TABLE OF CONTENTS

1.0 SCOPE .................................................................................................................. 3
2.0 DISTRICTS APPLICABLE ..................................................................................... 3
3.0 GLOSSARY OF TERMS ....................................................................................... 3
4.0 ELECTRICAL CHARACTERISTICS OF 265/460 VOLT INSTALLATIONS .......... 4
5.0 ELECTRICAL EQUIPMENT .................................................................................. 4
6.0 STRUCTURAL EQUIPMENT HOUSINGS .............................................................. 7
7.0 DESIGN CONSIDERATIONS ............................................................................... 7
8.0 GROUNDING ........................................................................................................ 13
9.0 REQUIREMENTS PRIOR TO INSTALLING EQUIPMENT .................................... 14
10.0 EXCEPTIONS ....................................................................................................... 14
11.0 REFERENCES ..................................................................................................... 15
1.0 SCOPE
1.1 This specification covers the design of 265/460 Volt network installations supplying:

1.1.1 Single bank installations.
1.1.2 Isolated networks.
1.1.3 Spot networks.

2.0 DISTRICTS APPLICABLE
2.1 All Regions

3.0 GLOSSARY OF TERMS
3.1 The following technical terms are defined:

3.1.1 Transformer Vault - Structure to contain a transformer.
3.1.2 Network Protector Compartment - Structure containing a network protector and paralleling bus. A service take-off and/or a 460 Volt disconnect switch may also be included.
3.1.3 Paralleling Bus - Bus bars used for the interconnection of transformer secondaries.
3.1.4 Bus to Bus Tie - Cables connecting the paralleling bus of two 265/460 Volt installations.
3.1.5 Disconnect Switch - A 600 Volt, 4000 Amperes switch connected in series at each end of the bus to bus tie.
3.1.6 Set of Cables - One cable of each phase and two neutral cable. (All cables are of the same size).
3.1.7 Phase Grouping - Cables of all three phases installed in the same duct with or without neutral cable. (All cables are of the same size).
3.1.8 Phase Isolation - Only cables of the same phase are installed in the same duct.
3.1.9 Unscramble - Rearrangement of phase grouped cables to phase isolated.
3.1.10 Service Take-Off - Bus or cable extension to Company's point of service termination.
4.0 ELECTRICAL CHARACTERISTICS OF 265/460 VOLT INSTALLATIONS

4.1 The following electrical characteristics apply to 265/460 Volt network installations:

4.1.1 Single transformer installations are paralleled to other 460 Volt installations by means of bus to bus ties.

4.1.2 A group of network distribution transformers installed on isolated and spot networks within buildings is called a "multibank installation" and has the low voltage windings paralleled by means of the paralleling bus. The primary windings of the transformers are supplied by different feeders that emanate from the same station or substation. For definitions of isolated and spot networks refer to Specification EO-4007 contained in System Operation Manual No. 5.

4.1.3 Network transformer winding connections for single and multibank installations are delta-wye and are supplied by 13, 27 or 33 kV feeders.

4.1.4 The service voltage for all network installations is referred to as "265/460 Volts nominal" and the design operating limits are stipulated in Specification EO-2065.

4.1.5 Single and multibank 265/460 Volt installations can be tied together by means of bus to bus ties to form a "multiple building grid." An example of such a grid is illustrated in Specification EO-11211 contained in Operation and Maintenance of Equipment Manual No. 1. There are presently multiple number of single and multibank installations tied together.

4.1.6 Each multibank installation is limited to a maximum of six transformers so that a possible solid 3-phase fault at the 265/460 Volt paralleling bus would not exceed 200,000 Amperes RMS Symmetrical.

5.0 ELECTRICAL EQUIPMENT

5.1 Transformers

5.1.1 The following transformers are used on 265/460 Volt installations:
<table>
<thead>
<tr>
<th>Nominal Voltage KV)</th>
<th>(KVA)</th>
<th>Phase</th>
<th>Type</th>
<th>%Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>13,27,33</td>
<td>1000</td>
<td>3</td>
<td>Liq. ( *)</td>
<td>4.0</td>
</tr>
<tr>
<td>13,27,33</td>
<td>2500</td>
<td>3</td>
<td>Liq. ( *)</td>
<td>7.0</td>
</tr>
</tbody>
</table>

( * ) Mineral oil or ester oil-filled transformers.

5.1.2 The above transformers are self-cooled. Detailed description of network transformers is given in Purchase and Test Specification EO-5031.

5.1.3 There are 265/460 Volt installations on the System where 2000 KVA transformers are now installed. This transformer size is no longer a standard. In the event of failure of a 2000 kVA transformer the installation should be examined for the possibility of replacing the failed unit with a 2500 kVA transformer. The following items should be examined for this purpose:

A. Structural Loading. Can the installation safely support the additional weight of the 2500 kVA transformer?

B. Size of Installation. Can the installation accommodate the larger dimensions of the 2500 kVA transformer?

C. Network Protector. Replacement of a 2000 KVA transformer with a 2500 kVA unit will also require replacement of the network protector with a 5100 Amperes rated protector. The additional weight of the new network protector/enclosure should also be considered.

D. Gap Cable Ratings. The cables that connect the 460 Volt side of a 2500 kVA transformer to the network protector should consist of 8 sets of 750 kcmil copper cables in order to match the 5100 Amperes rating of the protector. See Application and Design Specification EO-6002.

E. Ventilation. Ensure that the ventilation in the transformer vault and the network protector compartment will be adequate for the 2500 kVA transformer and the 5100 Ampere protector, according to the requirements of Application and Design Specification EO-2032.

5.1.4 A failed 2000 kVA transformer can be replaced by a 2500 kVA unit only if all considerations under Section 5.1.3, paragraphs A through E are fulfilled.

5.2 Autotransformers

5.2.1 An autotransformer may be used to connect a 265/460 Volt spot network to the 120/208 Volt network grid.
5.2.2 Autotransformers are self-cooled, oil-filled, vault type units purchased on the following standard sizes:

- 500 kVA, 3-phase, 480/277 to 216/125 Volts
- 1000 kVA, 3-phase, 480/277 to 216/125 Volts.

Note: The above autotransformers have not been purchased lately. If these units are still required, a spot buy purchase will be necessary. Lead time for a RFP takes about a month. Once proposals are received, a minimum of one week is required for technical review by DE Equipment. Once a contract is awarded lead time to manufacture is between 3 and 6 months.

5.2.3 Detailed description of autotransformers is given in Purchase and Test Specification EO-5011. For instructions on their use, see Operation and Maintenance of Equipment Specification EO-11,206 of Manual No. 1.

5.3 Network Protectors

5.3.1 The following network protectors are used on the 265/460 Volt installations:

<table>
<thead>
<tr>
<th>Network Protector Maximum Continuous Rating [Amp]</th>
<th>Associated Transformer [KVA]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2250</td>
<td>1000</td>
</tr>
<tr>
<td>5100</td>
<td>2500</td>
</tr>
</tbody>
</table>

5.3.2 These units are available in open ventilated frames or in submersible housings. Submersible housings shall be used for all targeted storm hardening installations or replacement of 265/460 V equipment. Refer to EO-5103 for detailed description of network protectors and to EO-117000 for specific roll-out and enclosure information.

5.4 Fuses

5.4.1 The fuses used on 265/460 Volt installations for network protectors and service take-offs are contained in Purchase and Test Specifications EO-5316 and EO-5317, respectively.

5.5 Limiters

5.5.1 Limiters employed on 265/460 Volt installations are listed in Purchase and Test Specification EO-5207.
5.6  Bus Bars

5.6.1 The standard paralleling bus bar for phase conductors is the aluminum "Integral Web Channel", with dimensions of 8" x 5" x 1/2", as described in Purchase and Test Specification EO-100079.

5.6.2 The standard bus for service take-offs is the rectangular ventilated copper tube, having dimensions of 6" x 5" x 1/4", as described in Purchase and Test Specification EO-100049.

5.6.3 The neutral bus in a transformer vault is one 6" x 1/2" copper rectangular bar, as per Specification EO-100049.

5.6.4 The neutral bus in a network protector compartment consists of two rectangular aluminum bus bars each having dimensions of 6" x 1/2", as per Specification EO-100079.

5.7  Cables

5.7.1 The following Ethylene Propylene Rubber (EPR) 600 Volt rated cables are used on 265/460 Volt installations.

   ➢ 500 kcmil, EPR, Copper, Cable EO-7654
   ➢ 750 kcmil, EPR, Copper, Cable EO-7655

Both the above cables are listed in Specification EO-18 in Section 3 of Manual No. 6.

5.7.2 No aluminum cables shall be used on such installations.

5.8  Disconnect Switches

5.8.1 The 3-phase disconnect switches used on 265/460 Volt installations are rated 600 Volts, 4000 Amperes and are detailed in Purchase and Test Specification EO-5350.

6.0  STRUCTURAL EQUIPMENT HOUSINGS

6.1  Construction requirements for transformer vaults and network protector compartments, on 265/460 Volt installations, are described in Specification EO-5023 of Construction Standards Manual No. 3.

7.0  DESIGN CONSIDERATIONS

7.1  Transformers and Autotransformers

7.1.1 Application and Design Specification EO-2120 gives the criteria and guidelines for selecting the type of network transformer for use on new or existing installations.
7.1.2 In general, liquid transformers are used on all outdoor installations.

7.1.3 Transformers installed within buildings shall be filled with natural ester fluid in the 13, 27 and 33 kV areas.

7.1.4 Only one network transformer shall be installed in each vault.

7.1.5 Autotransformers that may be used to connect 265/460 Volt spot networks to 120/208 Volt network grids shall be oil-filled units.

Note: The above autotransformers have not been purchased lately. If these units are still required, a spot buy purchase will be necessary. Lead time for a RFP takes about a month. Once proposals are received, a minimum of one week is required for technical review by DE Equipment. Once a contract is awarded lead time to manufacture is between 3 and 6 months.

7.2 Network Protectors

7.2.1 Network protectors shall be installed in waterproof structures (network protector compartments) within buildings above, below or at grade. Network protectors may also be installed in "separate from building enclosures." These structures are usually at grade within the customer's premises.

7.2.2 Only one protector shall be installed in a network protector compartment.

7.2.3 Network protector relay mode of operation is described in Application and Design Specification EO-5411.

7.3 Fuses

7.3.1 Fuses shall be used on every network protector and every service take-off.

7.3.2 Network protector and service take-off fuses are silver sand current limiting fuses listed in Purchase and Test Specifications EO-5316 and EO-5317, respectively.

7.3.3 An autotransformer, if employed, should also be fused.

7.3.4 Network protectors and the autotransformer shall be fused according to Application and Design Specification EO-5410.

7.3.5 At installations where one or more transformers will be added at a later date, Customer Engineering has the option of prescribing customer take-off fuses based on the ultimate load capability or considering reduced size fuses initially. In any event, proper electrical selectivity between network protector fuses and take-off fuses should be established.
7.3.6 Service take-off fuses should be selected according to Application and Design Specification EO-5402.

7.4 Limiters

7.4.1 Limiters should be provided at both ends of every phase cable.

7.4.2 Limiters may be eliminated at both ends of transformer secondary cables to the network protector when all of the following conditions are met:

A. The secondary ducts through adjacent walls are non-metallic.

B. The cables are phase isolated and rigidly supported on insulated cable racks.

C. The transformer secondary cables to the network protector are less than 30 feet long and maintain at least 11" center-to-center phase separation.

7.4.3 Limiter electrical selectivity with network protector fuses and autotransformer fuses is given in Application and Design Specification EO-5410.

7.5 Bus Bars

7.5.1 The "Integral Web Channel" aluminum bar, which is used for paralleling bus phase conductors on 265/460 installations, shall be placed at 15" center-to-center horizontal spacing among the phases.

7.5.2 Snap-on insulation shall be applied over the entire length of each paralleling bus (See Specification EO-7308-D contained in Section 2 of Purchase and Test Manual No. 6).

7.5.3 Buses in 265/460 Volt multibank installations are designed to withstand a maximum solid 3-phase fault of 200,000 Amperes RMS Symmetrical. Standard design of bus bar installations, bus ampere ratings and provision for service take-offs are described in Application and Design Specification EO-5415.

7.5.4 Network bus installations and bus supports are detailed in Section 46 of Construction Standards Manual No. 3.

7.5.5 New installations built without a transformer, which are supplied from an existing installation, require a 3-phase disconnect switch only at the existing installation. The switch shall be fused and the tie cables equipped with limiters.

7.5.6 New installations with one or more transformers, which are tied to another installation, require a 3-phase disconnect switch at both...
ends. The switches shall be fused and the tie cables equipped with limiters.

7.6 Bus to Bus Ties and 460 Volt Disconnect Switch

7.6.1 All 265/460 Volt installations shall have provisions for 16 sets of 750 kcmil copper cable connections near the center of the paralleling bus. A maximum of 8 sets of cables shall be permitted in any one network protector compartment. Two adjacent compartments shall accommodate these cables.

7.6.2 Bus to bus tie cables longer than 50 feet require phase grouping, but the cables shall enter the network protector compartments in a phase isolated configuration. Provisions shall be made for bus tie cable unscrambling space. When the space is provided within the transformer vault, a fireproof enclosure shall be constructed.

7.6.3 When tying one 265/460 Volt installation to another the available solid 3-phase short-circuit current of 200,000 Amperes limit applies to both installations.

7.6.4 Bus to bus ties shall be equipped with a disconnect switch at both ends. Bus to bus tie cables shall have limiters at each disconnect switch. The section of cables between the disconnect switch and the paralleling bus shall not contain limiters. Each disconnect switch shall be fused.

7.6.5 The purpose of the disconnect switch is to isolate the bus to bus tie in case of fault.

7.6.6 A sign shall be posted at each disconnect switch indicating the location of the other end of the tie.

7.6.7 Bus to bus 460 Volt tie cables shall not be interconnected or tapped between bus terminations.

7.6.8 Bus to bus 460 Volt tie cables shall not be permitted in boxes or manholes containing 208 Volt cables.

7.6.9 Bus to bus 460 Volt tie cables in boxes and manholes shall be arcproofed in accordance with Construction Standards Specification EO-6025 and tagged "460 Volts" as required by Application and Design Specification EO-6043.

7.7 Secondary Cables and Arrangements

7.7.1 The number of secondary cables per phase and their configuration from the transformer to the network protector shall be as follows:
### Table: Duct Diameter and Number of Cables

<table>
<thead>
<tr>
<th>Transformer Size [kVA]</th>
<th># of Cables Per Phase</th>
<th>Phase Isolated</th>
<th>Phase Grouped</th>
<th>Copper Bus</th>
<th>Copper Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>4-500 kcmil</td>
<td>6-5&quot;</td>
<td>8-5&quot;</td>
<td>1-6&quot; x 1/4&quot;</td>
<td>4-500 kcmil</td>
</tr>
<tr>
<td>2000(*)</td>
<td>6-750 kcmil</td>
<td>6-5&quot;</td>
<td>6-5&quot;</td>
<td>1-6&quot; x 1/2&quot;</td>
<td>6-750 kcmil</td>
</tr>
<tr>
<td>2500</td>
<td>8-750 kcmil</td>
<td>6-5&quot;</td>
<td>8-5&quot;</td>
<td>1-6&quot; x 1/2&quot;</td>
<td>8-750 kcmil</td>
</tr>
</tbody>
</table>

(* For Replacement Purposes Only)

### NOTES
- Duct is precast concrete or equivalent.
- Phase isolated arrangement uses copper bus as neutral.
- Phase grouped arrangement uses cables as neutral.
- Copper neutral bus is preferred to neutral cables whenever possible.
- For 1000 kVA provide the same conduits as for 2500 kVA.

#### 7.7.2
When transformers are installed in subsurface vaults under sidewalks or are in any way exposed to the weather, submersible secondary bushing adapters shall be used, as per EO-10704. Waterproofing is not necessary if transformers are installed within buildings.

#### 7.7.3
Transformers installed in areas other than those mentioned in Par. 7.7.2 in Purchase and Test Drawing EO-13,622-C.

#### 7.7.4
All 460 Volt cables entering network protector compartments shall be phase isolated.

#### 7.7.5
Phase isolated cables shall be installed in non-metallic ducts.

#### 7.7.6
Where the secondary cable length exceeds 50 feet, the cables shall be phase grouped. In this case, space shall be provided outside the network protector compartment for unscrambling phase grouped cables.

#### 7.7.7
Unscrambling of 460 Volt secondary cables shall be done at both ends of the cable run.

#### 7.7.8
All duct entrances to transformer vaults and network protector compartments shall be sealed in accordance with Construction Standards Specification EO-1100.

### 7.8 Service Take-off Connections

#### 7.8.1
Service take-offs constructed of copper bus stabs shall extend through the wall or floor of the network protector compartment. Service take-offs shall not extend through the roof of a network protector compartment.

#### 7.8.2
Service take-offs that consist of cables are allowed only when bus take-offs are not feasible (i.e. A Take-off supplying a customer
across the street). The take-off shall be fused and the cables equipped with limiters at both ends.

7.8.3 When a disconnect switch is used on a cable service takeoff to another building, the take-off fuses shall be installed within the disconnect switch. Refer to Drawing, No. EO-15501-B. EO-15501-B is part of Purchase and Test Specification EO-5350. If transformers will be installed at the service point at a later date, space must be provided in the transformer vaults for cable unscrambling. Customers with switchgears at elevated floors will have the option of installing a utility disconnect after the service take-off fuses. This will prevent the de-energization of the entire installation prior to removing or replacing service take-off fuses.

7.8.4 The requirement of a disconnect switch can be waived if line of sight (50 ft. or less) can be maintained from the service take off to the customer switch gear. The line of sight definition specifies an unobstructed view of the duct bank in question can be maintained at all points between the service take off and the customer switchgear.

7.8.5 Only one bus service take-off shall be allowed in a network protector compartment.

7.8.6 The phase arrangement and the neutral for service take-offs on 265/460 Volt installations is marked "4-5-6-N", reading left to right, when facing the source.

7.8.7 Exceptions to Paragraph 7.8.5 are floor take-offs and through the wall end-of-bus take-offs.

7.8.8 All take-off configurations shall be appropriately tagged and close coordination shall be maintained between the Company and the Customer during construction to mark the phases properly.

7.9 Loading Capacity of 265/460 Volt Network Installations

7.9.1 The maximum number of service take-offs at a 265/460 Volt multibank installation is equal to the number of transformers paralleled at that installation. The minimum number of service take-offs is equal to the number of transformers remaining in service during the ultimate design contingency condition (first or second contingency design), with the following limitations:

A. Each installation shall have at least two service take-offs. All transformers feeding an interconnected bus network are considered part of one installation.
B. The maximum loading of any service take-off shall be limited to 4000 Amperes per phase for 1/2 hour demand.

C. The total load capacity of a 265/460 Volt installation is determined by the number of transformers paralleled at that installation, the design criterion (first or second contingency design) and the type of daily load cycle. Loading limits for transformers and network protectors are given in Application and Design Specification EO-2002.

7.9.2 The total load of a 265/460 Volt installation shall be equally divided among its service take-offs.

7.9.3 Installations that contain a mix of 2000 kVA and 2500 kVA transformers should be monitored for load growth so that no overload can occur on 2500 kVA units because of dissimilar impedances. The 2500 kVA banks will always be loaded 25% more under normal and any contingency conditions.

7.10 Ventilation

7.10.1 Ventilation requirements for 265/460 Volt transformer vaults and network protector a compartment as given in Application and Design Specification EO-2032, is as follows:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>2000</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>2500</td>
<td>56</td>
<td>56</td>
</tr>
</tbody>
</table>

7.11 Power Supply for Auxiliaries

7.11.1 Low voltage power circuits operating at 120/208 Volts shall be provided in each 265/460 Volt installation to supply lighting, sump pumps, hand tools and outlets for testing.

7.11.2 The low voltage supply can be obtained from the 120/208 Volt secondary network grid or from three 3.33 kVA autotransformers energized by the 460 Volt paralleling bus at the installation.

7.11.3 Lighting and Power circuits for a 265/460 Volt installation are illustrated on Drawing. No. EO-13712-B. EO-13712-B is part of Operation and Maintenance Manual No. 1.

8.0 GROUNDING

8.1 The neutrals of the sets of cables that connect a network installation to the secondary grid (street ties) provide an adequate ground for such installations.
8.1.1 Grounding in isolated and spot networks (with no street ties) is achieved by using the concentric neutral/lead sheaths of the primary cables and insulated 4/0 copper cable to connect the neutral bus in the paralleling bus vault to the system ground. For future installations, one insulated 4/0 copper cable for each network transformer should be installed for safety and reliability reasons. If the above requirement cannot be met, a minimum of two insulated 4/0 copper cables in separate ducts are required for each installation with approval from System Design manager or the designee. In addition, one 500 kcmil copper cable shall be used to connect the neutral bus of the installation to the building steel frame.

9.0 REQUIREMENTS PRIOR TO INSTALLING EQUIPMENT

9.1 No equipment shall be installed in any network protector compartment until the roof has been thoroughly water-proofed and the walls painted.

9.2 The installation of transformers and network protectors shall be scheduled as close to the service date as possible to minimize atmospheric moisture ingress that could lead to equipment damage.

9.3 Dry type transformers shall have their internal heaters energized immediately upon delivery to the installation. This is required prior to primary energization in order to prevent excessive moisture accumulation on internal parts.

9.4 When there is excessive moisture in the atmosphere of network protector compartments, dehumidifiers shall be placed in the compartments for duration of two weeks prior to energizing the installation. Regional Engineering shall determine if excessive moisture is present, and have sole discretion in the matter.

10.0 EXCEPTIONS

10.0 Any exceptions to the stipulations of this Specification shall be forwarded to the Manager of System Design of Distribution Engineering or his/her designee.
11.0 REFERENCES

<table>
<thead>
<tr>
<th>Specification</th>
<th>Title</th>
<th>Manual No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>EO-18</td>
<td>Ethylene Propylene Rubber Insulated Cables - 600 Volts</td>
<td>6</td>
</tr>
<tr>
<td>EO-1100</td>
<td>Sealing of Service Duct Entrances and Bus Openings in Electrical Distribution Structures</td>
<td>3</td>
</tr>
<tr>
<td>EO-1101</td>
<td>Conduits for Transformer Manholes and Vaults</td>
<td>4</td>
</tr>
<tr>
<td>EO-2002</td>
<td>Loading Limits for Network Transformer Bank Installations</td>
<td>4</td>
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<tr>
<td>EO-2032</td>
<td>Design Criteria for Ventilation of Transformer Vaults and Network Protector Compartments</td>
<td>4</td>
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<tr>
<td>EO-2065</td>
<td>Low Tension A.C. Service Voltage Limits</td>
<td>4</td>
</tr>
<tr>
<td>EO-2120</td>
<td>Criteria for Network Transformer Usage</td>
<td>4</td>
</tr>
<tr>
<td>EO-4007</td>
<td>Operation of Isolated Networks</td>
<td>5</td>
</tr>
<tr>
<td>EO-5011</td>
<td>Detailed Specification for 480/216 Volt Autotransformers</td>
<td>6</td>
</tr>
<tr>
<td>EO-5023</td>
<td>Requirements for Construction of 265/460 Volt Network Installations</td>
<td>3</td>
</tr>
<tr>
<td>EO-5031</td>
<td>Detailed Specification for Secondary Network Transformers</td>
<td>6</td>
</tr>
<tr>
<td>EO-5083</td>
<td>General Specification for Submersible Distribution Transformers and Reactors - Part I</td>
<td>6</td>
</tr>
<tr>
<td>EO-5103</td>
<td>Purchase Requirements for Network Protectors, and Network Protector Housing/Enclosures</td>
<td>6</td>
</tr>
<tr>
<td>EO-5207</td>
<td>Design Features for 480 Volt Limiters</td>
<td>6</td>
</tr>
<tr>
<td>EO-5316</td>
<td>Network Protector Fuses - 277/480 Volts</td>
<td>6</td>
</tr>
<tr>
<td>EO-5317</td>
<td>Service Take-Off Fuses - 277/480 Volts</td>
<td>6</td>
</tr>
<tr>
<td>EO-5331</td>
<td>Polyester Glass Mat Insulating Sheet</td>
<td>6</td>
</tr>
<tr>
<td>EO-5350</td>
<td>Manually Operated, 480 Volt, High Pressure Contact, Disconnect Switch</td>
<td>6</td>
</tr>
<tr>
<td>EO-5402</td>
<td>Fuses for Service Take-Offs, 120/208 and 265/460 Volt Services</td>
<td>4</td>
</tr>
<tr>
<td>EO-5410</td>
<td>Network Protector and Autotransformer Fusing and Selectivity with Cable Limiters, 265/460 Volt Network Installations</td>
<td>4</td>
</tr>
<tr>
<td>EO-5411</td>
<td>Network Protector Relaying</td>
<td>4</td>
</tr>
<tr>
<td>EO-5415</td>
<td>Standard Design and Ratings for Aluminum and Copper Bus in Network Vaults and Provision for Service Take-Offs</td>
<td>4</td>
</tr>
<tr>
<td>EO-6025</td>
<td>Procedure for Arcproofing Cables with Tape</td>
<td>3</td>
</tr>
<tr>
<td>EO-6043</td>
<td>Tagging of Cables</td>
<td>4</td>
</tr>
<tr>
<td>EO-7308-D</td>
<td>Insulation for Integral Web Channel Aluminum Bus</td>
<td>6</td>
</tr>
<tr>
<td>EO-10460-B</td>
<td>Name Plates for 265/460 Volt Transformer and Network Protector Installations</td>
<td>6</td>
</tr>
<tr>
<td>EO-11206</td>
<td>Operating Instructions for 480/216 Volt Autotransformers</td>
<td>1</td>
</tr>
<tr>
<td>EO-11211</td>
<td>Operation of 265/460 Volt Multiple Building Network Grid at East 55 Street to East 57 Street, Manhattan</td>
<td>1</td>
</tr>
<tr>
<td>EO-10704</td>
<td>Installation of 480V Submersible Bushing Adapter.</td>
<td>1</td>
</tr>
<tr>
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Sergio Rodriguez (Signature on File)
Sergio Rodriguez
Department Manager, System Design
Distribution Engineering Department

Juan Londono.

REVISION 12
Added 7.8.4.

FILE:
APPLICATION AND DESIGN MANUAL NO. 4