

[Refer to Engineering Notes at End of Spec]

Section [16XXX] [264XXX] - SURGE PROTECTIVE DEVICES (SPDs)

PART 1 - GENERAL

1.1 SCOPE

- A. This section includes Surge Protective Devices (SPDs) for low-voltage power equipment (1000Vac and less).
- B. Work under this section consists of furnishing all materials necessary for the execution and complete installation of Surge Protective Devices (SPDs).

1.2 RELATED WORK/SECTIONS

- A. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others except when permitted and then only after arranging to provide temporary utility services according to requirements indicated. Notify and coordinate with the engineer when an interrupt is required and prior to interrupting.

1.3 QUALITY ASSURANCE/REFERENCE STANDARDS

The SPD surge protection system shall be designed and manufactured, and where appropriate, listed to the following standards:

- A. Underwriters Laboratory (UL)
 - 1. UL1449 4th Edition: Surge Protective Devices (SPD)
 - 2. UL1283 5th Edition: Electromagnetic Interference Filters
 - 3. cUL – UL: Evaluation to Canadian Safety Requirements (UL 1449, 1283)
- B. Institute of Electrical & Electronic Engineers (IEEE)
 - 1. C62.41.1: 2002 IEEE Guide on the Surge Environment in Low-Voltage (1000V and less) AC Power Circuits
 - 2. C62.41.2: 2002 IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits
 - 3. C62.45: 2002 IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits
 - 4. C62.62: 2010 IEEE Standard Test Specifications for Surge Protective Devices for Low Voltage (1000V and Less) AC Power Circuits
 - 5. C62.72: 2016 IEEE Guide for the Application of Surge Protective Devices for Low Voltage (1000V and Less) AC Power Circuits
- C. National Electrical Manufacturers Association (NEMA)
- D. National Fire Protection Association, NFPA 70, National Electric Code, 2014 (NEC)
- E. Federal Information Processing Standards Publication 94 (FIPS 94), 1983 Guideline on Electrical Power for ADP Installations
- F. MIL-STD 220A

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Prepared by THOR SYSTEMS, INC.

1.4 PROJECT CONDITIONS

- A. Service Conditions: The Surge Protective Device (SPD) shall be rated for continuous operation under the following conditions:
1. Maximum Continuous Operating Voltage (MCOV): 115% to 125% of the nominal operating voltage
 2. Operating Temperature: -40°C to 60°C
 3. Relative Humidity: 0% to 95%, non-condensing
 4. Operating Altitude: 0 feet to 12,000 feet

1.5 SUBMITTALS

- A. Alternate manufacturers shall submit specification compliance report and drawings ten (10) days prior to bid for consideration.
- B. The specific item proposed and its area of application shall be indicated on the product specification sheet.
- C. Submit certified test results for all models as follows:
- UL listing verification:
1. Submit UL1449 4th Edition Voltage Protection Ratings "VPR".
 2. Submit proof that products are UL *listed and labeled by Underwriters Laboratories* to UL 1449 4th Edition.
- D. Provide warranty statement.

1.6 LOCATIONS

- A. See the electrical power riser diagram for Surge Protective Device (SPD) unit locations.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The following are the general requirements of the SPD products:
1. UL 1449 4th Edition Listed, bearing the official UL 4th Edition gold hologram label.
 2. UL 1283 5th Edition Listed.
 3. The Surge Protective Device (SPD) shall be a stand alone configuration. Systems that must be integral to the switchgear will not be considered.
 4. All SPD systems shall be permanently connected, parallel designs. Series suppression elements shall not be acceptable.
 5. The SPD shall be marked with a Short Circuit Current Rating (SCCR) and shall not be installed at a point on the system where the available fault current is in excess of that rating per the National Electric Code, Article 285, Section 6.
 6. All SPD units shall be from the same manufacturer.
 7. SPD designs using a single fuse to protect two (2) or more surge paths shall not be acceptable.
 8. SPD designs that limit the 100% rated surge protection shall not be acceptable.

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9. Fuse links or printed circuit board trace fusing shall not be acceptable.
10. Hybrid, three-tier design utilizing:
 - (a) Thermally Protected Metal Oxide Varistors (TpMOVs) featuring:
 - “Fail-safe” design technology with integrated thermal apparatus that monitors the status of the metal oxide disk with built-in dielectric protection and indication by an integral micro-switch.
 - The TpMOV eliminates the requirement of internal or external fuses (which would limit surge protection capability) for the surge protection components, while providing a Short Circuit Current Rating (SCCR) of 200,000 Amps.
 - (b) TVS Diodes (SADs), the most ideal suppression element with very fast reaction time, providing enhanced system longevity.
 - (c) EMI/RFI Filter Capacitors which are UL1283 Listed as defined by MIL-STD-220A test procedures.

2.2 MODULAR SURGE PROTECTION FOR SERVICE ENTRANCE/MAIN DISTRIBUTION AND CRITICAL EQUIPMENT APPLICATIONS

- A. Configured for the voltage as shown on the riser diagram and/or panel schedules.
- B. The SPD surge current ratings shall be based on the electrical system ampacity listed in the table below.

Electrical System Ampacity @ SPD Install Point	Surge Protection (kA)	
	Per Mode	Per Phase
2500 – 6000A	300	600
1200 – 2000A	250	500
600 – 1000A	200	400
225 – 400A	150	300
125 – 200A	100	200

- C. Modes of Protection: The SPD system shall provide surge protection in all possible modes (L-N, L-G, L-L, and N-G). Each replaceable module shall provide the uncompromising ability to deliver full surge current rating per mode.
- D. SPD modules shall be configured to isolate individual suppression component failures without causing total loss of surge protection in that mode.
- E. Opening of supplementary protective devices, internal or external, shall not be permissible during UL 1449 4th Edition Nominal Discharge testing.
- F. Optional Connection Methods: **[Distribution Block, 100A, #2AWG Wire] [Terminal Block, 60A #6AWG Wire] [Fused Disconnect, 60A, #6AWG Wire].**
- G. Each individual module shall feature a green LED indicating the individual module has all surge protection devices active. If any module is taken off-line, the green LED will turn off and a red LED will illuminate, providing *individual module* as well as *total system* status indication.
- H. The SPD shall include **[Solid State Status Indication Lights and Dual Form C Contacts] [Solid State Status Indication Lights, Dual Form C Contacts, Audible Alarm & Surge Counter] [Solid State Status Indication Lights, Dual Form C Contacts & Phase Loss Relay] [Solid State Status Indication Lights, Dual Form C Contacts, Audible Alarm, Surge Counter & Phase Loss Relay].**
- I. The modular SPD shall be provided in a NEMA 4X enclosure not exceeding 18”H x16”Wx10”D.

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- J. The SPD shall provide EMI/RFI electrical noise attenuation up to 43dB in the range of 50kHz to 100MHz as defined by MIL-STD-220A test procedures.
- K. **(OPTIONAL)** Extended Filter providing additional EMI/RFI electrical noise attenuation up to 53dB in the range of 50kHz to 100MHz as defined by MIL-STD-220A test procedures.
- L. Voltage Protection Ratings: The UL 1449 4th Edition Voltage Protection Ratings “VPR” (6kV, 3000 Amps, 8/20µs waveform) shall not exceed the UL assigned values listed below.

Voltage Protection Ratings (VPR) 6kV, 3000A, 8/20µs Waveform	Voltage Rating	
	208/120V	480/277V
Line to Neutral	800V	1200V
Line to Ground	700V	1200V
Neutral to Ground	600V	1000V
Line to Line	1200V	1800V

- M. The SPD shall have a minimum UL 1449 4th Edition Nominal Discharge Current Rating (I_n) of 10,000 Amps. When used in conjunction with a UL 96A certified Lightning Protection System the (I_n) rating shall be 20,000 Amps.
- N. Each SPD system shall be supplied with one (1) field replaceable module.
- O. It is recommended that all modular units use #6 AWG Rope Lay Wire (with 259 strands/30AWG, seven [7] groups of 37 strands each).
- P. Approved Manufacturer: The following SPD manufacturer and respective models shall be deemed acceptable, subject to conformance with indicated requirements:
 THOR SYSTEMS TSr Product Series

2.3 NON-MODULAR SURGE PROTECTION FOR DISTRIBUTION, SUB-DISTRIBUTION AND BRANCH CIRCUIT PANELS (LOWER AMPACITY, 15A TO 800A, APPLICATIONS)

- A. Configured as shown on the riser diagram and/or panel schedules.
- B. The SPD surge current ratings shall be based on the electrical system ampacity listed in the table below.

Electrical System Ampacity @ SPD Install Point	Surge Protection (kA)	
	Per Mode	Per Phase
400 – 800A	150	300
125 – 225A	100	200
15-100A	50	100

- C. The SPD shall be rated for **[480/277Vac 3 Phase, 4 Wire + Ground, Wye] [208/120Vac 3 Phase, 4 Wire + Ground, Wye] [240Vac 3 Phase, 3 Wire + Ground, Delta] [480Vac 3 Phase, 3 Wire + Ground, Delta] [240/120Vac 3 Phase, 4 Wire + Ground, High Leg Delta] [240/120Vac 1 Phase, 3 Wire + Ground]**.
- D. Modes of Protection: The SPD system shall provide surge protection in all possible modes (L-N, L-G, L-L, and N-G). Each device shall provide the uncompromising ability to deliver full surge current rating per mode.
- E. All non-modular units shall be factory wired using color coded #10AWG Rope Lay Wire (with 413 strands/36AWG, seven [7] groups of 59 strands each): two feet (2') for each phase conductor and three feet (3') for Neutral and Ground conductors.
- F. The SPD shall include **[Solid State Status Indication Lights] [Solid State Status Indication Lights & Form C Contact] [Solid State Status Indication Lights, Form C Contact, Audible Alarm & Surge Counter]**.
- G. The non-modular SPD shall be provided in a compact NEMA 4X polycarbonate enclosure with a CLEAR cover.
- H. The SPD shall provide EMI/RFI electrical noise attenuation up to 35dB in the range of 50kHz to 100MHz as defined by MIL-STD-220A test procedures.

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- I. Voltage Protection Ratings: The let-through voltage test results used to obtain the UL 1449 4th Edition Voltage Performance Ratings "VPR" (6kV, 3000 Amps, 8/20µs waveform) shall not exceed the UL assigned values listed below.

Voltage Protection Ratings (VPR) 6kV, 3000A, 8/20µs Waveform	Voltage Rating	
	208/120V	480/277V
Line to Neutral	700V	1200V
Line to Ground	700V	1200V
Neutral to Ground	800V	1200V
Line to Line	1000V	2000V

- J. The SPD shall have a minimum UL 1449 4th Edition Nominal Discharge Current Rating (I_n) of 10,000 Amps. When used in conjunction with a UL 96A certified Lightning Protection System the (I_n) rating shall be 20,000 Amps.
- K. Approved Manufacturer: The following NON-MODULAR SPD manufacturer and respective models shall be deemed acceptable, subject to conformance with indicated requirements:
 THOR SYSTEMS TSn Product Series (50 to 150kA/Mode)

2.4 WARRANTY

- A. All Surge Protective Devices (SPDs), associated hardware, and supporting components shall be warranted to be free from defects in materials and workmanship, under normal use and in accordance with the instructions provided, for a period of five (5) years.
- B. A detailed warranty statement shall be provided with each unit.

PART 3 – EXECUTION

- A. This section covers the execution and commissioning of the Surge Protective Device (SPD) required on this project.
- B. Technical assistance shall be provided by the manufacturer through the efforts of a factory representative or a local distributor.
- C. Verify absence of damage.
- D. The unit shall be installed in accordance with the manufacturer's printed instructions. All local and national codes shall be observed.
- E. The unit shall be installed with the same voltage rating as the intended protected equipment.
- F. The unit shall be installed on the load side of the service equipment overcurrent device.
- G. The location of the field-mounted SPD shall allow adequate clearances for maintenance.
- H. Lead Length: The mounting of the SPD shall ensure the connecting leads are as short (recommend one [1] meter or less) and straight (no sharp bends) as reasonably possible.
- I. Before energizing the SPD, the unit shall be verified as to: correct as specified: manufacturer, product series, and model number.
- J. All voltage modes including L-L (Line-to-Line), L-G (Line-to-Ground), L-N (Line-to-Neutral), and N-G (Neutral-to-Ground) shall be measured and verified against the unit voltage ratings.
- K. Continuity measurements shall be made between the Neutral and Ground connections to verify the Neutral-to-Ground bond.

~ End of Specification ~

ENGINEERING NOTES

NOTE #1: TERMINOLOGY AND STANDARD CHANGES

The UL 1449 3rd Edition added new “SPD Type” designations with **Type 1** replacing the **Surge Arrestor** designation which must be permanently connected between the secondary of the service transformer and the line side of the service equipment overcurrent device, as well as the load side (including Watt-hour meter adapters). These devices, previously known as Surge Arrestors, are intended to be installed without an external overcurrent protective device. **Type 2** designates permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device, including **Service Entrance, Distribution Panel, and Branch Panel** locations. **Type 3** is the designation for SPD plug-in strips and receptacles which must have a minimum conductor length of thirty (30) feet from the electrical service panel to the point of utilization. **Type 4** designates components and equipment installed within other listed equipment; denoted as “recognized” equipment (**R**).

The term “Surge Protective Device (SPD)” has been receiving recognition as a replacement for Transient Voltage Surge Suppression (TVSS). The abbreviation TVSS was first introduced by Underwriters Laboratory in early publications governing the devices, while SPD has been the preferred abbreviation of the International Electrotechnical Commission (IEC). UL used SPD for the first time when publishing UL 1449 2nd Edition; this was the first step toward standardization of this terminology. The **UL 1449 3rd Edition** has replaced TVSS with **SPD**. For clarification throughout this specification, the abbreviation of “**SPD**” is used.

NOTE #2: SPD APPLICATIONS

A **cascaded** installation with SPD units at the Service Entrance and downstream at the protected equipment panelboards is required for effective surge protection. This cascading, or using multiple SPD units, provides a protective barrier at the Service Entrance to reduce the electrical system exposure to **externally generated transients**, i.e. lightning, utility grid switching, high winds causing power line arcing, and electrical accidents. These sources represent a low percentage (less than 20%) of all transient activity, but can be of typically higher magnitude causing immediate hardware damage to electrical systems and destroying sensitive electronic equipment. **Internally generated transients** are created by changes in electrical demand, involving inductive and capacitive loads (i.e. starting and stopping of electrical motors, machine processes, pumping equipment, HVAC systems, etc.) These internal transients are typically smaller in magnitude, but a far greater number of such transient events accounts for 80% of all voltage transient problems (i.e. hardware failures for no apparent reasons, time and material losses caused by unnecessary restarts). These far more prevalent internal transients require distributed surge protection barriers throughout the electrical distribution system to provide protection for critical equipment and processes. If SPD devices are not installed, providing a low impedance path to divert these transient events, the lowest impedance path will be sensitive electronic controls within the customer’s critical equipment and processes.

The SPD applications should coordinate the surge protection to the installation parameters, requiring evaluation not only of the Surge Protective Devices but the electrical environment of the facility.

Susceptibility and Risk Assessment are often referred to when describing the ability of an installation to be affected by surge events. **Electrical system size, geographical location, distribution system voltage/configuration, available Short Circuit Current, equipment location and criticality of equipment to be protected** are all factors to be evaluated during coordination of multiple Surge Protective Devices (SPDs) and locations. (Suggest SPD coordination using **Site Shield 3g Spreadsheet**, which is available at www.ThorSystems.us.)

Modular designs are specifically for the more harsh Service Entrance, Main Distribution, and where protected equipment criticality is a vital consideration. **Non-modular** designs are typically applied for lower ampacity distribution, sub-distribution, and branch circuit panels.

NOTE #3: RECOMMENDED MODULAR DESIGN SPD CONNECTION METHODS

- A. CONNECTION METHOD A (PREFERRED): SPD Integral **Distribution Block** for terminating #2 AWG conductors fed from external 100A OCPD.
- B. CONNECTION METHOD B: SPD Integral **Terminal Block** for terminating #6 AWG conductors fed from external 60A OCPD.
- C. CONNECTION METHOD C: SPD Integral **Fused Disconnect** wired with #6 AWG conductors direct bus connected.

ENGINEERING NOTES, CONT'D.

Additional connection notes:

- Suggest specifying SPD configured for **bottom feed** to be mounted directly on top of switchgear or distribution equipment, therefore keeping the conductors as short and straight as possible. [NEC 2014 Article 404.8(A) Exception No. 2]
- Lead Length: The mounting of the SPD shall ensure the connecting leads are as short (recommend three feet [3'] or less) and straight (no sharp bends) as reasonably possible.
- The SPD shall be marked with a **Short Circuit Current Rating (SCCR)** and shall not be installed at a point on the system where the available fault current is in excess of that rating per the National Electric Code, Article 285, Section 6.
- Integral **Fused Disconnects** enable the convenient replacement of sacrificial modules, minimize downtime, and maximize protection.

NOTE #4: RECOMMENDED NON-MODULAR SPD CONNECTION METHODS

Non-Modular SPD Connection Methods		
Internal SPD Connection	External OCPD	Electrical System
Factory Wired with #10AWG Rope Lay Wire	30A Circuit Breaker*	Any Size
*The 30A, dedicated Circuit Breaker serves as a maintenance disconnect.		

NOTE #5: SPD APPLICATION SIZING GUIDE

See attached "SITE RISK ASSESSMENT" spreadsheet or for quick reference, refer to text and table below.

The SPD surge current ratings shall be based on the electrical system ampacity listed in the table below. Note: The "per phase" value derived by adding the L-N mode and the L-G mode.

SPD Application Sizing Guide		
Electrical System Ampacity @ SPD Install Point	Surge Protection (kA)	
	Per Mode	Per Phase
2500 – 6000A	300*	600
1200 – 2000A	250*	500
600 – 1000A	200*	400
225 – 400A	150**	300
125 – 225A	100**	200
15-100A	50**	100
*Modular recommended for this size **Modular or Non-modular, depending on the application susceptibility and criticality (Modular recommended for the more harsh Service Entry, Main Distribution, and where protected equipment criticality is a vital consideration.		

~ End of Engineering Notes ~

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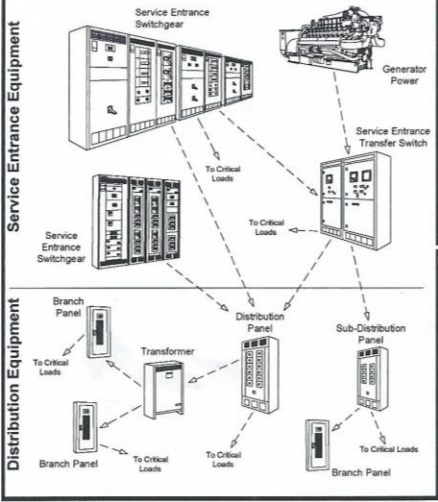
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SITE RISK ASSESSMENT

Proj Name _____
 Proj Location _____
 Company _____
 Contact _____
 Ph _____ Fx _____
 Email _____
 Prepared by _____
 Date _____



Determine Surge Protective Device (SPD) placement within facility. Complete Criteria Selections 1-7 below for each facility location (seven locations can be assessed on form). Total the value (refer to Table B for recommended SPD series/size. (See Example Application below.)

Assessment Criteria Selection	Location(s)							Example Application
	A	B	C	D	E	F	G	
1. Electrical System Capacity (at installation point) 9 (2500-6000A) 7 (1200-2000A) 4 (600-1000A) 3 (225-400A) 2 (125-200A) 1 (Up to 100A)								9 2,500A Switchgear
2. Geographical Location (see Maps below) Isokeraunic Map (Thunderstorm Days/Year): 4 (80-100) 3 (60-70) 2 (40-50) 1 (5-30) Mean Ground Flash Map (Mean Ground Flashes/Yr): 4 (13-16) 3 (9-12) 2 (5-8) 1 (1-4)								3 Dallas, TX 60 Storm Days
3. System Voltage 4 (600V) 3 (480V) 2 (240 or 208V) 1 (120V)								3 480V
4. Distribution System Configuration 3 (WYE) 2 (Delta)(Hi-Res Gnd) 1 (Single Ph)								3 WYE
5. Short Circuit Current (at installation point) 6 (101-200kA) 5 (51-100kA) 3 (26-50kA) 2 (15-25kA) 1 (5-14kA)								5 65kAIC
6. SPD Location (within electrical system) 8 (Svc Entrance w/Transfer Switch; power from utility) 7 (Svc Entrance w/o Transfer Switch; power from utility) 3 (Dist Panel ≥1000A; power from switchgear) 2 (Sub-dist Panel ≤1000A; power from panel; no Xfmr) 1 (Branch Panel ≤400A; power Xfmr)								8 Svc Entrance w/Transfer Switch
7. Load Criticality Range: 3 (least) to 10 (most)								10 7x24 Data Ctr
8. Numerical Value Total (see Table B)	0	0	0	0	0	0	0	43 43 = TSr300

Model Number (See Table "A")										Install Location - Description	Qty	
Key	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)			(10)
Example	TSr	i	300	F	x	3Y4	P	2	01	BFI	MSB1; 2500A, 480/277Vac	1
A												
B												
C												
D												
E												
F												
G												

Table "A" MODEL NUMBER

Example Model #: TSr i 300 F x 3Y4 P 2 01 BFI

Key (1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

(1) Thor Series
 TSr Modular Design
 TSn Non-Modular Design

(2) Grade
 i Industrial (with SADs)
 c Commercial (without SADs)

(3) Surge Current Rating
 TSn or TSr
 050 (50kA/Mode) 200 (200kA/Mode)
 100 (100kA/Mode) 250 (250kA/Mode)
 150 (150kA/Mode) 300 (300kA/Mode)

(4) Input Connection Type
 D Dist Block (Up to 1/0AWG) [TSr Only]
 F Fused Disc Switch (Up to #6AWG) [TSr Only]
 T Terminal Block (Up to #4AWG) [TSr Only]
 W Pre-Wired with #10AWG Wire [TSn Only]

(5) SAD Type
 s 1.5kW Series
 x 15kW Series
 z No SADs

(6) Voltage (ac) Configuration
 2S1 (240/120V Single Phase; 3W + G) 3D2 (240V 3-Phase Delta; 3W + G)
 2S2 (240V Single Phase; 2W + G) 3D4 (480V 3-Phase Delta; 3W + G)
 2S4 (480V Single Phase; 2W + G) 3H (240V Hi-Leg Delta; 4W + G)
 3Y2 (208/120V 3-Phase Wye; 4W + G) *3R2 (208/120V Hi-Resis Gnd; 3W + G)
 3Y4 (480/277V 3-Phase Wye; 4W + G) *3Y4 (480/277V Hi-Resis Gnd; 3W + G)

(7) Enclosure Type
 P Fiberglass, NEMA 4X [TSr Only]
 Polycarbonate, NEMA 4X [TSn Only]
 M Metal, NEMA 4 [TSn or TSr]
 S Stainless Steel, NEMA 4X [TSn or TSr]

(8) Monitor Type
 1 Status Lights Only
 2 Status Lights Plus Surge Counter & Audible Alarm

(9) Options
 00 No Options TSr or TSn
 01 Form C
 02 Extended EMI/RFI Filter
 03 Phase Loss relay
 04 Multi-Function Relay
 05 Combo of 01 & 02
 06 Combo of 01 & 03
 07 Combo of 01 & 04
 08 Combo of 02 & 03
 09 Combo of 03 & 04
 10 Combo of 01, 02 & 03
 11 Combo of 01, 03 & 04

(10) Orientation (TSr Only)
 TF Top Feed
 TF1 Top Feed / Internal Mtg Type 2 Monitor
 BF Bottom Feed
 BFI Bottom Feed / Internal Mtg Type 2 Monitor

*NOTE: If Assessment #7, Load Criticality, is 8 or higher, an Industrial Series is Recommended.

*SPD Built as Delta Configured - Neutral Conductor is not Connected.

Table "B" Numerical Total Recm'd SPD kA/Mode

Numeric Total	kA Rating	Product Series
42 - 48	300kA	TSr300
35 - 41	250kA	TSr250
28 - 34	200kA	TSr200
21 - 27	150kA	TSr/TSn150
16 - 20	100kA	TSr/TSn150
11 - 15	50kA	TSr/TSn150

Ground Improvement Required?

Ohms	Best	No
< 5 Ohms	Yes	No
5-10 Ohms	Typical	No
> 10 Ohms	High	Yes

