

SECTION 26 43 13 – TRANSIENT VOLTAGE SURGE SUPPRESORS (TVSSs)

1.01 SUMMARY:

- A. ^{A16}**Scope:** Scope of work shall be in accordance with Paragraph 1.01 D. of Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), as required, to protect electrical and electronic circuits in parts of the Works. This Section of the Employer's Requirements shall be read in conjunction with the Sections listed in Table 26 43 13-1.^{A16}
- B. **Related Sections:**

Table 26 43 13-1: Related Sections			
1.	Section 01 81 26	-	Communications, Control, Safety, and Security Systems.
2.	Section 01 81 29	-	Electrical Systems.
3.	Section 26 05 26	-	Grounding and Bonding for Electrical Systems.
4.	Section 26 20 00	-	Electrical Low Voltage Distribution Work.
5.	Section 26 41 16	-	Lightning Prevention and Dissipation Systems.
6.	Section 27 10 00	-	Structured Cabling Systems for Communications Inside Plant.
7.	Section 27 37 00	-	Mobile Radio-communication Systems.
8.	Section 27 51 16	-	Public Address Systems.
9.	Section 27 53 13	-	Time Synchronization Systems.
10.	Section 28 23 00	-	Closed Circuit Video Systems.
11.	Section 40 94 43	-	Programmable Logic Controllers.
12.	Section 40 95 13	-	Process Control Hardware.

1.02 REFERENCE:

- A. **Applicable Publications:** Refer to Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.02.

1.03 REQUIREMENTS:

- A. **General Requirements:**
1. The contractor shall meet all applicable requirements of the following:
 - a) Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.03; and
 - b) Section 01 81 29 (*Electrical and Lighting Systems*).
 2. The units shall contain an adequate combination of high energy dissipators, filters, gas tubes, metal oxide varistors (MOVs), silicon avalanche suppressor diodes, voltage limiters, and zener diodes, as required.

3. Protectors shall meet the applicable requirements of ^{A10}IEC 61643-11, IEEE C62.41.1, and UL 1863. ^{A10}
 4. Units shall be compatible with the frequencies, impedances, power and voltage levels, and protected system, as applicable, and shall not interfere with the regular operation of the protected devices. The effects on frequency (i.e., insertion attenuation) and impedance (i.e., dBRL or VSWR) shall be negligible.
 5. TVSSs shall provide clear visual indication of operability or failure.
- B. **Items to be Provided:** The contractor shall furnish all required items including, but not being limited to, the following:
1. Grounding cables.
 2. Surge protected power bars.
 3. TVSSs for AC electrical panels, DC distribution lines, I/O Concentrator and PLC I/O, RF transmission lines, and telecommunications copper cables.
 4. Terminal blocks with OVPs for PLC I/O.
- C. **Equipment and Materials:**
1. **Grounding Cables:** Shall be made of copper sized as required but no less than #6 AWG.
 2. **Bulkheads:** Shall be suitable for entry/exit of multiple RF transmission lines and waveguides through a building wall.
 3. **Protectors for 24 VDC-derived Analog Signals:** All analog signals (i.e., 20 mA) that enter or leave a control enclosure shall be individually protected with a terminal block equipped with over-voltage protection (OVP) devices, constructed with at least a 3 stage circuit including a voltage suppression diode, a MOV and voltage arrestors.
 4. **Protectors for 24 VDC Discrete Signals:** Each control signal type shall be individually protected by electronic elements in the format of terminal blocks as follows:
 - a. All TTL-type discrete signals that enter or leave a control enclosure shall be protected with over-voltage protection (OVP) devices, constructed with at least a voltage suppression diode.
 - b. All PLC outputs that drive relay coils, solenoids or any other type coils, shall be protected by feedback suppression diodes.
 - c. Appropriate parallel RC circuits shall protect all PLC outputs or relay contacts that drive inductive loads.

- d. Appropriate parallel MOV circuits shall protect all PLC outputs or relay contacts that drive motor loads.

5. **Protectors for AC Electrical Power Distribution Circuits:**

a. **General:**

- 1) Each protector shall effectively and safely protect loads connected to electrical panel-boards against over-voltage, and shall be adequate for the corresponding voltages and number of lines or phases.
- 2) Modes of protection shall be the following:
 - a) **For Star Systems:** Shall include line to neutral (L-N), line to ground (L-G), and neutral to ground (N-G).
 - b) **For Delta Systems:** Shall include line to line (L-L).
- 3) Protection shall be in accordance with ^{A10}IEEE C62.41.1 ^{A10} or IEC62305-4 Ed. 2.0 zone of protection concept, and shall be coordinated between zones of protection.
- 4) Dissipation capacity shall be adequate for zone A or B, as applicable (assuming 8 x 20 us waveform). Protector for main boards shall be category "A", and for secondary panel-boards shall be category "B".
- 5) Equipment shall be based on replaceable metal oxide varistors (MOVs) modules, and shall be tested in accordance to UL 1449 or IEC equivalent. Equipment shall include an internal thermal fuse on its design.
- 6) Protective equipment shall be rated for short circuit level at the point of application.
- 7) Equipment shall be modular and shall include surge counter which displays the combined total number of transient voltage surges detected.
- 8) Equipment shall indicate status for each individual mode of protection. Each mode of protection shall be able to be independently replaced without the need to replace the complete equipment.

- 9) To limit the possibility of frequent TVSS replacements due to TOV, it is recommended that the Maximum Continuous Operating Voltage for the equipment be at least 125% of nominal voltage.
- 10) Equipment let-through voltages shall be in accordance with ^{A10}IEEE C62.41.1 ^{A10} Location categories A3 and B3 Ring waves and B3 and C3 Combination waves.
- 11) Equipment data and specifications shall be supplied in accordance with NEMA LS1 format.
- 12) Each protector shall have the following or better characteristics:

Table 26 43 13-2: Characteristics of Over-Voltage Protectors for Electrical Distribution Circuits	
Enclosure	NEMA 4 or 4X, non metallic
Fault Indicators	A light source for each feeder (phase or line), and dry contacts for remote indication

b. **Protectors for 120/208 VAC Panel-Boards:**

- 1) Protectors shall be 120/208 VAC, four-wire, three-phase panel-boards.
- 2) Units shall not pass a voltage higher than 210 VAC between line and neutral (per phase).

c. **Protectors for 120/240 VAC Single Phase Panel-Boards:**

- 1) Protectors shall be adequate for 120/240 VAC, 3-wire, single-phase panel-boards.

d. **Protectors for 480/277 VAC Three Phase Panel-Boards:**

- 1) Protectors shall be adequate for 480/277 VAC, 4-wire, three-phase panel-boards.

6. **Protectors for +125 VDC Distribution Lines:** Shall be as required to prevent or minimize damage to batteries, battery chargers, inverters, and power supplies in DC power systems of Section 26 33 00 (*Direct Current Equipment*).

7. **Protectors for Radio Frequency Transmission Lines:**

- a. Protectors shall have the following or better characteristics:

Table 26 43 13-3: Characteristics of Protectors for VHF and UHF Radio Transmission Lines	
Bandwidth	50-700 MHz
Connectors	“N” type, female
Enclosure	Aluminum
Impedance	50 Ω input and output
Insertion Loss	≤ 0.1 dB over the entire band
Maximum Power	125 watts in VHF and 375 w in UHF, unless a higher power capacity is required by other equipment being provided
Standing Wave Ratio (VSWR)	1.1:1
Supported Capacity	Multiple strikes up to 50 kA each
Throughput Energy	As required considering activation voltage and response time

- b. Units shall be considering whether DC continuity is required.

8. **Protectors for CCVS Coaxial Lines:**

- a. Protectors shall be adequate for protecting CCVS cameras and related equipment connected via coaxial cables.
- b. Units shall provide bidirectional protection and have the following or better characteristics:

Table 26 43 13-4: Characteristics of CCVS Coaxial Line Protectors	
Bandwidth	0-15 MHz
Connectors	“BNC” type
Enclosure	Aluminum
Impedance	75 Ω input and output
Insertion Loss	≤ 0.3 dB over the entire band
Standing Wave Ratio (VSWR)	1.1:1 over the entire video frequency band
Supported Capacity	Multiple strikes up to 18 kA each

9. **Protectors for Copper Telephone Lines:**

- a. Protectors shall be solid-state, 5-pin, plug-in type, interchangeable, ATIS T1.313 compliant, and adequate for the corresponding type of service.
- b. Protectors shall be provided with adequate base for multiple protectors.

10. **Surge Protected Power Bars for Cabinets and Racks:**

- a. Power bars shall be for rack mounting, surge protected 120 VAC, and UL 1449 compliant.
- b. Units shall have NEMA 5-15R type outlets, a lighted on/off power switch, diagnostics LEDs, an overload circuit breaker, and a metal housing with black color finish.

D. Installation:

1. General:

- a. All protectors shall be grounded in accordance with NFPA 70 and installed according to manufacturer's written instructions.
- b. Protectors shall be installed at "single point ground" locations whenever feasible.

2. Protectors for 24 VDC-derived Analog Signals: Shall be furnished for DIN rail mounting.

3. Protectors for 24 VDC Discrete Signals: Shall be furnished for DIN rail mounting.

4. Protectors for AC Electrical Power Circuits: Shall be installed on service entrance and electrical panel boards, with coordinated protection for the load.

5. Protectors for DC Distribution Lines: Shall be installed in the main control buildings and every machinery room where DC lines enter.

6. Protectors for Radio Frequency Transmission Lines: Shall be installed at bulkhead(s), as illustrated on Figure 26 43 13-1. One protector shall be furnished for every line, including GPS time receiver coaxial cables.



Figure 26 43 13-1: Typical RF line bulkhead with TVSSs.

7. Protectors for CCVS Coaxial Lines: Shall be furnished for coaxial end of CCVS camera cable before media converters.

8. Protectors for Outside Plant Copper Telephone Lines: Shall be installed in blocks of 5-pin connectors near the corresponding MDF.

1.04 DESIGN CRITERIA/SYSTEM PERFORMANCE

A. General:

1. **Problem to be Solved:** Over-voltage protection systems shall solve the following business needs:
 1. Protect equipment against possible damages due to excessive voltage and lightning.
 2. **Restrictions to be Considered:** (reserved)

B. Design Criteria:

1. The units shall be adequate for the operating signal voltage, current, frequency range, and rate.
2. Whenever possible, TVSSs shall have a contact closure and/or TTL 24 VDC output for alarm monitoring and audible alarm.
3. TVSSs shall be coordinated in cascade from primary to secondary power systems and other subsequent power transformation or conversion.

C. System Performance:

1. Unless otherwise specified, TVSS' response time shall be as follows or faster:
 - a. 25 nS for electronic devices and electrical line-to-neutral protection.
 - b. 100 nS for neutral to ground protection.
2. The protectors shall drain any potential which exceeds the limits established for the equipment being furnished.
3. Protectors shall have low insertion loss and a negligible effect on line impedance under normal operating conditions.

1.05 SUBMITTALS: The following shall be submitted for substantiation purposes:

- A. **Design:** The following shall be in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), ^{A10}Subparagraph 1.05 D.: ^{A10}
 1. Descriptive literature.
- B. **Re-submittals Just Prior to Purchasing Materials:** All items in A. above that have changed from original submittal shall be resubmitted in a Design Conference in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.05.

C. Upon Receipt of Shipped Items in Panama:

1. Instruction manuals for installation and maintenance.
2. Packing lists.

D. Prior to Issuance of Taking-Over Certificate:

1. List of recommended spare parts.
2. Test reports.

1.06 QUALITY ASSURANCE: Shall include the following in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Paragraph 1.06:

- A. Factory Quality Control Tests (FQCT).
- B. Warranty.

END OF SECTION