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Utility Tunnels, Trenches and Manholes

The mechanical and electrical services in the Seattle Campus are distributed in a network of underground trenches and arched tunnels.

("tunnel", hereafter, applies to both "trenches" and "tunnels").

A. DESIGN AND CONSTRUCTION REQUIREMENTS

General

1. Submit tunnel network addition/alteration proposal to Engineering Services for review and approval.
2. Indicate access aisle ways in tunnels and manholes on all plans and sections. Provide unobstructed access aisle ways.
3. Design utility tunnels and trenches in accordance with American Concrete Institute (ACI) standards.
4. Do not install City water, gas, sewer, or storm drain piping inside utility tunnels.

Alignment and Grade

1. Tunnel work generally consists of extensions of the existing tunnel system. Therefore, the general elevations are predetermined.
2. Provide a uniform tunnel slope between manholes.
3. Avoid grade interference with future building construction.

Drainage

1. Provide a drainage sump at the lowest level of all manholes and as required at intermediate points between manholes.
2. Provide a line of open joint or perforated drain tile between sumps. Locate drain tile below and parallel to the tunnel floor slab.
3. Pitch tunnel floor slab transversely to the piping side of the tunnel.

Manholes

1. Design and locate manholes to provide access for equipment removal and the installation of future equipment.
2. Do not locate equipment access openings and ventilation shafts in roadways or sidewalks.
3. Size manholes for equipment access to allow the entry or removal of the largest item; e.g. clearance for electrical feeder bend radius or 20-foot lengths of pipe.
4. Manhole openings to be made of precast concrete panels with recessed lifting eyes. Cover the panels with a water-proof membrane after installation.

5. Locate the top of the equipment access opening at a depth for convenient accessibility and to allow landscaping over; generally four feet. Slope the top slightly for water run-off.
6. In certain cases, where a utility trench is located near the grade, equipment openings may be required in the trench roof. At these locations, form the roof slab for removable precast concrete panels, with a waterproof membrane over. Slope precast roof panels to one side of the trench for water run-off.
7. Design ventilation shafts to prevent rain or surface water from entering the manhole. Shafts must offset from the manhole or provide a concrete pan below the shaft to catch any entering water. In either case, provide a floor drain and a curb to retain any water. Raise the surface opening six inches above grade.
8. Provide each manhole with a ventilation shaft to grade, approximately four feet square, with grating installed at grade and secured to allow removal by unfastening from below. Provide tunnel gratings that comply with AASHTO H20 loading criteria.
9. Provide galvanized, safety type, ladder rungs on one face of the manhole shaft to grade.
10. Provide landings in the manhole as required for equipment space and servicing. At landings provide removable open steel grating; suitable for all loads likely to be encountered during the life of the structure.
11. Provide stairs or 60° ship's ladders to connect the various levels. Vertical ladders are not acceptable without University approval.
12. Closely cut and neatly band all edges and openings in the grating.
13. Provide railings and kick plates on stairs and landings not adjacent to walls.
14. Do not rest pipe supports on gratings in manholes.
15. At the top of manhole sections to grade install galvanized, safety type, ladders for tunnel access through the top grating. Provide ladder extensions to provide safe access/egress.

Security

1. Provide ventilation openings at manholes fitted with an open grating with security locks bolted from below.
2. Secure tunnel portals at buildings with a six-inch concrete masonry block wall. Provide access by means of a 2'-0" x 6'-0" x1-3/4" hollow metal door fitted for pin tumbler locking mechanism (lock cylinder is furnished by the University). Sleeve openings for piping and cabling.

Construction

1. It is extremely important that tunnels be of watertight construction. Provide reinforced concrete construction for tunnels and manholes. Carefully prepare concrete specifications and construction details to insure a watertight tunnel.
2. For cast in place concrete conform to requirements of ASTM C-150 for Portland Cement.
3. For cast in place concrete conform to ASTM A-15 and A-305 for concrete reinforcing.
4. For cast in place concrete conform to the requirements of ASTM C33 for sand.
5. For prefabricated concrete provide steel reinforced concrete in conformance with ACI standards.
6. Provide water stops at all joints and keyways. Take special care to assure watertight joints at connections to existing construction.

7. Provide waterproof membranes over access panels, and elsewhere, if ground water is suspected. Apply damp-proofing to exterior wall and roof surfaces of trenches and manholes.
8. Fasten mechanical and electrical supports to embedded inserts and plates as noted hereinafter.
9. Do not use explosives in excavation.
10. Provide tunnel tolerances not to exceed the following:

Plumb	¼ inch in 12 feet
Surface Deviation	1/8 inch in 10 feet
Tunnel Variation from Line	¼ inch in 50 feet
Manhole variation from Line	¼ inch in 12 feet
Cross sectional variation in thickness	6 inch thick slab and under – minus 1/8 inch, plus ¼ inch. Over 6 inch thick slab - minus 1/8 inch, plus 1/2 inch.

Embedded Items

1. Provide flush mounted welding plates for anchorage of piping support structures. Locate at all tunnel deflection points, tunnel junctures with manholes or buildings and such intermediate points as required.
2. Provide cast metal inserts for piping support structures. Pipe support structures are at 12'-0" centers, in general; closer spacing as required for proper pipe alignment. Provide inserts set with the long dimension horizontal for adjustment.
3. Provide Unistrut No.6 260, or equal, for electrical tray support brackets; at five foot centers.

B. MECHANICAL

Utility tunnel piping is the main artery of the University mechanical systems. Any disruption in the systems affects the normal operation of the campus. Therefore, these systems must be designed and constructed for longevity and low maintenance.

Mechanical Drawings

1. Provide design details on drawings at a scale not less than 3/8” = 1'-0".
2. Provide details for each manhole to show the routing of all piping and location of all equipment.
3. Provide piping and equipment layout in detailed tunnel sections.

4. Include electrical work on drawings to indicate proper clearances and accessibility.

Piping General

1. For piping comply with the latest ASA Code for Pressure Piping, with welding operators qualified by either the National Certified Pipe Welding Bureau, American Petroleum Institute or ASME Boiler Codes.
2. Arrange and align piping to minimize pipe stress. For steel piping 2 inch size and larger provide welded construction.
3. For branch piping, welded tees are preferred. For connections to existing piping when the branch is smaller than the main, welding fittings or reinforced saddle welds may be used.
4. Miter welded joints are not acceptable.
5. Provide unions or flanged connections, with valves, where necessary for equipment isolation and removal.
6. Locate valves in the manholes for building services.
7. Do not use 3-1/2 inch and 5 inch size piping.
8. Provide slip type, internally guided, without base, welded end pattern, expansion joints. Adsco Type IS expansion joints are preferred. Provide joints with adequate traverse to provide a minimum movement of one inch over and above the computed expansion or contraction. Adjust expansion joints at the time of installation to take into account the tunnel temperature at the time of installation.
9. Provide insulation for steam and condensate piping in tunnels suitable for the temperature with no off-gassing or binder oxidation occurring near the pipe's operating temperature. Do not use fiberglass insulation on tunnel steam and condensate piping.
10. Insulation for CCW piping in tunnels shall be cellular glass or polyisocyanurate.
11. Provide metal jackets for all new piping insulation in the utility tunnels.

Anchors, Supports, Guides

1. Locate anchors in such a manner that "force couples are not be created. Locate branch take-offs near anchors.
2. Provide cast iron rollers with cast iron stand for bracket supported units; or cast iron roller with sockets for two hanger rods; sized to allow for insulation and pipe saddle. Provide bolts with lock nuts. Rod sizes as follows:

Pipe 2 inch size and smaller	3/8 inch
Pipe 2-1/2 inch through 4 inch size	½ inch
Pipe larger than 4 inch size	5/8 inch

3. Provide cast iron or steel alignment guides; concentric circle type, with an alignment spider centering the pipe; sized to allow the insulation to pass through the outer ring plus 1/2 inch clearance.
4. Provide welded angle iron frames, supported at floor, wall and roof at pipe support structures for rollers and alignment guides. Provide embedded inserts in walls and roof and drilled in anchors in the floor.
5. Provide raised and grouted floor supports off the floor to prevent rusting at the floor. Locate horizontal frame members at each support structure to minimize the use of shims.
6. Provide steel channel frames secured to the floor, wall and roof at pipe anchor structures. Provide embedded channel sections in the floor, wall, and roof. Provide continuous fillet welds (no tack-welds) on steel members.
7. Provide Star "Slug-in" compounded anchor bolts or equal at supports in existing construction and at floor supports in new construction. Provide galvanized or cadmium plated anchor bolts.
8. Provide drilled (not burned) holes for fastening.

STEAM & CONDENSATE SYSTEMS

Steam

1. Provide drip traps on steam piping at all changes of elevation, grade, or valves as required, with suitable drip legs and valved free blow connections no smaller than 3/4 inch size.
2. Seal weld screwed fittings on steam piping from the main to the first valve.

Condensate

Flashing and Returning of High Pressure Steam (30 to 185 psig)

1. Discharge high pressure traps as follows (in the order of preference):
   a. To lower pressure 15 psig mains
   b. To building flash tanks
   c. To tunnel high pressure drip piping
2. Provide inverted bucket type traps with replaceable seats and air bypass; 3/4 inch minimum size.
3. Provide gate valves at trap connections for isolation, stainless steel strainer with 1/16 inch perforations and swing check valve at discharge.

Returning of Low Pressure Steam (15 psig or less)

1. Discharge low pressure traps to gravity condensate return mains where possible, or to building condensate receivers.
2. Provide float type traps with integral thermostatic air bypass; fully repairable.

Compressed Air

1. Provide float traps at low points to drain condensation; with shut off valves and strainers.

Central Cooling Water System

1. Provide expansion joints with guides allowing full insulation and continuous vapor barrier jacket.
2. Central cooling water system pressure varies at different campus Locations. Obtain operating pressures at specific locations prior to the design for piping modifications.

C. ELECTRICAL

Electrical Drawings

1. The requirements of other electrical sections are applicable except for modifications as stated herein.
2. Experience has shown that proper electrical installations in tunnels and manholes can only be achieved when detail design drawings are provided at a scale of not less than 3/8" = 1'-0". Cables should be shown double line, with the minimal bending radius not exceeded. Cables less than one inch diameter may be shown with one line.
3. A sufficient number of details must be provided for each manhole to clearly show the routing of all cables and the proper location of all equipment.
4. Provide detailed tunnel sections for each variation of conditions.
5. Sufficient mechanical work should be shown to indicate proper clearances and accessibility.

Electrical Cables

1. The various electrical utility systems owned and operated by the University have been described in other electrical sections. The electrical cables required in the tunnels to implement these systems are herewith indicated with designation of particulars.
2. The following specifications for the various electrical utility cables carried in the University tunnel system are presented as a guide for the minimum requirements.

15 KV CABLE

1. Three conductor 15 KV cable, 500 MCM or #2/0, for grounded neutral service.

5 KV CABLE

1. Cable for 4.16 KV systems shall be rated for 5 KV and shall conform to the requirements for 15 KV cable except as noted herein.
2. Clock and Program Cable.
3. IPCEA Standard, 6-conductor, No. 12 AWG wires, plastic insulated with outer plastic jacket; insulation thickness, 0.030 inch on wires and 0.060 inch outer jacket.
4. Conductors shall be colored as follows: Black, white with yellow tracer, red, green, orange, and blue.

FIRE ALARM CABLE

1. IPCEA Standard, 6-conductor or 12 conductor as programmed,

2. No. 14G wires, plastic insulated with outer plastic jacket; insulation thickness, 0.030 inch on wires, 0.045 inch for 6- conductor cable outer jacket and 0.060 inch for 12-conductor cable outer jacket.
3. Color coding shall be as follows: Black, white, red, green, orange, and blue, for 6-conductor cable; 12-conductor cable, two sets of conductors with the foregoing colors, one set with tracer.

Cable Trays

1. Cable trays are used in the tunnels and manholes, and elsewhere as indicated in other Electrical sections, for carrying electric cables for utility systems.
2. Cable trays shall be galvanized sheet steel of the basket type construction. Manufacturer: Type "B" Globe Cable-Strut or Type "A", Husky Ventrib, SH series.
3. Cable trays shall be 9 inch wide size in tunnels and 12 inch wide size in manholes.
4. Ells and reducing fittings for cable trays shall be provided as shown on the Standard Drawings. Standard fittings shall be modified as required to suit the layouts shown. Reducing fittings shall be provided with a smooth transition; abrupt transitions are not allowed. Changes in elevation shall be made with standard fittings, modified where necessary to suit, or a special fitting shall be provided, of the same material, fabricated at a sheet metal shop. Connections to existing cable trays of a different type and/or dimension shall be provided with a special fitting of galvanized steel fabricated in a sheet metal shop.
5. Cable tray support brackets shall be Husky "VBK" series or equal with slotted holes on top for securing embedded formed metal inserts in the tunnel and manhole walls. Support brackets shall be galvanized steel and shall not project beyond the front edge of the tray.
6. The necessary bolts, nuts, Washers, etc., required for cable tray installation shall be galvanized steel or a material that is rust proof; shall be the size and type as shown on the Standard Drawings and as recommended or furnished by the manufacturer.
7. Install cable trays as shown on the Standard Drawings unless otherwise directed. It is intended that all cable tray installations, including special and modified fittings, reflect a neat and truly workmanlike job.
8. All cable trays carrying 4.16 KV and 13.8 KV cables shall be provided with a liner consisting of 1/4 inch thick non-asbestos sheet completely covering the bottom of the tray. Provide a single non-asbestos sheet cut to neatly fit the contour of the tray bottom at all fittings. Small individual pieces fitted together are not allowed. The installation of non-asbestos liners in high voltage cable trays is to afford protection to adjacent cables in the event of a fault or damage to a high voltage cable.
9. In the interest of the utmost in service reliability and safety, provide only one high voltage cable in any individual cable tray unless otherwise directed. Alarm and signal cables, such as supervisory, fire alarm and clock and program, may be carried in a common tray.
10. Cable trays shall be labeled for identification; such as 13,800 volts, 4160 volts, alarm and signaling, etc. Labeling consists of ¾ inch high black stencil letters on side of tray. Provide labeling at each manhole and at 100 foot intervals in tunnels.

Cable Clamps

1. Frequently it is necessary to run cables vertically in manholes from one elevation to another. Cable clamps shall be used for supporting cables in such installations and at all other locations where cable trays cannot be used.
2. In general, cable clamps shall be provided on 4 foot centers. They may be fastened to inserts spaced on 5 foot centers in tunnel walls, where they are available.
3. Cable clamps shall be constructed of close-grained maple hardwood impregnated with paraffin to a depth of 1/16 inch minimum after finishing. They shall be rectangular, two-piece, drilled for anchor bolts and for cable; shall be Unistrut series U-159 to 166. The cable hole shall be exactly fitted to the cable outside diameter.

Cable Splices and Terminations

1. Stress relief cones shall be provided on all 15 KV cable splices and potheads and shall be in strict accordance with the manufacturer's instructions. Stress relief cones are not required for cables used on lower voltage systems on the campus.
2. Interlocked armor tie cables (480 volts) shall be terminated with a fitting specifically designed for jacketed armor cable; such as OZ Type "SPK" series. Connections to equipment shall be with solderless lugs.
3. Splicing and termination of high voltage power cables must be done by qualified persons specializing in this art. All work of this type will be supervised by University personnel. The UW will provide “hi-pot” testing on all cable systems including splices and terminations and the tests must pass I.P.C.E.A. and N.E.M.A. standards.

Grounding

1. Grounding shall be provided for electrical equipment in tunnels and man- holes. Exposed, non-current carrying metal parts of all fixed electrical equipment shall be grounded. Items to be grounded shall include but not be limited to metallic cable trays, cable armor, terminal cabinets, sectionalizing switches, potheads, splicing fittings, metallic raceway systems, panel boards, lighting fixtures, receptacles, etc.
2. Grounds shall be provided with ground rods in each manhole located near the electrical side of the tunnel entries to the manhole. Rods shall be copperweld 3/4 inch diameter, not less than 8 feet long. Ground resistance should not exceed 25 ohms and should be measured by the contractor and witnessed by the engineer. Additional ground rods shall be provided to reduce the resistance if the allowable value is exceeded.
3. Grounding conductors shall comply with the National Electrical Code but in no case be less than 500KCM AWG bare stranded copper. Ground conductors shall be neatly surface mounted and supported at intervals not exceeding 4 feet.

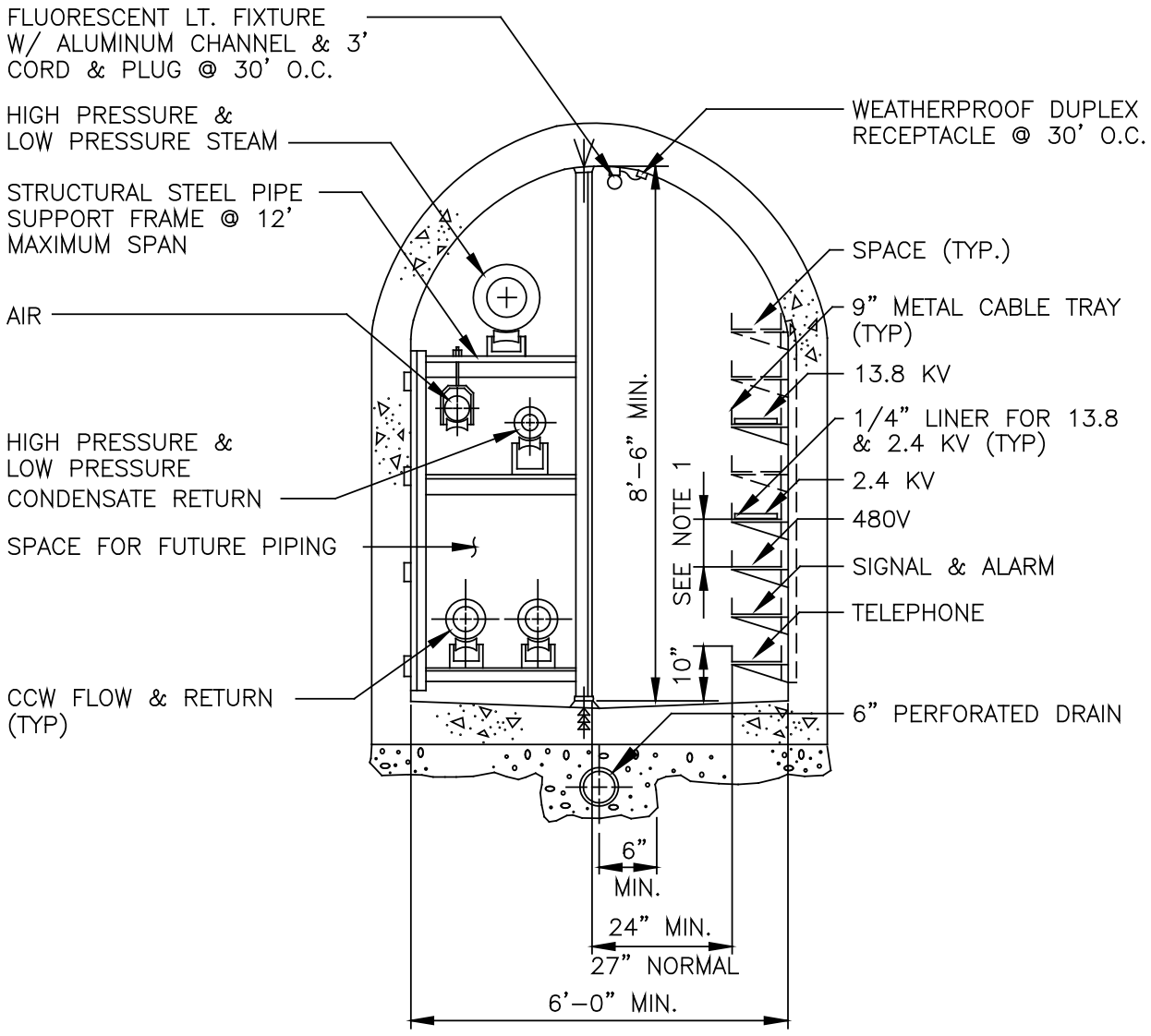
Terminal Cabinets

1. In general, provide terminal cabinets in all manholes for supervisory, fire alarm and clock and program systems. Cabinets shall be mounted so as to be readily accessible for maintenance and ease of wiring.

2. Terminal cabinets for the clock and program system and the fire alarm system shall be cast aluminum with barrier and with common hinged neoprene gasketed cover; OZ Type "YW-A" or equal. The barrier shall be removable and shall divide the cabinet equally into two sections. Cabinets shall be provided with mounting lugs. All hardware shall be stainless steel. Size shall be 12 inches long, 12 inches wide and 4 inches deep. Provide bosses tapped 1 inch NPT; 3 equally spaced on each 12 inch clear side and one on each 6 inch side of each section for a total of 10 bosses. Aluminum plugs shall be provided for all unused openings. A 20 point terminal block, rated 300 volts, shall be provided in each section of the cabinet, bolted to mounting buttons provided. Terminal blocks shall be Buchanan Catalog No. 625 or equal.
3. Cable connectors for connecting cables to the clock and program and fire alarm terminal cabinets shall be Crouse Hinds type CGB. Connectors shall be aluminum, 3/4 inch NPT, with tapered neoprene bushings sized to exactly fit the cable to be connected.

Tunnel and Manhole Lighting Systems

1. Normal tunnel lighting is intended to serve as pathway lighting and, as such, it is at a low average foot candle level. Lighting in manholes in addition to serving as pathway lighting should be sufficient for the operation of valves and switches. Provide adequate illumination must for stairways in manholes.
2. Lighting fixtures for use in manholes and tunnels shall be single lamp fluorescent strip units with 40 watt rapid start lamps; fixture channel constructed of aluminum. Fixtures shall be mounted at 30 foot intervals in tunnels, except if programmed othen1ise; surface mounted. Fixtures shall be mounted in manholes as required; surface mounted. Avoid mounting fixtures on removable sections of platforms. Fixtures for use in tunnels shall be provided with a 3 foot rubber cord with cap.
3. Wiring shall be with rigid conduit and type TRW conductors and shall be run exposed in tunnels and manholes. Wiring in manholes must be mounted to clear all removable sections of platforms.
4. A weatherproof duplex receptacle shall be provided at each fixture location in the tunnels. One receptacle shall serve as a power source for the lighting fixture. The other receptacle shall serve as a connection for hand tools. Provide adequate receptacles in manholes.
5. Tunnel lighting shall be wired with 3-way switches between manholes so that the lighting in a section of tunnel may be controlled by a switch in the manhole at either end of the section. Lighting in manholes shall be controlled by 3-way switches located at the top and bottom levels of the manhole. 4-way switches shall be provided at intermediate levels where tunnels connect.
6. Power for tunnel lighting shall be provided from the emergency system. If the emergency power system is not readily available, power shall be served from an emergency panel in a nearby building.
7. The applicable portions of other Electrical sections, shall apply to tunnel lighting systems.



NOTES :

1. TRAY SPACING 9" TYPICAL EXCEPT AS DIRECTED BY THE UNIVERSITY

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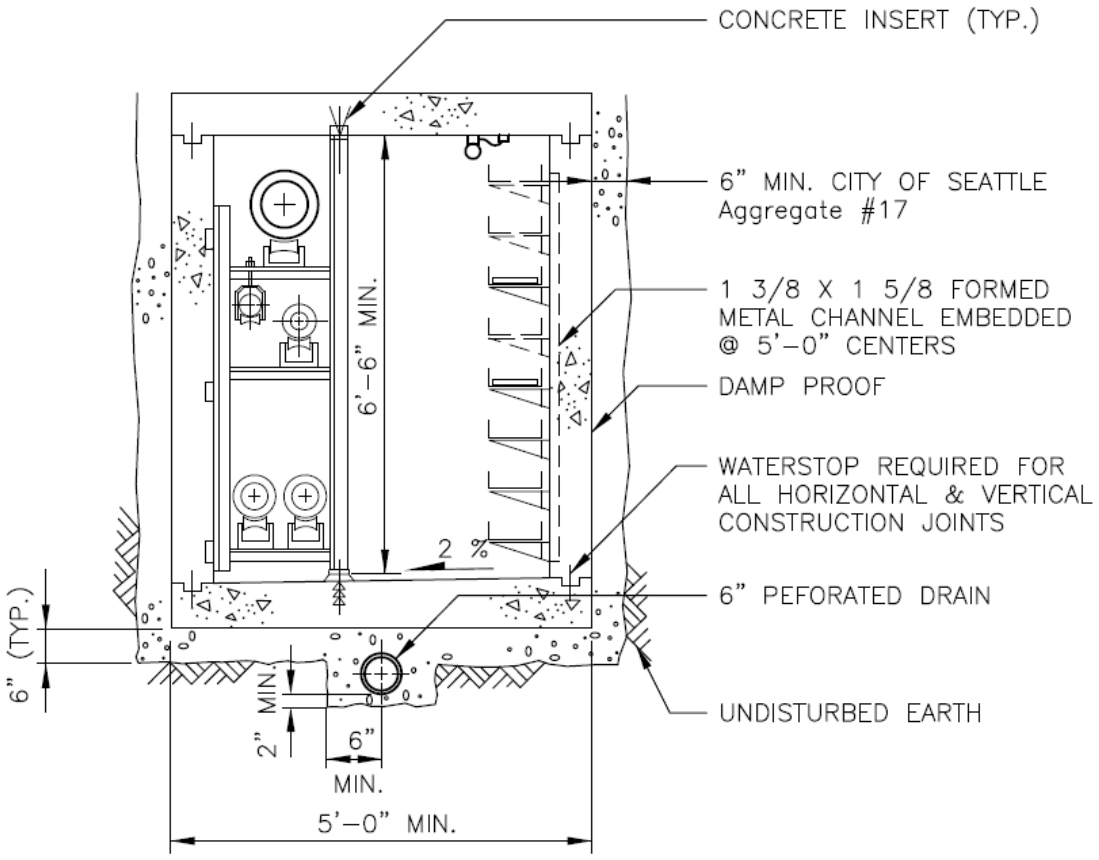
CONCRETE INSERT (TYP.)
6" MIN. CITY OF SEATTLE Aggregate #17
1 3/8 X 1 5/8 FORMED METAL CHANNEL EMBEDDED @ 5'-0" CENTERS
DAMP PROOF
WATERSTOP REQUIRED FOR ALL HORIZONTAL & VERTICAL CONSTRUCTION JOINTS
6" PEFORATED DRAIN
UNDISTURBED EARTH
6'-6" MIN.
2 %
6" (TYP.)
2" MIN.
6" MIN.
5'-0" MIN.

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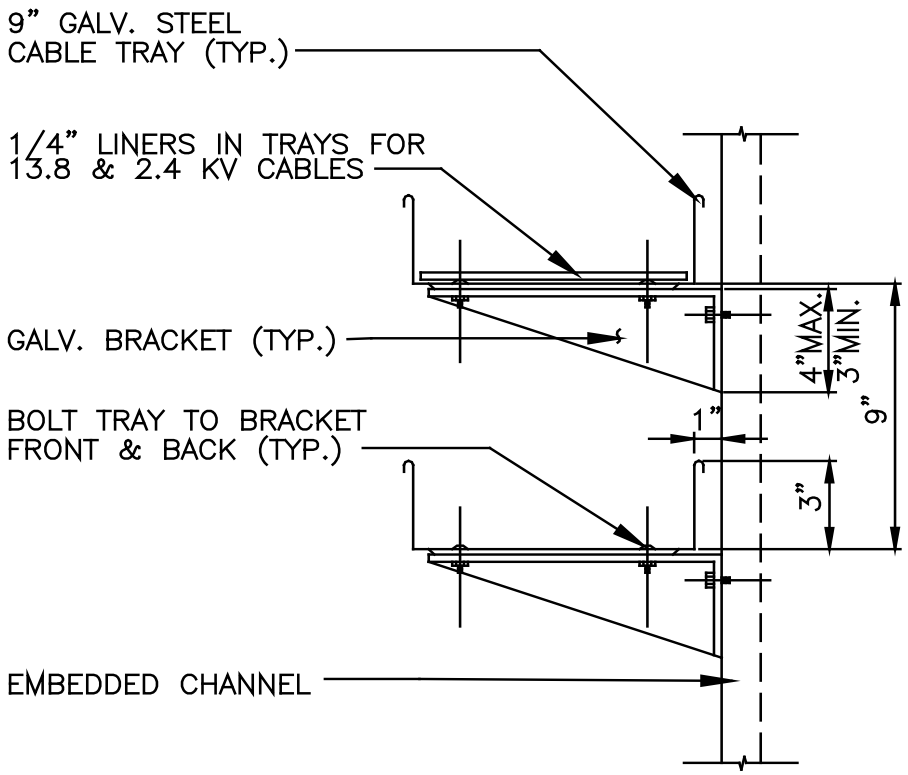
9" GALV. STEEL
CABLE TRAY (TYP.)
1/4" LINERS IN TRAYS FOR
13.8 & 2.4 KV CABLES
GALV. BRACKET (TYP.)
BOLT TRAY TO BRACKET
FRONT & BACK (TYP.)
EMBEDDED CHANNEL
4"MAX.
3"MIN.
9"
1"
3"

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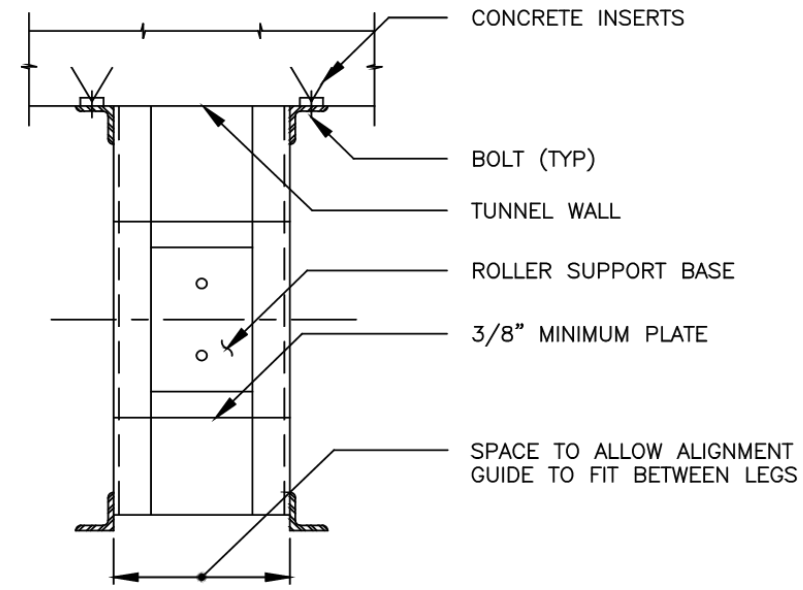
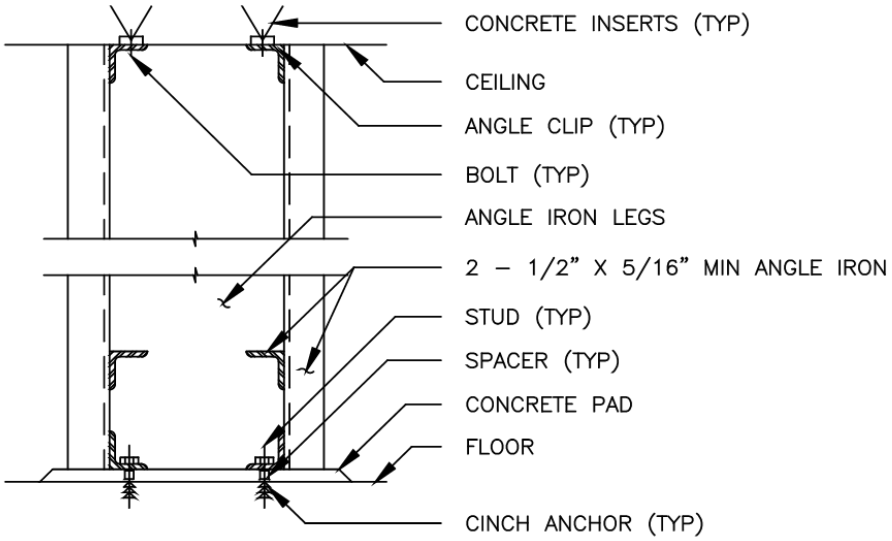


ROLLER SUPPORT PLAN



ELEVATION

NOTES :

1. STRUCTURAL MEMBER SIZES & FASTENERS WILL VERY. SIZE ALL COMPONENTS FOR THE MAX POSSIBLE LOADS & FORCES TAKING IN ACCOUNT FUTURE PIPING.
2. WELD ALL JOINTS. FULL LENGTH WELDS (NO TACK WELD).
3. WITH TWO PIPES ON ONE SUPPORT MEMBER, SHIM AS REQUIRED WITH STEEL PLATES UNDER ONE ONLY.
4. PAINT ALL STEEL AFTER FABRICATION.

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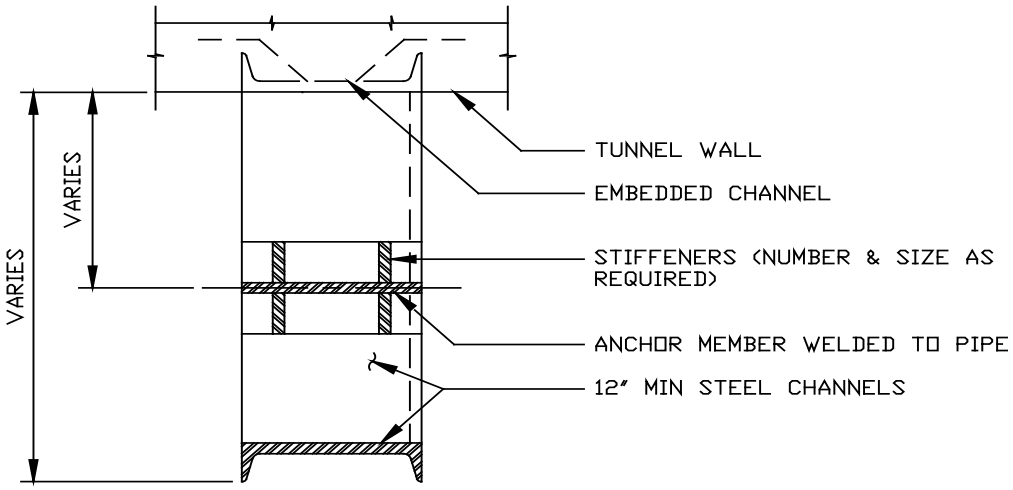
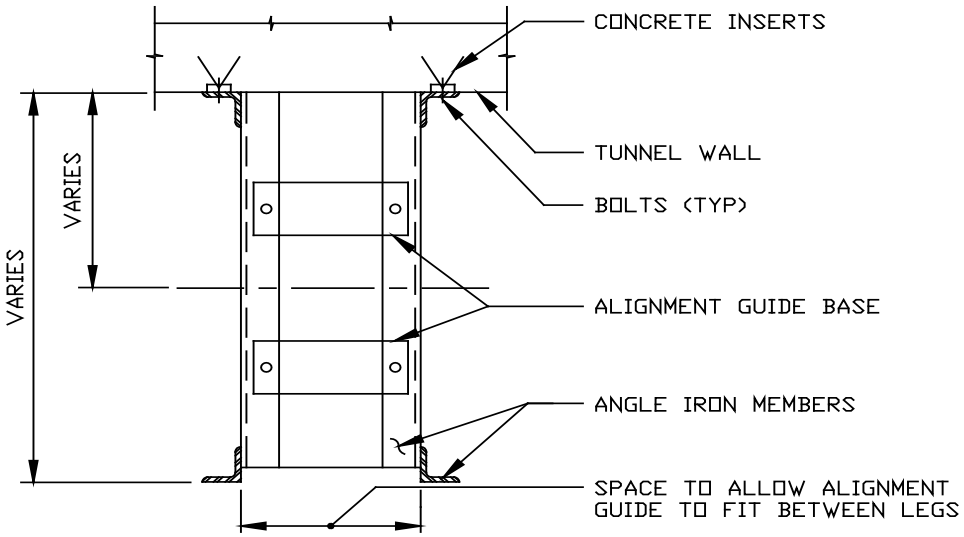


PIPE ANCHOR PLAN



ALIGNMENT GUIDE PLAN

NOTES :

1. STRUCTURAL MEMBER SIZES & FASTENERS WILL VERY. SIZE ALL COMPONENTS FOR THE MAX POSSIBLE LOADS & FORCES TAKING IN ACCOUNT FUTURE PIPING.
2. WELD ALL JOINTS. FULL LENGTH WELDS (NO TACK WELD).
3. WITH TWO PIPES ON ONE SUPPORT MEMBER, SHIM AS REQUIRED WITH STEEL PLATES UNDER ONE ONLY.
4. PAINT ALL STEEL AFTER FABRICATION.

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