ALBERTA ELECTRICAL UTILITY CODE

Safety Codes Council

Sixth Edition - August 2022

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Established by the
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PREFACE

▲ This sixth edition of the *Alberta Electrical Utility Code* supersedes the previous editions published in 2016, 2013, 2007, 2002, and 1999.

▲ For this Code to be comprehensive and complete, users must have access to two CSA Standards, namely CSA Standard C22.3 No. 1:20, *Overhead Systems*, and CSA Standard C22.3 No.7:20 *Underground Systems*.

General arrangement

The *Alberta Electrical Utility Code* (the AEUC) is divided into numbered Sections, each covering a specific topic related to the work. The Sections are divided into numbered Rules, with captions for easy reference, as follows:

(a) **Numbering system** - Even numbers have been used throughout to identify Sections and Rules. Rule numbers consist of the Section number separated by a hyphen from the 3-digit figure. The intention is that odd numbers may be used for new Rules required by interim revisions. Due to the introduction of some new Rules and the deletion of some existing Rules during the revision of each edition, the Rule numbers for any particular requirement are not always the same in successive editions.

(b) **Subdivision of Rules** - Rules are subdivided as follows:

00-000 Rule
(1) Subrule
(a) Item
(i) Item
(A) Item

(c) **Tables** - Tabulated information has been included in order to best organize information and to avoid unnecessary repetition of information. Tabulated information is not intended to be a mandatory requirement. Information provided in Tables may be made a requirement of the AEUC by the Rule which references the Table.

(d) **Figures** - Several figures have been included in this edition of the AEUC. Users are reminded that the included figures are intended only as examples of the requirements of the AEUC and are not intended to be mandatory requirements.

(e) **Appendices** - Notes on Rules have been grouped into appendices. Informational notes are not intended to be mandatory requirements. Notes on Rules located in the AEUC are found in Appendix B. Notes on Rules found in CSA C22.3 No. 1 are included in Appendix C. Notes on Rules found in CSA C22.3 No. 7 are found in Appendix D. Information included in Appendix B, C, or D may be made a requirement of the AEUC by a Rule which references the informational note.

Identification of Changes

Changes from the last edition of the AEUC are indicated with a triangle ▲ where a requirement has been added or amended. A triangle ▲ is not included where the change to a Rule is due to simple re-numbering, grammar correction, text formatting, or other non-functional change. The null symbol ∅ denotes the removal of a requirement. Care must be taken not to rely on the change markers to determine the current requirements of the AEUC.

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SECTION 0 - OBJECT, SCOPE, AND DEFINITIONS

Object

▲ The object of this **Code** is to establish a minimum safety standard for the installation and maintenance of electrical utility systems in Alberta. Enhancing safety for electrical utility installations by minimizing the potential risk of shock and fire hazards have been guiding principles in its preparation.

Compliance with this **Code** coupled with proper maintenance will provide an essentially safe installation. This **Code** is not intended as an instructional manual for untrained persons.

This **Code** and any standards referenced herein do not make or imply any assurance or guarantee by the authority adopting this **Code**, with respect to life expectancy, durability, or operating performance of equipment and materials referenced herein.

Scope

(See Appendix B.)

This **Code** applies to

(1) The construction, maintenance, and replacement of:

- **(a)** electrical utility systems that are used to transform, transmit, distribute, and deliver electrical power or energy to consumers' services or their equivalent, including street lighting;
- **(b)** the portion of generation facilities that are used to provide inter-connection to an electrical utility system up to the demarcation point as established between the generator and the electrical utility system; and
- **(c)** **transmission lines** and **electric distribution systems** connected to the Alberta Interconnected Electric System meeting the following conditions:
  - **(i)** this **Code** is applied only insofar as it applies to high-voltage **transmission lines** and **electric distribution systems** designed under the care and control of a **registered engineering professional** experienced in the application of this **Code**, and
  - **(ii)** the installation, design, and selection of the equipment is documented by a **registered engineering professional** experienced in the application of this **Code**;

(2) other objects located in such proximity to electrical utility systems that safety hazards or physical or inductive interference may result, and

(3) activities conducted in such proximity to electrical utility systems that safety hazards or physical or inductive interference may result.

Existing installations, including maintenance replacements, maintenance additions, and additions that meet the original design that currently comply with prior editions of this **Code** need not be modified to comply with this edition of the **Code** except as might be required for safety reasons by the **authority having jurisdiction.**

▲ Communication lines, circuits, and systems under the scope of this **Code** include **communication systems** owned by **electric utilities** for the sole purpose of the operation of the electrical utility system.

▲ **Communication utilities** which fall under federal jurisdiction are excluded from the scope of this **Code**. This notwithstanding, the clearances identified in this **Code** shall apply to **communication systems** owned or maintained by **communication utilities** but installed on electrical utility infrastructure.

Definitions

(See Appendix B.)

For the purpose of correct interpretation, certain terms have been identified in this **Code** in bold text. Where such terms or their derivatives appear throughout this **Code**, they shall be understood to have the meanings shown below. For terms not specifically defined below, the meaning shall come from the latest revision of C22.3 No. 1 or C22.3 No.7 if the term is defined therein, and from an ordinary dictionary if not.

acceptable – acceptable to the **operator of the utility system**.

activity or **activities** – the execution of a task or action by a person or persons.

approved – equipment that has been:

- **(a)** certified by a certification body in accordance with the certification body's terms of accreditation with the Standards Council of Canada, or
- **(b)** inspected by an inspection body in accordance with the inspection body's terms of accreditation with the Standards Council of Canada.

authority having jurisdiction – the organization, office, or individual legally authorized to enforce this **Code**, unless otherwise noted, and having jurisdiction over specified territory. (See Appendix B.)

Code – the Alberta Electrical Utility Code (AEUC).

combustible dust – dust particles that present a fire or explosion hazard when dispersed and ignited in air.

combustible flyings – solid particles, including fibres that may be suspended in air and can settle out of the atmosphere under their own weight.

communication system(s) – any physical apparatus, device, line, network segment, or other thing that is used or is capable of being used for electronic transmission of information over distances. The information may be in the form of voice telephone calls, data, text, images, or video. Transmission may be by wire, radio, optical cable, electromagnetic, or other similar means.

communication utility – any corporation, company, individual or association of individuals, or its lessees, trustees or receivers, that owns, operates, manages or controls all or a part of any plant or equipment for the provision of telecommunications service, directly or indirectly to or for the public.

competent – adequately qualified, suitably trained and with sufficient experience to safely perform work without supervision or with only a minimal degree of supervision.

conductive dust – combustible metal dust.

electric distribution system – as defined in the Alberta Hydro and Electric Energy Act. (See Appendix B.)

electric utility – an entity as defined in the Electric Utilities Act. (See Appendix B.)

fire point – the lowest temperature of a liquid in an open container at which vapours are evolved fast enough to support continuous combustion.

gradient control conductor(s) – a buried conductor used to control **touch potential** and **step potential**.

ground potential – the voltage between the point in the earth under consideration and a point in the earth considered to be at zero voltage.

ground potential gradient – the rate of change with respect to the distance along or through the earth, expressed in volts per unit distance.

ground resistance – the ohmic resistance measured by the two-probe method or equivalent measuring method.

guarded – covered, fenced, enclosed, or otherwise protected by means of suitable covers or casings, barrier rails or screens, mats or platforms, designed to limit the likelihood, under normal conditions, of dangerous approach or accidental contact by persons or objects.

isolated – to disconnect completely a device or circuit from other devices or circuits, separating it physically, electrically, and mechanically from all sources of electrical energy. (See Appendix B.)

non-propagating liquid – an insulating liquid that, when subjected to a source of ignition, may burn but the flame does not spread from the source of ignition.

operator of a utility system or **operator of the utility system** – the owner of the electrical utility system, and may include an organization, office, or individual designated by the owner to make policy decisions affecting the utility.

registered engineering professional – an individual who is authorized to engage in the practice of engineering under the Alberta Engineering and Geoscience Professions Act and its Regulations.

special permission – the written permission of the **authority having jurisdiction**.

step potential – the difference in voltage level from one foot of a person to the opposite foot. This can be felt when a person steps across an energized path of earth. The worker forms a parallel path to the earth and current flows through the worker as well as the earth. This can result in harmful current levels in some situations.

substation(s) – as defined in the Alberta Hydro and Electric Energy Act. (See Appendix B.)

transmission line – as defined in the Alberta Hydro and Electric Energy Act. (See Appendix B.)

touch potential – the difference in voltage level between energized electric lines or equipment and the earth. This may be felt by a person standing on the ground when they contact the electric lines or equipment and complete a parallel path to earth. The voltage may be supplied by a power system element such as a portable generator, or by unintentional energization. or by induction. **Touch potential** can vary greatly, as it depends on the distance from where the worker is standing to the location of the source voltage.

SECTION 2 - GENERAL RULES

2-002 Prohibition

(1) No person shall construct, maintain, or replace objects, or conduct activities near electrical utility systems or other objects described in the Scope, except in accordance with this **Code**.

2-004 Unsafe Conditions

If a person contravenes any of the Rules of this **Code** and an unsafe condition exists, then the system, object or **activity** shall be altered in a manner and within time limits specified by the **authority having jurisdiction**.

2-006 Canadian Electrical Code, Part I

If there is any conflict between any provisions of CSA Standard C22.1, *Canadian Electrical Code, Part I,* and this **Code**, the provincial ministry responsible for the adoption of these codes shall determine which provision shall apply.

2-008 Referenced Standards

If standards or other documents referenced in this **Code** have been amended, revised, or supplemented, the amendments, revisions, or supplements may be used where **special permission** has been granted.

2-010 Responsibility for Alterations (See Appendix B.)

If any installation, construction, building or other improvement, or equipment has been installed, placed, or erected and the installation, placing, or erection results in some other existing installation, construction, building or other improvement, or equipment being in contravention of this **Code,** then the installation, construction, building or other improvement, or equipment last placed in point of time shall be considered as being in contravention of this **Code**.

2-012 Interference with Systems

(1) No person shall interfere with, tamper with, or wilfully damage electrical utility systems covered by this **Code**.

(2) Electrical utility system poles and structures shall be kept free of all materials and equipment not required for the system, unless permitted by the **operator of the utility system**.

(3) No person shall make attachments to electrical utility system poles and structures unless authorization has been received from the **operator of the utility system**.

(4) No person shall climb electrical utility system poles or structures or make connections or disconnections to electrical utility system equipment unless the person has been authorized to do so by the **operator of the utility system**.

(5) No person shall enter an electrical utility system generating station, **substation**, subsurface chamber, equipment room, or similar location unless that person is authorized to enter by the **operator of the utility system**.

2-014 Activities near Overhead Power Lines (See Appendix B.)

(1) This Rule applies to activities near overhead powerlines and not the movement of persons, equipment, buildings, vehicles, or objects under overhead powerlines.

(2) A person must contact the **operator of the utility system** before activities other than those in Subrule (1) are undertaken or equipment is operated within 7.0 meters of an energized overhead line to:

(a) determine the voltage of the power line; and
(b) establish the appropriate safe limit of approach distance listed in Table 1.

(3) Except as provided for in Subrule (4), a person must ensure that the safe limit of approach distance, as established in Subrule (2), is maintained and that no activities are undertaken and no equipment is operated at distances less than the established safe limit of approach distance.

(4) A person must notify the **operator of the utility system** before activities are undertaken or equipment is operated in the vicinity of the power line at distances less than the safe limit of approach distances listed in Table 1, and obtain the operator's assistance in protecting persons involved.

▲ **(5)** Notwithstanding Subrules (1) through (4), Table 1 does not apply to utility workers falling under the OH&S Code, Part 40 Utility Workers – Electrical.

(6) A person must ensure that earth or other materials are not placed under or beside an overhead power line if doing so reduces the safe clearance to less than the *Minimum Vertical Design Clearances above Ground or Rails* as defined in Table 5 of this **Code** and the safe limit of approach distances listed in Table 1.

(7) A person must follow the direction of the **operator of the utility system** in maintaining the appropriate safe clearance when conducting activities near an overhead power line.

▲ **(8)** If an **activity** is being carried out near the safe limits of approach distances specified in Table 1, the person completing the **activity** shall assign a **competent** person to act as an observer whose only responsibility is to ensure that the safe limit of approach distances will be maintained.

▲ **(9)** A person shall not excavate or perform similar operations in the vicinity of an overhead or underground power line if it reduces the electrical and structural integrity of the power line including associated grounding equipment.

2-016 Buildings or Objects near Overhead Equipment or Lines

No person shall construct or place buildings or other objects within the minimum clearances from overhead equipment or lines prescribed by this **Code** unless it is **acceptable** to the **authority having jurisdiction** and the **operator of the utility system**.

2-018 Moving Equipment or Buildings

(1) The safe limit of approach distances listed in Table 1 do not apply to a transported load, equipment, or building that is transported under energized overhead power lines.

(2) If the total height, including equipment transporting it, is less than 4.15 m, the load can be moved under lines.

▲ **(3)** If the height of the equipment, building, or object exceeds 4.15 m and the equipment, building, or object must be moved under overhead power lines or communication lines, the following precautions shall be taken:

▲ **a)** the person or persons responsible for moving the equipment, building, or object shall contact the operators of the overhead lines before the move has started and request assistance;

▲ **b)** the operators of the overhead lines shall comply with the request for assistance as soon as possible; and

▲ **c)** the operators of the overhead lines shall provide assistance in accordance with the requirements of the Occupational Health and Safety Act and the Safety Codes Act.

2-020 Excavation Activities in the Vicinity of Underground Power Lines (See Appendix B.)

▲ **(1)** Before an excavation is started, the person responsible for the excavation shall contact the operator of the underground cables in the area to determine:

(a) if underground cables are present at the excavation site;
(b) if direct supervision is required during the excavation activity; and
(c) if specific safety measures are required to complete the excavation activity.

(2) Before an excavation is commenced, the operator of the underground cables shall identify and mark any underground cables that could be interfered with when the excavation is undertaken at the proposed excavation site.

▲ **(3)** The person responsible for an excavation shall ensure that no excavations are undertaken within 1 m of any underground utility cable unless:

(a) the excavation is done under the care and control of the operator of the underground cables; and
(b) the excavation method is **acceptable**.

2-022 Amusement Rides and High Equipment

The minimum clearance between the highest point of an amusement ride or area where high equipment may be displayed and an overhead power line, measured horizontally between the nearest vertical planes formed by the amusement ride or the displayed equipment and the overhead power line, shall be:

(a) the height of the amusement ride or displayed equipment, or 8 m, whichever is greater for overhead power lines operated at voltages above 750 V phase to phase;
(b) as specified in Clause (a) for overhead power lines with bare conductors operated at voltages below 750 V phase to phase; and
(c) 3 m for overhead power lines with insulated or polyethylene-covered conductors operated at voltages below 750 V phase to phase.

2-024 Consumer's Service Connection

The **operator of a utility system** shall not connect, or allow to be connected, an electrical consumer's service to the electrical utility system unless:

(a) the attachment point for conductors used on overhead systems to supply the consumer's service is located so that the conductors maintain required clearances;

(b) the metering equipment and location are **acceptable**;

▲ **(c)** the **operator of the utility system** has assurance from the owner or the owner's agent that the installation is ready for connection and no obvious hazards should result;

▲ **(d)** the **operator of the utility system** has received a copy of a valid permit or authorization issued by the consumer's authority having jurisdiction; and

▲ **(e)** for existing service re-connections, and at the discretion of the **operator of the utility system**, a re-inspection of the consumer's service is performed.

2-026 Decorative Fixtures and Circuits

(1) No person shall install lighting fixtures, lighting circuits, garlands, or any other apparatus used for decorative purposes on electrical utility system poles or structures unless the **operator of the utility system** approves the installation.

(2) The installation and removal of decorative lighting on electrical utility system poles and structures shall be controlled by the **operator of the utility system**.

(3) Decorative lighting equipment installed on electrical utility system poles and structures must be **approved**.

▲ 2-028 Plans

The **operator of the utility system** shall maintain, and produce when required by the **authority having jurisdiction**, documents, including but not limited to drawings and specifications, covering new construction of or alterations to an electrical utility system.

2-030 Other Lines in Rural Areas

(1) If underground pipelines are installed in rural areas, the **operator of the utility system** shall ensure that a separation of 8 m is maintained from:

(a) the poles and structures of an overhead power line operating at voltages above 750 V phase to phase; or

(b) an electrical utility system pole with earth return system grounding and conductors operating below 750 V phase to phase.

(2) If the separation described in Subrule (1) cannot be met, the separation may be reduced if:

(a) the **operator of the utility system** locates buried ground conductors; and

(b) the installation is **acceptable**.

▲ 2-032 Operation and Maintenance (See Appendix B.)

(1) The **operator of a utility system** shall ensure that the equipment and lines are:

(a) not energized unless the equipment and lines meet the requirements of this **Code**; and

(b) inspected at regular intervals, as required; and

(c) maintained in accordance with this **Code**.

(2) The **operator of an electrical utility system** shall ensure that equipment or lines not in use are maintained in accordance with this **Code**.

(3) The operator of a **communication system** shall ensure that equipment or lines not in use are maintained in accordance with this **Code**.

SECTION 6 - GROUNDING OF OTHER THAN OVERHEAD AND UNDERGROUND POWERLINES

6-000 Scope (See Appendix B.)

This Section applies to the grounding of:

(a) generating stations and **substations** covered by this **Code**; and

(b) other objects in proximity to electrical utility systems where the operation of the electrical utility systems may cause unsafe or objectionable voltages to appear on the other objects.

6-002 Object (See Appendix B.)

All electrical utility and **communication systems** covered by this **Code** shall be grounded in order to:

(a) reduce the risk of exposure to harmful voltages and the danger of electrical shock;

(b) stabilize system voltages;

(c) facilitate the operation of protective devices to reduce the risk and duration of harmful voltages; and

(d) protect communication circuits, control circuits, and other equipment.

Grounding of Generating Stations and Substations

6-100 Scope

▲ **(1)** Rules 6-100 to 6-120 apply to:

(a) generating stations; and

(b) **substations**

▲ **(2)** The requirements of Rules 6-100 to 6-120 do not apply to:

(a) electrical equipment at generating stations that is required to operate the station but is not a part of an electrical utility system; and

(b) power supplies, lighting circuits, or similar equipment located in **substation** buildings that are required to operate the **substation** but are not a part of an electrical utility system.

6-102 Generating Station, Substation Grounding

Substation and generating station grounding shall follow the grounding principles and practices outlined in the latest publication of IEEE 80 or CAN/CSA-C22.3 No. 61936-1, Section 10.

▲ 6-104 Generating Station, Substation Ground Resistance (See Appendix B.)

(1) The **ground resistance** of a generation station or **substation** grounding system shall be established so that the **ground potential** rise resulting from the fault current flowing from the grounding system to earth does not exceed 3 kV peak.

(2) If the requirements of Subrule (1) cannot be met, the grounding system must be designed, engineered, and constructed in accordance with recognized industry standards.

(3) A generation station or **substation** shall have a measured **ground resistance** value for the grounding system.

▲ 6-106 Grounding Generator and Transformer Neutrals

(1) Subject to Subrule (2), at generation stations and **substations**, generator and transformer neutrals of star grounded systems shall be grounded with a ground conductor connected to the ground grid.

(2) Subrule (1) does not apply where an impedance grounded system is used.

6-108 Grounding Neutral Conductors

(1) Neutral conductors entering generating stations or **substations** shall be grounded with a ground conductor connected to the ground grid.

▲ **(2)** Impedance grounding devices may be used for the grounding system required by Subrule (1).

▲ 6-110 Grounding Metallic Equipment (See Appendix B.)

(1) All current and non-current-carrying metallic equipment located within 3 m of a generation station or **substation**, or located within a **substation**, shall be grounded or bonded in accordance with this Rule.

(2) All metallic structures contained within the station or **substation** shall be bonded to the grounding grid at a minimum of one point.

(3) All non-current-carrying metallic equipment shall be grounded or bonded.

(4) All current-carrying metallic equipment shall be grounded to the ground grid.

6-112 Grounding Metallic Equipment Entering a Station or Substation

(1) Non-current-carrying metallic equipment that enters a generating station or **substation** shall be grounded or **isolated** in accordance with this Rule.

(2) Lightning protection wires that terminate at generation stations or **substations** shall be grounded to the ground grid.

(3) Railway tracks entering generating stations or **substations** shall be **isolated** at the station or **substation** boundary to prevent the transfer of unsafe potentials to the tracks outside the station or substation.

(4) Guy wires shall be grounded or bonded in accordance with Section 10 of this **Code.**

(5) All other non-current-carrying metallic equipment entering a generating station or **substation** shall be effectively **isolated**, or precautions shall be taken where necessary to control unsafe potential transfers.

6-114 Communication and Control Circuits

Communication and control circuits entering a generating station or **substation** shall be **isolated** where necessary to prevent the transfer of unsafe potentials out of the station or **substation.**

6-116 Grounding of Generating Station and Substation Fences (See Appendix B.)

Fences enclosing substations and metallic fences located in proximity to generating stations where unsafe **touch potential** or **step potential** may be transferred to the fence or area adjacent to the fence shall be grounded in accordance with this rule. See Figures 7 and 8 for:

(1) A ground electrode shall be placed at:
- **(a)** all corner posts and hinged gate posts; and
- **(b)** line posts at intervals not exceeding 12 m.

(2) A ground conductor not smaller than No. 4 AWG shall connect the ground electrodes required by Subrule (1) to:
- **(a)** the base of the fence post;
- **(b)** two places on the chain link fabric; and
- **(c)** each barbed wire strand.

(3) An extra flexible conductor not smaller than No. 2 AWG shall be used to ground hinged gates to the gate post.

(4) A ground grid conductor or **gradient control conductor** connected to the gate post ground conductor shall be placed across all gate openings.

(5) If fences are located less than 3.0 m horizontally from generating station equipment, **substation** equipment, ground grid conductors, **gradient control conductors**, or where unsafe **touch potential** or **step potential** may be transferred to the fence or the area adjacent to the fence:
- **(a)** a **gradient control conductor** shall be installed around the fence at a horizontal distance of 500 to 1000 mm from the fence;
- **(b)** a **gradient control conductor** connected to the conductor required by Clause (a), shall be installed 500 to 1000 mm beyond the area where gates in the open position extend beyond the **gradient control conductor** required by Clause (a); and
- **(c)** two or more physically separated ground grid conductors shall be used to connect the **gradient control conductor** enclosing the fence to the generating station or **substation** ground grid.

(6) The **gradient control conductor** required by Subrule (5) shall be connected to the ground conductors required by Subrule (2).

(7) At generating stations or **substations** where the ground grid is extensive, the ground electrodes required at the line posts may be omitted where:
- **(a)** additional physically separated interconnecting ground grid conductors are installed to connect the fence **gradient control conductor** to the ground grid; and
- **(b)** no unsafe **touch potential** or **step potential** will be transferred to the fence or the area adjacent to the fence.

(8) If buildings are used to enclose generating stations or **substations** or to form part of the enclosure:
- **(a)** metallic structural parts shall be grounded to the ground grid; and
- **(b)** if metallic surfaces are used on the outside of the building and unsafe **touch potential** or **step potential** may be transferred to the metallic surface, or the area adjacent to the metallic surface, a **gradient control conductor** connected to the ground grid shall be installed around the building or part of the building at a horizontal distance of 500 to 1000 mm from the building.

(9) A surface material layer of suitable resistivity may be used to supplement the gradient control protection required by Subrules (5) and (8) or to eliminate the requirement for **gradient control conductors**.

(10) The composition of the surface material described in Subrule (9) shall not include conducting material.

6-118 Grounding Other Equipment at Stations, Substations

Electrical equipment referred to in Rule 6-100(2) at generating stations or located within **substation** buildings that is required to operate the station or **substation** but is not a part of an electrical utility system shall be grounded in accordance with the requirements of CSA Standard C22.1, Canadian Electrical Code, Part I.

6-120 Sizing of Grounding Conductor

Grounding conductor used for grounding current-carrying equipment or ground grid conductor shall be sized such that overall energy does not cause:

(a) mechanical failure,
(b) annealing, or
(c) thermal damage.

Grounding of Buildings, Pipelines, Fences, and Other Objects in Proximity to Generating Stations or Substations

▲ 6-200 Scope

Rules 6-200 to 6-210 apply to the grounding of buildings, pipelines, fences, and other objects in proximity to a generating station or **substation**.

6-202 Buildings

If buildings are located in proximity to generating stations or **substations** or form part of a generating station or **substation** enclosure, the buildings shall be grounded in accordance with Rule 6-116 (8) to (10).

6-204 Pipelines

(1) All pipelines in proximity to a generating station or **substation** shall be effectively **isolated** or precautions shall be taken where necessary to control unsafe potential transfers.

(2) Specific considerations with pipelines are the transfer of potential to cathodic protection systems or coating stress levels under fault conditions.

6-206 Metallic Fences

(1) Metallic fences located in proximity to generating station or **substation** fences where unsafe **touch potential** or **step potential** may be transferred to the fence or area adjacent to the fence shall be grounded in accordance with Rule 6-116.

(2) Metallic fences joining generating station or **substation** fences shall have insulating sections not less than 3 m in length installed between the metallic fence and the generating station or **substation** fence.

6-210 Close Metallic Objects

All other non-current-carrying metallic equipment in proximity to a generating station or **substation** shall be effectively **isolated**, or precautions shall be taken where necessary to control unsafe **touch potential** or **step potential.**

SECTION 8 - SUBSTATIONS AND ELECTRICAL EQUIPMENT INSTALLATIONS

8-000 Scope

This Section applies to **substations** and electrical equipment installations used by an **operator of the utility system** in the exercise of its function as a utility, in:

(a) the portion of generation facilities that are used to provide interconnection to a utility system up to the demarcation point, as established between the generator and utility;

▲ **(b)** **substations** that are enclosed with fencing or enclosed in a building;

(c) a mobile or temporary **substation** application; and

▲ **(d)** **substations** that have some or all components individually enclosed with no overall exterior fence.

8-004 General

All **substations** and electrical equipment shall be designed, engineered, and constructed in accordance with recognized industry standards, and shall be installed to reduce the hazard as far as practicable.

8-006 Maintenance

(1) **Substations** and electrical equipment shall comply with this **Code** when placed in service and shall thereafter be periodically maintained and inspected as required.

(2) **Substations** and electrical equipment shall be maintained in good working order.

8-008 New Equipment

New equipment shall be thoroughly inspected and tested before being put into service.

8-010 Idle Equipment

Infrequently used equipment or wiring maintained for future service shall be inspected and tested before use in order to determine its fitness for service.

8-012 Emergency Equipment

Equipment or wiring used for emergency electrical services shall be inspected and tested in accordance with the manufacturer's specifications, or with the specifications authenticated by a **registered engineering professional** to determine its fitness for service.

Electrical Equipment Buildings

8-014 Buildings

In **substation** buildings, all rooms or spaces in which electrical supply equipment is installed shall comply with the following requirements:

(a) they shall be non-combustible as far as practicable;

(b) they shall not be used for the storage of unnecessary materials;

▲ **(c)** they shall be free from **combustible dust, conductive dust, combustible flyings,** flammable gas, or acid fumes in dangerous quantities;

(d) they shall be well ventilated;
(e) they shall be kept dry as far as practicable unless the equipment is suitably designed to withstand prevailing conditions;
(f) they shall be adequately illuminated;
(g) illumination shall be provided, both for the front and rear of equipment, so that the equipment may be readily operated and instruments conveniently read;
(h) a separate emergency source of illumination shall be provided in every station;
(i) all external entries into buildings shall be secured; and
(j) active ventilation or evacuation of gas for buildings containing equipment capable of gas release.

8-016 Floors, Passageways, Guardrails, Handrails, Permanent Ladders, and Toe Boards

Floors, passageways, guardrails, handrails, permanent ladders, and toe boards shall be installed and maintained in accordance with the applicable Occupational Health and Safety standards.

8-018 Supporting Surfaces above Live Parts

(1) The supporting surfaces above live parts shall be without openings.

(2) Toe boards at least 150 mm high shall be provided at all edges, and the lower edge of the toe board shall be flush with the platform.

8-020 Exits

(1) Each room or space and each working space around equipment shall have a suitable means of exit, which shall be kept clear of all obstructions.

(2) Where the size of the room or space or the arrangement of cables and equipment is such that one means of exit may become inaccessible, two or more exits shall be provided and located to best serve the intended purpose.

(3) Where doors are used for emergency exits, panic hardware shall be provided to permit easy exit.

8-022 Dimensions of Working Space near Live Parts on Panelboards and Control Panels Indoors

The horizontal dimensions of the working space in front of exposed live parts operating at a maximum potential of 750 V phase to phase shall be not less than the following and as per Figure 5:

(a) for parts on one side of more than 150 V to ground, and no exposed live or grounded parts on the other side of the working space, 0.9 m;
(b) for parts on one side of more than 150 V to ground, and exposed live or grounded parts of the other, 1.2 m;
(c) for parts on one side of less than 150 V to ground, and no exposed live or grounded parts on the other side, a minimum of 0.75 m; and
(d) for parts on one side of less than 150 V to ground, and exposed live or grounded parts on the other side, 0.9 m.

8-024 Fire Extinguishers

(1) Fire extinguishers **approved** for use on electrical fires shall be provided near every **substation** building exit door.

(2) Notwithstanding Subrule (1), a fire extinguisher **approved** for use on electrical fires shall be provided at each interior exit where the nature of the work warrants it, or as required by Rule 8-020 (2).

Working Space near Electrical Equipment

8-030 General Requirements

(1) Adequate and readily accessible working space with secure footing shall be maintained about all electrical parts or equipment which require adjustment or examination while in service.

(2) Where necessary, steps and handrails shall be installed on or about large electrical equipment to allow ready access to controls or ancillaries.

(3) A minimum working space 0.9 m by 0.9 m by 2.2 m high shall be provided outside the guard zone. (See Figure 3.)

8-040 Exposed Parts of More Than 750 V

(1) No current-carrying parts of more than 750 V phase to phase shall be exposed (unguarded) unless those parts are effectively **isolated** by elevation.

(2) Subrule (1) does not apply where such parts are occasionally left exposed by the removal of covers of entrances into enclosures such as switch and instrument transformer cells or switchgear compartments.

(3) When exposing energized parts per Subrule (2) for any purpose (including buses and disconnections in compartments), the working space shall be provided in accordance with the requirements of Rule 8 030(3).

8-042 Elevated Parts

Separation or clearance about normally elevated or **isolated** parts requiring occasional adjustment shall be provided so that persons need not come within the guard zone near adjacent energized parts unless they are **guarded** in accordance with Rule 8-200.

8-044 Transmission Machinery

Pulleys, belts, and other equipment used in the mechanical transmission of power shall be safeguarded in accordance with the applicable Occupational Health and Safety standards.

8-046 Guarding of Suddenly Moving Parts

Parts of equipment, such as handles, levers, and operating arms, which may move suddenly in such a way that persons in the vicinity are liable to be injured by being struck, shall be **guarded** or **isolated.**

Liquid-Filled Electrical Equipment

8-100 Scope

Rules 8-102 and 8-104 apply to any liquid-filled electrical equipment.

8-102 Electrical Equipment Containing Flame Propagating Liquids

This rule applies to electrical equipment containing insulating liquids with a **fire point** of less than 300° C.

▲ **1)** If liquid-filled electrical equipment is installed outdoors, the **operator of the utility system** shall ensure that:

a) the electrical equipment is not placed on a pad or foundation at ground level unless all live parts are enclosed, fenced or elevated so as to be inaccessible to unauthorized persons;

b) the electrical equipment is arranged or protected to minimize fire hazards in proportion to the amount of liquid contained by one or more of the following methods as applicable:

i) space separations;
ii) fire resistant barriers;
iii) automatic extinguishing systems;
iv) crushed-rock absorption beds;
v) enclosures which confine the liquid of a ruptured tank; or
vi) sloping grade away from buildings; and

c) if the electrical equipment is located adjacent to a building, it shall be installed in accordance with the requirements of CSA Standard C22.1, *Canadian Electrical Code, Part I.*

2) If the liquid-filled electrical equipment is installed indoors, the **operator of the utility system** shall ensure that the installation:

a) meets the requirements of CSA Standard C22.1, *Canadian Electrical Code, Part I*; and

b) is equipped with fireproof doors where the doorways provide an opening from the outside of the building to the enclosure containing the equipment.

8-104 Electrical Equipment Containing Non-propagating Liquids

This rule applies to electrical equipment containing insulating liquids that are non-propagating and have a **fire point** of 300° C or greater.

▲ **(1)** If the liquid-filled electrical equipment is installed outdoors, the **operator of the utility system** shall ensure that:

(a) the electrical equipment is spaced a minimum of 6 m from any building ventilation, window, or door; and

(b) if a barrier is in place to prevent spray of liquid to areas listed in Clause (a), then the spacing requirement of Clause (a) does not apply.

▲ **(2)** If the liquid-filled electrical equipment is installed indoors, the **operator of the utility system** shall ensure that:

(a) the installation meets the requirements of CSA Standard C22.1, *Canadian Electrical Code, Part I*; and

(b) each pressure relieving device is separately vented to the outside of the building if the liquid is capable of producing explosive or toxic gases.

▲ 8-106 Electrical Liquid-Filled Equipment Containing Harmful Material

The **operator of the utility system** shall ensure that liquid-filled electrical equipment containing harmful material capable of causing adverse environmental or health effects:

(a) is provided with the means to prevent or mitigate the propagation of the liquid; and

(b) bears appropriate warning signs concerning any health or environmental hazards associated with the liquid; and provides reference to information indicating the proper methods of using, handling, and disposing of the liquid.

Guarding and Protection of Live Parts

8-200 Guarding of Live Parts

(1) Guards shall be provided near all live parts that operate above 150 V phase to ground without an adequate insulating covering, unless their location gives sufficient horizontal or vertical separations or clearances, or a combination thereof, in order to eliminate the possibility of accidental human contact.

(2) Separations or clearances from any live part to permanent supporting surface for persons shall equal or exceed those shown in Figure 3 and Table 3.

(3) The application of the distances in Table 3 and use in Figure 3 are absolute values from the reference surface plane.

8-202 Strength of Guards

Guards shall be sufficiently strong and shall be supported securely enough to prevent them from being displaced or deflected by a person slipping and falling against them.

8-204 Guarding by Location or Isolation

(1) Parts having clearances equal to or greater than those specified in Table 3, Columns 3 and 4 shall be considered **guarded** by location.

(2) Parts shall be considered **guarded** by isolation where all entrances to enclosed spaces, runways, and ladders are kept locked, and warning signs are posted at all entrances, in which case no other permanent guards need be supplied.

(3) Effectively grounded metal cable sheaths are suitable guards. Metal conduit or other suitable protection shall be provided where cables are exposed to mechanical damage.

(4) Guards less than 0.1 m outside of the guard zone shall completely enclose the parts from contact up to the heights listed in Column 3 of Table 3.

(5) Guards shall not be closer to the live parts than the limits listed in Column 5 of Table 3, unless suitable insulating material is used with circuits of less than 2.5 kV to ground.

(6) Where they are more than 0.1 m outside the guard zone, the guards shall be a minimum of 2.5 m above the floor for indoor applications.

(7) Covers or guards that may be removed while the parts they guard are energized shall be arranged so that they cannot readily be brought into contact with energized parts.

(8) If the vertical separation or clearance in Column 3 of Table 3 cannot be obtained, guardrails may be used.

(9) Guardrails used in Subrule (8) shall be a minimum of 1 m in height.

(10) Where guardrails are used, they shall be located at a horizontal separation or clearance of at least 1 m (and preferably not more than 1.2 m) from the nearest point of the guard zone which is less than 2.5 m above ground, and shall be fitted with a suitable warning sign. (See Figure 4.)

(11) Fences may serve as guards. (See Rule 8-300.)

(12) The insulation covering energized conductors or parts exceeding 750 V phase to phase, on its own, shall not be considered to be a guard.

(13) For parts less than 750 V phase to phase, positive barriers, enclosures, or similar arrangements shall be used, but in dry places which are not exposed to mechanical damage, other insulation suitable for the voltage involved may be used as a guard.

(14) Notwithstanding this Rule, on circuits where other guarding is impracticable, such as at the back of switchboards or in equivalent sheltered locations, insulating mats or platforms with an insulating value suitable for the voltage involved may be used so that a person is **isolated** from other live parts or ground.

Electrical Equipment and Station Yard

8-206 Identification of Electrical Equipment and Circuits

(1) Electrical equipment and circuits shall be identified for safety purposes, and the method of identification shall be uniform throughout the electrical utility system.

(2) Identification marks shall not be placed on removable covers or casings where the interchanging of these removable parts would result in incorrect identification.

(3) All signage shall be clearly visible, securely fastened, and maintained in legible condition.

8-208 Storage Batteries

CSA Standard C22.1, *Canadian Electrical Code, Part I*, applies to the installation of storage batteries.

8-210 Current Transformer Secondary Circuit Protection

Provision shall be made for shorting the secondary circuits of current transformers and the current transformer secondary winding, except where functional requirements do not permit the shorting of such circuits.

8-212 Grounding Secondary Circuits of Instrument Transformers

The secondary circuits of instrument transformers shall be effectively grounded, except where functional requirements do not permit the grounding of such circuits.

8-214 Surge Arresters

(1) Suitable precautions shall be taken to protect station equipment from lightning which might enter from associated overhead lines.

(2) Where surge arresters are installed in a building, they shall be located well away from passageways, combustible parts of the building, and all equipment other than the equipment they protect unless they are of the non-fragmenting type.

(3) The conductor between an arrester and any monitoring device shall be treated as an indeterminate potential and **guarded** as such.

8-216 Dry Core Transformers

Dry type transformers installed in a building shall be installed in accordance with the requirements of CSA Standard C22.1, *Canadian Electrical Code, Part I.*

8-218 Warning Signs

All **substation** fences, switching enclosures, padmount transformers and similar equipment shall display suitable high voltage warning signs at all gates and doors; all enclosures over 2.5 m in any dimension shall have additional signs displayed on all sides at least once every 12 m.

8-220 Locking

All enclosures shall be made secure from entry by unauthorized persons by locking or other **acceptable** means.

8-222 Illumination of Equipment

Adequate illumination shall be provided to enable proper operation and maintenance of electrical equipment.

8-224 Capacitor Banks

(1) Provision for dissipation of stored charge of disconnected capacitors shall be present.

(2) Stored energy warning signs shall be installed on the capacitor enclosure entrance or the capacitor-elevated support structure.

8-226 Air Core Reactors

Air core reactors shall be installed such that:

(a) the magnetic fields generated by short circuit currents will not draw nearby metallic objects into the coil; and

(b) foundation steel, support structure, and fences shall not be subject to excessive temperature rise under normal operation conditions due to induced circulating eddy currents.

8-228 Enclosed Air Insulated Switchgear

(1) All switchgear components shall be secured and levelled in a manner consistent with service conditions and manufacturer's instructions.

(2) Switchgear surfaces shall not be used as physical support for any item unless specifically designed for that purpose.

(3) Switchgear interior areas shall not be used as storage areas unless specifically designed for that purpose.

(4) When installed, switchgear arc flash discharge plenums for gaseous and molten decomposition products shall be installed to exit the building away from doors, stairwells, and outdoor equipment, and a controlled no-entry discharge zone shall be established outside the building.

(5) Notwithstanding Subrule (4), if other safety devices are used to reduce the internal switchgear pressure resulting from a fault, they must be arranged and installed with consideration for their potential hazards to personnel. The accumulation of dangerous concentrations of gas decomposition products in switching room areas shall be prevented.

8-240 Grounding

All non-current-carrying metal parts of electrical equipment shall be grounded or bonded in accordance with Section 6 of this **Code**.

8-242 Minimum Separations or Clearances from Unguarded Live Parts

(1) For the purpose of ensuring safety to operating and construction personnel walking under or adjacent to energized circuits, minimum separations or clearances between live parts and finished grade, as outlined in Table 3, shall be observed.

(2) The separations or clearances referred to in Subrule (1) may be used as a guide for **substation** design, but in no case shall the unguarded live parts be located at separations or clearances less than the minimums outlined in Table 3.

(3) In areas where vehicles may travel in **substation** yards, separation or clearance in accordance with Column 5 of Table 3, plus 4.2 m vehicle height shall be provided.

Fences

8-300 General Requirements of Substation Fences (Appendix B)

(1) Electrical utility system equipment with exposed energized parts that are not individually enclosed, located in a building or on an elevated platform in accordance with the requirements of Section 10 of this **Code** shall be enclosed within a fence constructed in accordance with this rule.

▲ **(2)** The horizontal separation between the exterior fence and exposed energized parts shall not be less than 2.5 m for voltages up to and including 200 kV (phase to phase), and no less than 4 m for voltages greater than 200 kV (phase to phase) for the area, as defined in Figure 6.

(3) The fence, excluding barbed wire, shall be not less than 1.8 m high.

(4) Subject to Subrule (5), fence posts shall be set at a depth of not less than 1.0 m.

(5) Subrule (4) does not apply where lesser setting depths are required due to ground conditions, or portable fencing is used, and methods designed, engineered, and constructed in accordance with recognized industry standards are used to brace and anchor the fence.

(6) If soil conditions are unstable, fences shall be braced or foundations designed to provide the same stability provided in stable soil conditions.

(7) The maximum spacing between posts shall be 3.0 m.

(8) If a building that is not owned by the operator of the utility system is located within 2.0 m of the fence or forms parts of the fence, a guard system shall be designed, engineered, and constructed in accordance with recognized industry standards. The guard shall be placed on the building where there is danger that persons accessing the building roof may fall into the fenced enclosure or inadvertently place conductive objects into the fenced enclosure.

▲ 8-302 Metallic Chain Link Fences

(1) Metal posts shall be of 80 mm nominal pipe size (11.3 kg/m) for corner, terminal, and gate posts and 50 mm nominal size (5.4 kg/m) for line posts. For gate openings greater than 6 m the metal gate posts shall be 100 mm nominal pipe size (16.1 kg/m).

(2) Chain link fabric shall be made with minimum 3.6 mm nominal wire size and have a mesh not greater than 50 mm.

(3) Chain link fabric shall be securely attached to all posts, gate frames, and rails.

(4) Chain link fabric shall be reinforced as necessary at top and bottom to prevent distortion and shall extend to within 50 mm of the ground.

(5) Top rails shall be of 32 mm nominal pipe size (3.35 kg/m) and shall be provided with suitable expansion joints, where necessary.

(6) Three or more separate strands of barbed wire supported by the posts or brackets on the posts shall be placed at the top of the fence and gates, extending vertically or obliquely out from the fenced enclosure.

▲ 8-304 Other Fencing Types

▲ **(1)** Other materials, combination of material, or style of fencing may be used for electrical utility system fencing enclosing electrical equipment if:

- **(a)** the material(s) and construction method(s) are designed, engineered, and constructed in accordance with recognized industry standards;
- **(b)** The fence has features that guard against and discourage unauthorized entry access;
- **(c)** Non-flame-propagating materials are used; and
- **(d)** Any exposed metallic components are bonded in accordance with Section 6 of this **Code.**

(2) Subrule (1)(c) does not apply to the section of isolation fence required by Rule 6-206(2).

8-306 Gates (Appendix B)

(1) Gates should open outwardly but, where it is necessary that they open inwardly:

- **(a)** they shall not come within 1.5 m of the frame or enclosure of any electrical equipment; and
- ▲ **(b)** shall have a separate outward opening personnel gate installed.

(2) Gates shall be adequately braced as necessary and double gates should be used where the width of the opening exceeds 1.5 m.

(3) Centre stops shall be provided for double gates.

(4) Gates shall be provided with locks.

(5) Notwithstanding Subrules (1), (2), and (3), cantilever sliding gates are acceptable provided that:
- **(a)** a manual opening method is provided;
- **(b)** the slide mechanism is on the interior of the **substation** fence; and
- **(c)** supporting posts shall meet or exceed requirements of 8-300 and 8-302.

8-308 Preservative Treatment

(1) Steel or iron parts shall be either hot dipped galvanized or electroplated with non-ferrous metal.

(2) Aluminium parts shall be suitably treated against corrosion where they will come in contact with the earth or with concrete.

(3) Wooden isolation fence parts shall be made from preserved wood to prevent wood rot. Current utility wood preservation practices shall be followed.

8-310 Substation Yards

▲ **(1)** **Substation** yards shall be drained to afford secure footing for vehicular/personnel access and inhibit the growth of weeds.

▲ **(2)** **Substations** enclosures shall not be used for storage of unnecessary materials.

8-312 Grounding of Substation Fences

The grounding of **substation** fences shall meet the requirements of Section 6 of this **Code**.

Circuit Breakers, Fuses, and Switches

8-400 Where Switches are Required

(1) Suitable circuit breakers, disconnects, or switches shall be inserted in the leads to all supply equipment and all outgoing supply circuits in accordance with this Rule.

(2) Any load breaking or interrupting device which has no visual means to determine if contacts are open shall be preceded by a visual disconnecting means or proven positive means of determining that the circuit or system is de-energized.

(3) Where two or more pieces of electrical supply equipment or supply lines are operated as a single unit, no switch is necessarily required between them.

(4) Where a local emergency or stand-by system could operate in conjunction with the **operator of the utility system**, suitable **approved** equipment shall be installed to prevent the possibility of feedback from one system to the other.

8-402 Overcurrent Protection

▲ **(1)** Each conductor (except neutral conductors, grounded conductors, bonding & grounding conductors, and conductors of circuits, the opening of which may cause a special hazard by the interruption of service or removal of protection) shall be protected against excessive current by a suitable fuse or other automatic circuit breaking device or by the design of the system.

(2) All outgoing circuits shall be protected by suitable current limiting or interrupting equipment, or by the design of the system except for:

- **(a)** a motor driven generator or rotary converter not operated in parallel with other machines or batteries if the supply leads to such apparatus are already protected by fuses or automatic circuit breakers;
- **(b)** grounded conductors;
- **(c)** circuits for field excitation;
- **(d)** leads of alternating-current generators;
- **(e)** leads connecting two or more pieces of electrical supply equipment operated as a single unit; and
- **(f)** leads of series transformers;
- **(g)** secondary leads of current transformers or other similar circuits when the opening of such circuits may cause hazard to life or property through interruption of service; or
- **(h)** conductors run between the secondary of a transformer and the nearest downstream distribution centre provided the conductors are suitably protected by protection on the primary side of the transformer.

8-404 Accessibility of Isolating Devices

(1) All switches, fuses, automatic circuit breakers, and other control devices shall be:

- **(a)** readily and safely accessible to authorized persons;
- **(b)** arranged or marked to identify the equipment controlled by them; and
- **(c)** except for fuses, shall indicate whether they are open or closed.

(2) All switches which are accessible to unauthorized persons shall have provision for locking them in both the open and closed positions.

(3) Cutouts, fuses, disconnects, or switches which are pole mounted shall be located so that they are readily accessible from climbing and working spaces.

(4) Such devices or their connecting leads shall not extend into the climbing space but may extend wholly, or in part, into the working space of poles.

(5) Adequate switching spaces or aisles shall be provided to allow safe hookstick operation of all **substation** overhead switches.

8-406 Accidental Operation

(1) Switches shall be installed and maintained so as to prevent the danger of accidental operation.

(2) For switching devices that can be operated remotely and automatically, the control circuit shall be provided with a positive disconnecting means near the switching device.

8-408 Suitability

(1) All switches shall have adequate voltage, current-carrying, current-interrupting, and short-circuit rating for their application.

(2) An acceptable insulated live line tool designed and manufactured to industry-recognized standards shall be provided for the operation of all disconnects and fuses where required.

8-410 Uniform Position

(1) The handles or control mechanism for all switches throughout any system shall have, insofar as practical, the same position when open and a uniformly different position when closed in order to minimize operating errors.

(2) Where it is necessary to depart from the practice prescribed in Subrule (1), the switches shall be marked to minimize the possibility of mistakes in operation.

8-412 Protection by Disconnection

Electrical equipment which requires maintenance work upon it shall have an industry recognized means of disconnecting it from all ungrounded conductors of its supply circuit.

8-414 Enclosures for Switches, Fuses and Circuit Breakers

All enclosures or parts of enclosures such as doors, covers, and tanks shall be firmly secured in place.

8-416 Spacing Between or from Switches

(1) Switches used to disconnect transformers, cables, and lines having magnetic or capacitive de-energization currents shall be spaced to comply with the minimum requirements (live part to live part and live part to grounded structure) prescribed in Table 4.

(2) Minimum electrical clearances for switches shall take into consideration all potential positions of the live parts before, during, and after switch operation.

(3) Metal-clad gear is not subject to this Rule.

8-418 Disconnection of Fuses

(1) Fuses shall be capable of being disconnected from the source of supply before being removed or replaced.

(2) Notwithstanding Subrule (1), where fuses cannot be disconnected from the source of supply before handling, acceptable insulating tools or handles designed and manufactured to industry-recognized standards shall be used.

8-420 Vented Fuses

All vented fuses for the expulsion of gases, arc plasma, and molten metal shall have:

(1) Clearances for vented material from any operating equipment, adjacent fuse, or controls; or

(2) A protective barrier to prevent or divert the vented material away from any operating equipment, adjacent fuse, or controls.

SECTION 10 - OVERHEAD SYSTEMS

10-002 Standard to be Used

CSA Standard C22.3 No.1:20, Overhead Systems, shall be the standard for the construction and maintenance of overhead electrical utility and **communication systems**, with amendments to that standard as follows:

(1) Remove Clause 1.2 and refer to AEUC Section 0, Scope.

(2) Amend Clause 4.1.7 by adding the following Subclause:

(a) For supply-line conductors that do not have a jacket and are over 750V, add a minimum vertical and horizontal clearance of 1.0 m to the distances indicated in CSA C22.3 No. 1, Table 35.

(3) Amend Clause 4.3 by adding the following:

4.3.5 Switching Devices

Switching devices that electrically isolate a line operated above 750 V phase to phase shall be identified for safety purposes by numbering, lettering, or a combination of both, using a permanent sign.

(4) Amend Clause 4.3 by adding the following:

4.3.6 Crossing Special Areas

(1) Subject to Subclause (2), overhead power lines shall not be constructed across a school ground, recreational area, boat launching area, storage yard where equipment is used that could contact the lines, or similar area where the risk of contacts is high.

(2) Subclause (1) does not apply if the risk of locating the overhead power line in the area described in Subclause (1) can be reduced to an acceptable level and the inspection **authority having jurisdiction** approves the installation.

(5) Replace Table 2 (Clause 5.3.1.1) with Table 5 attached.

(Minimum Vertical Design Clearances above Ground or Rails)

(6) Remove Table 4 (Clause 5.3.1.1) and refer to Column VIII of Table 5 attached.

(Minimum Vertical Design Clearances above Ground or Rails)

(7) Replace Table 8 (Clause 5.7.2) with Table 6 attached.

(Minimum Design Clearances of Supply Conductors Attached to Buildings)

(8) Replace Table 9 (Clause 5.7.3) with Table 7 attached.

(Minimum Design Clearances from Wires and Conductors not Attached to Buildings, Signs, and Similar Plant)

(9) Replace Clause 5.7.8 as follows:

5.7.8 Clearances to Hazardous Locations
An overhead power line shall not cross over a Zone 0, Zone 1, Zone 20, Zone 21 or Class I - Division 1, Class II - Division 1, or Class III – Division 1 hazardous location in accordance with CSA C22.1, *Canadian Electrical Code, Part I.*

An overhead power line adjacent to a hazardous area as described above shall maintain a horizontal clearance from the hazardous area equal to the height of the supporting structure unless:

(a) The supporting structure is of H-Frame or Grade 1 construction; or
(b) The supporting structure is guyed away from the hazardous area.

Where a power line adjacent to a hazardous area described above is deflected towards the hazardous area, additional precautions shall be taken to prevent conductors from entering the hazardous area due to failure of a conductor fastening.

Devices that can emit sparks or glowing embers, such as fuses and arrestors, where practicable, shall not be located on poles adjacent to the hazardous locations identified above.

(10) Replace Table 27 (Clause 6.3.1) with Table 9 attached.

(Minimum grades of construction for crossings)

(11) Amend 8.19 as follow:

8.19 Communication and power line hardware
Clause 8.19 is not mandatory in Alberta.

10-004 Grounding Methods for Supply Systems

(1) Buildings: If buildings are located in proximity to supply lines and unsafe or objectionable potentials exist or may exist on or adjacent to the metallic parts of the building as a result of the supply lines, the metallic parts shall be grounded at 2 or more physically separated locations with a minimum size No. 6 AWG ground conductor connected to a ground electrode.

(2) Pipelines: If pipelines are located in proximity to supply lines, the pipelines shall be grounded or controlled in accordance with CSA Standard C22.3 No. 6-13, *Principles and Practices of Electrical Coordination Between Pipelines and Electric Supply Lines.* (See Appendix B.)

(3) Metallic Fences Subjected to Objectionable Potentials: Where unsafe or objectionable potentials may be present on metallic fences located in parallel with supply lines, the metallic fences shall be grounded at appropriate intervals with a minimum size No. 6 AWG ground conductor connected to a ground electrode.

(4) Close Metallic Objects: Where unsafe or objectionable potentials may be present on other metallic objects located in proximity to supply lines, the metallic objects shall be grounded with a minimum size No. 6 AWG ground conductor connected to a ground electrode.

SECTION 12 - UNDERGROUND SYSTEMS

12-002 Standard to be Used

CSA Standard C22.3 No.7:20, *Underground Systems*, shall be the standard for the construction and maintenance of underground electrical utility and communication systems with amendments to that standard as follows:

(1) Replace Clause 1.1 as follows:

1.1 Scope

This Standard applies to the lines and equipment associated with underground electric supply and **communication systems** located entirely outside buildings and fenced supply stations.

This Standard, which forms part of the *Canadian Electrical Code, Part III*, covers the requirements for construction of underground systems and includes electric supply and communication circuits that are installed alone, in joint use, or in proximity to each other or other facilities.

(2) Remove Clause 1.2 and refer to AEUC Section 0, Scope.

(3) Replace Clause 4.9 as follows:

Corrosion control shall be considered in the design of underground installations. Methods for corrosion control include material selection, coatings, and cathodic protection (see CSA C22.3 No. 4). Corrosion control methods may be adjusted based on facility testing and maintainance and by engineering judgement.

(4) Add Clause 15.5.4 as follows:

15.5.4 Interconnecting Ground Electrodes and Grids

Where different systems serve the same consumer, the grounds of the different systems shall be bonded. A single grounding conductor may be used for both supply and communication grounding, provided that the ground connection is of sufficiently low impedance and of sufficient current-carrying capacity to prevent the buildup of voltages that can result in a hazard to persons or equipment.

(5) Add Clause 15.9 as follows: (See Appendix B.)

15.9 Ground Resistance Requirements

15.9.1 Multi-Grounded Systems

The neutral shall be of sufficient size and ampacity for the intended use, and shall be connected to a ground electrode at each piece of active electrical equipment and a sufficient number of additional ground electrodes (not including grounds at consumer's services) to prevent electric shock hazard to persons caused by the buildup of excessive steady-state neutral-to-earth voltage.

15.9.2 Earth Return Systems

15.9.2.1

When designing the grounding of an earth return system, the following factors shall be considered:

(a) soil resistivity,
(b) **touch potential** and **step potential** under steady-state and fault conditions,
(c) magnitude of fault currents, and
(d) frequency and number of ground electrodes installed.

15.9.2.2

Where earth return systems are used the following criteria shall be met:

(a) the resistance-to-ground of any individual electrode shall not exceed 25 Ω and the resistance of the grounding installation without interconnection to the consumer's service grounding system shall not exceed 6 Ω. Where these readings cannot be achieved, an additional two electrodes connected in parallel or two deep-driven electrodes shall be used. If the required readings cannot be achieved with the two additional electrodes, the grounding system shall be extended into a multi-grounded system until the 6 Ω interconnected reading can be obtained;
(b) measures shall be taken to prevent electric shock hazard to persons caused by the buildup of steady-state neutral-to-earth voltage;
(c) the grounding installation shall consist of a redundant grounding system with ground electrodes separated by a distance greater than their depth that are located on different sides of the pole or on separate poles;
(d) the transformer primary neutral terminal, transformer case, lightning arrester, grounded conductor, and secondary neutral terminal shall:
  (i) be connected to the ground electrode using the appropriate ground conductor; or
  (ii) have a suitable warning placed on the pole where primary and secondary neutrals are not connected.

(6) Add Clause 15.10 as follows:

15.10 Maintenance of Grounding System

Grounding systems shall be periodically tested for resistance, and periodically inspected and maintained, to ensure that the grounding systems comply with the requirements of this **Code.**

(7) Add Clause 15.11 as follows:

15.11 Objectionable Currents

If unsafe or objectionable ground current flows or may flow on other equipment, steps shall be taken to mitigate such current to safe or unobjectionable levels.

(8) Add Clause 15.13 as follows:

15.13 Grounding Sheaths, Raceways, Trays

(1) Power cable sheaths and metallic raceways shall be grounded at both ends unless circulating current flow on the cable sheath or raceway causes problems or cannot be tolerated, in which case the cable sheath or raceway shall be grounded at one end only.

(2) Subject to Subrule (5), the electrical conductivity of metallic raceways and cable trays shall be continuous throughout their length.

(3) Subject to Subrule (5), the current-carrying capacity of conductors or connections used to make metallic raceways or cable trays electrically continuous shall be:

(a) capable of carrying the electrical utility system fault current; or

(b) equal to or greater than the current-carrying capacity of the metallic raceway or cable tray.

(4) Subject to Subrule (5), metallic cable trays shall be grounded at intervals not exceeding 15 m.

(5) Subrules (2) to (4) do not apply where **isolated** grounding systems designed, engineered, and constructed in accordance with recognized industry standards are used.

FIGURES

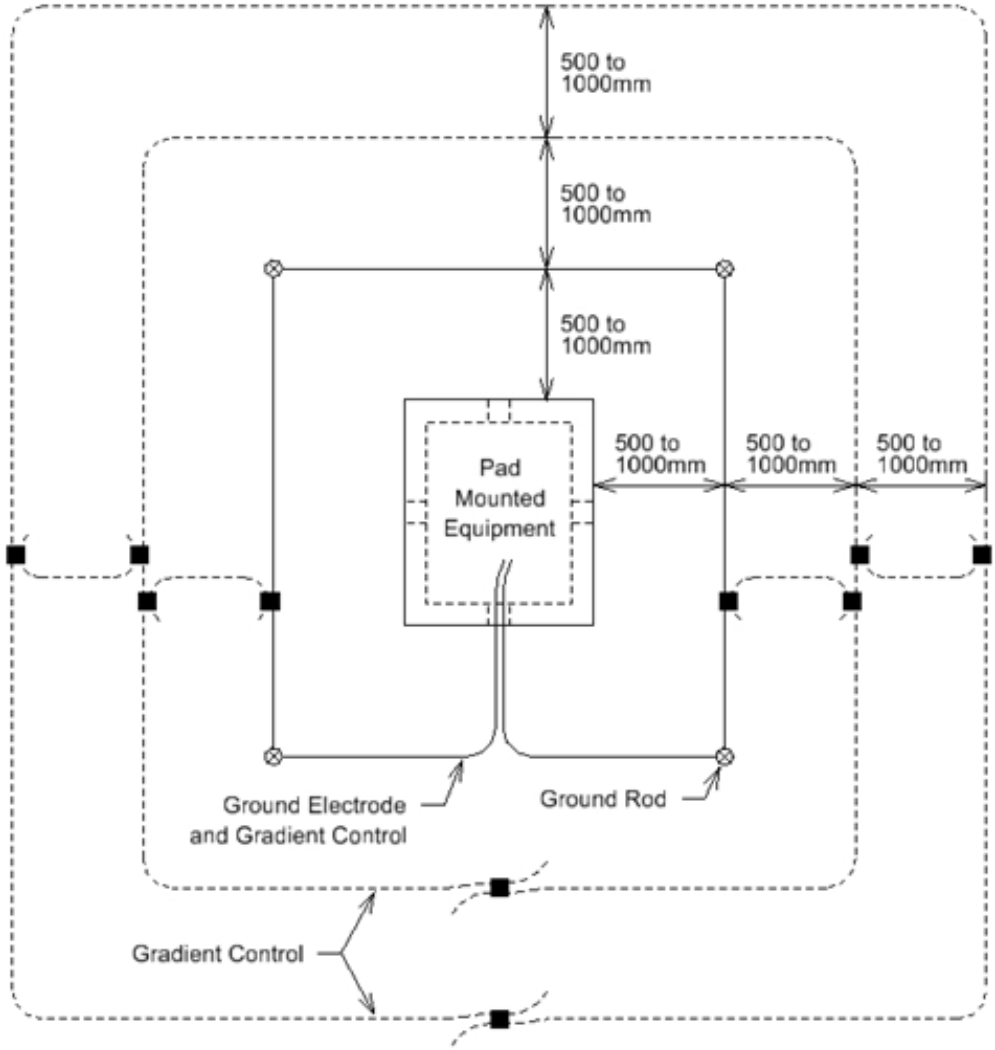


Figure 1 ~ Ground Electrode and Gradient Control
(See Appendix D.)

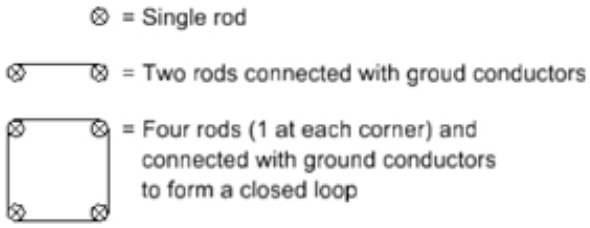


Figure 2 ~ Examples of Ground Electrodes
(See Appendix D.)

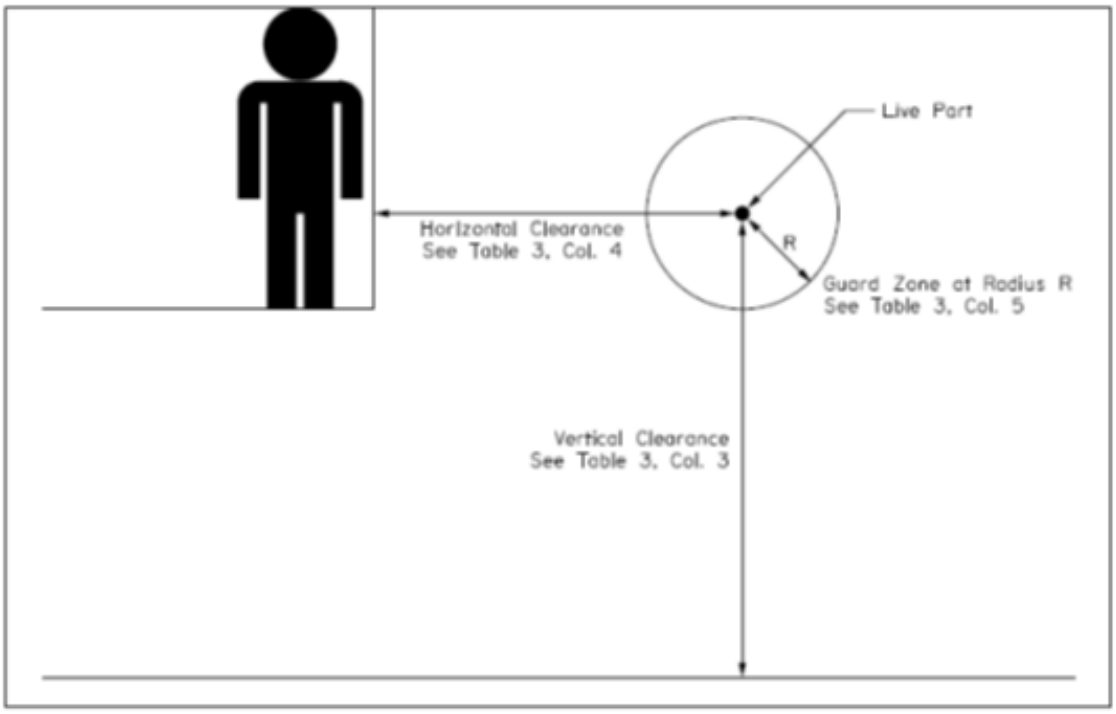


Figure 3 ~ Minimum Clearances about Live Parts
(See Table 3.)

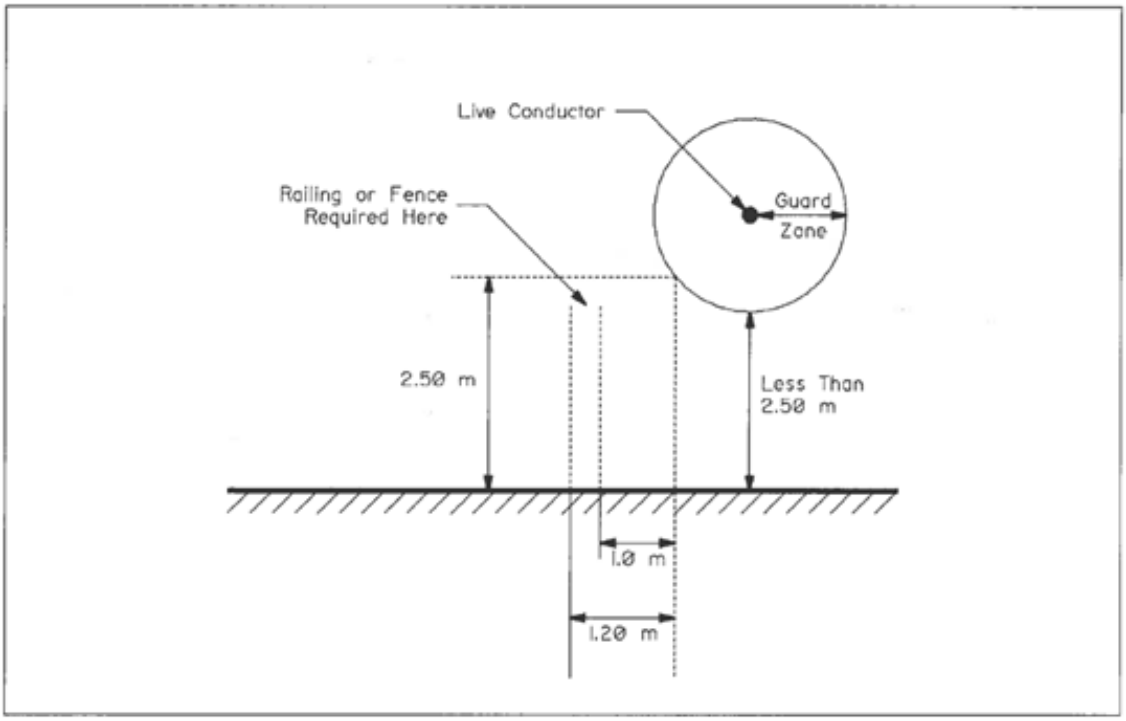


Figure 4 ~ Guarding of Live Parts

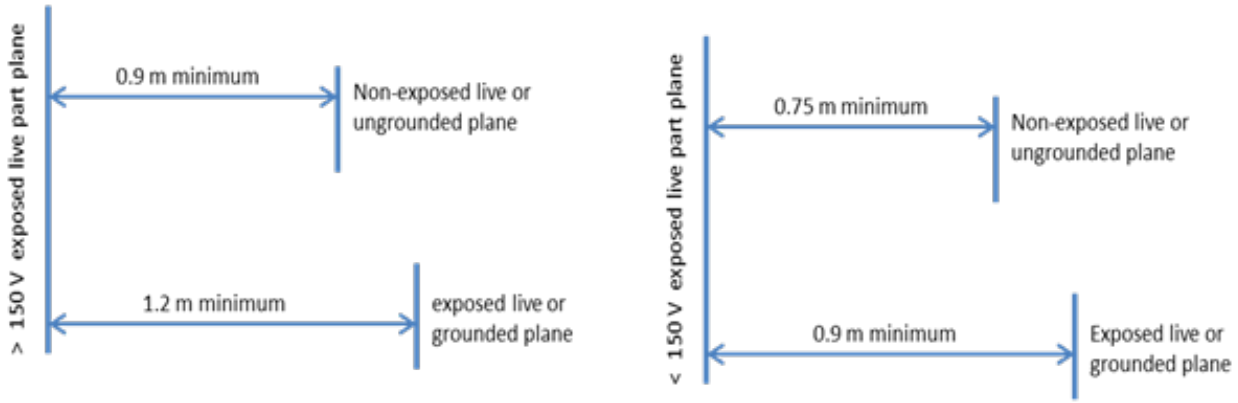


Figure 5 ~ Dimensions of Working Space near Live Parts on Panelboards and Control Panels Indoors
(See Rule 8-022.)

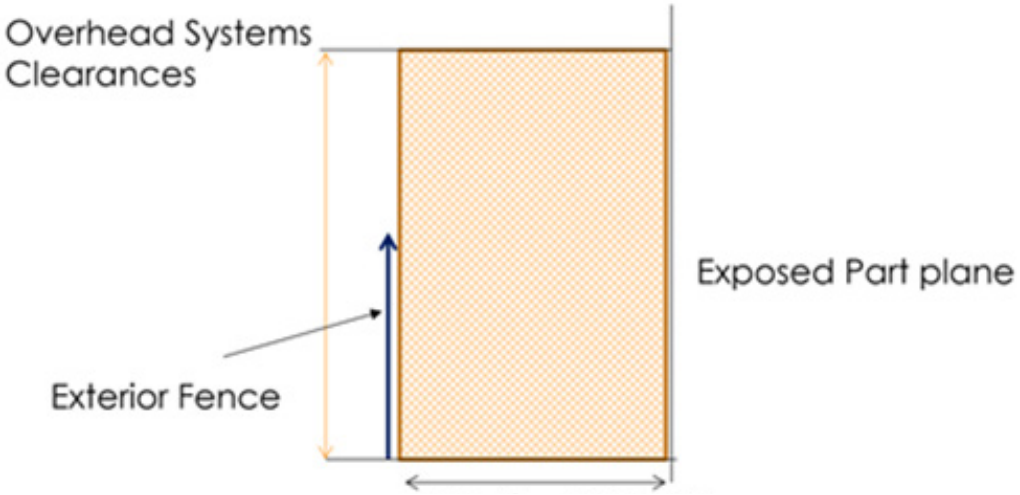


Figure 6 ~ Substation Fence Horizontal Separation for Exposed Parts
The horizontal separation between the exterior fence and exposed energized parts shall not be less than 2.5 m for voltages up to and including 200 kV (phase to phase), and no less than 4 m for voltages greater than 200 kV (phase to phase) for the area.
(See Rule 8-300(2).)

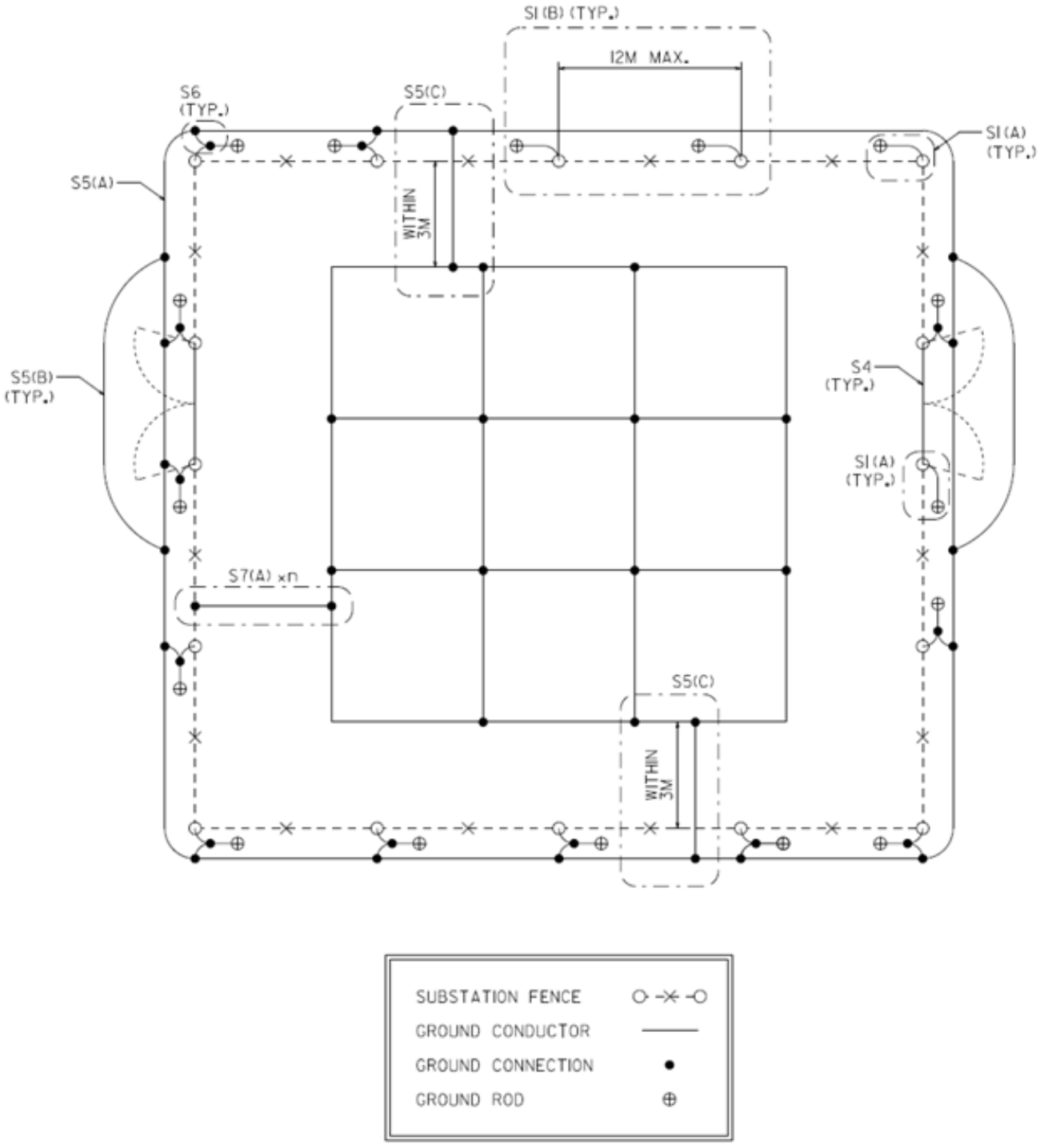
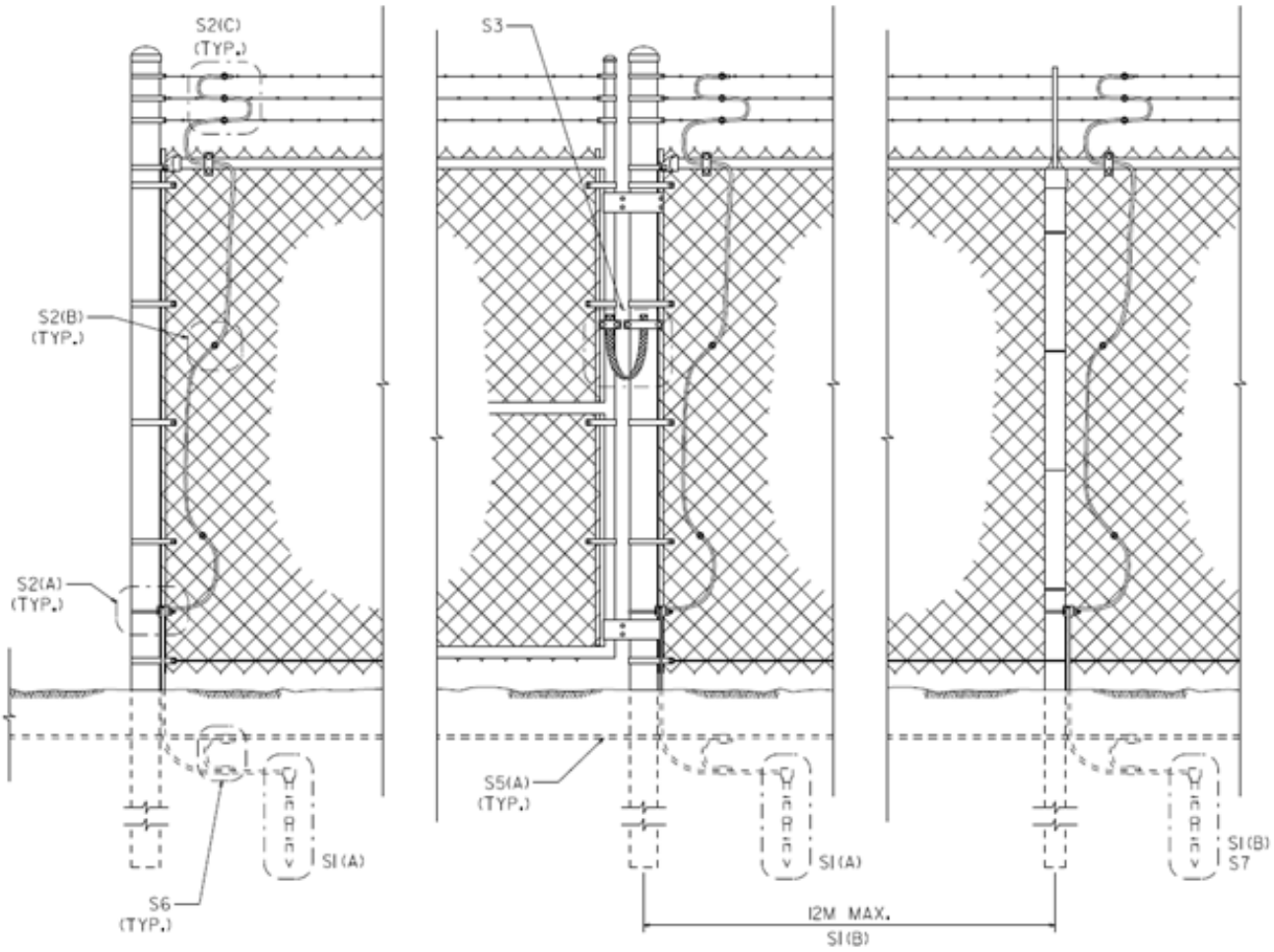


Figure 7 ~ Typical Grounding Plan View – Fence Grounding Interconnection
(See Rule 6-116.)



▲ **Figure 8 ~ Typical Substation Chain Link Fence Grounding Application**
(See Rule 6-116.)

TABLES

Table 1 ~ Safe Limits of Approach Distances from Overhead Power Lines for Persons and Equipment
(See Rule 2-014.)

Operating voltage of overhead power line between line conductors unless otherwise specified	Safe limit of approach distance for persons and equipment
0 - 750 V insulated or polyethylene covered conductors[1]	0.3 m
0 - 750 V bare, uninsulated	1.0 m
Above 750 V insulated conductors[1],[2]	1.0 m
0.75 kV - 40 kV	3.0 m
69 kV, 72 kV	3.5 m
138 kV, 144 kV	4.0 m
230 kV, 260 kV	5.0 m
500 kV	7.0 m
500 kV DC Pole-Ground	7.0 m

[1] Conductors must be insulated or covered throughout their entire length to comply with these groups.
[2] Conductors must be manufactured to rated and tested insulation levels.

▲ Table 2, *Stranded Copper Conductor Sizes Required to Conduct Electrical Utility System Fault Current,* has been deleted. Table numbers for Tables 3 through 9 have not been adjusted so as to maintain table numbering consistency with previous AEUC revisions.

Table 3 ~ Minimum Separation or Clearance from Live Parts
▲ (See Rules 8-200, 8-204 and 8-242.)

Column 1		Column 2	Column 3	Column 4	Column 5
Line to ground voltage (maximum) (kVrms)		Equivalent phase to phase voltage (kVrms)	Minimum vertical separation or clearance to unguarded parts (m)	Minimum horizontal separation or clearance to unguarded parts (m)	Minimum separation or clearance to guard live parts (guard zone) (m)
AC Systems	----	0.75	2.5	1.0	---
	5	9	2.6	1.1	0.10
	16	28	2.7	1.2	0.20
	23	40	2.8	1.3	0.30
	50	87	3.2	1.7	0.70
	90	156	3.5	2.0	1.00
	145	250	4.1	2.6	1.60
	165	285	4.5	2.9	2.00
	320	550	6.2	4.7	3.70
DC	500		5.2	3.6	2.7

[1] The separations or clearances in Column (5) of this table are solely for guidance in installing guards without definite engineering design, and are not to be considered as a requirement for such engineering design; i.e., the minimum separations or clearances in the above table are not intended to refer to the separations or clearances between live parts and the walls of cells, compartments, or enclosing structures. They do not apply to the separations between bus bars and supporting structures, or to the clearances between the blade of a disconnecting switch and its base.

[2] Minimum separations or clearances shall satisfy either switching surge or B.I.L. duty requirements, whichever is greater. Switching surge factor is an expression of the maximum Switching Surge Crest Voltage in terms of the maximum Line to Neutral Crest Voltage of the power system. Basic Insulation Level B.I.L. - represents the insulation level of the System.

*[3] Parts over or near passageways through which material may be carried, or in or near spaces such as corridors, storerooms, and boiler rooms used for non-electrical work, shall be **guarded** or given separations or clearances in excess of those specified, such as may be necessary to secure reasonable safety. The guards shall be substantial and, where practical, completely shield or enclose, without openings, the live parts. When in spaces used for non-electrical work, covers shall be removable only by means of tools or keys.*

*[4] Parts of indeterminate potential, such as telephone wires exposed to induction from high voltage lines, ungrounded neutral connections, ungrounded frames, ungrounded parts of lightning arresters, ungrounded instrument cases connected directly to the high voltage circuit, ungrounded parts of power cable terminations and cable shields, and other **substation** components subject to voltage build-up if not grounded shall, where practical, be **guarded** on the basis of the maximum voltage which may be present.*

[5] Refer also to Scope and General Requirements.

[6] Clearances shown for 500 kV HVDC are based on a TOV factor of 1.5.

Table 4 ~ Minimum Spacing for Outdoor Switches in Free Air (Live Part to Live Part and Live Part to Grounded Structure [2])
(See Rule 8-416.)

Maximum System Voltage (phase to phase) (kVrms)	Spacing [1] (mm)
9	300
15	400
30	550
40	650
50	750
80	1000
156	1800
275	3000
300	3300
550	6600

*[1] These spacing requirements do not apply to **approved** switchgear assemblies.*
[2] "Live Part to Grounded Structure" is the horizontal distance from any switch blade position to the switch support structure or any adjacent structure.

Table 5 ~ Minimum Vertical Design Clearances above Ground or Rails[1]
(See Rule 10-002 (5) and (6), Appendix C and CSA C22-3 No. 1-15 Clause 5.3.1.1.)

Location of Wires or Conductors[2]	Guys, Messengers, Span & Lightning Protection Wires and Communication Wires and Cables	Voltage of Open Supply Conductors And Service Conductors Voltages Line to Ground kVAC except where noted (Values in Parentheses represent AC Phase to Phase voltages typically used in Alberta)						
		0 to 0.75	0.75 to 22	22 to 50	50 to 90	120 to 150	318	+/- 500 kVDC
		(120 -600 V)	(4, 13 & 25 kV)	(35, 69 & 72 kV)	(138 &144 kV)	(240 kV)	(500 kV)	1000 kVDC Pole-to-Pole
	Column I	Column II	Column III	Column IV	Column V	Column VI	Column VII	Column VIII
Over walkways or land normally accessible only to pedestrians, snowmobiles, and all terrain vehicles not exceeding 3.6m.	3.7	4.0 (6)	4.3	4.7	5.0	5.6	9.9	6.5
Over rights of way of underground pipelines operating at a pressure of over 700 kilopascals; equipment not exceeding 4.15m.	4.5	4.5	4.8	5.2	5.5	6.1	9.9	7.7
Over land likely to be travelled by road vehicles (including roadways, streets, lanes, alleys, driveways, and entrances); equipment not exceeding 4.15m. [3]	4.5	4.5	4.8	5.2	5.5	6.1	15.4	7.7
Over land likely to be travelled by road vehicles (including highways, roadways, streets, lanes, alleys, driveways, and entrances); equipment not exceeding 5.3m. [4]	5.6	5.7	6.0	6.4	6.7	7.3	16.6	8.9
Over land likely to be travelled by agricultural or other equipment; equipment not exceeding 5.3m. [5]	5.6	5.7	6.0	6.4	6.7	7.3	12.2	8.9
Above top of rails at railway crossings, equipment not exceeding 7.2m.	7.3	7.5	7.8	8.2	8.5	9.1	11.1	10.7

[1] Includes Alternating Current and Direct Current Voltages commonly found in Alberta.
[2] Where a line runs parallel to land accessible to vehicles but is over land not requiring clearance for vehicles, the wire can swing out over the area accessible to vehicles or, at voltages over 200 kV AC, vehicles can be subjected to a hazard from induced voltages. These vertical clearances apply where the conductor (in the swing condition, where specified) is over, or within the following horizontal distances from the edge of, land accessible to vehicles:

- *(a) 0.0 m for communication circuits and 0 to 50 kV phase to phase AC supply circuits;*
- *(b) 0.9 m for 50 to 90 kV phase to phase AC supply circuits;*
- *(c) 1.7 m for 120 to 150 kV phase to phase AC supply circuits;* *(Table continues on next page)*
- *(d) 6.1 m for 250 to 350 kV phase to phase AC supply circuits;*

[3] Generally restricted to Urban areas.
[4] Provincial and municipal authorities may designate certain roads and highways as high load corridors and set specific ground clearances for these routes.
[5] This category includes farm fields and access roads to farm fields, as well as entrances to farm yards.
[6] This clearance can be reduced to 3.5 m in the last span connecting the overhead supply to the consumer's service point of attachment.

Table 6 ~ Minimum Design Clearances of Supply Conductors Attached to Buildings
(See Rule 10-002 (7) and CSA C22-3 No. 1-10 Clause 5.7.2.)

Conductor attached to building[1]		Minimum clearances (m)		
		Horizontal to surface	Vertical to normally inaccessible surface	Vertical to readily accessible surface
0 to 750 V	Insulated or grounded	1.0 [2]	1.0	2.5
	Enclosed in effectively grounded metallic sheath	0.0	0.0	0.0
	Neither insulated, nor grounded, nor enclosed in effectively grounded metallic sheath	1.0 [2]	1.0	2.5
Over 0.75 to 5 kV	Not enclosed in effectively grounded metallic sheath	3.0 [3]	1.2	2.7
	Enclosed in effectively grounded metallic sheath	0.0	0.0	0.0
Over 5 to 22 kV	Not enclosed in effectively grounded metallic sheath	3.0 [5]	1.5 [3]	3.0 [3]
	Enclosed in effectively grounded metallic sheath	0.0	0.0	0.0
Over 22 kV		3.0 plus 0.01 m/kV over 22 kV	3.6 plus 0.01 m/kV over 22 kV [3,4]	3.6 plus 0.01 m/kV over 22 kV [3,4]

[1] The tabulated clearances are applicable to nonmetallic buildings or buildings whose metallic parts are effectively grounded. Otherwise, a study to determine suitable greater clearances may be necessary, because of electrostatic induction.
[2] For inaccessible surfaces, this may be reduced to 0.08 m. At the service attachment point, this may be further reduced to 0.02 m.
[3] Carrying conductors of these voltage classes over buildings should be avoided if other suitable construction can be carried out.
[4] Where it is deemed necessary to carry conductors of these voltage classes over buildings, investigations should be made to determine if additional measures, including increased clearances, are required to ensure that safe and suitable use can be made of the building crossed over.
[5] This value may be reduced to 1.5 m when windows that can be opened, fire escapes, and balconies are not present on the building adjacent to the conductor.

Table 7 ~ Minimum Design Clearances from Wires and Conductors Not Attached to Buildings, Signs, and Similar Plant

(See Rule 10-002 [8] and CSA C22-3 No. 1-10 Clauses 5.7.3.1, 5.7.3.3.)

Wire or Conductor		Minimum clearances (meters) from wire to:			
		Buildings [1], [2]		Signs, billboards, lamp and traffic sign standards, above-ground pipelines, and similar plant	
		Horizontal to surface [3]	Vertical to surface	Horizontal to object [3]	Vertical to object
Guys, communication cables, and drop wires		0.0	0.08	0.0	0.08
Supply conductors					
0 to 750 V	Insulated or grounded	1.0	2.5 [4]	0.3	0.5
	Enclosed in effectively grounded metallic sheath	0.0	0.0	0.0	0.08
	Neither insulated nor grounded, nor enclosed in effectively grounded metallic sheath	1.0	2.5 [4]	1.0	0.5
Over 0.75 to 22 kV	Not enclosed in effectively grounded metallic sheath	3.0 [7]	3.0 [5]	3.0	3.0
	Enclosed in effectively grounded metallic sheath	0.0	0.0	0.0	0.08
Over 22 kV [5],[6]		3.0 plus 0.01 m/kV over 22 kV	3.6 plus 0.01 m/kV over 22 kV	3.0plus 0.01 m/kV over 22 kV	3.6 plus 0.01 m/kV over 22 kV

[1] Clearances over or adjacent to portions of a building normally traversed by pedestrians or vehicles are covered by Tables 5 and 6.

[2] The tabulated clearances are applicable to nonmetallic buildings or buildings whose metallic parts are effectively grounded. Otherwise, a study to determine suitable greater clearances may be necessary, due to electrostatic induction. (See Clause 54.7.3.3.)

[3] To these values the conductor swing must be added, in accordance with Clause 5.7.3.1.

[4] This clearance may be reduced to 1 m for portions of the building considered normally inaccessible.

[5] Carrying conductors of these voltage classes over buildings should be avoided if other suitable construction can be carried out.

[6] Where it appears necessary to carry conductors of these voltage classes over buildings, additional measures should be investigated, including increased clearances, to ensure that safe and suitable use can be made of the building crossed over.

[7] This value may be reduced to 1.5 m when windows that can be opened, fire escapes, and balconies are not present on the building adjacent to the conductor.

[8] Voltages are rms line-to-ground unless otherwise noted.

[9] See Table 1 for safety work clearances.

Table 9 ~ Minimum Grades of Construction for Crossings

(See Rule 10-002(11) and
CSA C22.3 No. 1-15 Clauses 6.3.1, 6.3.2.1, 7.8.1.1, 7.8.2, 7.8.3, 7.9.1, A.7.8.2, and A.8.1.)

Item at lower level	Minimum grade of construction where the conductors, messengers, or cables are at the upper level		
	Communication	0–750 V	> 750 V
Railway control facilities and tracks	1	1	1
Limited access or controlled access highways	1	1	1
Roads and highways — General	3	3	3
Over rights of way of underground pipelines at a pressure of over 700 kilopascals	3	3	3
Above-ground pipelines	1	1	1
Navigable waterways requiring permits	1	1	1
Aerial tramways	1	1	1
Other private or public property	3	3	3
Communications			
Cable	3	3	1 [1]
Open wire — General	3	3	1 [1]
Drop wire	3	3	3
Supply			
0–750 V	2 [2]	3	2 [3]
> 750 V	1 [2]	2	2

[1] The grade of construction may be Grade 2 where one of the following conditions exists:

(a) the supply and communication lines have coordinated electrical protection (see Clause 4.4.);

(b) where coordinated electrical protection is not practical, the supply conductors have a rated tensile strength of 12.4 kN or greater; or

(c) the supply conductors are enclosed in effectively grounded continuous metallic sheathed cable.

[2] The communication line may be Grade 3 where the supply conductors are in effectively grounded continuous metallic sheathed cable.

[3] Grade 3 construction may be used where the supply conductors at the upper level are in effectively grounded continuous metallic sheathed cable.

APPENDIX A - SAFETY RULES
(formerly Section 4)

▲ Alberta's 2013 Occupational Health and Safety (OH&S) Code, *Part 40, Utility Workers – Electrical*, refers to the Safety Rules in Section 4 of the 2002 edition of the Electrical and Communication Utility Code (ECUC). In 2007, the ECUC was renamed the Alberta Electric Utility Code (AEUC) and the Safety Rules were moved to Appendix A. These rules were carried in Appendix A for subsequent revisions, however the 2002 rules morphed over the years and no longer reflected the exact reference in the OH&S Code. To eliminate ambiguity and potential conflict, and until the OH&S Code is updated, readers should refer to the 2002 revision of the Electrical and Communication Utility Code (ECUC) for safety rules.

APPENDIX B - NOTES ON RULES

Note: This Appendix forms an informational (non-mandatory) part of this Code.

Authority Having Jurisdiction

In Alberta, "authorities having jurisdiction" may include: an accredited municipality for areas within the boundaries of the municipality, an accredited corporation for areas owned by or under the care and control of the corporation, and Alberta Safety Codes Authority (ASCA) for un-accredited areas of the province. (See Safety Codes Act)

Electric Distribution System

The Province of Alberta Hydro and Electric Energy Act (2000 ed., current as of December 5, 2019) (HEEA) defines an electric distribution system as follows:

"electric distribution system" means any system, works, plant, equipment or service for the delivery, distribution or furnishing of electric energy directly to the consumers, but does not include a power plant or transmission line;

The HEEA definitions for "power plant" and "transmission line" are provided below.

Electric Utility

The Province of Alberta Electric Utilities Act (2003 ed., current as of May 12,2020) defines electric utility as follows:

"electric utility" means an isolated generating unit, a transmission facility, or an electric distribution system that is used

- *(i) directly or indirectly for the public, or*
- *(ii) to supply electricity to members of an association whose principal object is to supply electricity to its members,*

the owner of which

- *i. is required by this Act or the regulations to apply to the Commission for approval of a tariff,*
- *ii. is permitted by this Act or the regulations to apply to the Commission for approval of a tariff, and has applied for that approval, or*
- *iii. passes a bylaw that has been approved by the Lieutenant Governor in Council under section 138, but does not include an arrangement of conductors intended to distribute electricity solely on property of which a person is the owner or a tenant, for use solely by that person and solely on that property of a facility exempted by Commission rules made under section 117.*

Isolated

Such separation may not eliminate all of the effects of electromagnetic induction.

Power Plant

The Province of Alberta Hydro and Electric Energy Act (2000 ed., current as of December 5, 2019) defines a power plant as follows:

"power plant" means the facilities for the generation and gathering of electric energy from any source.

Substation

The Province of Alberta Hydro and Electric Energy Act (2000 ed., current as of December 5, 2019) defines a substation as follows:

"substation" means a part of a transmission line that is not a transmission circuit and includes equipment for transforming, compensating, switching, rectifying or inverting of electric energy flowing to, over or from the transmission line.

Transmission Line

The Province of Alberta Hydro and Electric Energy Act (2000 ed., current as of December 5, 2019) defines a transmission line as follows:

"transmission line" means a system or arrangement of lines of wire or other conductors and transformation equipment, wholly in Alberta, whereby electric energy, however produced, is transmitted in bulk, and includes

- *(i) transmission circuits composed of the conductors that form the minimum set required to so transmit electric energy,*
- *(ii) insulating and supporting structures,*
- *(iii) substations,*
- *(iv) operational and control devices, and*
- *(v) all property of any kind used for the purpose of, or in connection with, or incidental to, the operation of the transmission line,*

but does not include a power plant or an electric distribution system.

Note that HEEA considers a substation to be within the definition of a transmission line.

Scope

The rules of this code are not considered to be retroactive, and therefore existing installations are not generally required to be upgraded to meet the new or revised requirements of this Code unless an unsafe condition exists or the existing installation is being renovated or altered. This item should be coordinated with the authority having jurisdiction prior to design/construction.

2-010 Responsibility for Alterations

Unobstructed working space around, near, and in front of utility equipment, such as padmount transformers and pedestals, must be maintained to the requirements of the operator of the utility system.

2-014 Activities near Overhead Powerlines

Rule 2-014 applies to the transportation of equipment, vehicles, people, or other objects under powerlines. A distinction is to be made between construction and maintenance activities related to the powerline and simple movement of material or personnel under the powerline. This Rule makes clear that the requirements for clearance allowances do not apply to the transportation of equipment, etc., which are not involved with any activities related to the powerlines. For example, the movement of digging equipment under a powerline is not subject to the restrictions of this Rule provided that the digging equipment is not being used for excavation under the powerline. Note that there are additional requirements in other Rules that deal with the movement of equipment or buildings. (See Rule 2-018.)

2-020 Excavation Activities in the Vicinity of Underground Powerlines

The operator of the utility system's determination of the requirement for direct supervision will be based on several factors, including the reliability of the excavator and the type of installation involved.

6-000 Scope

Grounding of overhead and underground electrical utility and communication systems are covered under Sections 10 and 12 of this Code.

6-002 Object

Objectives of Grounding

(1) Purposes of Grounding

(a) Adequate grounding is required to prevent dangerous conditions which may arise at electrical installations. Structures and equipment may become energized from a power circuit by failure of insulation, operation of protective devices, breakage or displacement of a conductor, arcing from the power circuit, or induction.
(b) There is always some resistance between a complete grounding connection and the earth, and fault currents passing through this resistance may cause a potential difference between grounded apparatus and the earth and may create a hazard. For example, with a ground rod in soil of uniform resistivity, the greatest potential gradient exists in the region immediately adjacent to the rod. Measurements show that 90 % of the total potential difference may exist within 6 to 10 feet from the rod that is approximately within the reach or stride of a person, so that a potential difference exists between their feet when placed apart. Moreover, any metallic connection to the rod may transfer the potential at the rod to points remote from the rod itself.
(c) Potential difference may be created in ungrounded systems without large fault currents. For example, accidental contact of non-current-carrying equipment by a phase conductor could impose a potential on the equipment with, perhaps, negligible fault current. It is therefore imperative to provide a low resistance path between the grounding connection and earth in order to control potential differences.

(2) Public Safety

For public safety it is required that facilities and equipment accessible to the public be free from hazardous potentials. This applies particularly to metallic fences surrounding supply stations and to metallic facilities such as communication circuits, railway tracks, and pipelines entering a supply station.

(3) Personnel Safety

(a) For the safety of personnel, a grounding system must ensure that accessible non-current-carrying metal parts are maintained at the same potential, and that the difference between this potential and that of the surrounding earth is not dangerous.
(a) Obviously it is impossible to prevent at all times, in all places, and under all conditions, the presence of dangerous voltages. However, in most cases the hazard can be reduced to an extremely low value by careful, intelligent design. Hazardous potential differences usually occur only when fault current flows. These potential differences can occur within electrical supply stations as well as at other locations.

(4) Equipment Protection

An adequate grounding system is essential to protect equipment by discharging into the earth the energy released by lightning discharges, fault currents, and other system disturbances. Otherwise these disturbances may cause extensive damage to equipment and apparatus, including non-associated equipment such as communication cables, etc. Such damage might include insulation breakdown, electrically ignited explosions, and fires, all of which may present hazards to personnel.

(5) System Operating Requirements

An adequate grounding system is essential also for the proper operation of the supply system. The grounding system must, at times, carry heavy power and fault currents without being damaged and without causing dangerous potential gradients on the surface of the earth. The severity of ground potential rise, in terms of duration and magnitude, is dependent on many things, such as operation of protective devices, system conditions, and effectiveness of overhead ground cables, etc. These in turn are dependent on the effectiveness of the grounding system.

6-104 Generating Station, Substation Ground Resistance

(1) & (2)The specification of ground potential rise (GPR) value does not imply that substation or generating station safety is achieved. The purpose for the GPR limit specified is to provide a point where consideration of the external assets such as telecommunication personnel and assets may become a concern. Refer to IEEE 487 for further discussion on the purpose of having a 3kVpeak limit. In all cases, consideration of the influence of transferring voltages to external assets should be evaluated.

(3) Measurement of the ground resistance of the grounding systems provides a base point of historical reference to evaluate the performance of the grounding system after construction. Seasonal variations in the soil conditions can significantly influence the resistance of the substation. Therefore, resistance testing for the substations are typically performed in seasons when the influence of frozen soil is not present.

6-110 Grounding Metallic Equipment

The definitions and applications of grounding and bonding are as per Section 0, Section 10-000 Series, and Section 36-000 Series of CSA Standard C22.1, *Canadian Electrical Code, Part I.*

6-116 Grounding Generating Station and Substation Fences

This rule is intended as a progressive evaluation of all subrules and not intended as standalone requirements. Subrules may supersede specific previous subrules requirements.

Figures 7 and 8 show the progression of the fencing grounding interconnections requirements. Figures outline where the subrules of 6-116 are applied.

References to minimum conductor size in subrules (2) and (3) are based on minimum electrical characteristics for grounding/bonding a fence. A #4 AWG minimum conductor matches commentary found in the AEUC Appendix D (§15.2) for current-carrying capacity.

The primary purpose of fence grounding is to prevent or mitigate touch and step potential hazards. If these hazards are shown not to be present or the potential mitigated, a fencing system may be isolated from the grounding system.

6-206 Metallic Fences

The 3 m minimum section requirement is for the prevention of:

(1) direct metallic connection to the utility fence and;
(2) physical bridging of a person between the two fences.

The installation of insulation fence section described in Subrule (2) may lower the transfer of potential through the soil to interconnected fence to acceptable levels in place of or in conjunction with Subrule (1).

8-014 Buildings

Electrical equipment often contains gases for insulation medium, or DC equipment can have gas generation under certain conditions. Subrule 8-14(j) is intended to cover the appropriate gas release scenario by either having active ventilation to prevent build up or triggered ventilation for specific scenarios. This is all determined by the gas scenario created by the equipment installed in the building.

Building code definition for non-combustible is to be used.

8-300 General Requirements of Substation Fences

Where extreme local environmental conditions exist, higher fences shall be considered to prevent:

(a) inadvertent entry of pedestrian and animal traffic; and
(b) blown conductive debris from nearby facilities.

8-306 Gates

Fences with only inward opening vehicle gates shall have a separate personnel gate installed adjacent to the inward opening gate, or a personnel gate built into the main vehicle gate to enable personnel entry into the substation for emergency access and snow removal.

8-310 Substation Yards

The substation yards should not contain material that is not required for equipment replacement/ sparing for speed of restoration, and should not include any consumables / general construction material (e.g., copper wiring,). These consumable items are targets for theft and the intention is to limit the access or entries into a live substation.

8-406 Accidental Operation

Locking, rather than blocking, is recommended for remotely controlled equipment.

8-414 Enclosures for Switches, Fuses, and Circuit Breakers

Securing firmly requires some form of latching, physical interlock, clasping, bolting, or screwing, and shall not solely rely on the weight of part of the enclosure or friction fit.

8-416 Spacing Between or from Switches

The measurement point is from any point along the switch path from the blade to neighbouring structures and other live parts. The intention is to consider the dynamic distance during switch operation, as the blade may be energized and arcing may occur.

10-004 Grounding Methods for Supply Systems above 22 kV

(2) Pipelines
Guidance for pipelines located in proximity to electrical utility system HVDC transmission lines can be found in *Influence of High Voltage DC Power Lines on Metallic Pipelines*, published by Canadian Association of Petroleum Producers and available on the CAPP website.

Guidance for pipelines located in proximity to distribution lines can be found in *Inductive Coordination of Distribution Lines and Pipelines*, published by Alberta Power Industry Consortium.

12-002 Standard to be Used

(1) Add Clause 15.9 as follows:
Multi-grounded neutral systems that extend over a substantial distance depend more on the multiplicity of grounding electrodes than on the resistance-to-ground of one individual electrode. Therefore, no specific values are prescribed for the resistance of individual electrodes.

APPENDIX C - NOTES ON RULES FOUND IN C22.3 NO. 1:20, OVERHEAD SYSTEMS

Note: This Appendix forms an informational (non-mandatory) part of this Code.

Note: Reference numbers found in this Appendix correlate to the Rule numbers found in C22.3 No. 1:20.

5.3.1.1 Basic Clearances

The Electrical Utilities Sub-Council (EUSC) agreed that the descriptions in the AEUC Table 5 (CSA C22.3 No.1 Table 2) under the column "Location of Wires or Conductors" were vague and interpretation was difficult and required clarification. Reference to the heights of vehicles that may be passing under the aerial lines was added to the AEUC Table 5 for clarity. It was also determined that clearances in the 2002 edition were more appropriate, so the values in the chart were changed back to that edition.

Trolley systems were prevalent in Alberta up to the year 2010. The Trolley transportation systems are not prevalent in Alberta, so this column was removed. Refer to CSA C22.3 No. 1 for further information.

Voltages were modified in the 2013 edition of the AEUC to reflect what is considered standard in Alberta. References to voltages that are not used in Alberta were removed.

The description at the top of Table 5 was modified in the 2013 edition of the AEUC to identify the voltage as line to ground, and the DC column for 500kV DC was added for clarity. DC transmission voltages were not referenced in the 2007 edition.

Table 5 notes were redone based on recalculation of transmission voltages and the following sample calculations.

Sample Calculation for max 150kV AC line to ground Flashover (260kV AC Line to Line)

From CSA C22.3 No.1 Table A.1, the switching surge factor or switching overvoltage (SOV) for a maximum line to ground voltage of 150kV is 2.75p.u. (per unit).

150kV is a root mean square (RMS) value that must be converted to a peak voltage value. For a sinusoid wave form, this conversion factor is the square root of 2.

$$V_{peak} = \left(\sqrt{2}\right)(Vrms)$$

$$V_{peak} = \left(\sqrt{2}\right)(150)\,kV = 212.13\,kV$$

The overvoltage on the line is 2.75 p.u.

$$V_{SOV} = (SOV)(V_{peak})$$

$$V_{SOV} = (2.75)(212.12\,kV) = 583.36\,kV$$

The flashover distance as per CSA C22.3 No.1 is calculated as:

$$D_{flash} = (500)(2.54) + (583.36 - 500)(3.81) = 1588\ mm$$

(Note that Table A.1 of the CSA C22.3 No.1 shows 1586 mm)

Example, for a road crossing allowing a 5.3m vehicle and load combined height:

$$DV = 5.3m + 1.588\ m + 0.3\ m = 7.2\ m$$

This clearance is close to what the current version of the AEUC requires (7.3 m).

500kV AC (line to line) Clearances

These clearances are governed by induction.
Minimum ground clearance as specified in ISO Rule 502.2 for Alberta is 12.2m.
Minimum clearance over rail is governed by flash over due to rail cars being well grounded.
Minimum clearance over rail as per CSA C22.3 No. 1 Table 5, CSA Clause 5.3.1.1 does not appear to be included, i.e. additional 0.3m clearance to permit normal ballast adjustments.

+/- 500 kV DC Clearances

Overall, the clearances derived from the CSA C22.3 No. 1, Table 4 converted to Alberta equipment heights exceed the calculated clearances; therefore, CSA C22.3 No. 1, Table 4 clearances were used for the AEUC Table 4. Steady state DC voltages do not induce currents and voltages that would require greater clearances where large vehicles or objects are expected.

+/- 500 kV DC governed by DC electric field level limits for general public exposure. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) suggests a limit for general public exposure of less than 28 kV/m, which will result in ground clearance of 12.2m

Sample Calculation for +/- 500 kV DC line to ground Flashover

From CSA C22.3 No. 1, Table A.2, the switching surge factor or switching overvoltage (SOV) for a maximum line to ground voltage of +/- 500 kV DC is 1.6p.u. (per unit). For up to 144 kV the air gap withstand is 2.0 mm/kV, and greater than 144 kV the air gap withstand is 2.92 mm/kV.

Vpeak=500kV Pole to Ground
The overvoltage on the line is 1.6 p.u.

$$V_{SOV} = (SOV)(V_{peak})$$
$$V_{SOV} = (1.6)(500kV) = 800kV$$

The flashover distance as calculated per CSA is:

$$D_{flash} = (144kV)(200\ mm/kV) + (800kV - 144kV)(2.92\ mm / kV) = 2204\ mm$$

Example, for a road crossing allowing a 5.3m vehicle and load combined height:

$$DV = 5.3\ m + 2.204\ m + 0.3\ m = 7.8\ m$$

Alternate calculation: use +/- 450 kV clearance and add 0.005 m/kV for each kV over 450 kV (as recommended by note on CSA C22.3 No. 1, Table 4.)

$$DV = 5.3\ m + 1.970\ m + 0.3\ m + 0.005\ m = 7.8\ m$$

The description was changed in Table 5 under “Location of Wires or Conductors” (Column 1) based on the height of equipment, building, or object being transported on the highways in Alberta.

APPENDIX D - NOTES ON RULES FOUND IN C22.3 NO. 7:20, UNDERGROUND SYSTEMS

Note: This Appendix forms an informational (non-mandatory) part of this Code.

Note: Reference numbers found in this Appendix correlate to the Rule numbers found in C22.3 No. 7:20.

15.1 General

(1) For bare grounding conductors, the short time ampacity is the current that the conductor can carry for the time during which the current flows without melting or affecting the design characteristics of the conductor.
(2) For insulated grounding conductors, the short time ampacity is the current that the conductor can carry for the applicable time without affecting the design characteristics of the insulation.
(3) Where grounding conductors at one location are paralleled, the increased total current capacity may be considered.

15.2 Current-carrying capacity

Typically, grounding conductors should have a minimum current-carrying capacity of #4 AWG copper size or equivalent.

15.5 Supply ground electrodes and connections

See Figures 1 and 2 for examples of Ground Electrode and Gradient Control

15.5.1 Corrosion of Grounding System

When the cross sectional area or mass of the grounding system equipment/assembly has been reduced by corrosion to less than 80% of the original amount, the grounding system equipment/assembly should be replaced.

15.6.2 Gradient Control

(1) The conductor used in gradient control to form loops and connections to grounding conductors or electrodes on electrical utility systems should be sufficient to prevent burn-off of the gradient control conductors when fault currents flow on the grounding conductors or electrodes.
(2) If gradient conductors are required at pad-mounted electrical equipment locations, the loops should:
    (a) be placed not less than 500 mm nor more than 1000 mm apart; and
    (b) be located not less than 200 mm below grade level.
(3) If gradient control conductor loops are placed around pad-mounted electrical equipment, two or more physically separated gradient control conductors should be used to interconnect the gradient loops to the grounding system.

15.9.1 Multi-Grounded Systems

(Note: These clauses have been taken from the CSA C22.3 No. 1:20, Overhead Systems.)
Where a single electrode resistance exceeds 25 Ω, up to two additional electrodes connected in parallel or up to two deep-driven electrodes should be used unless it is clear that additional electrodes will not significantly reduce the resistance.

The intent of the 25 Ω limit is to provide a starting point (or target) to confirm the interconnected resistance is below 6 Ω.

15.11 Objectionable Current

The following steps are recommended to mitigate current described in Clause 15.11:

(a) grounding the other equipment;
(b) improving the grounding system;
(c) changing the locations of ground connections or ground electrodes;
(d) eliminating parallel paths; or
(e) using other mitigation methods designed, engineered, and constructed in accordance with recognized industry standards.

16.3 Identification of Direct Buried Ducts

CSA C22.3 No.7:20, Section 16.3 permits the use of coloured ducts for identification of different systems, and defines the colours that are suggested for different systems. Coloured ducts are not required by Section 16.3, but may be required by the utility.

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