



**Hawaiian
Electric**

The information found in this document are general guidelines that may be used to aid in the preparation of your service request proposal. Please be advised that depending on the specific needs and actual conditions of your project, Hawaiian Electric may require your design to comply with different specifications including specifications that include more stringent requirements than those included in these design specification guidelines. For further guidance and clarification on the actual specifications that will apply to your particular project, please refer to instructions issued by Hawaiian Electric's Planner or Engineer who is assigned to your particular (Project/Review Request/...). Additionally, please be advised that Hawaiian Electric reserves the right to require additional modifications to any approved design if it is determined during actual construction that additional modifications must be made to address certain field conditions that were not detected or Hawaiian Electric was unaware of during the design review process.



HAWAIIAN ELECTRIC CO., INC.

SPECIFICATION NO. CS7001-19

FOR

CONSTRUCTION OF UNDERGROUND FACILITIES

Prepared by **T&D Engineering** Department

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REFERENCED STANDARDS

HECO Drawing 30-1005, Conduit Application Guide,
UG Ducts & Structures, Sheets 1-16

HECO Drawing 30-1030, Plastic Ducts, Special Installation Details,
Underground Details, Sheets 1-5.

HECO Drawing 30-1035, Plastic Ducts, Installation Details,
Underground Structures, Sheets 1-9.

HECO SPECIFICATION NO. CS7001-19

CONSTRUCTION OF UNDERGROUND FACILITIES

PART 1 GENERAL

1.01 GENERAL SUMMARY

- A. The work covered under this specification includes all labor, materials, equipment and services necessary to complete the construction of underground facilities as shown on the drawings and herein specified and in accordance with the contract documents except for underground conduit and duct line construction using trenchless installation methods (i.e. directional drilling, pipe jacking, microtunneling, etc.).
- B. Related Specifications
 - 1. HECO Specification No. CS7003 Construction of Electrical Facilities (latest edition).
 - 2. HECO Specification No. CS9301 Cast-in-Place Concrete Work (latest edition).
 - 3. HECO Specification No. CS9401 Design and Construction of Precast Concrete Manholes, Handholes and Vaults (latest edition).
 - 4. HECO Specification No. M0302 Warning Tape for Underground Conduit Systems (latest edition).
 - 5. HECO Specification No. CS1601 Low Strength Fluidized Thermal Backfill (FTB) (latest edition)
 - 6. HECO Specification No. CS1602 3,000 PSI Thermal Concrete (latest edition).
- C. Where conflicts or inconsistencies between the project documents, HECO standard Specifications, or HECO company standard drawings exist, the more stringent requirements shall control.

1.02 TRENCH AND STRUCTURE EXCAVATION AND BACKFILL

- A. The Contractor shall excavate and backfill for duct line trenches, vaults, manholes, handholes, service boxes, foundations and equipment pads, and underground facilities to accurate alignment, grades and dimensions as shown on the drawings, as directed by the Engineer, and as specified herein. The work includes sheeting and bracing, dewatering, hauling, disposing of excavated materials, temporary trench patching and surface finishing and restoration work.

B. Regulations

1. All excavation work on City and County streets and highways shall comply with the Revised Ordinances of Honolulu 1990, as amended, and sections of Standard Specifications for Public Works Construction dated September 1986 relating to streets and sidewalks excavation; the special provisions; and with the requirements herein.
2. Work on Federal-Aid Highways and State Roads shall comply with the Revised Laws of Hawaii, with the Hawaii Standard Specifications for Road and Bridge Construction (2005) of the Department of Transportation, State of Hawaii, (HDOT Standard Specs) and all subsequent amendments thereto.
3. The Contractor shall obtain the necessary permits from the Department of Planning and Permitting and the Department of Transportation Services, City and County of Honolulu, before beginning work on City and County streets. Contractor shall obtain the necessary permits from the State Department of Transportation for work on State and Federal-Aid Highways and Roads.

C. Controlled Low Strength Materials (CLSM)

1. In lieu of conventional backfill material and methods, manhole, handhole, vault, and other underground facility excavations may be backfilled using a controlled low strength material (CLSM) mixture as the backfill material, if permitting agencies having jurisdiction (City, State, etc.) approve. The project general contractor shall have the responsibility for obtaining these approvals. CLSM shall not be used where Fluidized Thermal Backfill (FTB) is specified.

The Contractor shall obtain permission from the appropriate permitting agencies (City, State, etc.) to use the CLSM before backfilling. If such permission is not obtained in time to meet the project schedule, the contractor shall backfill with appropriate materials as called for on the permitting agency approved construction drawings or in their specifications. Exploring these alternatives, obtaining approval, and providing and installing CLSM shall be done at no cost to HECO.

2. CLSM shall be placed to fill the excavation as indicated on the plans or as directed by the Engineer.

1.03 CONDUITS

- A. The Contractor shall furnish and install all conduits, fittings (i.e., couplings, adapters, end bells, etc.), spacers, tie wire, reinforcing steel and plastic cement (if plastic conduit is used).

1.04 CONCRETE MANHOLES, HANDHOLES, VAULTS AND UNDERGROUND STRUCTURES

- A. Concrete manholes, handholes and vaults shall conform to standard (or project) drawings prepared by the Company or to Company-approved Contractor or manufacturer designs. Contractor or manufacturer designs of underground concrete products shall conform to the requirements and loadings described in this specification and shall be designed, stamped and signed by an engineer with a current structural engineer's license from the State of Hawaii prior to submission to the Company for review. Underground concrete products shall include all components and accessories required by the Company.

Precast concrete manholes, handholes, vaults and underground products shall conform to the latest edition of HECO Specification CS9401.

- B. Vaults shall be designed so that when the bottoms are set near level, the tops match the grade of the ground or sidewalk surfaces at each location. Design features or transitions shall be provided with the structure such that the tops match the finish grades. The details and use of these features and transitions shall be illustrated on the Contractor or manufacturer design drawings.
- C. Design Requirements. Design of concrete manholes, handholes and vaults shall conform to the latest edition of the following except as modified herein:
1. ACI 318 Building Code Requirements for Structural Concrete
 2. ASTM C 857 Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures; shall apply to manholes, handholes, and vaults not located within areas under the jurisdiction of the State of Hawaii DOT.
 3. National Electrical Safety Code (NESC), 2002 edition.
 4. State of Hawaii Public Utilities Commission General Order No. 10, Rules for Construction of Underground Electric and Communications Systems, Section 32 – Manholes and Handholes.
 5. Standard Specifications for Highway Bridges, 17th Edition, American Association of State Highway and Transportation Officials (AASHTO) shall apply to traffic manholes, handholes and vaults not located within areas under the jurisdiction of State of Hawaii Department of Transportation (DOT).
 6. AASHTO LRFD Bridge Design Specifications, **Latest** Edition, shall apply to all manholes, handholes and vaults located within areas under the jurisdiction of the State of Hawaii DOT unless alternate design requirements are approved by the State of Hawaii DOT.

Cross referenced standards and codes shall respond to the applicable code version noted above. Where no version is specified/applicable, the latest standard/code shall apply.

Underground concrete products shall be designed to sustain all expected loads that may be imposed upon the structure. In case of conflicts among design requirements, the more stringent requirements shall apply.

- D. Design loads shall consist of dead load, live load, impact loading, loads due to the ground water and lateral soil pressure, and any other loads which may be imposed upon the structure. The governing design loading shall be the combination of loads which produces the maximum shears and bending moments in the structure. However, products shall be designed to withstand any combination of loadings at all points.
1. Unless the established flood elevations at the project site or the project drawings call for a different amount, the design criteria for ground water table shall be assumed to be 3 feet below finish grade.
 2. HECO design vertical live loads for manholes, handholes, vaults and underground structures are summarized in Table 1. Traffic live loads shall be increased for impact.

TABLE 1 – Vehicle and Pedestrian Loads

Load Designations (a)(b):	Gross Vehicle Weight (GVW) in Pounds	Max. Wheel Loads in Pounds (0.4 of GVW on one rear wheel) or as noted	Uses / Locations
1. Areas not located within the jurisdiction of the State of Hawaii Department of Transportation:			
a. Traffic: ASTM A-16; AASHTO Standard Spec. HS20-44	40,000	16,000	traffic areas; design per AASHTO Standard Specifications for Highway Bridges.
b. Light Traffic: ASTM A-5 (HECO TR Loading)	12,500	5,000	very light traffic
c. Pedestrian Loading: A 0.3		300 pounds /sq. ft.	walkways, sidewalks
2. Areas located within the jurisdiction of the State of Hawaii Department of Transportation:			
a. Traffic and non-traffic: AASHTO HL-93	as allowed by State law	16,000	traffic areas, walkways, sidewalks, shoulders including entire State right of way; design per AASHTO LRFD Bridge Design Specification

- (a) In the ASTM C857 designation (A-) the number after A is the maximum wheel load in thousands of pounds. In the AASHTO designation the number after the HS is the total loaded vehicle (comparable to GVW) in tons. The H stands for highway, and the S stands for semi-trailer.
- (b) Design loads other than those listed may be specified.
- (c) Typical, unless an alternate loading is approved by the State of Hawaii DOT for areas where there is no way a vehicle can have access to or impart load on the manhole, handhole or vault. Uniform lane load (psf) shall not apply.

- 3. Except for handholes 3’x5’ and smaller, all pulling eyes or irons and the concrete wall and structure to which it is attached shall be capable of holding a service load of 10,000 pounds pure tension (with a factor of safety of 2.0 where ASD methodology is used or with a load factor of 1.6 if LRFD methodology is used). For 3’x5’ and smaller handholes the service load shall be 2,000 pounds pure

tension with the small factors of safety of load factor. This loading shall be in conjunction with other design loads.

The locations of pulling eyes shall be as specified by the appropriate drawing in HECO Specification CS9401, Appendix A and shall be shown on the design and shop drawings. Pulling eyes shall be aligned as close as possible to the duct banks they serve on the opposite walls. Each duct cluster shall have one pulling eye in line with the top of the cluster and another in line with the bottom of the cluster. Locations are subject to Company approval. Pulling eyes shall be located 12” from the floors and the ceilings and on the vertical centerlines of the duct banks, unless the proximity of the ducts to the ceilings and walls makes this location impractical. In this situation, the distance shall be made as close to 12” as possible.

4. The buoyancy effect of structures subjected to high or fluctuating water table shall be considered in the design of the structure. The factor of safety against buoyancy of the structure shall be at least 1.3. Appropriate design or installation recommendations shall be provided to counteract the effects of buoyancy.
5. The duct entrance locations and sizes (including corner entrance conditions where applicable) shall be considered and incorporated into the structural design calculations. The initial and future locations and sizes of ducts and pulling eyes will be shown for each project structure. The Company drawing(s) in HECO Specification CS9401, Appendix A show the typical duct entrance and pulling eye arrangements for projects not within a State right of way (ROW). Refer to other Company drawing(s) for work within Sate ROW.

E. Design Method.

1. Except for projects on State highways, roadways and right of ways, the structural design method used for the concrete structures shall be either the “elastic” method (Allowable Stress Design) or the “ultimate strength” method of reinforced concrete design as outlined in ACI 318.

Minimum concrete cover:

- a. Typical minimum reinforcing concrete cover (except concrete handhole covers): 1 1/2 inch for the exterior and 3/4 inch for the interior of the structure. For waterproofing requirements, Section 3.07F.1 shall apply. The 3/4” cover for the interior bars is based on appropriate waterproofing.
 - b. Minimum reinforcing concrete cover for concrete handhole covers: 1 inch for the top of the cover and 3/4 inch for the interior and sides of the cover.
2. For projects in State highways, roadways and right of ways, the “LRFD” design method per AASHTO LRFD Bridge Specifications shall be followed. Design and construction details shall conform to the AASHTO LRFD Bridge Design

Specifications, unless alternate requirements are approved by the State of Hawaii DOT. Minimum concrete cover shall be as shown in the Company drawings.

1.05 REQUIREMENT FOR AREAS WITH CONTAMINATED SOILS

- A. The HECO underground infrastructure in contaminated areas shall be sealed to prevent seepage of groundwater or migration of chemical vapors with approved waterproofing and chemical resistant products.**
- B. HECO manholes, handholes and vaults shall be waterproofed using admixtures added at the precast manufacturer's plant or field application of waterproofed coating for cast-in-place boxes.**
- C. HECO manholes, handholes and vaults shall also be epoxy coated, including manhole collars and conduit penetrations. Coating shall be applied on the interior and exterior for precast boxes and on the interior only for cast-in-place boxes. For conduit penetrations, epoxy coating shall be applied prior to the concrete encasement and shall extend 12" beyond penetrations.**
- D. Epoxy coating shall consist of a primer and topcoat. Sherwin Williams TRM 37 Nova-Plate UHS primer and Sherwin Williams TRM 38 Nova-Plate UHS topcoat or approved equal shall be used. Epoxy coating shall be applied per the manufacturer's recommendation.**
- E. Conduit stub-outs shall be covered with plastic end caps and both the conduits joints and stub-out caps shall also be sealed with waterproof tape and approved epoxy coating.**
- F. Ground rod penetrations into the bottom of manholes, handholes, and vaults shall be sealed after the ground rod is installed using PCI Promatec SF-60 sealant or approved equivalent to provide watertight seal. Sealant shall be applied per the manufacturer's recommendation. If a watertight seal cannot be established, the Contractor shall coordinate with HECO to provide an alternate grounding method.**

1.06 SUBMITTALS

- A. General Requirements:** Before commencing the work, the Contractor shall submit three (3) sets of product data, shop drawings, and mix design as described below. After review by the Engineer one set will be returned, marked accepted or with notations requiring revisions. If corrections are required, the Contractor shall make and clearly mark such corrections and resubmit for final review.
 - 1. Product Data** shall include manufacturer's specifications, technical data, certificates of conformance and product descriptions for proprietary materials and items, including duct materials and fittings, reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing

compounds, **epoxy coatings**, and other products or items as requested by the Engineer.

2. Steel Reinforcement Shop Drawings for fabrication, bending, and placement of concrete reinforcement shall comply with ACI 315 "Details and Detailing of Concrete Reinforcement" and shall show bar schedules, stirrup spacing, diagrams of bent bars, arrangement of concrete reinforcement, and any special reinforcement required for openings through concrete structures. Drawings which bear the final review by the Engineer shall not relieve the Contractor of responsibility for completeness and accuracy of all dimensions and details.
3. Mix Designs and Test Reports for Concrete and CLSM: Include a tabulation of the proposed materials, aggregates, source location of aggregates, additives, water-cement ratio, 28-day compressive strength, and applicable reference specifications for each product. Include verification test results and reports for each product showing that the mix design has been tested to produce the properties specified and will be appropriate for the job conditions. If allowed by the mix design, indicate the amount of water and conditions whereby water may be added to ready-mix concrete at the project site.
4. Mix Designs and Test Reports for FTB and 3,000 PSI Thermal Concrete shall conform to HECO Specification CS1601, latest edition and HECO Specification CS1602, latest edition, respectively.

B. Design Drawings and Calculations for Contractor or Manufacturer Designs of Underground Structures or Products. Contractor or manufacturer designs of underground concrete products shall be submitted for HECO approval prior to commencement of work.

1. The design drawings shall have all the information necessary to conduct a complete structural analysis of the product and accessories.
2. Design drawings shall include details and location of structural and incidental features as specified herein:
 - a. Reinforcement size, configuration, location and placement details.
 - b. Dimensional details of the pulling iron, so the Company can verify that its cable pulling equipment will fit. Show locations and design capacities of pulling irons.
 - c. Details and dimensions of covers and frames. Where applicable, reference HECO drawing numbers for standard frames and covers.
 - d. Details, locations and design capacities of structure lifting devices.
 - e. Details and locations of sumps, water sealing gaskets and waterstops. Submit product data for water sealing gaskets and waterstops.

- f. Joint details, joint sealing material and method of application.
 - g. Weight of each precast concrete sections and covers, if used.
 - h. Design criteria and loadings for underground concrete product.
3. For alternate designs, the manufacturer may be asked to furnish, at no cost to the Company, certified evidence of physical proof tests which verify that specific components, such as the pulling irons, meet the specified design loads with the required factors of safety. The proof test shall be representative, in the opinion of HECO, of the proposed design. For pulling irons, the minimum proof load (load at failure) shall be 3 times the design working load. The test shall note the load at which initial concrete cracking occurs. Crack initiation shall not occur at less than 1.5 times the design service load.
 4. Product design drawings and calculations shall be stamped and signed by an engineer with a current structural engineer's license from the State of Hawaii.
 5. The Contractor shall submit three (3) sets of detailed design drawings and calculations to the Contractor for approval by the Company prior to submission of shop drawings.
- C. Project Shop Drawings for Underground Structures and Products.
1. In addition to the product design drawings mentioned above, the Contractor shall submit three (3) sets of Project Shop Drawings to HECO for review. These drawings shall show the location of the pulling eyes, duct entrances, sumps, and shall show other pertinent information, such as the dimensional layouts and reinforcing plans for the duct entrance sleeve clusters. The Company will return two (2) sets marked appropriately to the Contractor.
 2. Project Shop Drawings shall include the project, location and shall reference the Contractor's model number and design drawing on which it is based.
 3. Acceptance of this review of project shop drawings shall allow the contractor to proceed with construction of underground structures, manholes, handholes and covers.
 4. The review of the shop drawings by the Company is for general intent only and the Contractor is still responsible for the correctness of the product.
- D. Field Testing Reports for earthwork, concrete, CLSM, FTB and other specified conditions.

1.07 QUALITY ASSURANCE

- A. Special Inspections required by the Building Code are described in the SPECIAL INSPECTION paragraph 3.08H.

1.08 DELIVERY, STORAGE AND HANDLING

A. Plastic Conduit Storage and Transportation

1. Cover conduit that is to be stored for more than 2 weeks.
2. Provide support for the full length of the conduit when transporting or storing long lengths. Do not permit unsupported overhang.

PART 2 PRODUCTS

2.01 BEDDING FOR UNDERGROUND STRUCTURES

- A. Service boxes and structures without bottom slabs (open base): 4” minimum thickness of No. 3 fine gravel; ASTM C-33, #67.
- B. Underground structures with bottom slabs (closed base) not within the State ROW: 4” minimum thickness of clean, well-graded granular material with a maximum particle size of three (3) inches, and less than three (3) percent passing the No. 200 sieve or select borrow.
- C. Underground structures within the State ROW: Provide a soil stabilization layer consisting of 12” minimum thickness of select granular material (No. 3B Fine) wrapped in non-woven filter fabric (Mirafi 180N or approved equal).

2.02 CONVENTIONAL BACKFILL

- A. Trench material for direct buried ducts and conduits.
 1. Type B Material: For the first lift from the bottom of the duct or conduit to 8 inches above the duct or conduit barrel, or for the cushion under the duct or conduit, select granular material passing a one (1) inch sieve such as three-quarter (3/4) inch aggregate base course gravel, S4C or material that is free of organics, debris, or highly-plastic clay and meets the following gradation:

Sieve Size	Percent Passing by Weight
1”	100
3/4”	90 - 100
No. 4	35 - 100
No. 40	10 - 30
No. 200	3 - 15

2. Type A Material: For the intermediate lift from 8 inches above the duct or conduit barrel to 2 feet below the existing or proposed finished grade, material conforming to the requirements of the City and County of Honolulu Standard

Specification for Public Works Construction, dated September 1986, Section 16 – “Borrow”, or native soil material which does not contain more than 50% gravel, and also, does not contain hard lumps of earth 3-inches in greatest dimension, rocks larger than 3-inches in largest dimension, highly-plastic clay, poorly-graded sand and gravel (classified as SP and GP using the Unified Soil Classification System), organics, debris, or other unsuitable or deleterious materials.

3. For the surface or top 2-foot lift, see Section 2.02C below for material requirements.
- B. Trench for encased buried ducts and conduits and excavation for underground structures, foundations and pads.
1. Imported or native soil that is free of organics, debris and other deleterious material may be used in backfilling. The material shall meet Type A Material requirements as specified under Section 2.02A.2 above.
- C. For the surface or top 2-foot lift of all trenches and excavation for underground structures and foundations in streets and highways.
1. Select material conforming to City and County or State of Hawaii requirements for Subbase Course.
 2. Aggregate material conforming to City and County or State of Hawaii requirements for "Aggregate Base Course", for the base course layer.
 3. Top soil for the top 6-inch layer in trenches across lawn or planting area.
 4. The finished surface shall match the original ground surface or existing improvement prior to trenching in material composition and in thickness. The finished product shall be equal to or better than the original.
- D. Cold-mix asphalt concrete. Cold-mix asphalt concrete for temporary trench and underground structure excavation patches shall conform with the resurfacing mix requirements of the City and County or the State of Hawaii as applicable.

2.03 CONTROLLED LOW STRENGTH MATERIALS (CLSM)

- A. Controlled Low Strength Materials (CLSM) shall be self-compacting, cementitious backfill materials which when hardened can be readily excavated by conventional mechanical equipment to access underground facilities. CLSM shall conform to Section 314 of the HDOT Standard Specs.

2.04 FLUIDIZED THERMAL BACKFILL (FTB) AND 3,000 PSI THERMAL CONCRETE

- A. FTB and 3,000 PSI Thermal Concrete shall conform to HECO Specification CS1601, latest edition and HECO Specification CS1602, latest edition, respectively.

2.05 DUCTS AND CONDUITS

A. Plastic Conduits (PVC):

1. Plastic conduits shall be Schedule 40 or Schedule 80 conforming to the requirements of HECO Purchase Specification M7001 and HECO Engineering Standard 30-1035.
2. Accessories and fitting shall be of the same type and material as the conduit selected.
3. A twenty (20) foot length of conduit, with coupling attached on one end is recommended.

B. Steel Conduits: Rigid steel conduit, hot dipped galvanized inside and outside, conforming to Federal Specification WW-C-581E, Underwriters Laboratory Standard for Electrical Rigid Metal Conduit – Steel, UL 6, and ANSI C80.1.

2.06 CONCRETE

A. Concrete Materials, forms, reinforcing steel and related materials shall conform to HECO Specification CS9301, latest edition.

B. Concrete Strength Requirements, Proportioning and Design of Concrete Mixes and Concrete Mixing shall conform to HECO Specification CS9301, latest edition.

C. Non-Shrink Grout: Conform to CRD-C 621, non-metallic, factory pre-mixed grout.

2.07 METALS

A. Steel plates, bars, angles, anchor rods: Conform to ASTM A 36, hot dipped galvanized.

B. Steel shapes and channels: Conform to ASTM A 992, Grade 50 or ASTM A 36, hot dipped galvanized.

C. Stainless steel: Conform to ASTM A 276, Type 316.

2.08 COVERS FOR MANHOLES, HANDHOLES AND VAULTS

Frames and covers for manholes, handholes and vaults shall conform to the requirements specified in PART 2 of HECO Specification CS9401, latest edition.

2.09 ACCESSORIES

A. Pulling irons: Pulling irons and components, including the internal and external nuts, the u-bolts and plates of the u-bolt type of pulling eyes, shall be made of non-magnetic Type 316 stainless steel or of other non-corrosive material approved by HECO. Welding of stainless steel items shall be performed per American Welding Society

standards using an E316 electrode. When installed the u-bolt assemblies shall be water tight.

- B. Sumps shall be centrally located under the manhole openings. Sumps shall be provided with removable, non-slip, non-corroding covers that will safely cover the sump (3/8 inch thick pultruded vinyl ester floor plate with 2 each 1/2 inch diameter holes, gray, fire-retardant, self extinguishing, McNichols or approved by HECO). Provide a tether for the sump cover to the sump to prevent the cover from accidental displacement.
- C. Water sealing gaskets shall be adequate to withstand environmental conditions (i.e., saltwater, petroleum, acidic and alkaline liquids, etc.).
- D. Threaded concrete anchors 1/2" diameter x 3-3/4" length shall be provided at a maximum of 24" center to center horizontal and vertical spacing on each wall of the manhole, handhole, or vault, for cable racking purposes. Ultimate shear capacity = 4000 pounds and ultimate tensile capacity = 4000 pounds with 2.25 inch embedment. The project designer shall specify in advance whether these inserts shall be made of plastic, galvanized steel or stainless steel.
- E. Ground Rods: Two opposite corners of the manhole, handhole or vault floor shall be provided with sealed holes (for precast items) through which 5/8" diameter ground rods can be driven as needed and made water tight after the driving is completed. For cast in place concrete, ground rods shall be installed prior to the concrete pour.
- F. Duct Connectors: Preformed plastic adapters which will be cast in the concrete walls and will provide a smooth tight connection with the incoming ducts (Bowco Industries Duct Terminators or approved by HECO).
- G. Joint Sealant: Preformed flexible plastic gasket, conforming to Federal Specification SS-201A, Type 1, rope form, Ram-Nek or approved by HECO.
- H. Identification imprint: The manhole covers, the tops of visible end walls of handholes, or the handhole covers, if the end walls are too narrow or are not visible, shall be imprinted with the letters below to identify the ownership of the structures:

Owning Company	Identifying Letters
Hawaiian Electric Co., Inc.	HECO
Hawaii Electric Light Co., Ltd.	HELCO
Maui Electric Co., Ltd.	MECO

When required, imprint the load rating of the cover as shown in the Company drawings.

2.10 MISCELLANEOUS MATERIALS

- A. Electrical Warning Tape: 6 inch wide x 0.005 inch thick detectable warning tape conforming with HECO Specification No. M0302 (latest edition), "Warning Tape for Underground Conduit Systems."
- B. **For contaminated impacted areas:**
 - 1. **Epoxy Coating: Epoxy coating shall consist of a primer and topcoat. Sherwin Williams TRM 37 Nova-Plate UHS primer and Sherwin Williams TRM 38 Nova-Plate UHS topcoat or approved equal shall be used. Epoxy coating shall be applied per the manufacturer's recommendation.**
 - 2. **Ground Rod Sealant: Ground rods shall be sealed using PCI Promatec SF-60 or approval equal.**

PART 3 EXECUTION

3.01 EARTHWORK

A. Field Preparation

Contractor shall comply with provisions in the latest edition of HECO Specification CS7003, "Construction of Electrical Facilities."

B. Excavation

- 1. Trenches in existing improved streets, sidewalks, driveways and paved areas shall not be opened for more than 150 feet in advance of the duct or conduit laying unless specifically authorized by the Engineer. In other areas, the trenches shall not be opened for more than 200 feet. No jumping of excavation will be permitted.
- 2. Trenches shall be excavated for a minimum distance of 30 feet ahead of duct concreting operations except at duct line terminations.
- 3. Excavation for each manhole, vault, handhole or service box plus 30 feet of trenching for all ducts connected to these structures shall be completed before construction is started on these structures.
- 4. All excavation shall be approved by the Engineer before any ducts or conduits are placed or any structures and foundations are constructed.
- 5. Access to existing driveways, fire hydrants and meters shall be provided at all times.

6. When unsuitable material is encountered at the excavation, the Contractor shall be responsible for hauling and properly disposing of the material. The hauling shall be considered as incidental to the excavation work and no direct payment will be made. The Engineer shall determine if the excavated material is unsuitable.

C. Additional Excavation

1. When the subgrade material below the established trench structure or foundation grade is unsuitable; such as muck, buried debris, or adobe, the Contractor shall excavate below grade to such depth and width as directed. The excavated area below grade shall be filled with approved aggregate in 6-inch compacted layers and brought up to within 3 inches of the grade of the bottom of direct buried ducts or conduits or up to the grade of the bottom of concrete encased ducts or conduits, structures or foundations.
2. When water is encountered at the established grade for excavation for trenches or structures, the Contractor shall excavate to a depth 6 inches below required grade. This excavated area shall be filled with drainage fill consisting of a 4-inch bottom layer of No. 2B coarse rock (2-1/2" - 1-1/2") and a 2-inch top layer of No. 3B fine rock (3/4" - 3/8"). A drain pipe of 3-inch duct shall be installed in the bottom layer if directed by the Engineer.
3. Where a soil stabilization layer is required, excavate to the limits shown in the Company drawings or lower.

D. Overexcavation:

Any part of the trench of excavation for structures or foundations excavated below the established grade or beyond the maximum permitted width, other than work under "Additional Excavation," shall be refilled and compacted with select material by the Contractor at his own expense.

E. Sheet piling and Shoring

Wherever necessary, the Contractor shall properly sheet and brace the open trench or structure excavation to render it safe and secure from possible slides, to protect personnel, existing improvements and properties, and shall remove same before completing the backfill. Sheet piling and shoring of the trench shall be considered incidental to the construction and all costs thereof shall be included in the unit contract prices for the various bid items.

F. Dewatering

Trenches shall be kept free from water during the installation and backfilling of all ducts, conduits and structures. The Contractor shall determine the method in dewatering the trench and shall be responsible for any damages to adjacent and surrounding properties resulting from his dewatering operation. He shall be responsible to make his own arrangement for disposing of the water on or across

public or private property. Dewatering procedures shall comply with all applicable Federal, State, and City and County ordinances and regulations concerning water pollution prior to its release into waterways or drainage systems.

G. Placing Bedding Beneath Underground Structures

1. Bedding beneath manholes, handholes and vaults shall be placed in relatively uniform lifts no greater than six (6) inches in loose thickness, moisture conditioned to within three (3) percent of their optimum moisture content, and uniformly compacted to at least ninety (90) percent of the maximum dry density (ASTM D1557), unless noted otherwise in project geotechnical report.

H. Placing and Compacting Backfill

1. For direct buried ducts and conduits the first lift shall be backfilled by hand shoveling and tamping so that the backfill material is in contact with the entire periphery of the duct or conduit. Water saturation is not permitted.
2. For the intermediate lift, the backfill material shall be placed in horizontal uniform layers and thoroughly compacted by mechanical tamping in conformance with requirements of the City and County or the State of Hawaii.
3. At direct buried conduits a detectable warning tape per HECO Specification M0302 shall be placed in the backfill material one foot above the top of the conduit.
4. The backfill material around manholes and other structures or foundations shall be placed in horizontal layers not more than 6 inches in compacted thickness. Each layer shall be compacted to at least 95% of the maximum dry density (ASTM D1557), unless noted otherwise in project geotechnical report.
5. The surface 2-foot lift shall be placed and compacted in accordance with "Subbase Course," and "Aggregate Base Course" requirements of the City and County or the State of Hawaii.
6. All compaction tests required by the Federal, State of Hawaii and City and County shall be arranged and paid for by the Contractor.

I. Temporary Trench Patching

1. To accommodate traffic immediately after backfilling the trench and prior to constructing the permanent restoration, a temporary patch of cold-mix asphalt concrete shall be constructed over the compacted backfill. The cold-mix asphalt shall be compacted to a minimum thickness of 1-1/2 inches and shall be slightly humped not to exceed 3/8 inch for trench width less than 2 feet, and 3/4 inch for trench width greater than 2 feet.

2. The Contractor shall maintain the temporary trench patches in good condition at all times until the permanent restoration is completed. Check holes and any depression greater than 1/2 inch shall be repaired immediately.

J. Permanent Restoration

1. Permanent restoration work shall be done in conformance with requirements of the City and County or the State of Hawaii as applicable.

3.02 CONDUIT INSTALLATION

- A. Conduit installation shall commence only after trench is inspected and approved by the HECO Inspector. Notify HECO Inspector 3 working days prior to conduit installation to arrange for inspection.

B. Conduit Drainage

1. Whenever possible all conduits shall be installed with no "pockets" in the conduit run by maintaining a uniform grade of at least 0.25% for drainage towards manhole, vault, handhole, or service box.
2. All work must be done in the dry. If water is encountered during construction, provide appropriate drainage.

3.03 PLASTIC CONDUIT INSTALLTION

- A. Conduit installation shall conform to HECO Engineering Standard Drawings 30-1005, 30-1030 and 30-1035.

1. A fine tooth wood saw may be used to cut the conduit. Make a square cut and remove all burrs.
2. Wipe all foreign matter off the sockets of the fittings and the edges of the conduit with a clean cloth.

B. Plastic Conduit Solvent-Cemented Joints

1. The PVC cement should be obtained from the conduit manufacturer. A clean paper paint pot is convenient for containing the cement during use. Thinners are not recommended.
2. Apply a liberal and uniform coat of cement to the conduit for a length equal to the depth of the socket. Also apply sufficient cement to wet the socket of the fitting. Avoid excess cement on the fitting as it is wiped into the joint and tends to weaken the pipe. Do not use plastic bristle brushes. The brush size should be about equal to joint depth, for example, a 2-inch brush for a 4-inch conduit.

3. Slip conduit into the socket of the fitting with a slight twist until it bottoms. Hold the joint for 15 seconds so the conduit does not push out of the fitting. Do not twist or drive the pipe after the insertion is complete.
4. Cure the joined members for at least 5 minutes before disturbing or applying stress to the joint. After this initial cure, care must be exercised in handling to prevent twisting or pulling the joint. In damp weather, increase this interval to allow for slower evaporation of the solvent. Where possible, assemble all conduit above ground and allow it to lay undisturbed while curing before lowering it into the ditch.
5. Wipe off the excess cement left on the outer shoulder of the fitting.
6. Another fitting or section of conduit may be added to the opposite end within 2 or 3 minutes if care is exercised in handling so that strain is not placed on the previous assembly.
7. After covering the joint surfaces, return the brush to the cement pot. When stopping work, place the brush in a solvent; pour unused cement back in the can and cover tightly. When reusing the brush, shake the excess solvent out before dipping it into the cement. The cement brush can be cleaned with a wire brush.
8. Assemble above ground any joint included in a section of conduit to be bent in the ditch, and allow it to lay undisturbed for at least 2 hours before installation. In cases where a plastic connection is made with the union under stress, due to misalignment or other factors, stake it out to relieve stress on the joint until the conduit is backfilled or encased.
9. Do not expose the conduit in an open trench longer than is absolutely necessary to minimize accidental mechanical damage.
10. **Conduit system shall be sealed and made watertight so as not to allow migration of groundwater.**

C. Plastic Conduit Temperature

1. Expose all plastic conduit and fittings to the same temperature conditions for a reasonable length of time before assembly.
2. Precautions - Due to expansion and contraction of the plastic conduit of 1-1/2 inches per 100 feet for every 20°F change in the temperature, allow extra conduit footage at each tie-in for contraction when the conduit temperature is higher than that of the earth; or extra room for expansion if the converse condition exists.

D. Plastic Conduit Spacers

1. Spacers used for plastic conduit shall have the dimension shown on Company Drawing No. 30-1035, or be an equivalent approved by the Engineer.

2. Spacers for plastic conduit shall be placed along the length of the conduit as follows:

<u>Conduit Size</u>	<u>Maximum Spacing</u>
Up to 3 inches	8 feet
4 inches and greater	6 feet

3. Spacers must be 15 inches or more away from any coupling or joint. When conduit is assembled above the ground, the spacer may be supported in a vertical position by use of a #4 rebar and smooth black steel wire No. 14 gauge.
4. Spacers should not be located at the centers of a long radius bend: (1) On prefabricated bends, locate the spacer in the tangent, free of the coupling, (2) On trench formed bend, locate the spacer midway between the tangent and center of the bend.

E. Plastic Conduit Termination

1. Use ANSI/ASTM F512 as the specification for the terminations below. End bells or duct connectors shall be used to terminate all conduits ending in an underground structure (i.e., manhole, vault, handhole, or service box).
2. The ends of the conduit shall be sealed with a plastic cap, plug, or approved substitute at the end of each day's work, when work on duct installation has to be interrupted, where ducts may be submerged in water, and in stub outs.

3.04 STEEL CONDUIT INSTALLATION

- A. Place concrete envelope around all conduit runs and riser bends.

3.05 DUCT LINE INSPECTION

- A. All duct line installation work shall be inspected by the field representative of HECO. Contractor shall arrange for inspections and provide 3 working days advance notice to field representative of duct line installation work.
- B. **Contractor shall ensure that conduit system including manholes, handholes, and vaults installed in areas of high groundwater table shall be made watertight prior to calling for final inspection.**
- C. The completed duct lines shall be cleaned and field tested and pulling lines and plugs installed before final acceptance. The Contractor shall notify the Company Supervising Contract Engineer of the Inspection Division, Distribution Department a minimum of 72 hours before starting this work. An inspector of the Company shall be present at all times until the cleaning, and testing are completed and pulling lines and plugs are installed to his satisfaction.
- D. The Contractor shall use a rodding machine consisting of a compressor or vacuum unit with a parachute or ball 1/2" less in size than the inside diameter of the duct and

attached to a pulling line. The parachute or ball is then forced through the duct with air. By use of the pulling line a heavier cord then will be pulled through the duct to be used for cleaning and testing. Instead of using the rodding machine, fishing wire may be fed through the duct.

- E. The wire brush for cleaning the duct shall be a standard duct wire brush and the diameter shall be the same as the inside diameter of ducts to be cleaned.
- F. The Contractor shall pass a bullet-shaped wooden test mandrel through the entire length of each duct run of the duct line to test for freedom of burrs and obstructions. (Drawing 30-1030 Sheet 4 of 5)

The test mandrel shall be made of hardwood, 14 inches long with a diameter 1/2 inch less than the inside diameter of the duct.

- G. The wire brush and wooden mandrel may be used together to clean and test the duct lines. A backup cord attached to the wooden mandrel shall be used for withdrawal in case it cannot pass through the duct line.
- H. Scarring found on mandrel deeper than 1/32 inch, other than that caused by normal abrasion between the duct line and bottom of the mandrel shall be taken to indicate that burrs and/or obstructions are present in the duct run. The Contractor shall remove such burrs and/or obstructions after which the test mandrel is passed through again. The process will be repeated until a satisfactory result is obtained.
- I. After completion of cleaning and testing of the duct line, the Contractor shall install in each duct run "mule" tape rated at #1800 tensile strength with 1 foot interval markings (LH Dottie DWP 3001) or equal and plug both ends of each duct with plastic plugs.

3.06 CLSM INSTALLATION

- A. The trench shall be free of all debris and free of standing water before CLSM is placed.
- B. The Engineer or Inspector shall be notified 3 working days before placing any CLSM. CLSM shall be placed only in the presence of the Engineer or Inspector.
- C. The CLSM shall be placed to the designated fill line without vibration or other means of compaction. Placing CLSM shall be by chute, pumping, or other approved methods. During placement operations around manholes, handholes, vaults, or underground structures, care shall be used to avoid dislocating any part of the structure, conduit, or adjacent utilities due to fluid pressure from the CLSM.
- D. All structures or pipes within the backfill area shall be secured to avoid the buoyant effect of CLSM if necessary. Care shall be taken to assure tight seals to avoid infiltration into pipelines, structures, and other areas not intended to receive flowable fill.

- E. All CLSM fill areas subjected to traffic loads shall have durable riding surfaces before pavement is placed. No curing protection is required.
- F. Where CLSM is used for direct buried conduit applications, place an electrical warning tape 1 foot above the top of direct buried conduits.
- G. Field Testing: Conduct testing and submit reports for the following. Cost of all testing shall be borne by the Contractor.
 - 1. Consistency test: shall conform to ASTM D6103; one test for each day's pour.
 - 2. Strength tests: shall conform to ASTM D 4832; one set of 3 cylinders for each 100 cubic yards or fraction thereof placed in any one day.

3.07 FLUIDIZED THERMAL BACKFILL (FTB) AND PSI THERMAL CONCRETE INSTALLATION

- A. FTB and 3,000 PSI Thermal Concrete installation shall conform to HECO Specification CS1601, latest edition and HECO Specification CS 1602, latest edition, respectively. And as specified herein.
- B. Install FTB where shown on the drawings to encase pipes and ducts, and at other locations.
- C. The Engineer or Inspector shall be notified 3 working days before placing FTB. FTB shall be placed only in the presence of the Engineer or Inspector.
- D. The trench shall be free of all debris and free of standing water before FTB is poured.
- E. If trenches are shored or bulkheads are used on sloping ground, the shoring shall be lifted no later than one hour after the FTB is poured while the FTB is still in a semi-fluid state. The FTB should not be allowed to develop cracks. If cracks or voids are found to exist, they shall be filled by pouring additional FTB.
- F. Bleed water: In poorly draining native soils, provisions shall be made to allow excess bleed water to drain away or be pumped away.
- G. Where FTB is used for direct buried conduit applications, place an electrical warning tape 1 foot above the top of the direct buried conduits.

3.08 CONCRETE WORK

- A. Concrete work shall conform to HECO Specification CS9301 and as specified herein.
- B. The Contractor shall notify the Engineer and Special Inspector 3 working days before commencing any work requiring Special Inspection per paragraph 3.08H. Concrete shall be placed only in the presence of the Engineer or Inspector.

C. Duct Connectors in Manholes, Handholes and Vaults:

1. The manufacturer shall cast into the manhole, handhole and vault strong, plastic adapters that will provide for a smooth, tight connection with the incoming ducts. If the duct connections are to be made at some future time, these plastic adapters shall **be made watertight to** prevent any moisture or dirt from entering the manhole, handhole or vault. The external portion of the adapters shall be covered with a removable cover that will keep the dirt out of the adapter until the connections are made in the future. These sleeves shall snugly fit over and connect to Schedule 40 PVC ducts. The concrete around these sleeves shall be reinforced.
2. The number, size, and location of these sleeves and sleeve-banks shall be shown on the shop drawings submitted for final approval prior to fabrication. The sleeve configuration shall conform to the maximum size and number shown on the previously approved design drawing.

D. Duct Encasement:

1. Unless otherwise authorized, all duct line concrete shall be compacted by use of hand spades. The spade shall be inserted into the fresh concrete to the level of the bottom ducts, on both sides of each row of ducts and at intervals not greater than 9 inches along the ducts.
2. Unless otherwise authorized, concrete for encased duct lines shall be cured for 72 hours before motor traffic is allowed to pass over it.

E. Surface Finishes: All concrete surfaces shall be smooth and free from defects. Metal ties, where used, shall be removed and the resulting holes filled with mortar. Surface finish requirements shall be as follows:

1. Tops of encased duct lines and manholes and handholes over which backfill is to be placed - wood floated.
2. Tops of vaults, manholes and handholes at sidewalk grade - edged and finished to match sidewalk.
3. Tops of foundations and equipment pads - edged and steel troweled.
4. Floors of vaults, manholes and handholes - steel troweled.
5. Interior wall surfaces and ceilings of vaults, manholes and handholes - cement washed.

F. Curing and finishing shall comply with HECO Specification CS9301 and as specified herein.

1. Manholes, handholes and vaults. Interior walls and ceilings shall be smooth and free of irregularities and all surfaces shall be sound. Sections having cracks and other defects that may impair structural strength or that may allow water migration are not acceptable. At HECO's option, interior walls shall be coated with a white cement based, heavy duty, waterproof coating, unless noted otherwise in the project documents. Also, at the option of HECO the exterior surfaces subject to ground water exposure shall be treated with a cement based heavy duty waterproof coating so as to form a liquid tight seal, unless noted otherwise in the project documents.

G. Quality Control Concrete Testing During Construction:

1. The Contractor will employ a testing laboratory to perform concrete tests and to submit test reports three (3) each. Costs of all testing shall be borne by the contractor.
2. Field sampling, testing and reporting shall be in accordance with HECO Specification CS9301 and shall include slump test, air content, temperature and compression strength tests.

H. Special Inspections

1. Special inspections per Building Code requirements are required for the following types of concrete work:
 - a. Reinforcing steel and prestressing steel tendons.
 - b. Bolts installed in concrete.
 - c. Concrete placement and testing.
 - d. Other designated concrete related work requiring special inspections as indicated on the drawings.
2. Special Inspector shall be provided by HECO. Contractor shall arrange for special inspections and shall notify Engineer and Special Inspector at least 3 working days prior to performing work requiring special inspections.
3. Special Inspector shall observe the construction work and notify HECO and the Contractor of discrepancies in the work. Contractor shall correct deficiencies in a timely manner.
4. Special Inspector shall submit inspection reports to HECO and the engineer or architect of record. A final report per Building Code requirements shall also be submitted to HECO and the building official.

3.09 MISCELLANEOUS METALS

- A. Miscellaneous metal construction work shall comply with the American Institute of Steel Construction 360-05 “Specification for Structural Steel for Buildings”.
- B. Unless otherwise shown, all miscellaneous metal work shall be galvanized after fabrication. Galvanizing shall conform to ASTM A 123 and A 153.

3.10 RESTORING CURBS, GUTTERS, SIDEWALKS, DRIVEWAYS AND PAVEMENT

Restoration work shall comply with City and State Ordinances, Standard Specifications and Standard Drawings unless otherwise shown on the Construction Drawings.

3.11 CLEAN-UP

- A. The Contractor shall at all times keep the jobsite and work areas in a neat, clean and safe condition.
- B. Upon completion of the work the Contractor shall remove all waste and unused materials, debris, and equipment. Contractor shall leave premises in a neat, clean and safe condition.

End of Specification