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DISTRIBUTION ENGINEERING DEPARTMENT
SUBSTATION & EQUIPMENT SECTION

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REQUIREMENTS FOR CONSTRUCTION OF 265/460 VOLT NETWORK INSTALLATIONS

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REQUIREMENTS FOR CONSTRUCTION OF 265/460 VOLT NETWORK INSTALLATIONS

1.0 SCOPE

This specification covers the construction details of 265/460 volt transformer vaults and network protector compartments. It is divided into three sections, Part A for Transformer vaults, Part B for Network Protector Compartments, and Part C for Interior Distribution network protector compartments. It is divided into three sections, Part A for Transformer vaults, Part B for Network Protector Compartments, and Part C for Interior Distribution Systems.

2.0 DISTRICTS APPLICABLE

All Customer Service Areas.

3.0 DEFINITIONS

3.1 For the purpose of this specification, the following terms are defined:

3.1.1 Transformer vault - Structure to house a transformer with or without a network protector located in sidewalk areas or within buildings.

3.1.2 Network Protector Compartment/Network Bus Compartment - a structure which houses the network protector, paralleling bus, service take off, associated cable ties and, if required, a 460 V disconnect switch.

3.1.3 Interior Distribution System - an installation within the Customer's property, which is not touching to the property line.

PART A - TRANSFORMER VAULTS

4.0 CONSTRUCTION

4.1 Transformer vaults, which contain liquid filled transformer and which are constructed below grade, at grade and within buildings, shall be reinforced concrete structures designed in accordance with Local Municipal Regulations and EO-1121.

4.0 CONSTRUCTION (Cont'd)

4.2 Grade level transformer vaults in isolated locations not adjacent to buildings (minimum 20 foot separation) may be constructed on reinforced concrete mats with either chain link or filled concrete block enclosures. Concrete walls designed in accordance with EO-1121 shall be installed between transformers for multiple bank installations. Construction drawings shall be prepared for each installation in this paragraph and paragraph 4.1. Pad mounted transformers do not require enclosures.

4.3 Vaults shall not be constructed under a roadway, in a driveway or in a loading dock.

4.4 When vehicular traffic on sidewalk vaults is anticipated, heavy duty driveway type gratings shall be specified.

4.5 All sidewalk grating arrangements and designs are subject to municipal regulations.

4.6 Grade level transformer vaults adjacent to buildings shall be constructed on reinforced concrete mats with blast resistant reinforced concrete back, sidewalls and roofs designed in accordance with EO-1121. Additionally, concrete walls designed in accordance with EO-1121 shall be installed between transformers for multiple bank installations. The front wall may be constructed of louvers in accordance with EO-2032. Location of the vaults from doors and windows shall be in accordance with the applicable building code.

5.0 SPACE REQUIREMENTS

The minimum interior space requirements for 460 volt transformer vaults are listed below. Typical space arrangements are covered in EO-1114.

Liquid Filled Units
Vault Parallel (lengthwise) To Property Line/Building Line

Transformer Size	Length	Width	Headroom
2500 kVA	12' 0"	9' 7"	10' 0"
2000 kVA	12' 0"	9' 7"	10' 0"
1000 kVA	10' 0"	8' 7"	9' 0"

NOTE: These dimensions are subject to change due to field conditions and the type (size) of equipment purchased by the Company.

For Dry Type Transformers see paragraph 13.7, this specification.

6.0 VENTILATION

6.1 Transformer ventilation shall be provided in accordance with EO-2079 and EO-2032.

6.2 The vault ventilation ratio is defined as:

$$\frac{\text{Net Volume (Cubic Feet)}}{\text{Net Ventilation Area (Square Feet)}}$$

and shall be equal to or less than 50.

6.3 All ventilation for transformer vaults shall be directly to the outside air.

6.0 VENTILATION (Cont'd)

6.4 Natural ventilation to the outside air is preferred (in all cases, to mechanical means, however, when this is not possible provision is made for forced exhaust ventilation as described in EO-2032, latest revision.

7.0 ACCESS

7.1 Standard access to transformer vaults shall be as follows:

Vault Location	Access
Below Grade	Engineers exit (EO-1511A) in grating.
Within Buildings	Fire door to public corridor.
Grade Level	Solid or louvered steel door or chain link door from the outside.

7.2 Access shall be provided to minimize interference with driveways shall be permitted only with the approval of the Manager of Engineering. Access shall be immediately available to Company Representatives 24 hours of every day.

8.0 DRAINAGE

8.1 All vaults shall be provided with drainage to a public sewer. Only when field conditions do not permit connection to public sewers should connections for drains then be made to Customer's sewer. Both connections shall be in accordance with EO-12160-C. Water shall be directed into the sump(s) by means of pitched floors

and 4" square weep holes from adjacent vaults.

8.0 DRAINAGE (Cont'd)

8.2 When necessary, to minimize the accumulation of water, subsurface vaults shall be waterproofed in accordance with EO-1005 and EO-1007.

8.3 Plumbing within vaults shall be installed so as not to interfere with primary cables, secondary cables, electrical devices or personnel. Plumbing shall also be accessible for maintenance.

8.4 Sump pump discharge pipes from adjacent vaults may be connected to a common 4" sewer tap. All pumps shall be equipped with oil minders as per EO-12160-C to prevent oil infiltration into the drainage system.

8.5 Piping not directly associated with the installation, shall not be permitted in any transformer vault.

PART B - NETWORK PROTECTOR COMPARTMENTS

9.0 CONSTRUCTION

9.1 Network Protector Compartments shall be constructed in locations specified by EO-2079. Separation of network protector compartments from associated transformer vaults shall not exceed twenty-five feet.

9.2 In unusual cases, these compartments can be constructed below grade or beneath plazas, provided ventilation (paragraphs 42 and 43) and access (paragraphs 45 to 46) are from within the building. Compartments shall not be built beneath transformer vaults.

9.3 Walls may be constructed of reinforced concrete or filled concrete block. The Company shall prepare construction drawings for each installation.

9.4 Reinforcement bars shall clear all conduits into the network protector compartment by at least 4 inches. Bars shall not be installed between conduits. Building steel must clear all conduit and bus openings by at least 8 inches in order to prevent induced heat build-up in these steel members.

9.5 Network protector Compartments shall be designed as waterproof structures. In all cases, the roof shall nave membrane waterproofing as covered in EO-1007.

9.0 CONSTRUCTION (Cont'd)

9.6 When necessary to keep water out or to protect Customer's space below, the compartment floor shall have a membrane waterproofing covered with a 3" cement finish. This finish provides space for anchor bolts in the floor and also protects any waterproofing. The waterproofing and finished floor shall be installed prior to construction of partition walls.

9.7 In addition to the above, when compartments are constructed above grade, the exterior walls shall be protected with waterproofing as per EO-1005.

9.8 When it is anticipated that construction of network protector compartments will fall below the water line, the Customer shall build the network protector compartment floors in the following manner; thru paragraph 9.11.

a. Place a minimum 4" concrete working mat.

b. Waterproof the working mat in accordance with EO-1007.

c. Place a minimum 6" structural floor slab over the waterproofed working mat.

9.9 Any portion of the network protector compartment, which is part of the external walls of the building, including any portion below the transformer vaults, shall also be waterproofed on all external faces.

9.10 Exterior waterproofing shall be covered with protective boards.

9.11 The floor of the network protector compartment shall be finished (waterproofed & 3" protective slab) in accordance with paragraph 9.6 of this specification.

9.12 The interior of all compartment walls shall be painted in accordance with EO-1141.

9.13 The customers shall remove all structural building steel prior to vault construction. Exposed metal decking shall not be allowed in transformer vaults and network protector compartment ceilings. All steel shall be encased with a minimum of 2" of concrete.

9.14 All concrete forms within the network compartments shall be removed by the Customer prior vault construction.

9.0 CONSTRUCTION (Cont'd)

9.15 Waffle type concrete forms are acceptable for ceiling construction. However, when floor takeoffs are specified, the area adjacent to the bus opening must be smooth level surfaces to hold bus supports and steel plates.

9.16 All ducts entering a network protector compartment shall be non-metallic.

9.17 To prevent water from entering the network protector compartments, all ducts shall be set in place while pouring concrete wall. All ducts shall be sealed in accordance with EO-1100.

9.18 Ducts from the street system shall not enter a network protector compartment directly. They all be terminated in the adjacent transformer vault and non-metallic sleeves from the vault into the compartment shall be provided in the wall for the cable entry. Such sleeves shall be installed through the building q-all with the initial vault construction, and sealed until they are to be utilized.

10.0 VENTILATION

10.1 When natural ventilation is available, louvers shall be provided in the high and low positions at opposite ends of each network bus compartment. These louvers shall be adequately sized for allowing a natural air flow to attempt to maintain an ambient temperature of 35?C or less.

10.2 When natural ventilation is not available, a forced air ventilation system shall be installed and maintained by the customer. This system shall include power supply, ventilation and alarm controls and shall be in accordance with EO-2032.

11.0 ACCESS

11.1 At least one or the two required means of access (EO-2079) shall be adequate for equipment replacement.

11.2 Access doors shall be equipped with "fast egress" latch hardware.

11.0 ACCESS (Cont'd)

11.3 Access doors shall be specified as follows:

Location	Access
Within Building	Fire door to public corridor
Grade Level	Louvered door to the outside
Between Compartments	Solid steel door to adjacent compartment

11.4 Access doors shall be installed at the extreme ends of each compartment.

12.0 DRAINAGE

12.1 Suitable sills shall be provided to protect the network protector compartment from water in Customer's space. In general, sills of 6" to 18" are specified for access doors only. No sills shall be constructed between adjacent compartments.

12.2 Drainage of these compartments is generally required when they are constructed at the lowest building elevation. Drainage shall be provided by the customer and such drains shall be installed, preferably, just outside the access doors.

12.3 Foreign piping shall not be permitted in any network protector compartment.

12.4 The drainage system for network protector compartments and transformer vaults shall be completely independent.

12.5 Drainage requirements may be revised for unusual field conditions.

13.0 SPACE REQUIREMENTS

13.1 The minimum space requirements for 460 volt network protector compartments are shown in EO-1114.

PART C - INTERIOR DISTRIBUTION SYSTEMS GENERAL

14.0 SPACE REQUIREMENTS

14.2 Interior distribution systems may be installed, at Customer's request, at grade, below grade or on an upper floor(s) within the building. While all such installations are at Customer's expense, they shall each conform to all Company requirements of this and associated specifications.

14.3 The transformer vaults and network protector compartments shall be designed by the Customer in accordance with our "Space Allocation" drawing and submitted to the Company for approval.

14.4 For installations on upper floors within buildings, the "Space Allocation" drawing shall include complete description of the Customer's method of transporting Company equipment from the property line to the vault location. This method must be adequate for both initial and replacement installations. The Customer shall be required to sign the drawing.

14.5 Final Company construction drawings shall not be released without the information as required by paragraph 13.4.

14.6 All vaults and access ways shall be adequate for a transformer having maximum specification dimensions. See specification EO-5031 (liquid filled units) or EO-5025 (Dry type units).

14.7 Dry type transformers normally require more space than liquid filled units. This is due, primarily, to air flow requirements around the transformer cabinet necessary for cooling. In addition, more space is required so that the cabinet panels may be removed for maintenance.

The installation of dry type transformers requires the following:

a. 2' minimum clearance all around transformer

b. 3'6" minimum clearance in front of transformer (1'6" added to a.)

c. 11' minimum headroom for 2000 & 2500 kVA units

d. 10' minimum headroom for 1000 kVA units

14.0 SPACE REQUIREMENTS (Cont'd)

14.8 Transformers shall be rigged in a level position and clearances shall permit safe handling without physical damage.

15.0 CUSTOMER'S HIGH VOLTAGE SYSTEM

15.1 The conduits, splice chambers and cable shall be provided, installed and maintained by the Customer.

15.2 Customer-owned primary cable shall be terminated in a property line manhole or splice box for connection to the network system.

15.3 A separate duct bank and manhole (or splice box) system is required for each two primary feeders.

15.4 "Separate systems" shall be considered as those which are approximately 20 feet apart. Spacing less than this is subject to the approval of the Division Manager of Engineering.

15.5 The Company recommends the installation of a three duct system for each two primary feeders to provide one spare duct.

15.6 Customers' vertical risers shall have a splicing chamber at the top and at the base of each duct system. These chambers shall have provision for supporting the vertical feeder cables. Details of these items are shown in EO-5274-B, EO-5276-B and EO-5277-B.

15.7 Concrete encased steel conduits, for customer's primary riser cables, are permitted in the network protector compartment with the approval of the Manager of Engineering.

15.8 Customer's high voltage cable shall meet all Company Standards including high potential tests. Appropriate Specifications shall be given to the Customer by our Construction Representative.

16.0 COMPANY RESPONSIBILITY

16.1 The Company shall provide all transformers, protectors, bus and associated equipment for installation within the vault(s) and network protector compartment(s).

16.2 The Company shall maintain all Company owned equipment.

16.3 The Company will place its padlock on each transformer vault and network protector compartment.

16.4 The Company will provide labor and material for making final splices in the property line manhole or splice chamber.

17.0 SPLIT RESPONSIBILITY

At locations where the company builds the vaults and the Customer builds the network protector compartments, the Customer shall provide, install and maintain all conduit and cable systems between the vaults and network protector compartments. All other requirements remain the same.

18.0 EXCEPTIONS

Any exceptions or questions regarding this specification shall be forwarded to the Distribution Equipment Section Manager for consideration.

19.0 REFERENCE SPECIFICATIONS

Associated Specifications cited herein are listed below:

Number	Subject	Manual
EO-1005	Plaster coat Waterproofing	No. 3
EO-1007	Membrane Waterproofing	No. 3
EO-1114	Space Requirements for 460V Network Installations.	No. 3
EO-1121	Structural Design	No. 4
EO-1191	Painting of 460 V Network Compartments	No. 3
EO-1511A	Ladders and Safety guard	No. 3
EO-2032	Forced exhaust ventilation system for use with network installation	No. 4

EO-2079	Design of 265/460 V Network Installation	No. 4
EO-5025	13 kV Dry Type NW Transformers P&T	No. 6

REFERENCE SPECFICATIONS (Cont'd)

EO-5031	Detailed Spec. For 4, 13, 27, 33 kV Nwk. Trans. P&T	No. 6
EO-5051	Design & Const. of 460V NWP & Trans-former Vaults By Contractors	No. 3
EO-5274 -B	Details for primary vertical risers	No. 3
EO-5276 -B	" " " " "	No. 3
EO-5277 -B	" " " " "	No. 3
EO-11460-D	Gravity Drainage	No. 3
EO-12160-C	Sump pump Drainage	No. 3

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REVISION	FILE
Revised Construction Requirements for Transformer Vaults and specification number formatting.	Construction Standards Manual No. 3, Section 42 Field Manual No. 5, Section 2

APPENDIX 3 – EXCERPT FROM PST TEST PROCEDURE FOR LOADSHEDDING

4.8 208 Volt Load Shedding Trips

CAUTION: WHENEVER PERIODIC TRIP AND CLOSE TESTS ARE PERFORMED FROM THE 208 VOLT LOAD SHEDDING PANEL, IT IS OF THE UTMOST IMPORTANCE THAT THE PROPER PRECAUTIONS ARE TAKEN. REVIEW THE APPROPRIATE PRINTS BEFORE STARTING WITH THE TESTS. VERIFY THAT THE FEEDER PROGRAM IS AS INDICATED IN THE STATION OPERATING DIAGRAM. RECORD THE FEEDER PROGRAM ON THE 11208 VOLT LOAD SHEDDING AND START UP/SHUT DOWN PANELS" FORM (REFERENCE APPENDIX 4). PROVIDE THE FOLLOWING PROTECTION:

- ISOLATE THE TRIP CIRCUITS BY OPENING THE FLEXITEST SWITCHES, IF PROVIDED, AND/OR STATES LINK OF ALL FEEDER BREAKERS THAT ARE NOT UNDER TESTS (INCLUDE THE LINKS TO THE MULTICONTACT RELAY WHICH TRIPS THE CAPACITOR BANKS IF APPLICABLE).
- ASCERTAIN WITH THE STATION OPERATOR THAT FAULTY FEEDER BREAKERS AND OTTEM FEEDER BREAKERS WHICH ARE NOT TO BE CLOSED ARE ISOLATED AND CANNOT BE RECLOSED.

4.8.1 When providing protection by opening links and/or removing wires, follow the steps indicated in paragraph 3.2.

4.8.2 If States Links have been opened to provide the proper protection, tighten all screws to prevent accidental closure of the links.

4.8.3 Verify –with the Station Operator that the D.C. supply voltage to any breaker that is open and not to be closed is deenergized. Confirm that the D.C. supply voltage is energized for the feeder breakers under test.

4.8.4 For the bus section to be tested have all breakers in the connect close position.

4.8.5 At the 208 Volt Load Shedding panel, operate the AUTO "ON" pushbutton (PB-2). Request that the Energy Control Center initiate a trip via the console panel. Verify that:

- The trip relays TA-1, TA-2, (Clock Controller) and TR1 through TR4 operate.
- The trip indicating red light LA-1 goes on.
- Only the appropriate feeder breakers under test have tripped.

4.8.6 Request that a "Reclose" operation be initiated from the Energy Control Center. Verify that:

- The tripping relays TA-1, TA-2 and TR1 through TR4 reset.
- The red trip indicating lights LA-1 goes off.
- The close 11CA11 relay picks up and only the appropriate feeder breakers reclose.

4.8.7 After verifying that the ClarkController relays contacts are open (relays in the reset position) and all auxiliary tripping and reclose relays are reset, restore all trip and reclosure protection as provided in paragraphs 4.8.1 and 4.8.2 to normal.

4.8.8 Using a high resistance voltmeter such as a Simpson Multimeter, verify that the D.C. trip supply voltage has been restored.

4.9 Startup and Shutdown Panel

CAUTION: WHENEVER PERIODIC TRIP AND CLOSE TESTS ARE PERFORMED FROM THE STARTUP AND SHUTDOWN PANEL, IT IS OF THE UTMOST IMPORTANCE THAT PROPER PRE-CAUTIONS ARE TAKEN. REVIEW THE APPROPRIATE PRINTS BEFORE STARTING WITH THE TESTS. VERIFY THAT THE FEEDER PROGRAM IS AS INDICATED ON THE STATION OPERATING DIAGRAM. RECORD THE FEEDER PROGRAM ON THE 11208 VOLT LOAD SHEDDING AND START UP/SHUT DOWN PANELS" FORM (REFERENCE APPENDIX 4) PROVIDE THE FOLLOWING PROTECTION:

- ISOLATE THE TRIP CIRCUITS OF ALL FEEDER BREAKERS OF
- THAT PART OF THE SECTION WHICH IS NOT UNDER TEST BY:
  - A) OPENING THE APPROPRIATE STATES LINKS,
  - B) OR OPENING THE SECTION FLEXITEST SWITCHES (IF PROVIDED).