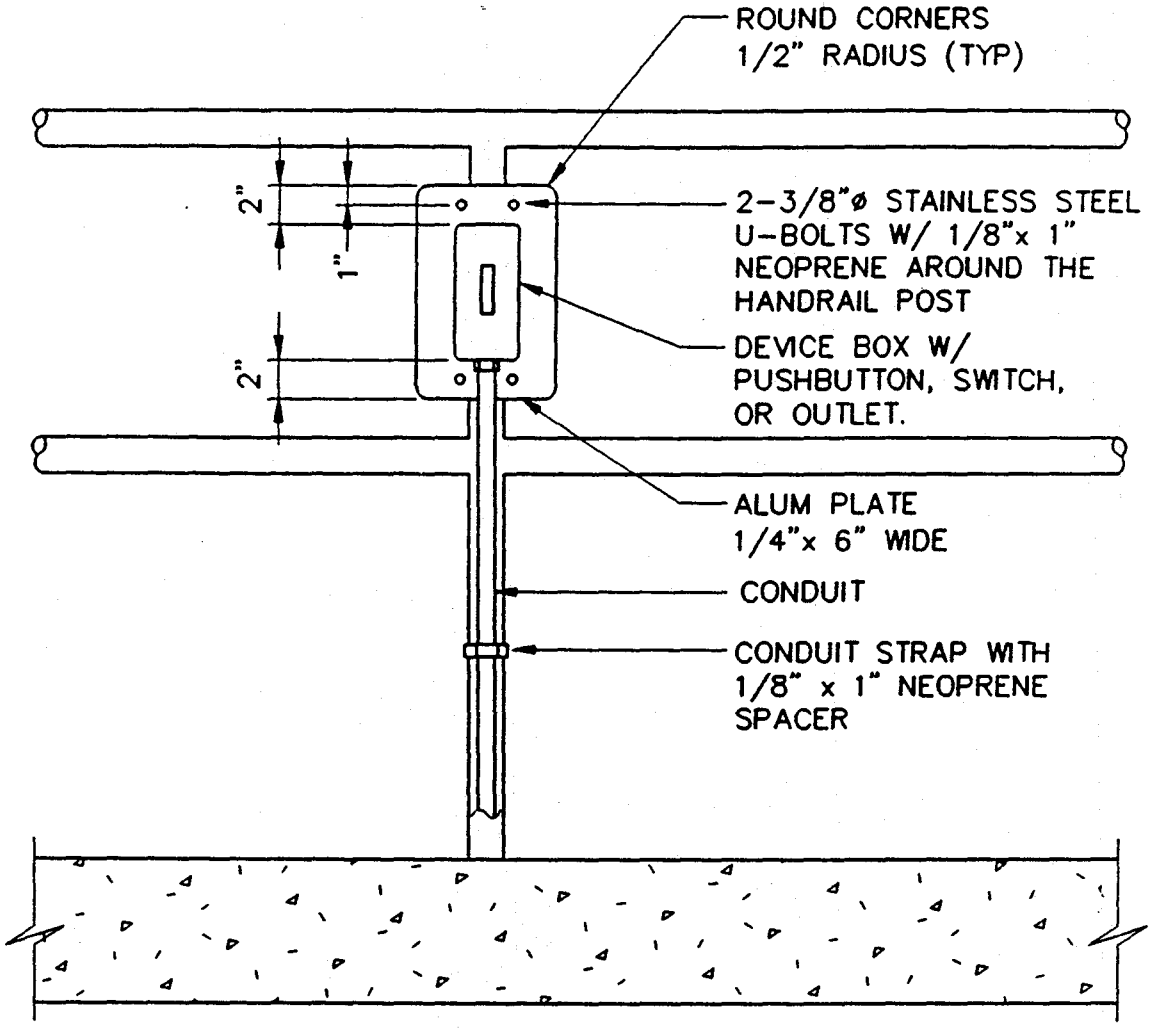


ELEVATION

NOTES:

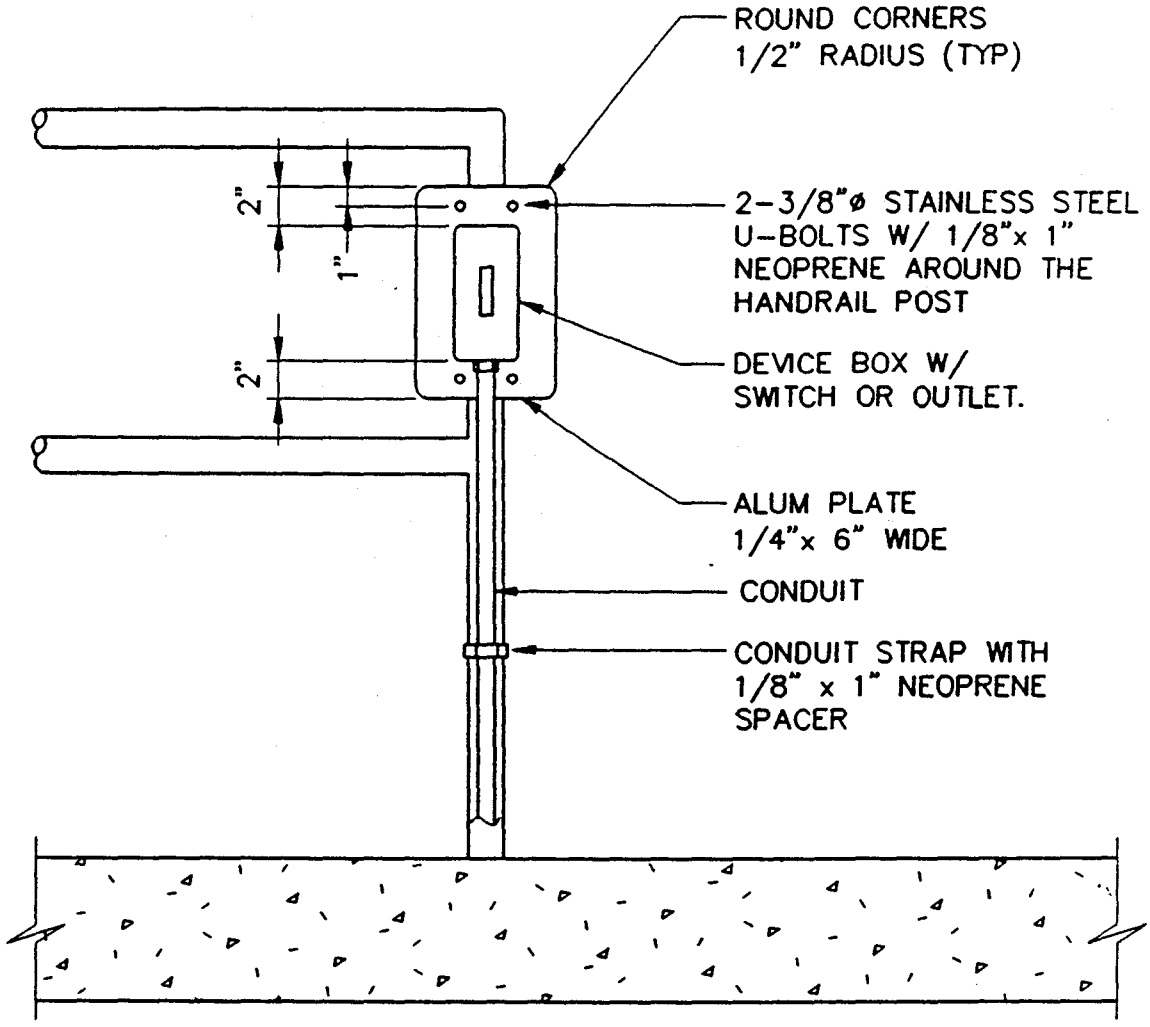
1. COAT ALUM SURFACES IN CONTACT WITH CONCRETE PER SPECIFICATIONS.
2. SUPPLY 1'-2" DIAMETER x 2'-6" DEEP FOUNDATION WHERE MOUNTING SURFACE IS NOT AVAILABLE.
3. USE ST STL WASHERS, NUTS AND BOLTS FOR MOUNTING DEVICES.

818 TYP PUSHBUTTON STATION

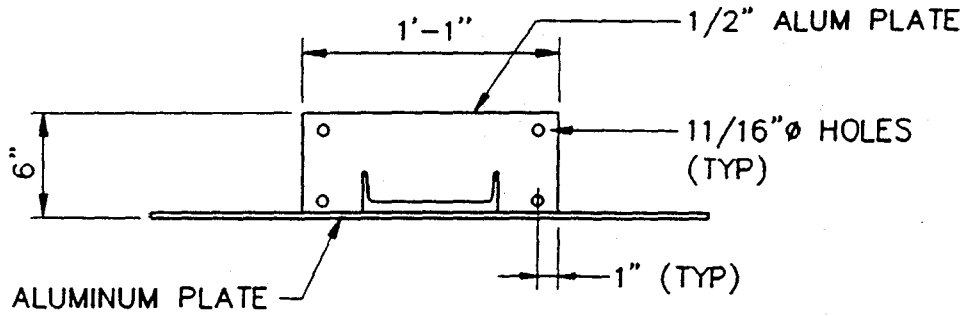


820 TYP HANDRAIL MOUNTED PUSHBUTTON, SWITCH OR OUTLET

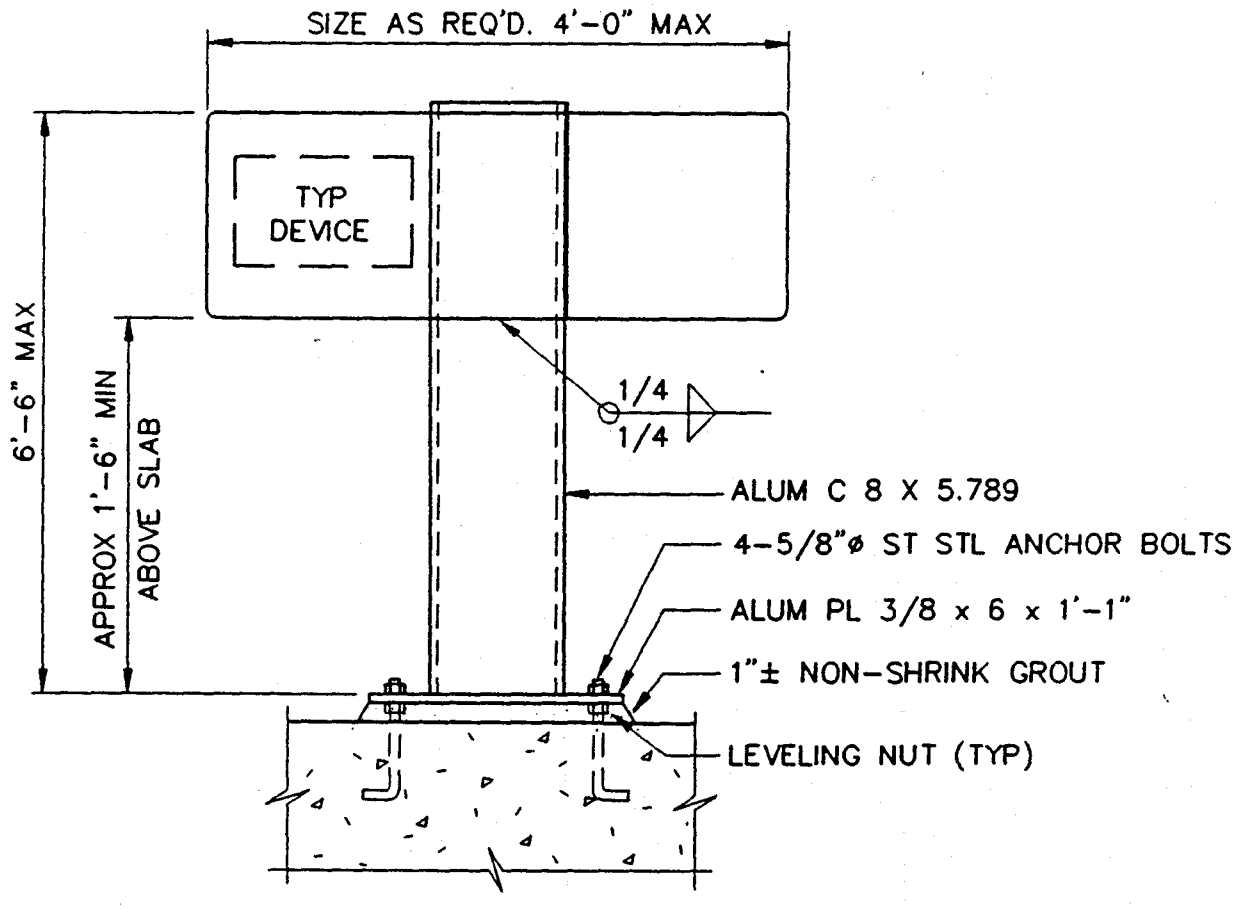
TYP820 5-14-91



821 TYP HANDRAIL MOUNTED SWITCH OR OUTLET



PLAN

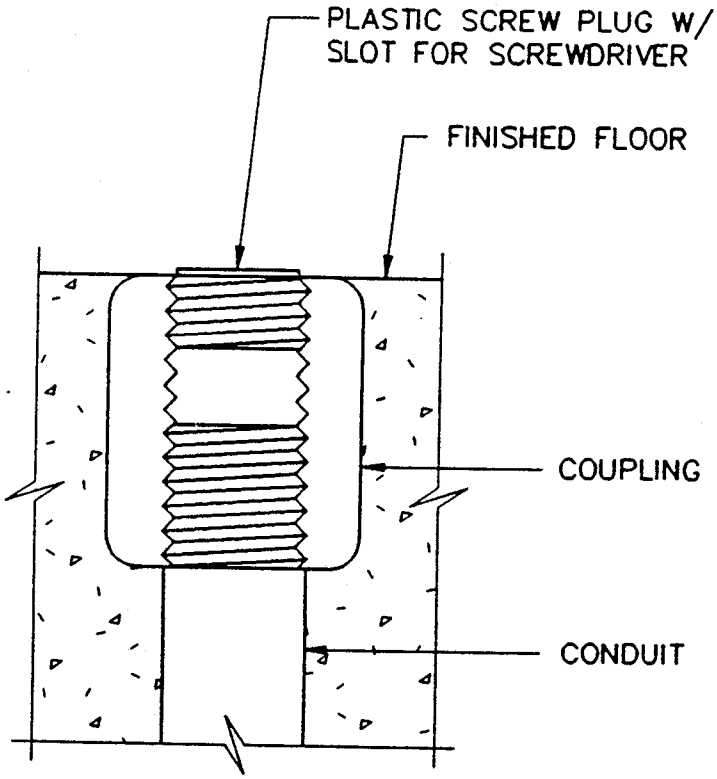


ELEVATION

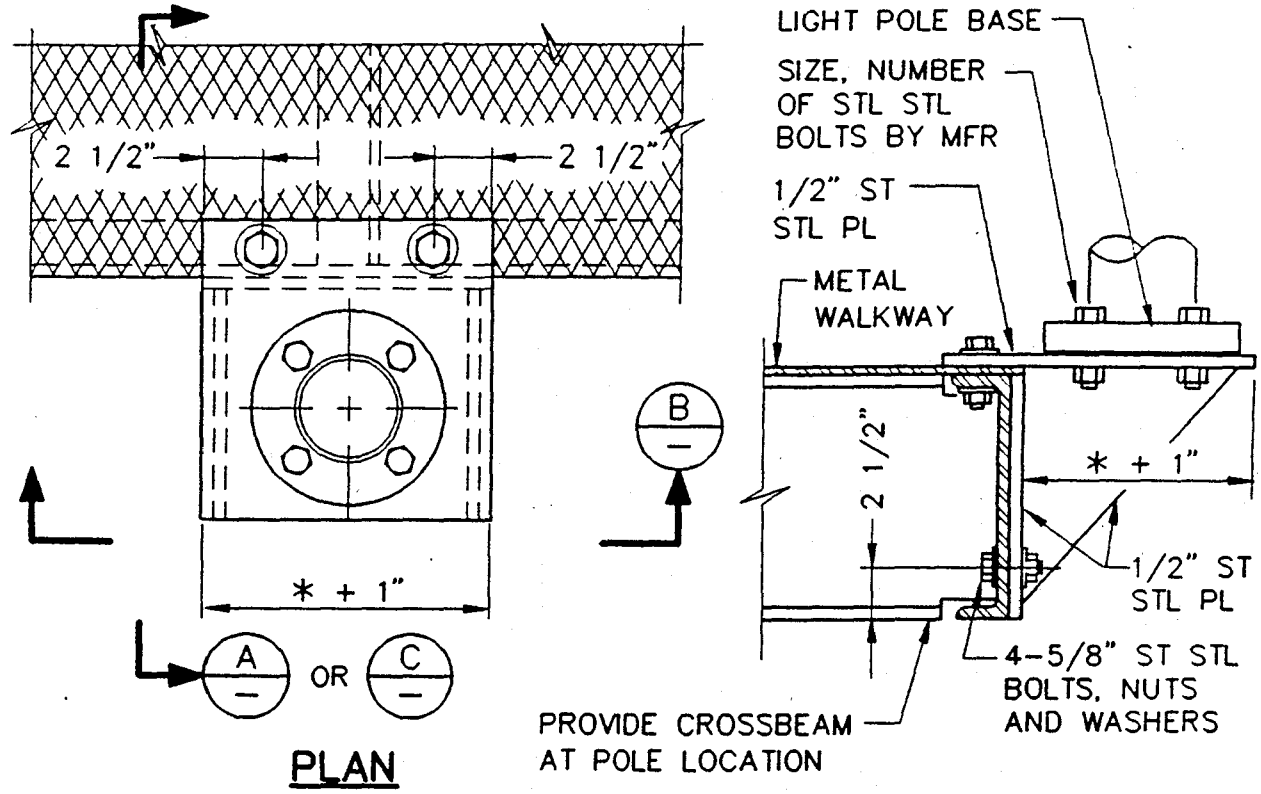
NOTES:

1. COAT ALUMINUM SURFACES IN CONTACT WITH CONCRETE PER SPECIFICATIONS.
2. CONSTRUCT 1'-6" DIA x 2'-6" DEEP CONCRETE FOUNDATION WHERE NO CONCRETE SLAB EXISTS.
3. USE ST STL NUTS AND BOLTS FOR MOUNTING DEVICES.

823 TYP DEVICE SUPPORT AND MOUNTING

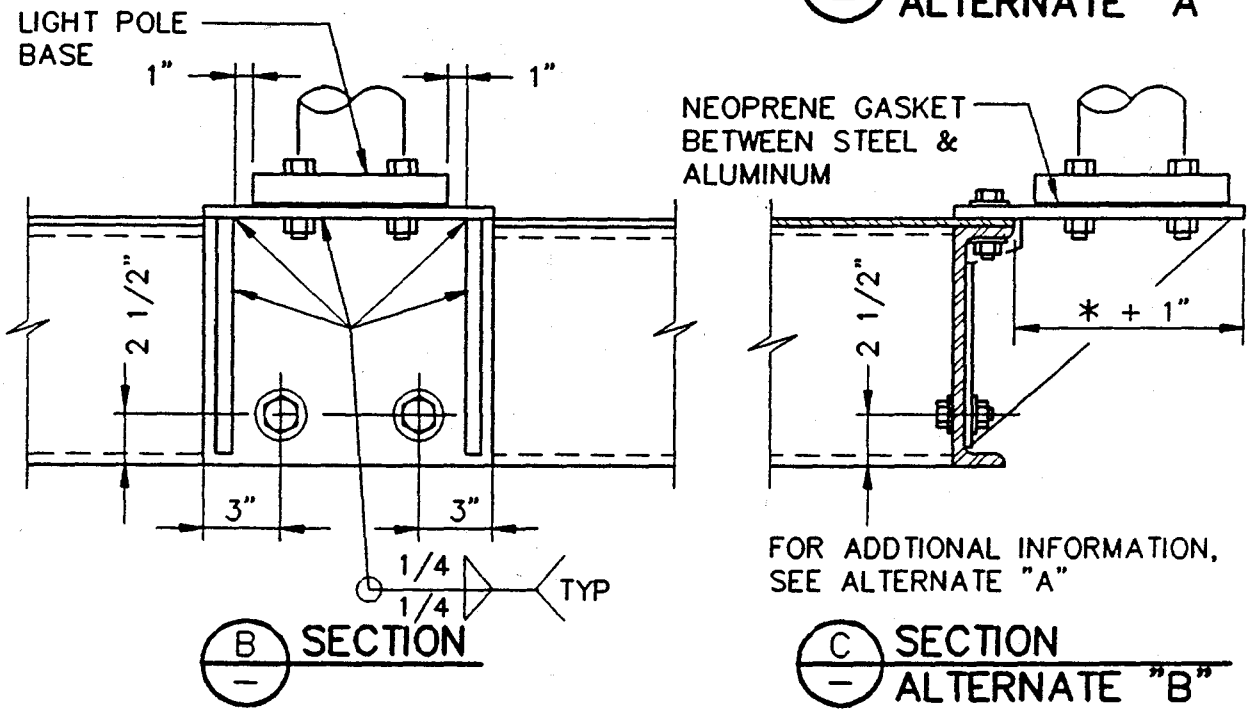


825 TYP CONDUIT, FLOOR STUB-UP



PLAN

A SECTION ALTERNATE "A"



B SECTION

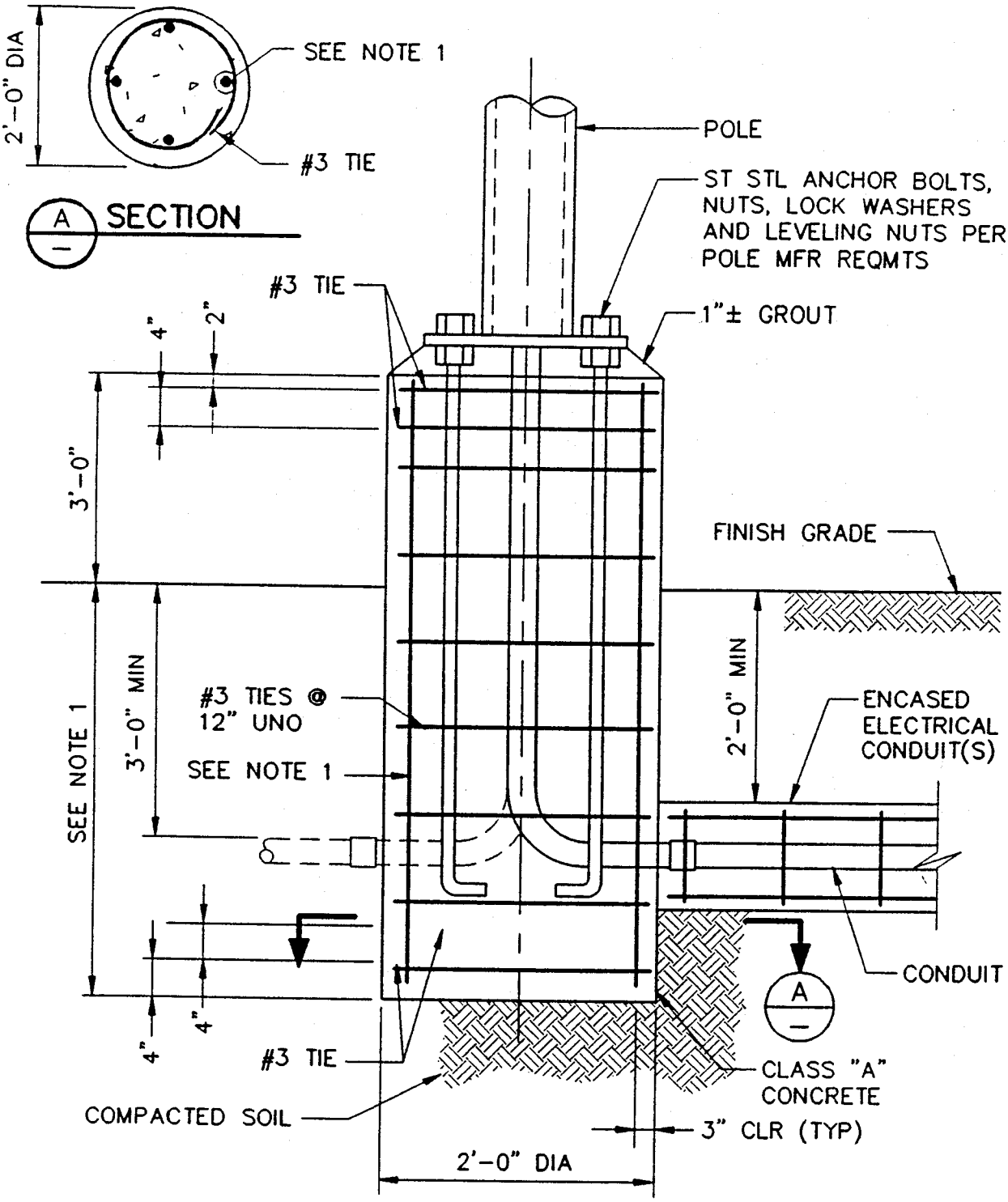
C SECTION ALTERNATE "B"

NOTES:

1. * = OD OF LIGHT POLE BASE.
2. MAXIMUM POLE HEIGHT = 15'-0"

828 TYP LIGHT POLE BRACKET ON METAL WALKWAY

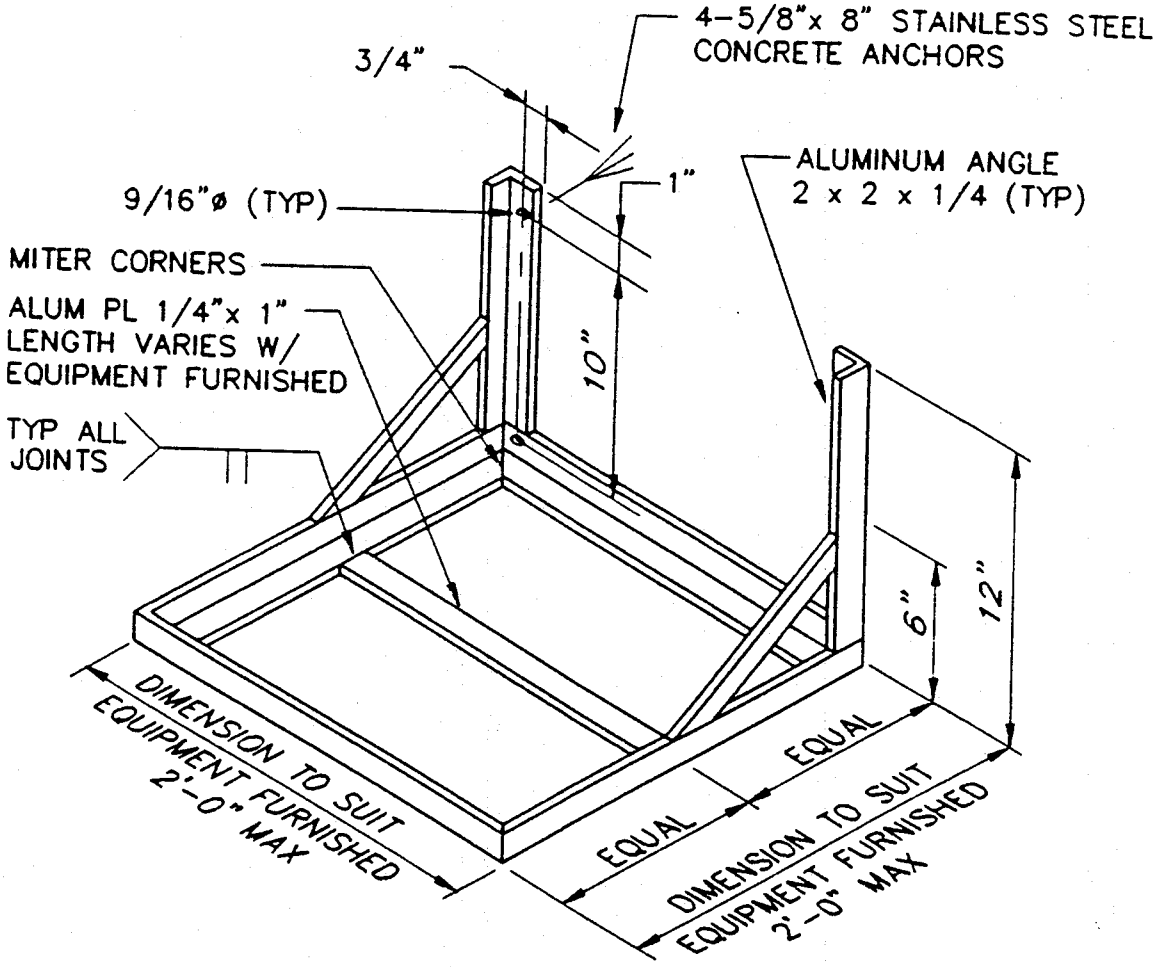
TYP828 5-14-91



NOTE:

1. IF NOT SPECIFIED OR SHOWN, DEPTH AND REINFORCEMENT SHALL BE DETERMINED BY POLE MANUFACTURER. LOADING SHALL BE DEAD LOAD PLUS 100 MPH WIND, EXPOSURE "C" PER UBC 88.

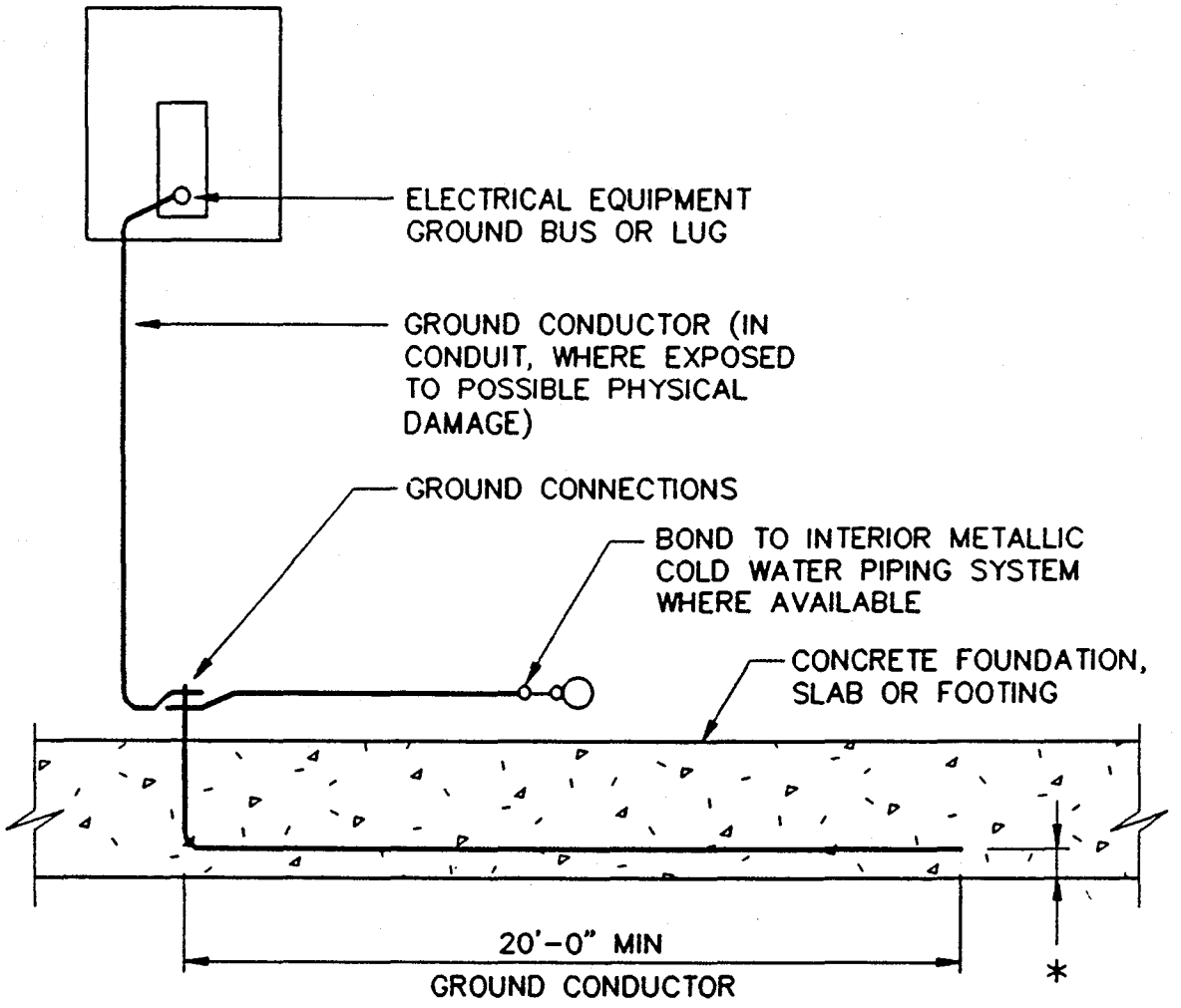
832 TYP AREA LIGHTING FIXTURE MOUNTING



NOTE:

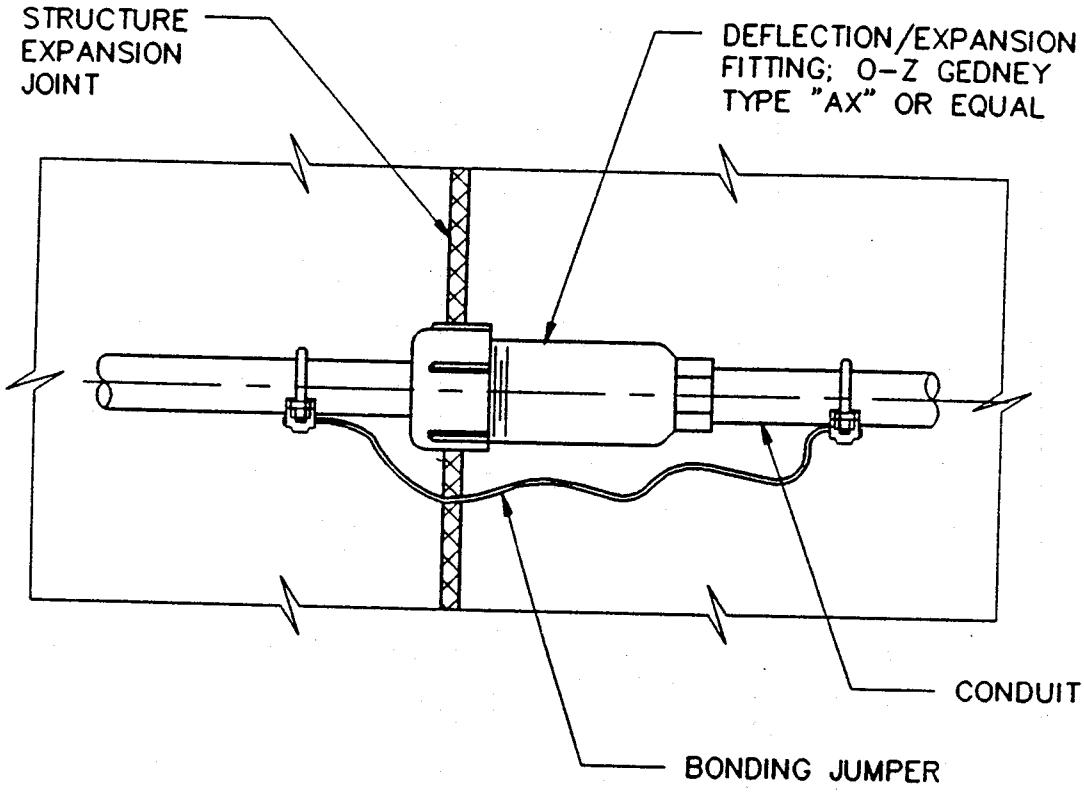
MAXIMUM LOAD - 250 LBS.

839 TYP ELECTRICAL EQUIPMENT MOUNTING BRACKET



* 1" CLEAR FOR ELEVATED SLABS
  3" CLEAR FOR SLABS ON GRADE
  OR FOOTING

842 TYP CONCRETE ENCASED GROUND

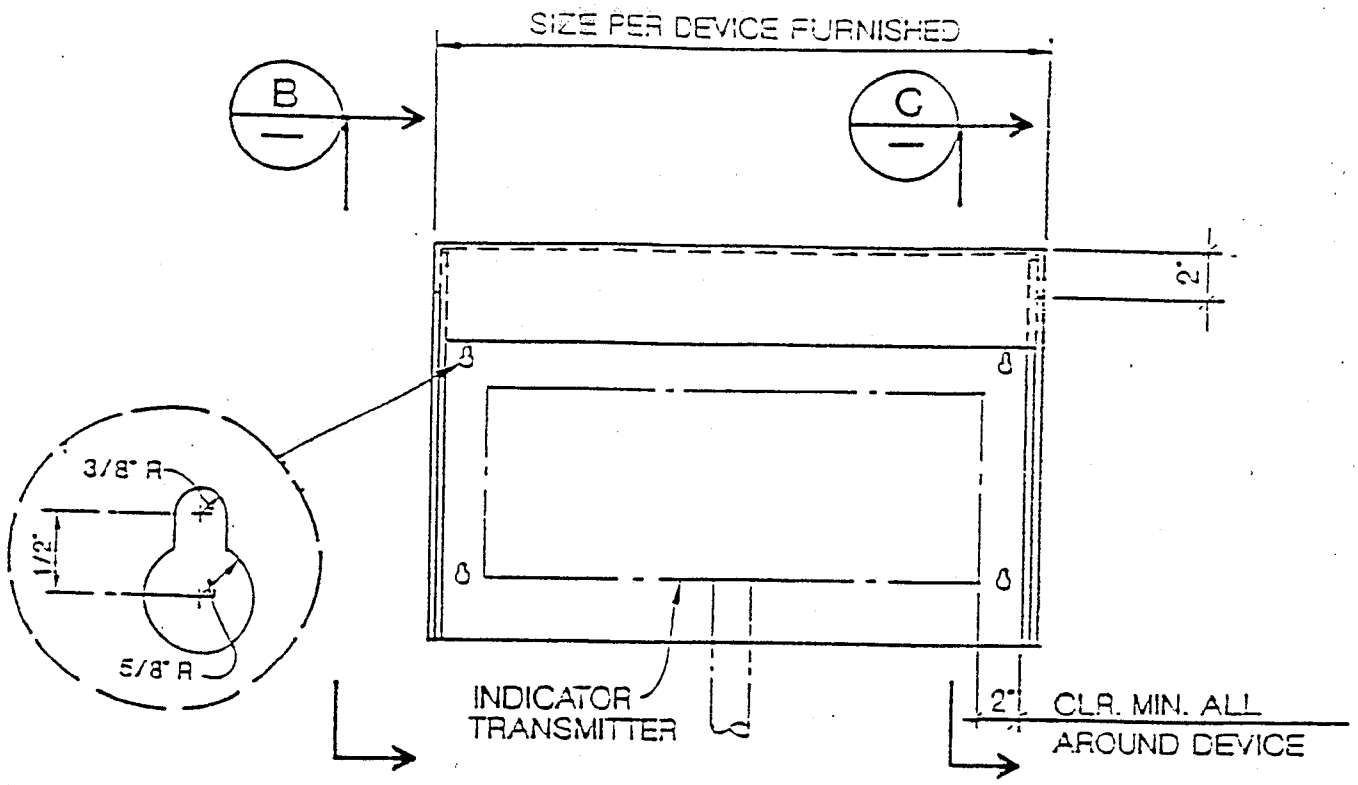


NOTE:

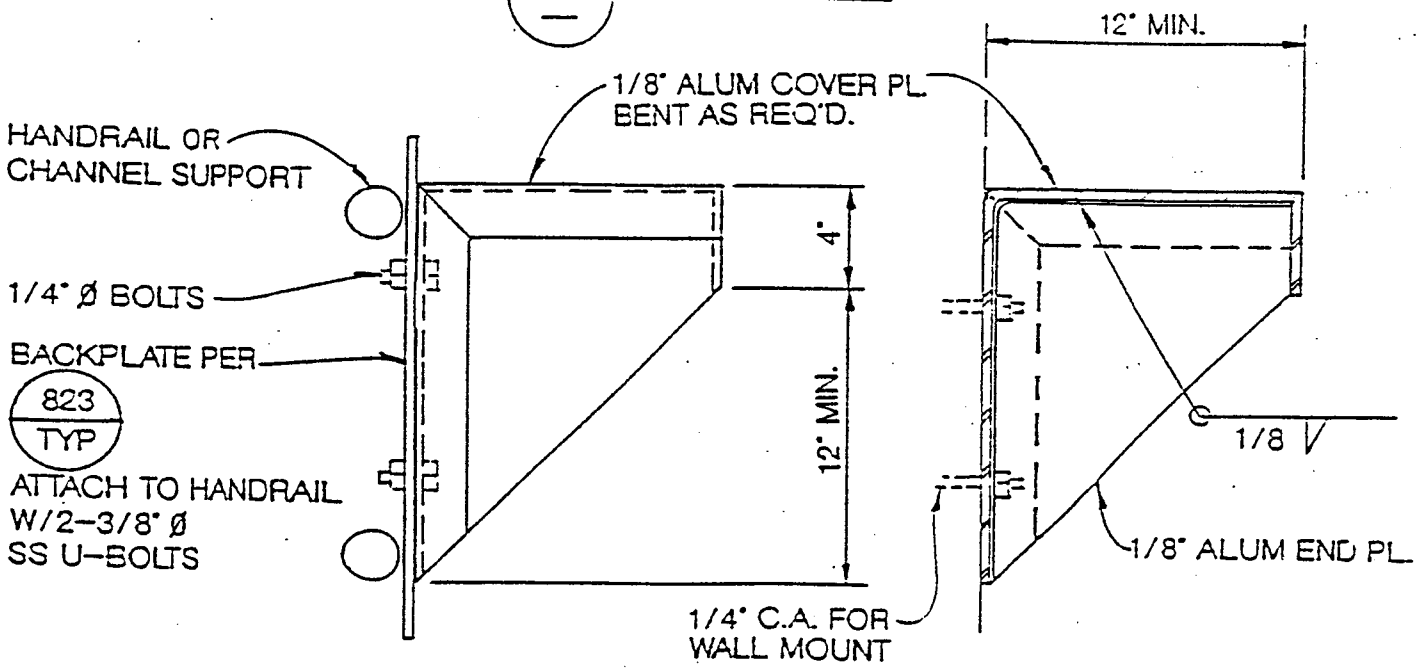
1. WHERE SEVERAL CONUITS ARE INSTALLED, FITTINGS MAY BE STAGGERED; BUT, IN NO CASE SHALL THEY BE MORE THAN 5'-0" FROM STRUCTURE'S EXPANSION JOINT.

846 TYP CONDUIT DEFLECTION/EXPANSION FITTING FOR EXPOSED CONDUIT

TYP846 5-14-91



A ELEVATION



B ELEVATION

C SECTION

881 TYP SUN SHIELD FOR INDICATOR TRANSMITTER