#### [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 3<sup>rd</sup> Edition: Surge Protective Devices (SPD)
  - 2. UL1283 5<sup>th</sup> 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: 2000 IEEE Standard Test Specifications for Surge Protective Devices for Low Voltage (1000V and Less) AC Power Circuits
  - 5. C62.72: 2007 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, 2008 (NEC)
- E. Federal Information Processing Standards Publication 94 (FIPS 94), 1983 Guideline on Electrical Power for ADP Installations
- F. MIL-STD 220A

#### 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 3<sup>rd</sup> Edition Voltage Protection Ratings "VPR".
- 2. Submit proof that products are UL *listed and labeled by Underwriters Laboratories* to UL 1449 3<sup>rd</sup> 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. Nomenclatures used herein are intended to indicate product type and configuration of equipment required.
  - 2. UL 1449 3<sup>rd</sup> Edition Listed, bearing the official UL 3<sup>rd</sup> Edition gold hologram label.
  - 3. UL 1283 5<sup>th</sup> Edition Listed.
  - 4. The Surge Protective Device (SPD) shall be a stand alone configuration. Systems that must be integral to the switchgear will not be considered.
  - 5. All SPD systems shall be permanently connected, parallel designs. Series suppression elements shall not be acceptable.
  - 6. 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.
  - 7. All SPD units shall be from the same manufacturer.
  - 8. SPD designs using a single fuse to protect two (2) or more surge paths shall not be acceptable.
  - 9. SPD designs that limit the 100% rated surge protection shall not be acceptable.

- 10. Fuse links or printed circuit board trace fusing shall not be acceptable.
- 11. 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 microswitch.
    - 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) Silicon Avalanche 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	Surge Protection (kA)				
Ampacity @ SPD Install Point	Per Mode	Per Phase			
2500 – 6000A	300	600			
1200 – 2000A	250	500			
600 – 1000A	200	400			
225 – 400A	150	300			
125 – 225A	100	200			

- 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 replaceable module shall provide the uncompromising ability to deliver full surge current rating per mode.
- E. SPD modules shall be configured to isolate individual suppression component failures without causing total loss of surge protection in that mode.
- F. Opening of supplementary protective devices, internal or external, shall not be permissible during UL 1449 3<sup>rd</sup> Edition Nominal Discharge testing.
- G. Optional Connection Methods: [Distribution Block, 100A, #2AWG Wire] [Terminal Block, 60A #6AWG Wire] [Fused Disconnect, 60A, #6AWG Wire].
- H. 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.
- 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].
- J. The modular SPD shall be provided in a NEMA 4X enclosure not exceeding 18"H x16"Wx10"D.

- K. 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.
- L. (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.
- M. Voltage Protection Ratings: The UL 1449 3<sup>rd</sup> Edition Voltage Protection Ratings "VPR" (6kV, 3000 Amps, 8/20µs waveform) shall not exceed the UL assigned values listed below.

Voltage Protection Ratings (VPR)	Voltage Rating				
6kV, 3000A, 8/20µs Waveform	208/120V	480/277V			
Line to Neutral	900V	1200V			
Line to Ground	800V	1200V			
Neutral to Ground	700V	1200V			
Line to Line	1200V	2000V			

- N. The SPD shall have a minimum UL 1449 3<sup>rd</sup> Edition Nominal Discharge Current Rating (I<sub>n</sub>) of 10,000 Amps. When used in conjunction with a UL 96A certified Lightning Protection System the (I<sub>n</sub>) rating shall be 20,000 Amps.
- O. Each SPD system shall be supplied with one (1) field replaceable module.
- P. All modular units are provided with thirty feet (30') of #6 AWG Rope Lay Wire (with 1050 strands/36AWG, seven [7] groups of 150 strands each).
- Q. Approved Manufacturers: The following SPD manufacturers 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	Surge Protection (kA)				
Ampacity @ SPD Install Point	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, 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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 Voltage Protection Ratings: The let-through voltage test results used to obtain the UL 1449 3<sup>rd</sup> Edition Voltage Performance Ratings "VPR" (6kV, 3000 Amps, 8/20µs waveform) shall not exceed the UL assigned values listed below.

Voltage Protection Ratings (VPR)	Voltage Rating			
6kV, 3000A, 8/20µs Waveform	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 3<sup>rd</sup> Edition Nominal Discharge Current Rating (I<sub>n</sub>) of 10,000 Amps. When used in conjunction with a UL 96A certified Lightning Protection System the (I<sub>n</sub>) rating shall be 20,000 Amps.
- K. Approved Manufacturers: The following NON-MODULAR SPD manufacturers 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 of 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.

### **ENGINEERING NOTES**

#### NOTE #1: TERMINOLOGY AND STANDARD CHANGES

The UL 1449 3<sup>rd</sup> 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 (**N**).

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 2<sup>nd</sup> Edition; this was the first step toward standardization of this terminology. The **UL 1449 3<sup>rd</sup> 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 protect from **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 2002 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 SHIELD 3g 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	Surge Prot	ection (kA)				
Ampacity @ SPD Install Point	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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# THOR SYSTEMS, INC.

# **SITE SHIELD 3g RISK ASSESSMENT SPREADSHEET** (Insert information in SHADED cells only . Totals automatically calculate as numbers are entered.)

PROJECT NAME/DATE/ORIGINATOR:									
	API	PLICATI	ON <u>CAL</u>		TIONS (7	7 SYSTI	EMS)		SAMPLE
SYSTEM	SYS	SYS	SYS	SYS	SYS	SYS	SYS		APPLICATION
APPLICATION CRITERIA	"A"	"B"	"C"	"D"	"E"	"F"	"G"	and the second	CALCULATION
1. Electrical System Ampacity at install point									
<b>9</b> (2500 - 6000A) <b>7</b> (1200 - 2000A) <b>4</b> (600 - 1000A) <b>3</b> (225 - 400A) <b>2</b> (125 - 200A) <b>1</b> (015 - 100A)								9	2,000A Switchgear
2. Geographical Location (City/State)									Dallas, TX
Isokeraunic Map (see map below)									
<b>4</b> (80-100) <b>3</b> (60-70) <b>2</b> (40-50) <b>1</b> (5-30)								3	60 Storm Days/yr
Mean Ground Flashes	And and a second second								
4 (13-16) 3 (7-12) 2 (5-8) 1 (1-4)								2	6 Flashes/km2/yr
3 System Voltage	1.00				representation				
<b>4</b> $(600)/(3)$ <b>3</b> $(480)/(3)$ <b>2</b> $(240 \text{ or } 208)/(3)$ <b>1</b> $(120)/(3)$								3	480V
4 Distribution System Configuration									
3 (M/XE) 2 (DELTA) 1 (Single/Split Phase)								3	Wye
5 Available short circuit current at install point						Constant of the second of the second s			
6 (125 - 200kA) 5 (65 - 100kA) 3 (30 - 50kA)								5	65kAIC
<b>2</b> (19 - 25kA) <b>1</b> (5 - 14kA)									
6. TVSS Location (within the electrical system)									
8 (Service Entrance/Switchgear/ATS)									
<ul><li>7 (Service Entrance/Switchboard/PB)</li><li>3 (Distribution Panelboard)</li></ul>								8	Svc Entrance/Swgr/ATS
2 (Sub-distribution Panelboard)									
1 (Branch Circuit Panelboard)									7.045 - 0 - 1
7. Appl. Criticality Range 5 to 10 (most critical)								10	7x24 Data Center
8. Numerical Value Lotals $(200)$ $= TC-200)$									
42-48  (300 KA = 157300) 35-41  (250 KA = 15r250)									
<b>28-34</b> (200kA = TSr200)								12	20064 - TC-200
<b>21-27</b> (150kA = TSr/TSn150)	0	0	0			0	0	43	300KA = 131300
<b>14-20</b> (100kA = $TSr/TSn100$ ) <b>8.12</b> (50kA = $TSr/TSn050$ )									
	ATION							EXAMP	PLE:
AFFLICATION RESOLTS. STSTEW IDENTIFIC	ATION							TSri3	00Sx 3Y4 M202
SYS A:								1Sn =	Replaceable Module
SYS C:								S=	Disconnect Switch
SYS D:								x =	15kW SADs
SYS E:					<b>Treff Tre</b>			3Y4 =	480/277vac 3Ph 4W+G
SYS F: -								M2 =	Metal Enc/Level 2 Mon
SYS G:								02 =	Extended Filter Network
THOR SYSTEMS OWNER ATTING CALCULATOR   MODEL, NUMBER NOMENCIATURE OD=No Options: Sid Model   151 1201/AC Single Phase 21+6   151 1201/AC Single Phase 21+6   151 2021/AC Single Phase 21+6   151 2021/AC Single Phase 21+6   151 201/AC Single Phase 21+6   151 201/AC Single Phase 21+6   151 201/AC Single Phase 21+6   152 240/120Vac Single Phase 11, N+6   152 240/120Vac Single Phase 12+6   150 150   150 150   150 150   150 150   150 150   150 150   150 150									
s of a boot of a									