	Title: YALE OFFICE OF FACILITIES PROCEDURE MANUAL Chapter: 01 - Yale Design Standard Division: Electrical Standards	Section: 26 05.43 Underground Electrical Duct Bank
		Date: 8/1/17
		Author: Office of Facilities
CC: Project Folder		

Change History

Date	Description of Change	Pages / Sections Modified	Change Approver Initials
8/1/17	Update sections Materials <i>and</i> Special Requirements	3 – F. 2. 4 – H. 2.; 10. & 11(added)	SO
6/15/16	Updated division section from 16600 to 26 05 43, removed references to other section numbers	-	mgl44
10/17/14	Amend text in section E (Manufacturers), paragraph #2 (Manhole Covers) to update vendor	2 - 16600, E. #2. (Underground Electrical Duct Bank; Manufacturers)	SO
10/17/14	Amend text in section F (Materials), paragraph #1 (Ductbank) subparagraph a. for clarity	3 - 16600, F. #1. a (Underground Electrical Duct Bank; Materials)	SO
10/17/14	Amend text in section H (Special Requirements), paragraphs #1 and #7 for correction.	3>4 – 16600, H. #1. & #7. (Underground Electrical Duct Bank; Special Requirements)	SO
10/17/14	Amend text in section I (Installation Guidelines) paragraphs #6. & #11.	5 - 16600, I. #6. & #11. (Underground Electrical Duct Bank; Installation Guidelines)	SO
10/17/14	Add paragraphs #12 & #13 to section I (Installation Guidelines)	5-16600, I. #12. & #13. (Underground Electrical Duct Bank; Installation Guidelines)	SO

A. Summary


This section summarizes the design criteria for underground exterior electrical distribution systems.

B. System Design and Performance Requirements

1. The minimum allowable concrete duct compressive strength is 5,000 psi at 28 days.
2. Design all underground electrical raceways and duct banks for seismic zone 2.
3. Steel reinforcement ASTM A-615, grade 60 minimum cover to steel reinforcement 1”.
4. Vault shall be designed to meet ASTM C857 and ACI 318 with AASHTO HS-20 loading.
5. Construction joint shall be sealed with BUTYL rubber resin or equivalent.

C. Submittals

Submit the following design and construction documents to Yale University.

	Title: YALE OFFICE OF FACILITIES PROCEDURE MANUAL Chapter: 01 - Yale Design Standard Division: Electrical Standards	Section: 26 05.43 Underground Electrical Duct Bank
		Date: 8/1/17
		Author: Office of Facilities
CC: Project Folder		

1. Design Documents

- a) Plan and profile views of all design drawings
- b) Maximum wire pulling tension calculations for proposed conduits

2. Construction Documents

- a) Product data on manholes, hand holes, and fittings
- b) Equipment and machinery proposed for bending metal conduit

D. Product Standards

The following products are standard for Yale University:

- Underwriters Laboratories
- ANSI/NEMA 70: National Electrical Code
- National Electrical Manufacturers Association (NEMA) TC6: PVC and ABS Plastic Utilities for Underground Installations
- National Fire Protection Association (NFPA) 70: National Electrical Code (NEC)
- National Electrical Contractors Association, Inc. (NECA) 5055: Standard of Installation

E. Manufacturers

Subject to compliance with the design requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following.

1. Pre-cast Manholes

- a) Arrow, Ditullio, Rotondo, or a Yale University approved equivalent


2. Manhole Covers

- a) Campbell Foundry 1108 or a Yale University approved equivalent with the word "Electrical" cast into the upper surface.
- b) The cover opening shall be 36" diameter as a minimum.
- c) All new covers shall have manhole numbers welded on surfaces (TIG Weld).

F. Materials

1. Ductbank

- a. Use 5" schedule 40 (encased in concrete by 2" minimum) or schedule 80, rigid, nonmetallic conduit in straight sections, unless otherwise noted or

	Title: YALE OFFICE OF FACILITIES PROCEDURE MANUAL Chapter: 01 - Yale Design Standard Division: Electrical Standards	Section: 26 05.43 Underground Electrical Duct Bank
		Date: 8/1/17
		Author: Office of Facilities
CC: Project Folder		

specified. Use rigid galvanized steel 5” conduit for bends, kicks, sweeps, elbows, offsets, and within five feet of ductbank wall penetrations.


- b. All conduits penetrating to the wall of manhole shall have end bells, or if not, conduits shall have grounding bushing attached to ground rod. There shall be a minimum of two ground rods per manhole.

2. Manhole

- a. All electrical devices in the electrical manholes, such as plugs, receptacles, outlets, switches and terminal blocks, shall be made by Hubbell Marine Grade products. The following are the cat #s for each item:
 - Switch and Receptacle Boxes: cat # HBL 60CM83
 - Switch: cat # HBL 1221PL
 - Switch Cover Plate: cat # HBL 1795
 - Receptacle: cat # GFR 5252MGY
 - Receptacle Cover Plate: CWP 26CR
- b. Receptacle shall be mounted four feet (4’) above the floor.
- c. Lighting fixtures in electrical manholes shall be made of Simkar cat # EN2 LED 4RAF5641U1WLHSSL with polycarbonate lens, wet location stainless steel latches and fittings, LED components.
- d. Install fault indicator on all feeders using Power Delivery Products Cat # 29-0074-000 with auto reset and trip with 4 hours delay, rated for 450 amps.
- e. Lighting and receptacle shall be on the same circuit. Sump pump shall be on a separate circuit than light and receptacle.


G. Accessories or Special Features

1. All end seals, gland seals, and anchors must be designed and factory prefabricated to prevent the ingress of moisture into the system.
2. All subassemblies must be designed to allow for complete draining and drying of the conduit system.
3. Anchors must be manufactured to minimize the heat transfer from the carrier pipe to the jackets.

	Title: YALE OFFICE OF FACILITIES PROCEDURE MANUAL Chapter: 01 - Yale Design Standard Division: Electrical Standards	Section: 26 05.43 Underground Electrical Duct Bank
		Date: 8/1/17
		Author: Office of Facilities
CC: Project Folder		


H. Special Requirements

1. Provide heavy duty non-metallic cable racks with demountable insulated cable brackets by Underground Devices, Inc in all manholes.
2. Provide a sump at the bottom of each manhole with sump pump wired to a ground fault outlet. The sump pump discharge must be piped to an adjacent storm sewer or to the surface. Cords for the sump pump shall be Type SOOW. Pump manufacturer shall be BJM Pumps, model # J400, no exceptions. Type SOOW cord manufacturers shall be Cerro, General Cable and Shaw Flex.
3. Pulling wiring irons shall be on all walls and floor.
4. Each manhole shall have a ground bus with two separate connections to ground rods.
5. Maintain a minimum grade of 4" in 100 feet, either from one manhole, hand hole, or pull box to the next, or from a high point between them, depending on surface contour.
6. Pipe bends must have at least a 10'radius.
7. Manhole and vault shall be sized per design requirements. Number of cables, splices, elbows, etc, but minimum size shall be 8'x11'x7' high.
8. All grounding wires shall be 4/0 AWG as a minimum.
9. Fiberglass ladder shall be installed in each manhole.
10. All wiring shall be XHHW-2.
 - a) Wiring Manufacturers for XHHW-2 wire shall be
 - Chromalox
 - Cerro
 - General Cable
 - Nelson
 - Rockbestos
 - ShawFlex
11. The Branch wiring to light fixture shall be SF-2.
 - a) Wiring Manufacturers for SF-2 wire shall be
 - Allied Wire & Cable,
 - Cable USA,
 - First Capital Wire
 - York Wire & Cable

	Title: YALE OFFICE OF FACILITIES PROCEDURE MANUAL Chapter: 01 - Yale Design Standard Division: Electrical Standards	Section: 26 05.43 Underground Electrical Duct Bank
		Date: 8/1/17
		Author: Office of Facilities
CC: Project Folder		

I. Installation Guidelines

1. Pipe bedding:
 - a) Where possible, provide a uniform pipe bedding of granular material conforming to the requirements of SW, SP, or SP-SW soil classifications for on-site material. If suitable material is not available, backfill the trench with sand.
 - b) Using a material similar to the bedding, backfill the entire trench width evenly in 6" lifts to 6" above the top of the pipe. Compact the lifts to at least a 95% Standard Proctor density, meeting ASTM D1556 standards at optimum moisture (or as recommended by the soils engineer).
 - c) Backfill the remaining trench in lifts not to exceed 12" up to the sub-grade height for the surface condition encountered. Compact the lifts to a 95% Standard Proctor density, meeting ASTM D1556 standards at optimum moisture (or as recommended by the soils engineer).
 - d) Backfilling and compacting above the sub-grade must be determined by the soils engineer or by the recommended paving design for the project.
 - e) Salvage existing topsoil and reuse it, where possible, as directed by Yale University grounds personnel. Replacement topsoil must meet Yale University grounds personnel requirements.
2. Leave a nylon fish tape in all spare conduits.
3. All conduits entering a building structure must terminate with a threaded end that will accept a lock nut, connector, or grounding bushing.
4. Bury all ducts at least 30" below grade, unless otherwise noted. The top of the ductbank must be dyed red with warning tape. Maintain 12" of vertical and horizontal separation with other piping systems.
5. Unless noted otherwise, encase conduits with 3,000 psi concrete, with 4-5" steel reinforcing steel re-bars running the length of ductbank. In addition, #5 reinforcing steel wraps is required every 5 feet for the entire run of the ductbank.
6. For each manhole, place a plaque on the manhole wall adjacent to the duct. Indicate the name of the manhole at the other end and the distance to the next structure. Plaques shall be made by Seton Cat # MO929, with a red back ground and white letters indicating manhole numbers.
7. Where duct banks enter buildings, vaults, or other structures, dowel into the concrete

	Title: YALE OFFICE OF FACILITIES PROCEDURE MANUAL Chapter: 01 - Yale Design Standard Division: Electrical Standards	Section: 26 05.43 Underground Electrical Duct Bank
		Date: 8/1/17
		Author: Office of Facilities
CC: Project Folder		

wall with #5 reinforcing steel at the four corners of the duct bank (minimum) and every 12" around the perimeter of the duct bank. Extend the dowels at least to the depth of the wall and the same distance into the duct bank.

8. Empty raceways must have a permanent removable cap over each end.
9. Install a metal lined, plastic, 6" wide warning tape 18" above all raceways and duct banks.
10. Furnish and install a "Danger – High Voltage" sign at each manhole, cable chamber, junction box, pull box, and vault.
11. Install #4/0 bare copper ground cable the length of the duct bank to be used to connect the manholes to grounding system.
12. New manholes shall have a plaque visible upon entry to manhole with the manhole number. Plaque shall be red with white lettering.
13. New manholes shall have a plaque at each compass point, north, south east and west, visible upon entry to the manhole with compass point, the next destination/source (building or manhole) of the cables leaving/entering that face of the manhole as well as the distance to that location.

J. Quality Control

Work on exterior electrical distribution systems must conform to the following quality control standards.

1. Testing Laboratory


- a. Yale University will retain the services of a qualified, independent testing laboratory to perform soil compaction tests, as directed, during construction.
- b. All materials within the scope of Underwriters Laboratories must conform to UL standards and have an applied UL listing mark.

2. Testing Methodology and Extent

- a. Inspect and test in accordance with NETA-ATS requirements, except section 4.
- b. Perform inspections and tests listed in NETA-ATS, section 7.3.2.

K. Startup and Training

1. A final inspection of electrical systems is required before final payment.

	Title: YALE OFFICE OF FACILITIES PROCEDURE MANUAL Chapter: 01 - Yale Design Standard Division: Electrical Standards	Section: 26 05.43 Underground Electrical Duct Bank
		Date: 8/1/17
		Author: Office of Facilities
CC: Project Folder		

2. Contractors must provide competent instructors to train Yale University personnel in the care, adjustment, and operation of all parts of the electrical system.

“END OF SECTION”