Bulletin 36-15-12
High voltage equipment standards/tamper-resistant transformer cooling fan/transformer cooling class designations Rules 2-024 3), 26-010 and 36-110

Issued May 2023
Supersedes Bulletin 36-15-11

Scope

1) Approval of high voltage equipment
2) Standards used for high voltage equipment
3) Outdoor transformer cooling fans
4) Tamper-resistant transformer cooling fans
5) Transformer cooling class designations
6) *Gas Insulated Switchgear (GIS)*

1) Approval of high voltage equipment

High voltage equipment shall be approved for use when certification product standards accredited by Standards Council of Canada are available. Rule 2-024 3) permits ESA to accept electrical products where there is no certification program; provided the equipment is built to a recognized standard and test data has been submitted demonstrating it is safe for use. In the absence of certification standards, the manufacturer or their agent, upon request, shall submit to the Electrical Safety Authority a declaration of conformance signed by a professional engineer. The declaration shall identify the equipment type, model number, serial number and the specific standard from which it is constructed. The declaration shall also include copies of the mandatory test documents which are required of the standard.

Note
A professional engineer (P.Eng) licensed by the Professional Engineers of Ontario (PEO) or an individual licensed by another professional engineering association, where the licensure's obligation to public safety of the home jurisdiction is substantially equivalent to those required by Ontario.

2) Standards used for high voltage equipment

Background
As explained above, high voltage equipment shall be certified or built to a recognized current standard.

Direction
Table B1 details the appropriate CSA standards to be used for high voltage transformers, enclosed switchgear and high voltage cable.

The acceptance of products based on the engineering standards listed in Table B1 may be subject to additional requirements based on the application.
Equipment such as oil filled distribution transformers and in-line reactors built to IEEE and ANSI standards, are also acceptable for use in Ontario. *(See Appendix A of this bulletin)*

Table B1: CSA Standards used for high voltage equipment

High Voltage Equipment	Application	Equipment Standard
Power transformers and reactors Liquid filled transformers	Outdoors within a fence*or Indoors within a vault	Built to CSA C88
Single-phase and three-phase liquid-filled distribution transformers Rated up to: - 34.5 kV; -1000 kVA single phase; and -3000 kVA for three phase	Outdoors within a fence*, or Indoors within a vault	Built to CAN/CSA C2.1 (See Note 1)
Pole-mounted, single phase distribution transformers for electric utilities Rated up to: -25 kV -167 kVA type ONAN	Outdoors or Indoors within a vault	Built to CAN/CSA C2.2
Low-profile, single-phase, pad-mounted distribution transformers with separable insulated high-voltage connectors Rated up to: -18 kV; -167 kVA	*-Outdoors* *-Pad-mounted,* *-Tamper-resistant or fence required**	Built to CAN/CSA C227.3 (See Notes 1 & 2)
Three-phase, pad-mounted distribution transformers with separable insulated high-voltage connectors Rated up to: -34.5 kV; -3000 kVA	*-Outdoors* *-Pad-mounted,* *-Tamper-resistant or fence required**	Built to CAN/CSA C227.4 (See Notes 1 and 2)

High Voltage Equipment	**Application**	**Equipment Standard**
Three-phase live-front pad-mounted distribution transformers Rated up to: -27.6/16 kV; -75 to 3000 kVA	-Outdoors -Pad-mounted, -*Tamper-resistant or fence required**	Built to CAN/CSA C227.5 (See Notes 1 and 2)
Power transformers and reactors Liquid filled transformers	-Outdoors -Pad-mounted -*Tamper-resistant or fence required**	Built to CSA C88 and built to general principles of tamper-resistant requirements such as C227 series or IEEE C57.12.28 (See Notes 1, 2 and 3)
Air-cooled transformers (Dry Type) Rated up to 72.5 kV	Single-phase and three-phase Non-hazardous indoor or outdoor	Certified to C22.2 No.47
Enclosed Switchgear up to and including 46 kV	Indoors or Outdoors within a fence*	Certified to C22.2 No.31
Enclosed Switchgear up to and including 46 kV	Outdoors No fence required	Certified to C22.2 No.31 (Marked “Tamper-resistant”)
Gas Insulated Switchgear	*-Indoors or outdoors* *-Pad-mounted* *-Tamper-resistant when outdoors or fence required**	*Field Evaluated SPE1000 and built to the general principles of tamper-resistant with additional requirements as specified in Section 6)*
Shielded and concentric neutral power cable for distribution utilities, Rated 15-46 kV	For direct burial or installation in ducts in both wet and dry locations and where cable will be exposed to sunlight. Installed in compliance with Part I	Built to CAN/CSA- C68.5
Shielded Power Cable for Commercial and Industrial Applications, 5-46 kV	Indoor, Outdoor, Aerial, Underground, or Underwater locations. Installed in compliance with Part I	Built to CSA C68.10
Type TECK 90 cable Rated up to:	Indoors or Outdoors Exposed wet or dry.	Certified to C22.2 No. 131

High Voltage Equipment	Application	Equipment Standard
- 5000 V and less; - maximum temperature rating of 90°C	Installed in compliance with Part I	
High voltage fuses rated above 1000 V		Built to IEEE Std. C37.41

See Bulletin 36-6- for fence requirements

Note 1
In addition to the applicable standard listed in Table B1, transformers with an integral load break switch, when used for service entrance, shall be:

- Built to recognized standards (as applicable) for transformers and a declaration of conformance is provided by the manufacturer or their agent (as described in Item (1) of this bulletin) attesting that:
    - the compartment which provides access to fuses does not contain consumer service conductors or other parts that remain energized when the load break switch is in the open position, and
    - the compartment which provides access to fuses is interlocked with the load break switch; or
- Field evaluated by an inspection body to the applicable standards including service entrance equipment requirements.

The scope of the CAN/CSA C227 series standards is primarily for utility transformers and further states: 'The operation of transformers complying with this Standard by other than an electric utility may be subject to additional requirements by the electrical inspection authority having jurisdiction.'

Note 2
In addition to the applicable standard listed in Table B1, transformers with an integral load break switch, when supplied by a customer owned high voltage feeder and where the integral preceding load break switch de-energizes the fuses in compliance with Rule 36-208 but does not de-energize other high voltage parts (also contained in the fuse compartment) such as load and dead break elbows, shall have the fuse compartment interlocked with an external visible break switch.

Note 3
Tamper-resistant means, in any normal operating condition, contact with live parts cannot be made either directly or by means of any conductive material, with or without the use of such common tools as might be accessible to children. It does not imply proof against any deliberate actions of adults or children.

All tamper-resistant transformers shall meet the requirements of Standard CAN/CSA C227 series or IEEE C57.12.28 including the following:

i) All gauges, valves, primary and secondary terminations, tap changers, oil pressure relief vents etc. shall be contained within the transformer enclosure.

ii) All access doors shall be hinged and be capable of being locked with a single lock.
iii) All access doors shall have no exposed bolts or nuts, and have a minimum of one captive penta bolt complete with fixed cup(s) as detailed in their respective clauses in C227 series standards or Clause 4.1.8 and Figure 1 of IEEE C57.12.28..
iv) Transformers shall have no external means of operation of switching equipment nor shall it have an external glass viewing window.
v) There shall be no exposed screws, bolts, or other fastening devices that are externally removable, except for any auxiliary fastening device that may be specified by the purchaser.
vi) There shall be no openings through which foreign objects such as sticks, rods, or wire may be inserted to contact live parts.
vii) Metal enclosed switchgear shall be certified to CSA C22.2 NO.31 for the intended application.

Appendix A: Additional **IEEE Standards for High Voltage Equipment**

C37.41-
Design Tests for High Voltage (>1000 V) Fuses and Accessories

C57.12.00 -
IEEE Standard For General Requirements For Liquid-Immersed Distribution, Power And Regulating Transformers.

C57.12.10 -
IEEE Standard Requirements for Liquid-Immersed Transformers.

C57.12.22 -
American National Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High Voltage Bushings, 2500 kVA and Smaller; High Voltage, 34 500 GrdY/19 920 Volts and Below; Low Voltage, 480 Volts and Below.

C57.12.28 -
IEEE Standard for Pad-Mounted Equipment - Enclosure Integrity.

C57.12.70-
For Terminal Markings and Connections for Distribution and Power Transformers.

C57.12.80 -
IEEE Standard Terminology for Power and Distribution Transformers.

C57.12.90 -
IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.

C57.16-
IEEE Standard for Requirements, Terminology, and Test Code for Dry-Type Air-Core Series-Connected Reactors.

C57.92 -
IEEE Guide for Loading Mineral-Oil-Immersed Power Transformers Up to and Including 100 MVA with 55°C or 65°C Average Winding Rise.

3) Outdoor transformer cooling fans

Direction
Cooling fans installed on outdoor transformers shall be installed:

1. within a fenced in station; or
2. as part of a tamper-resistant transformer supplying an industrial establishment in an area zoned industrial.

Note
Fan packages can only be installed on tamper-resistant transformers in low pedestrian traffic areas such as commercial and industrial area. Fan packages are not to be installed on tamper-resistant transformers located in residential areas.

4) Tamper-resistant transformer cooling fans

Direction
Tamper-resistant transformer cooling fans shall be provided with:

1. a totally enclosed fan motor; and
2. fan blades suitably guarded with openings no larger than 12.7 mm wide; and
3. wiring to the fan motor,
    a. installed in rigid metal conduit with metallic liquid-tight flexible conduit or Teck cable no longer than required to connect the motors, with heat shrink tubing installed over all fittings, and
    b. stainless steel torx screws used on all junction box covers to prevent access to cable connections, and
    c. supplied from a circuit or common breaker that when de-energized will be easily recognized such as a lighting circuit; and
4. a visible or audible alarm, or both, located in the facility's electrical room to alert personnel of a possible fan failure;
    a. clearly identified to indicate any overheating of the transformer, and
    b. with a manual reset.
5. If the fan control box is located at the transformer and contains fuses for protection of the individual fans, then the fuse holders shall be of the disconnecting type and be of touch or finger safe design in accordance with Rule 14-402.
6. Local motor disconnecting means located within sight of and within 9 m of the controller and the fan motors is neither required nor preferred provided Rule 28-604 1) b) ii) is complied with.

Used high voltage transformers shall bear the markings as may be necessary to identify the equipment, and require ratio, polarity, megger, oil dielectric, oil analysis and insulation resistance tests.

5) Transformer cooling class designations

Example: ONAF – **O**il **N**atural **A**ir **F**orced circulation

Liquid Filled Transformers Designations

Internal	First Letter Cooling Medium	O	Liquid with flash point less than or equal to 300°C
		K	Liquid with flash point greater than 300°C
		L	Liquid with no measurable flash point
	Second Letter Cooling Mechanism	N	Natural convection through cooling equipment and windings
		F	Forced circulation through cooling equipment, natural convection in windings
		D	Forced circulation through cooling equipment, directed flow in main windings
External	Third Letter Cooling Medium	A	Air
		W	Water
	Fourth Letter Cooling Mechanism	N	Natural convection
		F	Forced circulation

Dry Type Transformer Designations

1	Ventilated self-cooled: Class AA
2	Ventilated forced-air-cooled: Class AFA
3	Ventilated self-cooled / forced-air-cooled: Class AA/FA
4	Non-Ventilated self-cooled: Class ANV
5	Sealed -self-cooled: Class GA

6) Gas Insulated Switchgear (GIS)

Background:

Pad-mounted Gas Insulated Switchgear (GIS) complying with IEEE and IEC Standards that have traditionally been used by supply authorities is now commonly being specified for both service entrance and non-service entrance customer-owned high voltage installations. Recently, it has been identified the programmable overcurrent control typically used by this type of equipment does not meet the high voltage service entrance requirements of CSA C22.2 No. 31 and OESC Rule 36-204, which specifically requires a circuit breaker or fuse. The programmable overcurrent control uses fault interrupters complying with recognized applicable IEEE and IEC Standards.

In addition, certain configurations of GIS may include a grounding switch that has a potential of unintentionally grounding the supply authority service conductors.

For service entrance applications:
As an interim solution notwithstanding Rules 2-034, 26-250 and 36-204 and until ***May 1, 2025 (based on the date of notification of work to ESA)****, the ESA will* ***consider accepting under a deviation request*** *GIS equipment that is not approved for service entrance where the following criteria are met:*

- *Field Evaluated based on the SPE1000 (not including service entrance requirements);*
- *All fault interrupters are configured to provide equivalent overcurrent protection and have a full-load rating that may be closed with the safety of the operator with a fault on the system as required by Rule 36-204. Information on the required settings for that installation shall be provided by a third party (manufacturer, professional engineer, or other qualified person);*
- *Enclosure to have lockable separate compartments for:*
    - *Supply authority switching;*
    - *Supply authority cables; and*
    - *Main consumer switch;*
- *Main Consumer switch shall have load interrupting capability and the compartment shall be permanently labelled (factory or field) "MAIN CONSUMER SWITCH";*
- *All other switches shall have load interrupting capability;*
- *Compartments containing the cables and switch for supply authority use shall be locked by the supply authority and labelled "COMPARTMENT FOR SUPPLY AUTHORITY USE ONLY";*
- *Switches capable of grounding the service conductors shall be made incapable of being placed in the grounded position (Figure B2), unless locked in a separate compartment under the control of the supply authority (Figure B1) ; and*
- *The main consumer switch shall remain readily accessible (not locked by the supply authority)*

Diagram B3 is an example of a 2-way GIS configuration with a single main consumer switch application.
Diagram B4 shows a main consumer switch incorporating a supply authority loop or dual radial feed application.

Figure B1: 2 Way GIS with first switch under the control of the Supply Authority

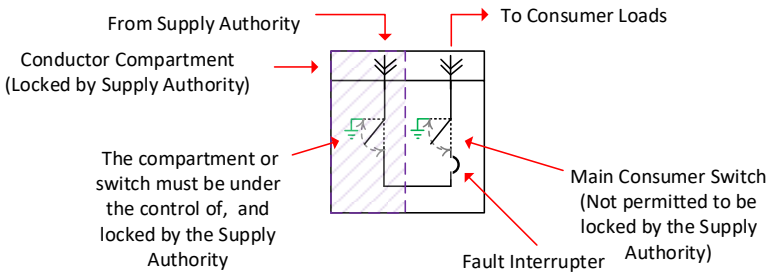


Figure B2: 2 Way GIS with first switch not under the control of the Supply Authority

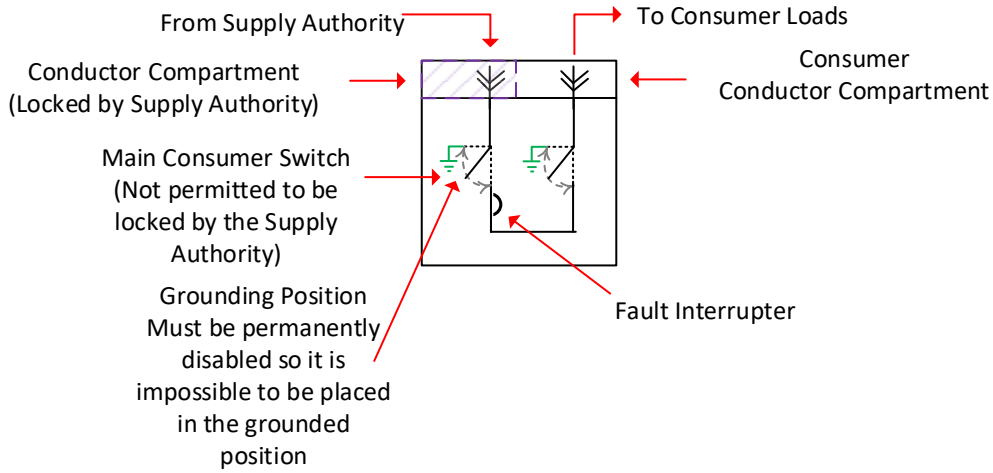


Figure B3: 2 Way GIS with single main consumer switch

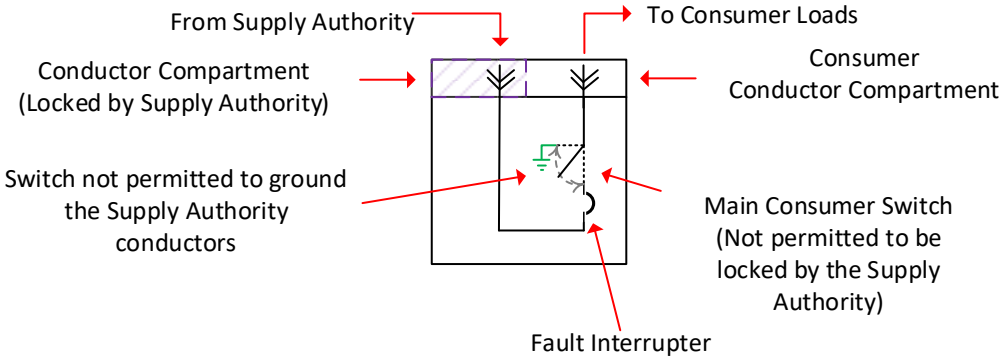
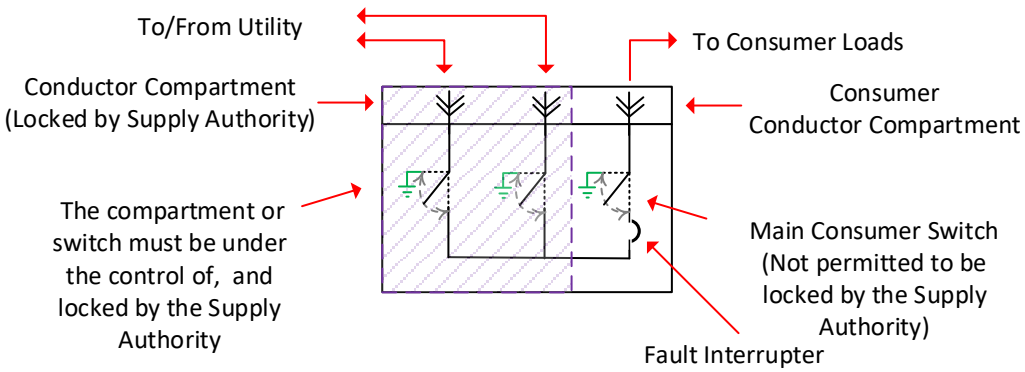


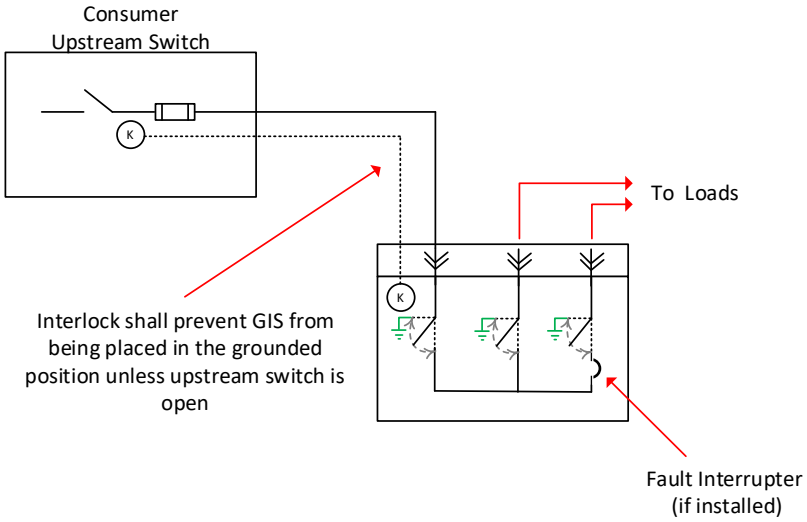
Figure B4: Supply Authority Distribution Loop/Dual Radial Feed



For Non-Service entrance applications:
As an interim solution notwithstanding Rules 26-250 and 36-204 and until ***May 1, 2025 (based on the date of notification of work to ESA)****, the ESA will* ***consider accepting under a deviation request*** *GIS equipment that incorporates fault interrupters where the following criteria are met:*

- *Field Evaluated based on the SPE1000;*
- *All fault interrupters are configured to provide equivalent overcurrent protection and have a full-load rating that may be closed with the safety of the operator with a fault on the system as required by Rule 36-204. Information on the required settings for that installation shall be provided by a third party (manufacturer, professional engineer, or other responsible qualified person) ;*
- *All other switches shall have load interrupting capability; and*
- *Switches capable of grounding energized conductors shall be made incapable of being placed in the grounded position unless interlocked with a preceding switch (Figure B5). (See Note 4)*

Figure B5: Consumer Owned (non-service entrance application)



Note 4:

For complex installations where it is impractical to provide interlocks. The deviation request will need to contain additional information detailing the reason for the request and written assurance detailing competent staff and procedures for switching will be implemented to avoid inadvertent back-feeding, live fuses, or grounding of energized conductors.