SECTION 27-05-43
UNDERGROUND DUCTS AND RACEWAYS FOR COMM SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

A. The work covered by this section of the specifications shall include all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:

1. Conduits, Ducts, and Duct Banks
2. (Signal) Hand Holes (SPH)
3. (Signal) Pull Boxes (SPB)
4. (Signal) Vaults/Manholes (SMH)

1.02 QUALITY ASSURANCE

A. Refer to Section 27-00-00 for general details.

1.03 CODES AND STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27-00-00.

B. AASHTO HB 17 - American Association of State Highway and Transportation Officials, Standard Specifications for Highway Bridges, 17th Edition

C. ANSI C80.1 – Galvanized Rigid Steel Conduit

D. ANSI C1037 – Standard Practice for Inspection of Underground Precast Concrete Utility Structures

E. ASTM A48/A48M – Standard Specification for Grey Iron Castings

F. ASTM F512 - Standard Specification for Smooth-Wall PVC Conduit and Fittings for Underground Installation

G. ASTM C857-95 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

H. ASTM C858 – Standard Specification for Underground Precast Concrete Utility Structures

I. ASTM C891 – Standard Practice for Installation of Underground Precast Concrete Utility Structures

J. ASTM C 1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures

K. Cal PUC G.O. 128 Rules for Construction of Underground Electrical Supply and Communications Systems, State of California Public Utilities Commission

L. ISO 9000 – Quality Management Systems – Fundamentals and Vocabulary

M. ISO 10012 – Measurement Management Systems, Requirements for Measurement Processes and Measuring Equipment

N. NEMA TC2 – Electrical PVC Conduit

O. NEMA TC3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing

P. NEMA TC6&8 – PVC Plastic Utilities Duct for Underground Installations

Q. NEMA TC9 – Fittings for PVC Plastic Utilities Duct for Underground Installations

R. SCTE 77 - Specification for Underground Enclosure Integrity, Society of Cable Telecommunications Engineers

S. UL 651 – Schedule 40 and 80 Rigid PVC Conduit and Fittings

T. UL 514B – Conduit, Tubing, and Cable Fittings

U. The Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design and Syntax Standards in Appendix B.

1.04 SUBMITTALS

A. Refer to Section 27-00-00 for general details.

B. Shop Drawings:

1. Shop drawings shall show the position of all underground telecommunications Vaults, Pull Boxes, Hand Holes, Ducts, Duct Banks and Conduits.

2. Drawings are to indicate as-built fill percentages on all conduits within the project scope

C. Submit Manufacturer's Cut Sheets for the following:

1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets for approval by the Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

A. Refer to Section 27-05-53 for general details.

B. All Vault Covers, Pull Box and Hand Hole lids are to be factory labeled (at minimum) "COMMUNICATIONS". (See Fig. #156 & 157 in Appendix B)

C. All copper and fiber cables run underground shall be labeled in each Vault, Pull Box, Hand Hole, and Pull Box with the appropriate label as detailed in Section 27-05-53, and described in the Labeling, Design and Syntax Standard in Appendix B.

1.06 DEFINITIONS

A. Duct: Interchangeable term for a conduit.

B. Duct Bank: An assembly of conduits that may either be directly buried in earth or encased in concrete.

C. Signal Hand Hole (SHH): Small underground structure (15" x 20" x 10") containing a maximum of one 2" conduit and is typically used for distribution to a single end point.

D. Signal Pull Box (SPB): Small underground structure (15" x 26 x 18") containing a maximum of two 4" conduits.

E. Signal Manhole (SMH): Large underground structure of varying size used for 4" conduits.

1. Up to six 4" conduits minimum vault size is 5' x 7' x 7'

2. Six to twelve 4" conduits minimum vault size is 6' x 10' x 7"

3. Thirteen to eighteen 4" conduits minimum vault size is 6' x 12' x 7"
4. Nineteen to twenty four 4" conduits minimum vault size is 8' x 15' x 7"

1.07 WARRANTY

A. Refer to Section 27-00-00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

B. A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted, unless specifically noted otherwise.

2.02 METALLIC CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complies with NEMA TC 3 and UL 514B.

2.03 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-40-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

B. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide the minimum duct spacing indicated while supporting ducts during concreting or backfilling.
2. Warning Tape:
    a. Tape is to be metal/detectable
    b. Color: Orange
    c. Labeled "FIBER OPTIC CABLE" or "COMMUNICATIONS"

C. Approved Manufacturers: Lamson & Sessions; Carlon Electrical Products, Manhattan/CDT; a division of Cable Design Technologies, Spiraduct/AFC Cable Systems, Inc. or Cal Poly ITS Telecomm group approved equal.

2.04 PRECAST CONCRETE SIGNAL PULL HOLE (SPH)

A. Comply with ASTM C 858 for design and manufacturing processes.

B. Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of the hand hole.

C. Cover Legend: Molded lettering, "COMMUNICATIONS" (at minimum)

D. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.

E. Approved Manufacturers: Christy Concrete Products, Oldcastle Precast Group, Utility Concrete Products, LLC, Utility Vault Co. or Cal Poly ITS Telecomm group approved equal.

2.05 PRECAST CONCRETE SIGNAL PULL BOX (SPB)

A. Comply with ASTM C 858 for design and manufacturing processes.

B. Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom. Frame and cover shall form top of enclosure and shall have load rating consistent with that of the pull box.

C. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

D. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

E. Cover Legend: Molded lettering, “COMMUNICATIONS” (at minimum) (See Fig. #156 & 157 in Appendix B)

F. Configuration: Units shall be designed for flush burial.

G. Extensions and Slabs: Designed to mate with bottom of enclosure. Use same material as enclosure.

1. Extension shall provide increased depth of 12 inches.
2. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

H. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

1. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of pull boxes, but close enough to corners to facilitate racking of cables on walls.
2. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
3. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

I. Duct Entrances in Pull Box Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct or conduit to be terminated.
2. Fittings shall align with elevations of approaching ducts and be located near interior corners of pull boxes to facilitate racking of cable.
3. All ducts entering pull boxes shall be grouted in place flush with the finished surface.

J. Pull Boxes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

K. Approved Manufacturers: Christy Concrete Products, Oldcastle Precast Group, Utility Concrete Products, LLC, Utility Vault Co. or Cal Poly ITS Telecomm group approved equal.

2.06 PRECAST SIGNAL MANHOLE (SMH)

A. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.

B. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment.

1. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of vaults, but close enough to corners to facilitate racking of cables on walls.
2. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
3. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
4. Duct Entrances in Vault Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of vaults to facilitate racking of cable.
    c. All ducts entering vaults shall be grouted in place flush with the finished surface.

C. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.

D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

E. Approved Manufacturers: Christy Concrete Products, Oldcastle Precast Group, Utility Concrete Products, LLC, Utility Vault Co. or Cal Poly ITS Telecomm group approved equal.

2.07 UTILITY STRUCTURE ACCESSORIES

A. Approved Manufacturers: Bilco Company (The), Campbell Foundry Company, Christy Concrete Products, McKinley Iron Works, Inc., Oldcastle Precast Group, Utility Concrete Products, LLC, Utility Vault Co., or Cal Poly ITS Telecomm group approved equal.

B. Vault Frames, Covers, and Chimney Components: Comply with structural design loading specified for vault.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches.
    a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
    b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
2. Cover Legend: Cast in.
    a. Legend: “COMMUNICATIONS” (at minimum), for Telecommunications, data, and telephone duct systems. (See Fig. #156 & 157 in Appendix B)

C. Vault Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- diameter eye, and 1-by-4-inch bolt.

1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- diameter eye, rated 2500- lbf. minimum tension.

F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000-lbf minimums.

H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

I. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.

1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.

2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions. Provide two arms per stanchion section.

3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

J. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35° F. Capable of withstanding temperature of 300° F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals. (See Fig. #136 in Appendix B)

K. Fixed Vault Ladders: Arranged for attachment to wall of vault. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.

L. Cover Hooks: Heavy duty, designed for lifts 60 lbs. and greater. Two required.

2.08 UNDERGROUND ENCLOSURE APPLICATION

A. SPH & SPB:-

1. Units in Roadways and Other Deliberate Traffic Paths:

a. Precast concrete. AASHTO HB 17, H-10 structural load rating.

2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles:

a. Precast concrete, AASHTO HB 17, H-20 structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles:

a. Precast concrete, AASHTO HB 17, H-10 structural load rating.

B. Vaults: Precast or cast-in-place concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles:

a. AASHTO HB 17, H-20 structural load rating.

2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles:

a. AASHTO HB 17, H-10 structural load rating.

2.09 DUCT SEAL (POPULATED WITH CABLING)

A. To be used only in situations where a fire rated assembly is not required. B.Shall be Asbestos Free, easily formable clay.

B. Shall not dry hard but shall be re-enterable/reusable.

C. Shall be Resistant to water, alcohols, solvents & fuels

D. Shall be non-corrosive to metals or plastics and a non-irritant to skin.

E. Approved Manufacturer: Gardner Bender DS-130 or Cal Poly ITS Telecomm group approved equal.

2.10 DUCT SEAL (UNPOPULATED CONDUITS)

A. To be used only in situations where a fire rated assembly is not required.

B. Shall be removable and reusable compression type fittings. **(See Fig. #137 in Appendix B)**

C. Shall be corrosion proof, water-tight and gas-tight.

D. Shall be equipped with a rear side pull rope tiedown.

E. Approved Manufacturer: Cherne Industries, Inc. (Gripper) or Cal Poly ITS Telecomm group approved equal.

PART 3 – EXECUTION

3.01 GENERAL

A. Cut trenches neatly and uniformly, and slope uniformly away from underground structures and building entrances.

B. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Replace removed sod immediately after backfilling is completed.

3.02 QUANTITIES

A. Quantities of system elements shown on the drawings are illustrative only and shall be meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and all relevant codes.

3.03 INSTALLATION

A. Conduit and Duct Installation

1. Install nonmetallic conduit and duct as indicated according to manufacturer's written instructions.

2. Pitch ducts minimum of 4 inches per 100 feet (1:300) to drain away from building entrances.

3. Use manufactured long sweep bends with a minimum radius of 48” both horizontally and vertically at all locations.
4. Make joints in ducts and fittings watertight in accordance with manufacturer's instructions. Duct joint sealing should be avoided if ambient temperature is over 86° (F). Stagger couplings so those adjacent ducts do not lie in the same plane.
5. Space cast-in-place end bells approximately 8 inches on center in a pattern that best meets the requirements of the arrangement of the duct bank for 5-inch ducts and varied proportionately for other duct sizes. Change from regular spacing to end bell spacing, 10 ft. from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into vault walls from both sides to provide watertight entrances.
6. Support concrete encased nonmetallic ducts on plastic separators coordinated with duct size and required duct spacing, and install according to the following:
    a. Space separators 4-feet on centers to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting.
    b. Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between vaults or other terminations in one continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into the concrete on both sides of joint near the corners of the envelope.
    c. Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and concrete envelope can be poured without soil inclusions, otherwise use forms.
    d. Three inches minimum clearance between ducts and exterior envelope wall, 7.5 inches minimum clearance between ducts for like services and 12 inches minimum clearance between power and signal ducts.
    e. Except as otherwise indicated on the Civil drawings, install top of duct bank at least 36 inches below finished grade.
7. Use galvanized rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete pads, extend steel conduit a minimum of 5 feet from edge of pad. Install insulated grounding bushings on the terminations. Couple steel conduits to the ducts with adapters designed for the purpose and then encase coupling with 3 inches of concrete.
8. Provide temporary closure at terminations of ducts that are wired under this Project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi hydrostatic pressure.
9. Install 600-pound test nylon rope as a pull rope in ducts, including spares.

B. Duct Installation

1. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.
2. Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

3. At duct entrances to vaults, pull boxes and hand holes, use end bells, spaced approximately 10 inches on center for 5-inch ducts, and vary proportionately for other duct sizes.
    a. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
    b. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to vaults, pull boxes and hand holes.
    c. Grout end bells into structure walls from both sides to provide watertight entrances.
4. For building wall penetrations, make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition.
5. Provide temporary closure at terminations of ducts that are wired under this Project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi hydrostatic pressure.
6. Concrete-Encased Ducts: Support ducts on duct separators.
    a. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
    b. Pour each run of envelope between vaults or other terminations in one continuous operation. Unless otherwise specified, the term “concrete”, as it relates to the fill envelope encasing buried communications duct banks, shall mean a “2 bag” sand slurry mix.
        (1) Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion- contraction damage.
        (2) If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 36 inches into concrete on both sides of joint near corners of envelope.
    c. Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
    d. Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
    e. Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
    f. Provide 3 inches minimum space between ducts and exterior envelope wall, 2 inches minimum space between ducts for like services, and 4 inches minimum space between power and signal ducts.

g. Install top of duct bank at least 36 inches below finished grade in areas not subject to deliberate traffic, and also at least 36 inches below finished grade in deliberate traffic paths for vehicles, unless greater depth is otherwise indicated on approved drawings.

h. Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

(1) Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

(2) Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

i. Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

7. Direct-Buried Duct Banks:

a. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.

b. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.

c. Install ducts with a minimum of 3 inches between ducts for like services and 12 inches between power and signal ducts.

d. Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated on approved drawings.

e. Set elevation of bottom of duct bank below the frost line.

f. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

(1) Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

(2) For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

8. Duct Entrances to Buildings:

a. For entrances using steel or schedule 80 PVC conduit, transformations from underground duct to conduit shall be made 10 ft. minimum, outside the building wall and shall use fittings manufactured for the purpose. Install in accordance with the following:

b. For entrances using Concrete-Encased Ducts, install reinforcing in duct banks through disturbed earth near buildings and excavations and coordinate duct bank with structural design at wall so duct bank is supported at wall without reducing structural or watertight integrity.

c. For waterproof entrances: Where ducts enter buildings through a waterproofed floor or wall, a watertight entrance-sealing device shall be installed with the sealing gland assembly on the

inside. The device shall be securely anchored into the masonry construction with one or more integral flanges and the membrane waterproofing secured to the device in a permanently watertight manner.

C. Underground Utility Structure Installation

1. Install vaults with roof top 24 inches below finished grade, typical. Covers shall be adjusted to finish grade and carefully grouted in to provide adequate bearing for H-20 traffic loading.
2. Install removable hardware including cable stanchions, cable arms, and insulators as required for installation and support of cable and conductors. (See Fig. #165 in Appendix B)
3. Do not drill deeper than 3-7/8 inches for anchor bolts installed in the field.
4. Install precast concrete underground structures as indicated, according to manufacturer's written instructions and ASTM C 891.
    a. Install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.
    b. Support units on a 12-inch level bed of crushed stone or gravel, graded from the 1-inch sieve to the No. 4 sieve and compacted to same density as adjacent undisturbed earth.

D. Installation of Concrete Vaults, Pull Boxes, and Hand Holes

1. Precast Concrete Vault and Pull Box:
    a. Comply with ASTM C 891, unless otherwise indicated.
    b. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
    c. Unless otherwise indicated, support units shall be placed on a 12" deep level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
2. Elevations:
    a. Vault Roof: Install with rooftop at least 15 inches below finished grade.
    b. Vault Frame: In paved areas and traffic-ways, set frames flush with finished grade.
    c. Pull Box Covers: In paved areas and traffic-ways, set surface flush with finished grade.
    d. Where indicated, cast pull box cover frame integrally with pull box structure.
3. Install drains in bottom of vaults where indicated. Coordinate with drainage provisions indicated.
4. Circular opening in Vault roof; sized to match cover size.
    a. Vaults with Fixed Ladders: Offset access opening from vault centerlines to align with ladder.
    b. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with vault roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
    c. No more than a total of 24" of traffic rings are to be used.
5. Apply waterproofing to exterior surfaces of vaults and pull boxes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of vault chimneys after mortar has cured at least three days.

6. Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
7. Install fixed vault ladders to provide for safe entry with maximum clearance from cables and other items in vaults.

E. CLEANING

1. Pull brush through full length of ducts. Use round bristle brush with a diameter 1/2 inch greater than internal diameter of duct.
2. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
3. Clean internal surfaces of vaults, including sump. Remove foreign material.

3.04 GROUNDING & BONDING

A. Install ground rod through floor of each vault with top protruding 4 inches above floor. Ground rod shall be installed during placement of the vault, in a corner of the vault. Ground rod is not to be placed in the center of the vault.

B. Seal the floor opening against water penetration with waterproof non-shrink grout.

C. Ground all exposed metal components and hardware with #2 bare copper ground conductor. Train conductors neatly around corners. Install on walls and roof using cable clamps secured with expansion anchors.

D. A continuous #2 bare copper conductor shall extend with each conduit or duct bank entering and leaving the structure to the next underground structure or building. This conductor shall be bonded to the duct bank steel reinforcement bar (if used) every 20'.

E. All ground connections for underground structures shall be installed using exothermic welding. Refer to Section 27-05-26 for additional details.

3.05 TESTING

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000, ISO 10012 and traceable to NIST standards.

B. Testing: demonstrate capability and compliance with requirements upon completion of installation of underground duct and utility structures.

1. Test vault grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results. Use an instrument specifically designed for ground-resistance measurements.
2. Rod ducts with a mandrel 1/4 inch smaller in diameter than internal diameter of ducts. Where rodding indicates obstructions in ducts, remove the obstructions and retest.
3. Test for water leaks.

C. Correct installations where possible, and retest to demonstrate compliance. Otherwise, remove and replace defective products and retest.

D. All testing must be done in the presence of a Cal Poly ITS Telecomm group representative.

3.06 ACCEPTANCE

A. Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the ITS Telecomm group representative shall notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

A. The Project Record Drawings shall show the position and depth of all underground telecommunications vaults, pull boxes, hand holes, ducts, duct banks and conduits.

B. Drawings are also to indicate as-built fill percentages on all conduits within the project scope.

END OF SECTION

DOCUMENT VERSION CONTROL

REVISION	DATE	AUTHOR	REASON
1	02/20/2014	R. VOLK	INITIAL DOCUMENT DEVELOPMENT
	02/20/2014	DW&MH	PRIMARY REVIEW COMPLETE