Z463-13

CSA Group

Guideline on maintenance of electrical systems

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The following revisions have been formally approved and are marked by the symbol delta (Δ) in the margin on the attached replacement pages:

Revised	Clause 8.2.7
New	None
Deleted	None

- Update your copy by inserting these revised pages.
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The following diagnostic tools can be employed to check the integrity of the outer sheath, metallic shield, and main insulation on power cables:
(a) time domain reflectometry (TDR);
(b) off-line PD at 60 Hz, very low frequency (VLF) or damped ac voltage (DAC);
(c) tan delta testing or dielectric spectroscopy at 60 Hz, VLF or DAC;
(d) reco voltage [i.e., transient recovery voltage (TRV)];
(e) dc leakage current;
(f) polarization and depolarization current; and
(g) online PD measurement.

8.2.4.2 Asset life cycle stages

The stage or phase of the power cables' life cycle should be taken into consideration in the selection of the diagnostic tool to be used.

The asset life cycle stages are as follows:
(a) commissioning (new cables);
(b) end-of-warranty period;
(c) in-service maintenance and condition assessment (aged cable); or
(d) after failure and repair (aged cables).

At the time of commissioning a newly installed cable system, the application of a dielectric withstand test using a 60 Hz, VLF or dc voltage waveform is acceptable and does not cause any reduction in cable life expectancy.

Thermographic inspection can be an effective condition-monitoring tool for cables on trays and for exposed terminations of underground cables.

8.2.4.3 Physical inspections

Physical inspections should be carried out on a routine basis and also during major maintenance shutdowns for
(a) signs of physical damage;
(b) loose screws, bolts, and nuts;
(c) evidence of overheating;
(d) discoloured, cracked, or brittle insulation or jacket;
(e) signs of sharp bends;
(f) signs of corrosion, discoloration, and oxidation of metallic shield;
(g) shield grounding and cable support; and
(h) signs of corona.

See Table M.3 for further details on the frequency of tests for different cable types.

8.2.5 Metal-enclosed busways

Metal-enclosed busways consist in high-current power circuits for distribution systems. They are categorized as cable busways and solid busways. They are primarily used in low- and high-voltage installations for plant distributions. They are often used to connect incoming supply transformers to primary switchgear.

Although metal-enclosed busways require minimal routine maintenance and inspection, they are often used to make connections between outdoor and indoor equipment and are therefore subject to deterioration due to environmental factors, such as moisture and mechanical damage from freeze/thaw cycles or thermocycling from large load fluctuations. As well, because they are typically part of the high current circuit, they are prone to thermal failures.

When incoming service equipment is de-energized for maintenance, busways should be inspected and evaluated for insulation resistance and contact resistance. See Table M.1.

8.2.6 Disconnect (isolation or load-break) switches and circuit switchers

It is important to understand the difference between circuit switchers and disconnect switches. Disconnect switches are used to isolate a circuit from a power source. A circuit switcher combines the functions of a

disconnect switch and of a load interrupter for interrupting (at rated voltage) currents not exceeding the continuous current rating of the switch.

Disconnect switches and circuit switchers require periodic maintenance to ensure their basic function (i.e., to safely open and close). The most important requirement is to exercise switches to ensure smooth operation and alignment. Switches should be scanned thermographically on a yearly basis.

Basic function testing requires several manual open-and-close operations at set intervals to drive linkage and prevent gears from seizing or grease from hardening, which would lead to slower action or no action at all. When switches are equipped with shunt trip devices, it is important to manually close the switch and then operate the shunt trip within the control schematic to confirm that the switch opens.

If the disconnect switch or circuit switcher has fuses, it is important to do a visual inspection to confirm that the fuse clips and latching mechanisms that hold the fuse are securely in place.

If the disconnect switch or circuit switcher enclosure has anti-condensation heaters, it is important to power up the heater and ensure that it functions as intended.

If the disconnect switch or circuit switcher has door interlocks, e.g., Kirk® keys, it is important to function test each device to confirm correct operation.

The inspections and maintenance tests should be documented and the results kept on file for future reference. As applicable, the program and settings should be documented in both hardcopy and electronic form. The sequence of events and fault indications should be documented and analyzed regularly. See Table M.4.2.

Δ 8.2.7 Circuit breakers

Circuit breakers require periodic maintenance to ensure that they perform their basic function (i.e., to safely open and close as required). Breakers should be exercised periodically to ensure smooth operation and alignment.

Basic exercising requires several manual open-and-close operations at set intervals to prevent bearings from flat topping or grease from hardening, which would lead to slower action or no action at all. Electrically operated circuit breakers should be exercised using their solid-state tripping devices or cell-mounted relays, if so equipped. When circuit breakers are equipped with tripping devices that can be tested by secondary injection or even with a 9 V battery, the first trip action should be initiated in this way to confirm that the breaker will interrupt a fault as intended.

Consideration should be given to

(a) phasing out dashpot relays on low-voltage circuit breakers; and
(b) replacing older high-voltage circuit breakers instead of rebuilding them. This will help to eliminate asbestos from the workplace, result in quicker opening times as new technologies are introduced (new, faster-tripping, more reliable circuit breakers), and produce lighter, more ergonomic equipment.

See Table M.4.1.

Note: *The* CEC, Part I *prohibits the use of rebuilt or refurbished moulded case circuit breakers or moulded case switches.*

8.2.8 Network protectors

Network protectors require periodic maintenance to confirm that they will perform their basic function (i.e., to safely open and close as required). The most important requirement for maintaining network protectors is to operate them. Thorough cleaning, inspection, and mechanical operation should be performed regularly to ensure correct operation. Mechanical operation should be performed manually as well as electrically and via protective devices.

Electrical tests should be performed to confirm adequate insulation integrity, contact resistance, and protective device calibration.

Protective devices, instrument transformers, and communication systems should be maintained in accordance with this Guideline.

The inspections and maintenance tests should be documented and the results kept on file for future reference. As applicable, the protective device settings should be documented in both hardcopy and electronic form.

See Table M.5.

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Preface

This is the first edition of CSA Z463, *Guideline on maintenance of electrical systems.* Several codes and standards, rather than a single seed document, have been used as references to develop this Guideline.

This Guideline on maintenance of electrical systems provides guidance on the application of safety management systems, the selection of reference standards and maintenance procedures, and the assessment of electrical equipment to verify correct function.

CSA acknowledges that the development of this Guideline was made possible, in part, by the financial support of Bruce Power, Cenovus Canada, Chemco Electric, Hydro-Québec, IRISS Inc., Magna Electric, Magna IV Engineering, Orbis Engineering, PACE, Pacific Powertech, PEARL, PSAMS, REV Engineering, Schneider Electric, and Vale.

This Guideline was prepared by the Technical Committee on Industrial and Commercial Electrical System Maintenance, under the jurisdiction of the Strategic Steering Committee on Occupational Health and Safety, and has been formally approved by the Technical Committee. Because of this Guideline's close association with the *Canadian Electrical Code*, it has also been reviewed by the Strategic Steering Committee on Requirements for Electrical Safety (SCORES).

Notes:

(1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*

(2) *Although the intended primary application of this Guideline is stated in its Scope, it is important to note that it remains the responsibility of the users of the Guideline to judge its suitability for their particular purpose.*

(3) *This Guideline was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Guideline.*

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(b) provide an explanation of circumstances surrounding the actual field condition; and
(c) where possible, phrase the request in such a way that a specific "yes" or "no" answer will address the issue.
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(5) *This Guideline is subject to review five years from the date of publication. Suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to* ***inquiries@csagroup.org*** *and include "Proposal for change" in the subject line:*
(a) Guideline designation (number);
(b) relevant clause, table, and/or figure number;
(c) wording of the proposed change; and
(d) rationale for the change.

Z463-13
Guideline on maintenance of electrical systems

0 Introduction (see Annex A)

0.1

This CSA Guideline on maintenance of electrical systems has been developed to improve safety for workers and protection of property through the adoption and systematic application of maintenance strategies for electrical equipment. It provides guidance on preferred practices for maintenance of electrical equipment and promotes the importance of maintenance of electrical systems.

The maintenance necessary for electrical equipment and systems that are critical to electrical safety for workers can be different than the maintenance required for uptime production or other business objectives. This Guideline defines methods of identifying equipment and systems that directly impact worker electrical safety and the reliability necessary for the safe operation of electrical equipment. The reliability objectives for electrical equipment and systems should be managed within the context of an organization's overall safety, reliability, and maintenance management system.

Organizations can use this Guideline to optimize the integration of other programs and systems, such as hazardous energy lockout control programs and workplace electrical safety programs, into their business management systems for critical equipment maintenance strategies. By conducting a critical analysis of existing maintenance strategies, an organization can improve the management of the electrical safety program as well as its maintenance and reliability program.

This Guideline highlights opportunities to derive benefits across a broad set of business performance parameters that depend on defect-free operation of electrical energy control and communications systems that are critical to sustaining operations. Recognition of limitations and the engagement of experts and teams in a multidisciplinary, collaborative process can lead to the discovery of new synergies and opportunities for optimization.

This Guideline incorporates management system concepts as a core value that establishes a foundation for the five "legs" of electrical safety summarized in Clause 0.2. It provides general guidance, with more detailed information provided in Clauses 7 to 9 addressing specific equipment and applications. The annexes provide practical information and tables that users of the Guideline can draw on to enhance the program for their particular industry

This Guideline is part of the CSA Z460 series, which constitutes a comprehensive trilogy of electrical safety publications. The trilogy consists of

(a) CSA Z460, *Control of hazardous energy — Lockout and other methods*;
(b) CSA Z462, *Workplace electrical safety*; and
(c) CSA Z463, *Guideline on maintenance of electrical systems*.

0.2

The five legs of electrical safety consist of the following elements (key references are listed for each item):

(a) standards and guidelines for safety by design techniques: Institute of Electrical and Electronics Engineers (IEEE) standards;
(b) equipment manufacturing engineering standards:
    (i) CSA C22.2, *Canadian Electrical Code, Part II*;
    (ii) American National Standards Institute (ANSI) standards;
    (iii) National Electrical Manufacturers Association (NEMA) standards; and
    (iv) National Fire Protection Association (NFPA) *National Electrical Code* series;

(c) Canadian installation codes, standards, and guidelines:
  (i) CSA C22.1, *Canadian Electrical Code, Part I* (*CEC, Part I*); and
  (ii) Canadian Electrical Contractors Association *Canadian Electrical Installation Standards* (*CEIS*);
(d) CSA safety management and safe work practices standards:
  (i) CAN/CSA-Z1000, *Occupational health and safety management*;
  (ii) CSA Z1002, *Occupational health and safety — Hazard identification and elimination and risk assessment and control*;
  (iii) CSA Z1006, *Management of work in confined spaces*;
  (iv) CSA Z1600, *Emergency management and business continuity programs*;
  (v) CSA Z460, *Control of hazardous energy — Lockout and other methods*; and
  (vi) CSA Z462, *Workplace electrical safety*; and
(e) maintenance practices standards:
  (i) CSA Z463, *Guideline on maintenance of electrical systems*;
  (ii) InterNational Electrical Testing Association (NETA) standards and specifications; and
  (iii) NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance.*

1 Scope

1.1 General

1.1.1
This Guideline provides guidance for the maintenance of electrical equipment and systems.

1.1.2
This Guideline applies to new and existing electrical equipment.

For new installations of electrical equipment, this Guideline can be applied during the early design stages to allow for the implementation of proactive electrical maintenance practices and maintenance safety.

1.2 Purpose
The purpose of this Guideline is to facilitate the safe, reliable, and cost-effective operation of electrical equipment and systems through the application of consistent maintenance practices.

The recommendations in this Guideline are intended to address worker safety as a primary objective and the protection of property and the environment as secondary objectives.

1.3 Application
This Guideline is suitable for application by organizations of any type or size.

1.4 Terminology
This Guideline is written in non-prescriptive language. In this Guideline, “should” is used to express a recommendation, or that which is advised but not required, and “may” is used to express an option, or that which is permissible within the limits of the Guideline.