Δ Section 64 — Renewable energy systems, energy production systems, and energy storage systems

64-000 Scope (see Appendix B)

Δ 1) This Section applies to the installation of renewable energy systems, energy production systems, and energy storage systems except where the voltage and current are limited in accordance with Rule 16-200 1) a) and b).

2) This Section supplements or amends the general requirements of this Code.

64-002 Special terminology (see Appendix B)

In this Section, the following definitions shall apply:

AC module — a complete, environmentally protected assembly of interconnected solar cells, an inverter, and other components designed to generate ac power from sunlight.

Array — a mechanical integrated assembly of photovoltaic modules with a support structure and foundation, tracking, and other components as required to form a power-producing unit.

Auxiliary grounding electrode — a grounding electrode that augments equipment grounding and that is not required to be directly connected to the electrode(s) that makes up the grounding electrode system.

Δ **Battery** — an assembly of more than one cell connected in series, parallel, or both.

Δ **Sealed cell battery** — a battery that has no provision for the addition of water or electrolyte, nor for the external measurement of electrolyte specific gravity.

Bipolar system — a solar photovoltaic system that has two monopole photovoltaic source or output circuits, each having opposite polarity to a common reference point or centre tap.

Δ **Cell** — an electrochemical device used to receive, store, and deliver electrical energy.

Controller —

Charge controller — equipment that controls dc voltage or dc current, or both, and that is used to charge a battery or other storage device.

Diversion charge controller — equipment that regulates the charging process of a battery or other storage device by diverting energy to ballast loads or to an interconnected supply authority service.

Diversion load controller — equipment that regulates the output of a generator by diverting energy from the generator to ballast loads or to an interconnected utility service.

Dump load controller — equipment that regulates the output power of a micro-hydropower system by adjusting the amount of energy flowing into the ballast load to compensate for main load variations (e.g., in stand-alone systems) and prevent generator overvoltage.

Electronic governor — equipment that regulates the output power of a micro-hydropower system by adjusting power flowing into the ballast load to compensate for main load variations (used only in stand-alone systems).

Δ **Energy storage system** — a system capable of supplying electrical energy to local power loads or operating in parallel with a supply authority system or any other power sources.

Δ **Field-assembled energy storage system** — a system with storage capacity not exceeding 1 kWh (3.6 MJ) that has not been evaluated in accordance with UL 9540.

Δ **Non-residential use energy storage system** — an energy storage system that is not marked as being suitable for residential use.

Δ **Residential use energy storage system** — an energy storage system that
a) is marked as being suitable for residential use; and
b) conforms to the requirements of UL 9540.

Δ **Self-contained energy storage system** — a system that conforms to the requirements of UL 9540.

Flow channel — a natural or fabricated structure, channel, or waterway creating water flow from which electric power is generated.

Fuel cell — a device that generates a dc electrical current by the electrochemical combination of a continuously supplied fuel and oxidant.

Fuel cell system — a system consisting of one or more fuel cells and associated equipment that produces usable electricity.

Portable fuel cell system — a fuel cell power system that is not intended to be permanently fastened or otherwise secured in a specific location.

Stationary fuel cell system — a permanently installed fuel cell power system.

Full load rating — the maximum power that a micro-hydropower system is designed to generate continuously.

Δ **Functionally-grounded photovoltaic system** — a solar photovoltaic system that has an electrical reference to ground that is not solidly grounded.

Guy wire — a wire rope not intended to conduct electricity that mechanically supports a wind turbine tower.

Head — the difference in elevation between two water surfaces, measured in metres.

Hydraulic turbine — equipment that converts the kinetic and potential energy of flowing water to mechanical energy.

Hydrokinetic power system — a system operating as an interconnected or stand-alone system and consisting of one or more hydrokinetic turbines that convert the kinetic energy of flowing water into electrical energy.

Hydrokinetic turbine electrical system — all electrical equipment from the hydrokinetic turbine generator terminals to the point of distributed resource connection, including equipment for power transmission, power conditioning, energy storage, grounding, bonding, and communications.

Hydrokinetic turbine generator — all electrical equipment and circuits within the hydrokinetic turbine structure up to the hydrokinetic turbine generator terminals.

Hydrokinetic turbine generator terminal — a point(s) identified by the hydrokinetic turbine supplier at which the hydrokinetic turbine generator can be connected to the electrical power system, including connection for the purposes of transferring energy as well as communications.

Installed capacity — the maximum capacity of the generating units in a micro-hydropower or hydrokinetic power system.

Interactive system — a power production system that operates in parallel with and can deliver power to another system, such as a supply authority system.

Inverter —

Combination inverter/power conditioning unit (PCU) — equipment that is used to invert direct current into alternating current either at a fixed voltage and frequency in a stand-alone system or following an imposed waveform in an interactive system.

Interactive inverter — an inverter whose ac output is intended for use in parallel with an electric utility or other electricity supply authority network, whether or not the inverter injects net power into the utility or supply network.

Power conditioning unit (PCU) — equipment that is used to change voltage level or waveform or otherwise alter or regulate the output of a power source.

Inverter input circuit — the insulated conductors between
a) the inverter and the battery in stand-alone systems; or
b) the renewable energy source and the inverter.

Inverter output circuit — the insulated conductors between
a) the inverter and a panelboard for stand-alone systems; or
b) the inverter and the service equipment or another electric power production source, such as a supply authority.

Load —

Ballast load — see **Diversion load**.

Diversion load — a resistive device, usually consisting of water or air electric heating elements, to which energy is diverted when more energy is generated than required.

Dump load — see **Diversion load**.

Mechanical governor — a controlling device that adjusts the flow of water through a hydraulic turbine.

Micro-hydropower system — a system with a rated output of 100 kW or less operating as an interconnected or stand-alone system and consisting of one or more hydraulic turbines that convert energy derived from flowing and falling water primarily by utilizing the available head difference.

Battery-based micro-hydropower system — a micro-hydropower system that uses batteries for energy storage, usually in less than 5 kW capacities.

Monopole — an array or portion of an array that has two source circuit insulated conductors, one positive (+) and one negative (–).

Nacelle — the body, shell, and casing covering the gearbox, generator, blade hub, and other parts mounted on the top of the tower structure of a propeller-type wind turbine and electrically connected to the rest of the wind turbine generator electrical system after installation.

Photovoltaic combiner — an assembly of buses and connections that may contain overcurrent protective devices, control apparatus, switches, or other equipment and that connects photovoltaic source circuits or the outputs of other combiners together to create an output at higher current or higher voltage, or both.

Photovoltaic module — a complete, environmentally protected assembly of interconnected solar cells.

Application Class A photovoltaic module — an unrestricted access module for use in solar photovoltaic systems operating in excess of 50 V dc or in excess of 240 W.

Application Class B photovoltaic module — a restricted access module for use in solar photovoltaic systems where the module is inaccessible to the public.

Application Class C photovoltaic module — a limited voltage, unrestricted access module for use in photovoltaic systems operating at 50 V dc or less and 240 W or less.

Photovoltaic output circuit — circuit insulated conductors or cables between the photovoltaic source circuit(s) and the power conditioning unit or dc utilization equipment.

Photovoltaic power source — an array or aggregate of arrays that generates dc power at system voltage and current.

Photovoltaic recombiner — an assembly of buses and connections that may contain overcurrent protective devices, control apparatus, switches, or other equipment and that connects outputs from photovoltaic combiners together to create an output at higher current or higher voltage, or both.

Photovoltaic source circuit — insulated conductors or cables between photovoltaic modules and from photovoltaic modules to the common connection point(s) of the dc system.

Point of common coupling — the point where the supply authority's system is connected to the power producer's facilities or conductors.

Point of distributed resource connection — the point where the renewable energy system is connected to a different system, and that can be the same as the point of common coupling or, in the case of a stand-alone system, the point at which the stand-alone network or load is connected to the renewable energy system.

Power conditioning unit (PCU) — see **Inverter**.

Power conditioning unit output circuit — see **Inverter output circuit**.

Power electronics input — the insulated conductors or cables between the hydrokinetic turbine terminals and the first stage of the power electronics system.

Rated power (as applied to small wind turbines) — a wind turbine's maximum power output at a wind speed of 11.0 m/s or less.

Renewable energy — energy derived from resources that are naturally replenished, such as sunlight, wind, water, tides, and geothermal heat.

Δ **Renewable energy system** — all interconnected equipment, up to and including the system disconnecting means, that converts renewable energy into electrical energy.

Solar cell — the basic photovoltaic device that generates electricity when exposed to light.

Δ **Solar photovoltaic system** — a renewable energy system that converts solar energy into electrical energy.

Stand-alone system — a system that supplies power independently of a supply authority's electrical production and distribution network.

Supply wiring — the insulated conductors or cables used to connect the renewable energy system to its electrical point of delivery, which can include an alternator, integrated rectifier, controller or inverter or both, or batteries.

Tower — a pole or other structure that supports a wind turbine.

Turbine speed/load controller — equipment that adjusts the electrical load applied to the hydrokinetic turbine generator to control turbine speed.

Wind —

Large wind system — a system consisting of one or more wind turbines with a rated power output exceeding 100 kW.

Small wind system — a system consisting of one or more wind turbines with a rated output up to and including 100 kW.

Wind turbine — mechanical equipment that converts the kinetic energy of wind into electrical energy and includes all electrical components and circuits within the wind turbine structure.

Wind turbine electrical system — a system consisting of all the electrical equipment integral to the wind turbine, including the wind turbine terminals, generators, inverters, controllers, and equipment for grounding, bonding, and communications, up to the point of common coupling to the load or grid.

Wind turbine generator (WTG) — all electrical equipment and circuits within the wind turbine structure, to the point of coupling to the load or grid.

Wind turbine generator (WTG) system — a system that converts the kinetic energy of wind into electrical energy.

Wind turbine terminal — a point(s) identified by the wind turbine supplier at which the wind turbine can be connected to the power collection system, including connection for the purposes of transferring energy and communications.

General

Δ **64-050 General**

Renewable energy system and energy storage system wiring shall be permitted to supply a building or other structure in addition to any service(s) from another supply system(s).

64-052 Insulated conductors of different systems (see Appendix B)

Insulated conductors of renewable energy systems shall be separated from different systems in accordance with Rules 12-904 2) and 12-3030.

64-054 Common return conductor

For a renewable energy power source that has multiple supply circuit voltages and employs a common return conductor, the ampacity of the common return conductor shall not be less than the sum of the ampere ratings of the overcurrent devices of the individual supply circuits.

64-056 Bipolar systems

1) Where the sum, without consideration of polarity, of the voltages of the two monopoles of a bipolar system exceeds the voltage rating of the insulated conductors and connected equipment, the monopoles shall be physically separated, and the electrical output circuits from each monopole shall be installed in separate raceways until they are connected to the inverter.
2) The disconnecting means and overcurrent protective devices for each monopole output circuit shall be in separate enclosures.
3) Notwithstanding Subrule 2), equipment rated for the maximum voltage between circuits and containing a physical barrier separating the disconnecting means for each monopole shall be permitted to be used instead of disconnecting means in separate enclosures.
4) All insulated conductors from each separate monopole shall be routed in the same raceway.
5) Bipolar systems shall be clearly marked with a permanent, legible warning notice, indicating that the disconnection of the grounded conductor(s) may result in overvoltage on the equipment.

64-058 Overcurrent protection (see Appendix B)

1) Circuits connected to more than one electrical source shall have overcurrent devices located so as to provide overcurrent protection from all sources.
2) Overcurrent protection for a transformer with a source(s) on each side shall be provided in accordance with Section 26 by considering first one side of the transformer, then the other side of the transformer, as the primary.
3) Overcurrent devices used in any dc portion of a renewable energy power system shall be marked for the purpose.
4) Overcurrent devices such as circuit breakers, if backfed, shall be suitable for such operation.

64-060 Disconnecting means (see Appendix B)

Δ 1) A disconnecting means shall be provided to disconnect simultaneously all ungrounded conductors supplied from
   a) a renewable energy system from all other insulated conductors in a building or other structure; and
   b) batteries.
2) The disconnecting means referred to in Subrule 1) shall
   a) be capable of being energized from both sides;
   b) indicate whether it is in the open or closed position;
   c) have provision for being locked in the open position;
   d) conform to Section 14;
   e) be capable of being opened at rated load;
   f) be capable of being closed with a fault on the system; and
   g) be located within sight of and within 9 m of the equipment or be integral to the equipment.
3) Where the disconnecting means referred to in Subrule 1) is used as the service disconnecting means, it shall be suitable for service entrance equipment.
Δ 4) A disconnecting means shall be provided to disconnect equipment such as inverters, batteries, and charge controllers from all conductors of all sources that are not solidly grounded.
Δ 5) The disconnecting means required by this Rule shall not be connected in any solidly grounded conductor if operation of that disconnecting means would cause the grounded conductor to be in an ungrounded and energized state.
6) Where the equipment is energized from more than one supply source, the disconnecting means shall comply with Rules 14-414 and 14-700.
7) Output circuits rated 48 V and greater shall have means to disable and isolate them.
8) Disconnecting means shall be provided to disconnect a fuse from all sources of supply if the fuse is energized from both directions, as required by Rule 14-402.

9) Disconnecting means provided on dc circuits shall be marked for the purpose.
10) The disconnecting means shall bear a warning to the effect that the terminals on both the line and load sides could be energized when the disconnecting means is open.
11) The disconnecting means for a hydrokinetic power system shall be permitted to be located beyond the limits defined in Subrule 2), provided that it is capable of being locked in the open position.
12) For installations with combiners, a single disconnecting means capable of being opened at the ampere rating of its photovoltaic output circuit in accordance with Rule 64-206 shall be installed for the photovoltaic output circuit as follows:
    a) for photovoltaic combiners equipped with fuses protecting photovoltaic source circuits, the disconnecting means shall be
        i) integral with the photovoltaic combiner and interlocked with the door; or
        ii) installed within 2 m of the photovoltaic combiner and interlocked with the combiner door; and
    b) for photovoltaic combiners equipped with circuit breakers protecting photovoltaic source circuits, the disconnecting means shall be integral with the photovoltaic combiner or located not more than 2 m from each photovoltaic combiner.
13) Notwithstanding Subrules 6) and 12), for installations with recombiners, where the recombiner is installed in excess of 7.5 m from the inverter, a single disconnecting means capable of being opened at the ampere rating of the inverter input circuit in accordance with Rule 64-206 shall be installed for the inverter input circuit as follows:
    a) for photovoltaic recombiners equipped with fuses protecting photovoltaic output circuits, the disconnecting means shall be
        i) integral with the photovoltaic recombiner and interlocked with the door; or
        ii) installed within 2 m of the photovoltaic recombiner and interlocked with the recombiner door; and
    b) for photovoltaic recombiners equipped with circuit breakers protecting photovoltaic output circuits, the disconnecting means shall be
        i) integral with the photovoltaic recombiner; or
        ii) located not more than 2 m from each photovoltaic recombiner.

64-062 Wiring methods

Δ 1) Except as provided for by Rule 64-210, insulated conductors between dc renewable energy sources and an inverter, installed inside a building or structure, shall be contained in metallic raceways, metal enclosures, or cables with a metal armour or metal sheath.
2) Wiring methods as required by Subrule 1) shall be provided from the point of penetration of the surface of the building or structure to the first readily accessible disconnecting means.

Δ 64-064 System grounding (see Appendix B)

1) Subject to Rule 84-028 and except as permitted by Subrule 2), for renewable energy dc supply circuits, one conductor of a 2-wire system or the reference (centre tap) conductor of a bipolar system shall be grounded in accordance with Section 10.
2) 2-wire photovoltaic source and output circuits shall be permitted to be functionally grounded.
3) The dc supply circuits referred to in Subrules 1) and 2) shall be provided with a ground fault protection device or system that
    a) detects a ground fault;
    b) indicates that a ground fault has occurred; and
    c) controls the faulted circuit by either
        i) automatically disconnecting all conductors of the dc supply circuit or of the faulted portion of the dc supply circuit; or

ii) automatically causing the inverter or charge controller connected to the faulted circuit to
A) cease supplying power to the output circuits; and
B) in a functionally-grounded system, interrupt the faulted photovoltaic system dc circuits from the ground reference.

4) The dc circuit grounding connection shall be made at any single point on the renewable energy supply circuit and shall be located as close as practicable to the supply source.
5) A renewable energy dc supply system equipped with a ground fault protection device shall be permitted to have the grounding conductor connected to the grounding electrode via the ground fault protection device.
6) Where the connection permitted in Subrule 6) is internal to the equipment equipped with a ground fault protection device, it shall not be duplicated by an external connection.
7) Systems that are not solidly grounded shall bear a warning stating that a shock hazard can be present when a ground fault exists in the system.
8) Equipment providing ground-fault protection mounted in locations that are not readily accessible shall provide remote indication of ground faults.
9) The remote indication required by Subrule 8) shall
a) be clearly labelled as to its purpose;
b) annunciate the status of the system to persons monitoring it; and
c) continue signalling until the condition has been corrected.
10) Solidly grounded renewable energy dc supply systems shall be connected to a grounding electrode by means of a grounding conductor in accordance with Rule 64-068.

64-066 Ungrounded renewable energy power systems (see Appendix B)

1) Notwithstanding Rule 64-064, renewable energy power systems shall be permitted to operate with ungrounded source and supply circuits where the system complies with the following:
a) all source and supply circuit conductors shall have overcurrent protection except as permitted by Rule 64-214 1);
b) the renewable energy power source shall be labelled in a conspicuous, legible, and permanent manner with a suitable warning at each junction box, disconnecting means, and device where the ungrounded circuits can be exposed during service;
c) inverters or charge controllers used in systems with ungrounded source and supply circuits shall be suitable for the purpose; and
d) all ungrounded dc systems shall be provided with a ground fault protection device or system that
i) detects a ground fault;
ii) interrupts the fault current, if fault current can result from a single ground fault;
iii) indicates that a ground fault has occurred; and
iv) either
A) automatically disconnects all conductors of the dc supply circuit or of the faulted portion of the dc supply circuit; or
B) automatically causes the inverter or charge controller connected to the faulted circuit to cease supplying power to inverter output circuits.
2) Notwithstanding Subrule 1), the renewable energy power system dc circuits shall be permitted to be ungrounded where they are used with ungrounded battery systems that comply with Rule 64-800.

64-068 Grounding electrodes and grounding conductors (see Appendix B)

AC and DC renewable energy power systems required to be grounded shall be connected to a grounding conductor by one of the following means:

a) the dc grounding conductor and ac grounding conductor shall be connected to a single electrode, with separate grounding conductors sized as required by Rule 10-114;

b) the dc grounding conductor shall be connected to a separate electrode by
   i) the grounding conductor connected between the identified dc grounding point and a separate dc grounding electrode; and
   ii) bonding the dc grounding electrode to the ac grounding electrode where such bonding means is required by Rule 10-104 b); or

c) a combined dc grounding conductor and ac equipment bonding conductor shall be
   i) installed in accordance with Rule 10-116; and
   ii) sized in accordance with Rule 10-114 or 10-616, whichever is larger.

Δ **64-070 Equipment bonding** (see Appendix B)

The bonding connection between exposed conductive surfaces of the renewable energy source or supply circuit equipment shall be in accordance with Section 10.

64-072 Marking

Δ 1) All interactive system(s) points of interconnection with other sources shall be marked with the rated ac operating voltage and current.

2) The marking referred to in Subrule 1) shall be provided at the disconnecting means for each interconnecting power source.

Δ **64-074 Warning notice and diagram**

1) Any structure or building with a renewable energy power system or an energy storage system that is not connected to a supply service source and is a stand-alone system shall be marked in a conspicuous, legible, and permanent manner to indicate the location of the system disconnecting means and that the structure contains a stand-alone electrical power system.

2) Buildings and structures with a utility supply service and
   a) a renewable energy system;
   b) an energy storage system; or
   c) both

   shall, where practicable, have the disconnecting means grouped in accordance with Rule 6-102 2) or, where such an arrangement is not practicable, shall have a permanent plaque posted on or near each disconnecting means, indicating the location of all other service boxes supplying power to the building, in accordance with Rule 6-102 3).

3) Markings for renewable energy systems and energy storage systems shall include a permanent plaque or directory identifying all electrical power sources on or in the premises and shall be installed at each service equipment location and
   a) at the supply authority meter location; or
   b) in the case of a stand-alone system, at a location acceptable to the inspection department.

64-076 Interconnections to other circuits (see Appendix B)

Where an installation is supplied from a renewable energy system that is not intended to be interconnected with a supply authority, the switching equipment controlling the systems shall be constructed or arranged so that it will be impossible to accidentally switch on power from one source before power from another has been cut off.

64-078 Loss of interactive system power (see Appendix B)

1) The renewable energy system shall
   a) be provided with a means of detecting when the electrical production and distribution network has become de-energized; and

b) not feed the electrical production and distribution network side of the point of common coupling during this condition.

2) The renewable energy system shall remain in the state described in Subrule 1) until the normal voltage and frequency of the supply authority system have been restored.

3) A normally interactive renewable energy system shall be permitted to operate as a stand-alone system to supply loads that have been disconnected from electrical production and distribution network sources.

Inverters

64-100 Maximum circuit loading (see Appendix B)

1) The maximum current of the inverter output circuit shall be the inverter continuous output current rating.

2) The maximum current of a stand-alone inverter input circuit shall be the stand-alone continuous inverter input current rating when the inverter is producing rated power at the lowest input voltage.

3) Renewable energy system maximum current ratings shall be based on continuous operation.

64-102 Stand-alone systems (see Appendix B)

The premises wiring system and the wiring on the supply side of the building or structure disconnecting means shall comply with the applicable requirements of this Code, except as follows:

a) the ac inverter output from a stand-alone system shall be permitted to supply ac power to the building or structure disconnecting means at current levels below the rating of that disconnecting means, provided that the inverter output rating is equal to or greater than the connected load of the largest single utilization equipment connected to the system;

b) the circuit conductors between the inverter output and the building or structure disconnecting means shall be
   i) sized based on the output rating of the inverter; and
   ii) provided with overcurrent protection located at the output of the inverter, in accordance with Section 14; and

c) the inverter output of a stand-alone renewable energy system shall be permitted to supply 120 V to single-phase, 3-wire, 120/240 V service equipment or distribution panels, provided that
   i) there are no 240 V loads;
   ii) there are no multi-wire branch circuits;
   iii) the rating of the overcurrent device connected to the output of the inverter does not exceed the rating of the neutral bus in the service equipment; and
   iv) the equipment is marked in a conspicuous, legible, and permanent manner with a warning not to connect it to multi-wire branch circuits.

64-104 Interactive inverters mounted in locations that are not readily accessible

Interactive inverters shall be permitted to be mounted on roofs or other exterior areas that are not readily accessible, provided that

a) a dc and ac disconnecting means is provided in accordance with Rule 64-060 2);

b) an additional ac disconnecting means for the inverter is provided in accordance with Rule 84-020; and

c) a diagram is installed in accordance with Rule 84-030 2).

64-106 Connection to other sources (see Appendix B)

Only inverters and ac modules marked as interactive shall be permitted in interactive systems.

64-108 Ampacity of neutral conductor

1) The inverter output rating and maximum load connected between the neutral and any one ungrounded conductor shall not exceed the ampacity of the neutral conductor, where an inverter

with a single-phase, 2-wire output is connected to the neutral and only one ungrounded conductor of

a) a single-phase, 3-wire system; or
b) a three-phase, 4-wire wye-connected system.

2) A conductor used solely for instrumentation, voltage detection, or phase detection, and connected to a single-phase or three-phase interactive inverter, shall be
   a) permitted to be sized at less than the ampacity of the other current-carrying conductors; and
   b) in no case smaller than the bonding conductor required by Rule 10-616.

64-110 Unbalanced interconnections (see Appendix B)

1) Single-phase inverters for renewable energy systems and ac modules in interactive renewable energy systems shall not be connected to three-phase systems unless the interactive system
   a) is designed such that under normal operating conditions, the resulting three-phase system voltages are balanced within the limits of supply authority requirements; and
   b) complies with Rules 84-008 and 84-018.
2) Three-phase inverters and three-phase ac modules in interactive systems shall have all phases automatically de-energized upon loss of the system voltage in one or more phases.

64-112 Interactive point of connection (see Appendix B)

1) The output of an interactive inverter or power conditioning unit shall be connected to the supply authority system in accordance with Section 84.
2) Except as provided for in Subrule 3), the output of an interactive inverter described in this Section shall be connected to the supply side of the service disconnecting means.
3) The output of an interactive inverter shall be permitted to be connected to the load side of the service disconnecting means of the other source(s) at any distribution equipment on the premises under the provisions of Subrule 4).
4) Where distribution equipment such as switchboards or panelboards located on the premises is supplied simultaneously by a primary power source and one or more interactive inverters and where the distribution equipment connected as permitted by Subrule 3) is capable of supplying multiple branch circuits or feeders, or both, provisions for interconnection between the primary power supply source and the interactive inverter(s) shall comply with the following conditions:
   a) each source interconnection shall be made at a dedicated circuit breaker or fusible disconnecting means;
   b) each panelboard, busbar, or conductor supplied by the multiple sources in the interactive system shall be provided with
      i) suitable warning signs adjacent to each source disconnecting means to indicate that all of the disconnecting means must be opened to ensure complete de-energization of the equipment in accordance with Rule 14-414;
      ii) the point of connection positioned at the opposite (load) end from the input feeder location or main circuit location, where the panelboard is rated less than the sum of the ampere ratings of all overcurrent devices in source circuits supplying the panelboard; and
      iii) a permanent warning label at the distribution equipment to indicate that the overcurrent device shall not be relocated;
   c) notwithstanding Section 14, the sum of the ampere ratings of the overcurrent devices in source circuits supplying power to a busbar or conductor shall be permitted to exceed the busbar or conductor rating to a maximum of 120% of the rating of the busbar or conductor;
   d) notwithstanding Section 14, for a dwelling unit, the sum of the ampere ratings of the overcurrent devices in source circuits supplying power to a busbar or conductor shall be permitted to exceed the busbar or conductor rating to a maximum of 125% of the rating of the busbar or conductor;

Δ e) notwithstanding Items c) and d), the sum of the ampere rating of the overcurrent devices shall be permitted to exceed the rating of the busbar or conductor where means are provided to limit the input and output current of the interconnected systems to ensure the busbar or conductor cannot be overloaded; and

f) except as provided for in Subrule 5), the interconnection point shall be made on the line side of all ground fault protection equipment.

5) The interconnection point described in Subrule 4) e) shall be permitted to be made on the load side of ground fault protection equipment, provided that

a) there is ground fault protection for equipment from all ground fault current sources; and

b) ground fault protection devices used with supplies connected to the load side terminals are suitable for back-feeding.

Solar photovoltaic systems

64-200 Marking (see Appendix B)

1) In addition to the marking requirements given in Rule 64-072, a permanent marking shall be provided at an accessible location at the disconnecting means for the photovoltaic output circuit, specifying the following:

a) the rated operating current and voltage;

b) the maximum photovoltaic source circuit voltage calculated in accordance with Rule 64-202 1) and 2); and

c) the rated short-circuit current.

2) A photovoltaic system with rapid shutdown in accordance with Rule 64-218 shall be provided with a permanent marking in an accessible location at the disconnecting means for the photovoltaic output circuit stating that the photovoltaic system is equipped with rapid shutdown.

3) A warning sign for a photovoltaic system shall be in capital letters with a minimum height of 9.5 mm, in white on a red background.

64-202 Voltage of solar photovoltaic systems (see Appendix B)

1) The maximum photovoltaic source and output circuit voltage shall be the rated open-circuit voltage of the photovoltaic power source multiplied by 125%.

2) Notwithstanding Subrule 1), the maximum photovoltaic source and output circuit voltage shall be permitted to be calculated using

a) the rated open-circuit voltage of the photovoltaic power source;

b) the difference between 25 °C and the lowest expected daily minimum temperature; and

c) the voltage temperature coefficient as specified by the manufacturer.

3) The maximum photovoltaic source and output circuit voltage shall be used to determine the voltage ratings of insulated conductors, cables, disconnects, overcurrent protection, and other equipment in photovoltaic source or output circuits.

Δ 4) Photovoltaic source and output circuits installed in or on dwelling units shall be permitted to have a voltage not exceeding 600 V dc between any two conductors and between any conductor and ground, provided that

a) all energized parts in the photovoltaic source and output circuits over 150 volts-to-ground are accessible only to qualified persons; and

b) the insulated conductors for photovoltaic source and output circuits over 30 V located inside the building are contained in metallic raceways, metal enclosures, or cables with a metal armour or metal sheath.

5) Photovoltaic source and output circuits, and equipment connected to or within those circuits, with maximum voltages higher than 750 V dc but not exceeding 1500 V dc shall not be required to comply with Rules 36-204, 36-208, and 36-214, provided that
   a) the installation is serviced only by qualified persons;
   b) the part of the installation exceeding 750 V dc is inaccessible to the public; and
   c) enclosures in which photovoltaic source and output circuits exceeding 750 V dc are present are marked with the word "DANGER" followed by the maximum rated photovoltaic circuit voltage of the equipment.

64-204 Voltage drop

Notwithstanding the requirements of Rule 8-102, photovoltaic output circuit and photovoltaic source circuit conductors shall meet one of the following requirements:

a) the voltage drop shall be considered acceptable where the conductors are rated not less than 125% of the maximum available short-circuit current of the solar photovoltaic system;
b) the voltage drop shall not exceed 5% of the rated operating voltage;
c) the rated operating voltage drop shall not exceed the percentage calculated by multiplying 50% of the rated current of the photovoltaic source circuit under consideration divided by the rated current of the entire array connected to the power conditioning unit or directly connected loads; or
d) the resistance shall be sufficiently low to facilitate the operation of the overcurrent device protecting the circuit in the event of a short-circuit.

64-206 Ampere rating of photovoltaic source and output circuits

The ampere rating of a photovoltaic source and output circuit shall be

a) the ampere rating of the overcurrent device protecting the circuit or the ampacity of the conductors, whichever is less; and
b) not less than 125% of the rated short-circuit current of that photovoltaic source's circuit.

64-208 Photovoltaic module application class use (see Appendix B)

1) Photovoltaic modules marked with application Class A or C shall be permitted to be installed in a location accessible to the public.
2) Photovoltaic modules marked with an application Class B shall not be permitted for installations accessible to the public.

64-210 Wiring method (see Appendix B)

1) Notwithstanding Rule 12-102 3), flexible cords suitable for extra-hard usage shall be permitted for the interconnection of photovoltaic modules within an array.
Δ 2) Notwithstanding Rule 12-202, cables included as part of photovoltaic modules shall be permitted for the interconnection of photovoltaic modules within an array, provided that the photovoltaic source and output circuits operate at a maximum system voltage
   a) of 30 V or less; or
   b) greater than 30 V where the array is not installed in readily accessible locations.
Δ 3) Notwithstanding Rule 12-202, Type RPVU cables shall be permitted for the interconnection of photovoltaic modules within an array, provided that
   a) the installation is serviced only by qualified persons; and
   b) the installation is inaccessible to the public.
4) Insulated conductors and cables installed in accordance with Subrules 1), 2), and 3) shall be adequately protected against mechanical damage during and after installation, and supported by straps or other devices located
   a) within 300 mm of every box or connector; and
   b) at intervals of not more than 1 m throughout the run.

5) Where the dc arc-fault protection referred to in Rule 64-216 is not located at the module, photovoltaic source circuit insulated conductors and cables installed on or above a building and installed in accordance with Subrules 1), 2), and 3) shall be provided with mechanical protection in the form of an enclosed raceway or other acceptable material to protect against damage from rodents.
6) Notwithstanding Rule 12-2202 1), 2), and 3), Type RPVU cables shall be permitted to be installed in cable tray for the interconnection of the solar photovoltaic system.
7) Type RPV conductors installed in a raceway shall be permitted for the interconnection of the solar photovoltaic system.
8) Cables used for solar photovoltaic installations on or above a building shall meet the flame spread requirements of the *National Building Code of Canada* or local building legislation.
9) Type RPV insulated conductors and Type RPVU cables installed inside a building or structure shall be contained in a raceway.
10) Notwithstanding Rules 12-904 and 12-3030, junction boxes, enclosures, fittings, and raceways or compartments of multiple-channel raceways shall be permitted to contain insulated conductors of a single renewable energy system that are connected to different sources of voltage where
    a) all conductors are insulated for at least the same voltage as that of the circuit having the highest voltage; and
    b) a suitable warning notice is placed at each enclosure and junction box giving access to the insulated conductors, indicating where multiple photovoltaic source circuits and photovoltaic output circuits are available within the junction boxes, enclosures, and raceways or compartments of a multiple-channel raceway.

64-212 Insulated conductor marking or colour coding (see Appendix B)

1) Notwithstanding Rule 4-032, dc photovoltaic output circuit insulated conductors, and photovoltaic source circuit insulated conductors installed between a module and the power conditioning unit of the dc system, shall be coloured or coded, or both, as follows:
    a) for a 2-wire circuit,
        i) red for positive and black for negative; or
        ii) black insulated conductors manufactured with permanent surface printing indicating the polarity on the insulated conductor; and
    b) for a 3-wire circuit (bipolar circuit),
Δ   i) white or white with a coloured stripe for the mid-wire (identified as the centre tap), red for positive, and black for negative; or
        ii) black insulated conductors manufactured with permanent surface printing indicating the polarity on the conductor insulation.
2) The requirements of Subrule 1) shall not be met by field marking or labelling.
3) Notwithstanding Subrule 2), insulated conductor colour coding for multi-conductor cables required in Subrule 1) shall be permitted to be made through suitable field labelling or marking in a permanent manner.
4) The insulated conductor labelling and marking permitted in Subrule 3) shall
    a) be made at every point where the separate insulated conductors are rendered accessible and visible by removal of the outer jacket of the cable;
    b) be made by painting or other suitable means; and
    c) not render the manufacturer's numbering of the insulated conductors illegible.

64-214 Overcurrent protection for apparatus and conductors (see Appendix B)

Δ 1) Notwithstanding Rules 64-058 1) and 64-066 1) a), individual overcurrent protection devices shall not be required where the sum of the available short-circuit currents from all photovoltaic source

circuits connected to the same power conditioning unit is not greater than the rated ampacity of the apparatus or conductors.

2) Where overcurrent protection is required by Rule 64-058 1) for a photovoltaic source circuit, each photovoltaic source circuit shall be protected by an individual overcurrent device rated or set at not more than the allowable ampacity of the conductors of the photovoltaic source circuit or the maximum overcurrent protection indicated on the photovoltaic module nameplate, whichever is less.

Δ 3) For 2-wire photovoltaic circuits that are not solidly grounded, conductors of each source circuit or the conductors of each output circuit shall be permitted to be protected by an overcurrent device that interrupts the current in only one conductor of the circuit.

Δ 4) Where overcurrent protection devices are used to protect photovoltaic source or output circuits as described in Subrule 3), all overcurrent devices shall be placed in conductors of the same polarity for all circuits within a photovoltaic system.

5) Where the value as specified in Subrule 2) does not correspond to the standard rating of an overcurrent device, the next higher standard rating shall be permitted.

6) Overcurrent devices for photovoltaic source circuits shall be accessible and shall be grouped where practicable.

64-216 Photovoltaic dc arc-fault circuit protection

Δ 1) Solar photovoltaic systems with a dc source or dc output circuit voltage of 80 V or greater when calculated in accordance with Rules 64-202 1) or 2) shall be protected by

a) a dc arc-fault circuit interrupter; or

b) other system equipment that provides equivalent protection.

2) The protection required in Subrule 1) shall

a) detect and interrupt arcing faults resulting from a failure in the intended continuity of a conductor, connection, photovoltaic module, or other system component in the dc photovoltaic source and output circuits;

b) not have the capability of being automatically restarted;

c) have annunciation, without an automatic reset, that provides a visual indication that the circuit interrupter has operated; and

d) disable or disconnect

i) inverters or charge controllers connected to the faulted circuit when the fault is detected; or

ii) the photovoltaic dc source circuits or dc output circuits either within the combiner, at the module junction box, or at the module cable connectors.

64-218 Photovoltaic rapid shutdown (see Appendix B)

1) Photovoltaic rapid shutdown shall be provided for a photovoltaic system installed on or in buildings where the photovoltaic source or output circuit insulated conductors or cables installed on or in buildings are more than 1 m from a photovoltaic array.

2) Notwithstanding Subrule 1), photovoltaic rapid shutdown shall not be required for ground-mounted photovoltaic system circuits that enter a building whose sole purpose is to house photovoltaic system equipment.

3) Photovoltaic rapid shutdown shall limit photovoltaic source or output circuits located more than 1 m from the photovoltaic array to not more than 30 V within 30 s of rapid shutdown initiation.

4) A device used to initiate photovoltaic rapid shutdown shall be readily accessible and located

a) for single dwelling units, at the supply authority meter location;

b) for other than single dwelling units, at the consumer's service equipment or supply authority meter location, and

i) at a permanent access to a building roof where an array(s) is installed; or

ii) within sight and within 9 m of the array(s); and

c) for a stand-alone system, in accordance with Items b) i) and ii).

5) The location of the device used to initiate photovoltaic rapid shutdown shall be shown on the diagram required in Rule 84-030 2).

6) A label indicating that the photovoltaic system is equipped with photovoltaic rapid shutdown shall be installed at the supply authority meter location and at the consumer's service equipment location.

64-220 Attachment plugs and similar wiring devices (see Appendix B)

1) Attachment plugs and similar wiring devices shall be permitted to connect cables between photovoltaic modules, or between dc photovoltaic source and photovoltaic output circuits, where
   a) there are no exposed energized parts, whether the devices are connected or disconnected;
   b) the devices are polarized;
   c) the devices have a configuration that is not interchangeable with receptacles or attachment plugs of other systems on the premises;
   d) the devices are of the locking type;
   e) the devices are rated for the voltage and current of the circuit in which they are installed;
   f) the devices provide strain relief;
   g) the devices are a mated pair; and
   h) the attachment plugs and similar wiring devices are compatible with the types of cables used.

2) Where attachment plugs and similar wiring devices installed in accordance with Subrule 1) are readily accessible and are used in circuits operating at over 30 V, they shall be of a type that requires the use of a tool to open the connector.

3) Attachment plugs and similar wiring devices shall
   a) be rated for interrupting current without hazard to the operator; or
   b) be of a type that requires the use of a tool to open them and be marked "Do Not Disconnect Under Load" or "Not for Interrupting Current."

4) A single-pole attachment plug or similar wiring device designed for dc use shall be permitted to be used as a dc isolation means, provided that it complies with the requirements of Subrules 1), 2), and 3).

5) A multi-pole attachment plug or similar wiring device shall be permitted to be used as an ac isolation means, provided that it complies with the requirements of
   a) Subrule 1) a), b), c), e), f), and g); and
   b) Subrule 3).

Δ 64-222 Photovoltaic module bonding (see Appendix B)

1) Exposed, non-current-carrying metal parts of photovoltaic modules shall be bonded in accordance with Section 10.

2) Module bonding connections shall be as specified in the module installation manual.

3) Notwithstanding Subrule 2), bonding connectors intended for bonding photovoltaic modules and installed in accordance with the manufacturer's instructions shall be permitted to be used.

4) The connections to a photovoltaic module shall be arranged so that removal of a single photovoltaic module from a photovoltaic source circuit does not interrupt bonding continuity to the inverter or controller.

5) The connections to an inverter or controller shall be arranged so that removal of either the inverter or controller does not interrupt bonding continuity.

Small wind systems

64-300 Marking (see Appendix B)

1) A permanent marking shall be provided in accordance with Rule 2-100 at a readily accessible location at the disconnecting means for the wind turbine output circuit, specifying the following additional information:
   a) overcurrent protection values provided by the wind turbine for the stator and rotor, if applicable;
   b) short-circuit current rating (SCCR);
   c) a brief system description, including the type of generator (synchronous or induction);
   d) the rated output current; and
   e) the rated output voltage(s) at the connection to the turbine.
2) A plaque shall be installed at or adjacent to a turbine location providing instructions for disabling the turbine.

64-302 Maximum voltage (see Appendix B)

1) For wind turbines connected to single dwellings, turbine output circuits shall be permitted to have a maximum nominal voltage up to 600 V.
2) When wind turbines are connected to single dwellings, live parts in circuits over 150 volts-to-ground shall be accessible only to qualified personnel.
3) Small wind systems operating on dedicated branch or feeder circuits shall be permitted to exceed normal voltage operating ranges at the end of these circuits, provided that the voltage at any distribution equipment supplying other loads remains within normal ranges.

64-304 Insulated conductors

1) Supply wiring insulated conductors or cables from the wind turbine shall have an ampacity of not less than 125% of the maximum rated current of the generator.
2) Supply wiring insulated conductors or cables shall have a temperature rating of not less than 90 °C.

64-306 Wiring methods

1) Insulated conductors installed in raceways shall be of types specified in accordance with Rule 12-102 as suitable for use in raceways in wet locations.
2) Cables installed on the exterior of a support pole or tower structure shall be installed in one of the following ways:
   a) in rigid or flexible liquid-tight conduit;
   b) in mineral-insulated cable; or
   c) in armoured cable suitable for exposed wiring in wet locations as specified in accordance with Rule 12-102.
3) Insulated conductors and cables run up the centre of a support pole or hollow tower shall be
   a) insulated conductors as specified in Subrule 1);
   b) notwithstanding Section 12, flexible cords of the extra-hard-usage type suitable for use in wet locations in accordance with Rule 12-402; or
   c) in armoured cable suitable for exposed wiring in wet locations in accordance with Rule 12-102.
4) Insulated conductors and cables run up the centre of a support pole or hollow tower shall be supported in accordance with Rule 12-120.
5) Mechanical protection shall be provided where insulated conductors, cables, and grounding conductors are within 2.5 m of locations accessible to unauthorized persons.
6) Cables run on the outside of a support pole or tower structure shall be supported in accordance with Section 12.

64-308 Overcurrent protection for apparatus and insulated conductors (see Appendix B)

1) Notwithstanding Rules 64-058 1) and 64-066 1) a), individual overcurrent protection devices shall not be required where the available steady-state short-circuit current is not greater than the rated ampacity of the apparatus or insulated conductor.
2) Each ungrounded supply insulated conductor from the wind turbine shall be protected by an overcurrent device not exceeding 125% of the maximum rated current of the generator.
3) Notwithstanding Subrule 2), an overcurrent device shall not be required for insulated circuit conductors sized in accordance with this Rule and when the maximum currents from all sources do not exceed the allowable ampacity of the insulated conductors.
4) Notwithstanding Subrule 2), wind turbines with a maximum current of 12 A or less shall be permitted to be protected by an overcurrent device with a rating of 15 A.
5) Circuits connected to more than one electrical supply shall have overcurrent devices located so as to provide overcurrent protection from all sources.
6) Overcurrent devices for small wind turbine supply circuits shall be accessible.
7) Overcurrent protection for a power transformer shall be in accordance with Rule 64-058.
8) Notwithstanding Subrule 7), a power transformer with a full load current rating on the side connected to the inverter output that is not less than the rated continuous output current rating of the inverter shall be permitted without overcurrent protection from the inverter.

64-310 Disconnecting means (see Appendix B)

1) A disconnecting means shall be installed in each load circuit of the wind turbine.
2) Notwithstanding Subrule 1), a wind turbine that uses the turbine output circuit for regulating turbine speed shall not require a turbine output circuit disconnecting means.
3) All disconnecting means shall be rated for 125% of the full load rated current.
4) Disconnecting means shall be in accordance with Rule 84-024.
5) A disconnecting means of the lockable type shall be installed at each wind turbine and shall be labelled in a conspicuous, legible, and permanent manner identifying it as the wind turbine disconnecting means.
6) Means shall be provided to disconnect all equipment, including the power conditioning unit, from all ungrounded conductors of all sources.
7) Notwithstanding Rule 64-060 2), a disconnecting means shall be located within sight of the base of the wind turbine or be capable of being locked in the open position.
8) Notwithstanding Rule 64-060 2), the disconnecting means referred to in Subrule 1) shall be installed
   a) at a readily accessible location either on or adjacent to the turbine tower;
   b) on the outside of a building or structure or as close as practicable to the point of entrance of the system insulated conductors or cables; and
   c) not more than 9.0 m from the base of the turbine tower.

64-312 Grounding and bonding (see Appendix B)

1) Exposed non-current-carrying metal parts of towers, turbine nacelles, other metallic equipment, and insulated conductor enclosures shall be bonded to ground in accordance with Section 10 regardless of voltage.
2) Metallic towers or supporting structures shall be bonded to ground with a minimum No. 6 AWG.
3) Guy wires used to support turbine towers need not be grounded.
4) Towers or structures shall be grounded by means of grounding electrodes in accordance with Section 10 to limit voltages imposed by lightning.
5) Notwithstanding Subrule 4), metal towers located on steel-supported buildings shall be bonded to non-current-carrying metal parts of the building.

64-314 Receptacles for maintenance

Receptacles installed for maintenance of the wind turbine having CSA configuration 5-15R or 5-20R shall be protected by a ground fault circuit interrupter of the Class A type.

64-316 Lightning protection systems (see Appendix B)

Where auxiliary grounding conductors and grounding electrodes for a renewable energy system are used for lightning protection, the grounding conductors and grounding electrodes shall be installed in accordance with Rule 10-108 and shall be interconnected with grounding electrodes of other systems in conformance with Rule 10-104 c).

64-318 Diversion load controllers (see Appendix B)

A diversion load controller shall not use the supply authority system as a diversion load.

64-320 Surge protective devices (see Appendix B)

1) A surge protective device shall be installed between a small wind system and any loads served by the premises electrical system.
2) The surge protective device shall be permitted to be located on a dedicated branch circuit serving a small wind electric system or anywhere on the load side of the service disconnect.

Large wind systems

64-400 Marking (see Appendix B)

1) A permanent marking shall be provided at a readily accessible location at the base of the tower (entrance) of the wind turbine and shall include the following:
   a) overcurrent protection values provided by the wind turbine for the stator and rotor, if applicable;
   b) short-circuit current-interrupting capacity for stator and rotor protective devices;
   c) a brief system description, including the type of generator (synchronous or induction);
   d) rated output current;
   e) rated voltage(s) at the connection to the turbine; and
   f) a warning notice and diagram in accordance with Rule 84-030.
2) The information required to complete the electrical shock and arc flash labels, where such labels are supplied and installed by the manufacturer within a wind turbine and on the wind turbine access door, shall be field assessed and recorded on those labels.

64-402 Insulated conductors

1) Supply wiring insulated conductors or cables from the wind turbine shall have an ampacity of not less than 125% of the maximum rated current of the generator.
2) Supply wiring insulated conductors or cables shall have an insulation temperature rating of not less than 90 °C.

64-404 Overcurrent protection for apparatus and conductors (see Appendix B)

1) Each ungrounded supply wiring insulated conductor or cables from the wind turbine shall be protected by an overcurrent device not exceeding 125% of the maximum rated current of the generator.
2) Overcurrent devices shall be accessible.

64-406 Disconnecting means (see Appendix B)

1) A disconnecting means shall be installed in the supply conductors at the base of the tower.
2) All disconnecting means shall be rated for 125% of the maximum rated generator current.
Δ 3) Notwithstanding Subrule 2), the large wind turbine disconnecting means shall be permitted to be rated less than 125% of the maximum rated output current where the maximum current marking on the wind turbine nameplate indicates that the generator output current does not exceed the disconnecting means continuous operation marking.
4) Disconnecting means shall be in accordance with Rule 84-024.

5) Notwithstanding Rules 26-248 and 36-204 1), a single disconnect shall be permitted to serve as a disconnecting means for multiple transformers where mechanical interlocking is installed between the disconnecting means and the transformer access doors.
6) The disconnecting means installed in accordance with Rules 64-060 and 84-020 shall be labelled in a conspicuous, legible, and permanent manner, identifying it as the wind turbine generator system disconnecting means.

64-408 Grounding and bonding

1) Exposed non-current-carrying metal parts of towers, turbine nacelles, other equipment, and insulated conductor enclosures shall be bonded to ground in accordance with Section 10.
2) Metallic towers or supporting structures shall be bonded to ground with a minimum No. 2/0 AWG bare copper conductor.
3) Towers or structures shall be grounded by means of grounding electrodes in accordance with Section 10.
4) Grounding electrodes installed in accordance with Subrule 3) shall be interconnected in accordance with Rule 10-104.
5) Station ground electrodes shall be in accordance with Section 36 and, when installed within 2.4 m of the tower grounding electrodes, shall be interconnected with the tower grounding system with a minimum No. 2/0 AWG bare copper conductor.

64-410 Receptacles for maintenance

Receptacles installed for maintenance of the wind turbine having CSA configuration 5-15R or 5-20R shall be protected by a ground fault circuit interrupter of the Class A type.

64-412 Lightning protection systems (see Appendix B)

1) Auxiliary electrodes and grounding conductors shall be permitted to act as lightning protection system components if they meet applicable requirements.
2) If separate, the tower lightning protection system grounding electrodes shall be bonded to the tower grounding electrode system with a minimum No. 2/0 AWG bare copper conductor.

Micro-hydropower systems

64-500 Marking (see Appendix B)

A permanent marking shall be provided in accordance with Rule 2-100 at an accessible location at the disconnecting means or the micro-hydropower system output circuit and shall include the following additional information:

a) a brief system description, including rated power and the type of generation system; and
b) rated ballast load voltage and current (if a ballast load is used).

64-502 Insulated conductors (see Appendix B)

Supply wiring insulated conductors or cables supplying electric power from the micro-hydropower system shall have

a) an ampacity of not less than 125% of the full load rated current of the micro-hydropower system; and
b) an insulation temperature rating of not less than 90 °C.

64-504 Wiring methods

1) Wiring methods in micro-hydropower systems shall comply with Section 12.
2) Wiring methods in locations where excessive moisture is likely to be present shall comply with Section 22.

64-506 Overcurrent protection for apparatus and insulated conductors

1) Notwithstanding Rules 64-058 1) and 64-066 1) a), individual overcurrent protection devices shall not be required where the available short-circuit current is not greater than the rated ampacity of the equipment or insulated conductor.

2) Overcurrent devices for micro-hydropower system source circuits shall be accessible.
3) Each ungrounded conductor supplying power to or from the micro-hydropower system shall be protected by an overcurrent device not exceeding 125% of the full load rated current of the generator.
4) Notwithstanding Subrule 3), a micro-hydropower system with a full load rated current of 12 A or less shall be permitted to be protected by an overcurrent device with a rating of 15 A.

64-508 Disconnecting means (see Appendix B)

The disconnecting means installed in accordance with Rules 64-060 and 84-020 shall be labelled in a conspicuous, legible, and permanent manner, identifying it as the micro-hydropower generator system disconnecting means.

64-510 Stand-alone systems (see Appendix B)

1) An electronic governor used to regulate the micro-hydropower system shall have a rating equal to the installed capacity unless mechanical governors of sufficient capacity are used to regulate power generation.
2) The diversion load shall be rated to a minimum of 100% of the rating of the electronic governor.
3) The identified conductor shall be rated at the same ampacity as the phase insulated conductors where an electronic governor or power converter is connected.
4) Battery-based micro-hydropower systems shall comply with Rules 64-800 to 64-814.

64-512 Grounding and bonding

All supporting structures shall be bonded to ground with a minimum No. 6 AWG.

Hydrokinetic power systems

64-600 Marking (see Appendix B)

A permanent marking shall be provided for each piece of electrical equipment in accordance with Rule 2-100 at an accessible location at the disconnecting means or the hydrokinetic turbine electrical system output circuit and shall include the following additional information:

a) a brief system description, including rated power and the type of hydrokinetic power system generation system (variable speed or fixed speed); and
b) rated diversion load voltage and current (if a diversion load is used).

64-602 Insulated conductors and cables (see Appendix B)

1) Insulated conductors and cables used to supply power generated by the hydrokinetic turbine generator shall have an ampacity of not less than 125% of the full load rated current.
2) Current calculations shall be made in accordance with Rule 8-100 except where frequencies are different from 60 Hz (e.g., in dc or hydrokinetic turbine generator conductors).
3) For cables used to transmit power from the hydrokinetic turbine generator terminals to the power electronics input, the cables shall be sized using recommended factors supplied by the manufacturer to account
   a) for the skin effect where frequencies are different from 60 Hz; and
   b) for non-unity power factors.
4) Notwithstanding Rule 8-102, a voltage drop not exceeding 10% in the conductors between the electric generator and the input of the power electronics input shall be permitted.

64-604 Stand-alone systems (see Appendix B)

1) The diversion load shall be rated to a minimum of 100% of the installed capacity of the hydrokinetic power system it protects unless otherwise specified by the hydrokinetic power system generation manufacturer.
2) Battery-based hydrokinetic power systems shall comply with Rule 64-800.
3) The neutral conductor shall be rated at the same ampacity as the phase insulated conductors in cases where an electronic governor or power converter is connected.

64-606 Overcurrent protection for apparatus and insulated conductors

1) Notwithstanding Rules 64-058 1) and 64-066 1) a), individual overcurrent protection devices shall not be required where the available steady-state short-circuit current is not greater than the rated ampacity of the apparatus or insulated conductor.
2) Each overcurrent protection device shall be either rated for, or adjusted in size for, the frequency range of the current passing through it.
3) Each ungrounded conductor supplying power to or from the hydrokinetic turbine terminals shall be protected by an overcurrent device not exceeding 125% of the full load rated current.
4) Notwithstanding Subrule 3), a hydrokinetic turbine electrical system with a full load rated current of 12 A or less shall be permitted to be protected by an overcurrent device with a rating of 15 A.

64-608 Wiring methods

1) Notwithstanding Section 12, flow-channel-based insulated conductors shall be permitted to be
   a) of the types specified in accordance with Rule 12-102 for exposed wiring in wet locations; or
   b) flexible cords of the extra-hard-usage type suitable for wet locations as specified in Rule 12-402.
2) Insulated conductors installed in raceways shall be of types specified in accordance with Rule 12-102 for use in raceways in wet locations.
3) Cables installed in the flow channel shall be installed in accordance with Section 22.

64-610 Disconnecting means (see Appendix B)

The disconnecting means installed in accordance with Rules 64-060 and 84-020 shall be labelled in a conspicuous, legible, and permanent manner, identifying it as the hydrokinetic power system generator disconnecting means.

Stationary fuel cell systems

64-700 Marking (see Appendix B)

1) A permanent marking shall be provided in accordance with Rule 2-100 at the disconnecting means, specifying the following additional information:
   a) overcurrent protection values provided by the output;
   b) short-circuit current-interrupting capacity for protective devices; and
   c) a brief system description.
2) The location of the manual fuel shut-off valve shall be marked at the location of the primary disconnecting means of the building or circuits supplied.
3) A fuel cell system that stores electrical energy shall be labelled in a conspicuous, legible, and permanent manner with a suitable warning sign at the location of the service disconnecting means of the premises.

64-702 Conductors

1) The rated circuit current shall be the rated current indicated on the fuel cell system nameplate(s).
2) The ampacity of the feeder or circuit insulated conductors from the fuel cell system(s) to the premises wiring system shall not be less than the greater of
   a) the nameplate(s) rated circuit current; or
   b) the rating of the fuel cell system(s) overcurrent protection device(s).

64-704 Overcurrent protection

1) If the stationary fuel cell system is provided with overcurrent protection sufficient to protect the circuit conductors that supply the load, additional circuit overcurrent devices shall not be required.
2) Overcurrent devices shall be readily accessible.

64-706 Disconnecting means (see Appendix B)

The disconnecting means installed in accordance with Rules 64-060 and 84-020 shall be labelled in a conspicuous, legible, and permanent manner, identifying it as the fuel cell system disconnecting means.

64-708 Grounding and bonding

Hydrogen and fuel containers, associated piping, flanges, and hydrogen vent systems shall be bonded to ground by means of a copper bonding conductor not smaller than No. 6 AWG except as required for cathodic protection.

64-710 Location of fuel cells (see Appendix B)

A fuel cell system(s) and associated equipment, components, and controls shall meet the following requirements:

a) stationary fuel cell systems shall be sited and installed in accordance with the manufacturer's instructions;

b) the area classification around outlets from processes or compartments that contain fuel-bearing components shall be in accordance with the manufacturer's instructions and Section 18;

c) stationary fuel cell systems shall not be located in clothes closets, bathrooms, stairways, high ambient rooms, hazardous locations, or any similar undesirable places; and

d) stationary fuel cell systems shall be marked as suitable for the particular location.

64-712 Outdoor installations

For outdoor installations, a stationary fuel cell system shall meet the following requirements:

a) the stationary fuel cell system shall be suitable for outdoor installation; and

b) security barriers, fences, landscaping, and other enclosures shall not affect the required air flow into or exhaust out of the stationary fuel cell system.

64-714 Indoor installations

Stationary fuel cell systems that are to be installed indoors shall be marked for indoor installation.

64-716 Electrical equipment (see Appendix B)

1) Transformers installed in rooms that contain fuel cell power systems shall be of the dry type.

2) Areas provided with mechanical ventilation required for safety during normal operation shall be interlocked to provide an alarm and shut down the fuel cell power system upon loss of ventilation.

3) Indoor installations of fuel cell power systems that are fuelled by a gas that has not been odorized shall have an automatic shut-off valve located outdoors that is interlocked with indoor combustible gas detection.

4) Where an automatic fire suppression system is provided for the fuel cell system, it shall be interconnected to shut off the fuel supply when the suppression system is activated.

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Installation of batteries

64-800 Scope (see Appendix B)

1) Batteries shall be installed in accordance with the provisions of Rules 64-800 to 64-814, except as otherwise required by the manufacturer.

2) Rules 64-816 to 64-820 apply to the installation of electrical equipment, other than batteries, in a battery room.

64-802 Ventilation of battery rooms or areas (see Appendix B)

1) Rooms or areas that contain batteries that vent hydrogen to the atmosphere shall be adequately ventilated.

2) Lead-acid batteries shall not be subjected to ambient temperatures greater than 45 °C or less than the freezing point of the electrolyte.

64-804 Installation (see Appendix B)

1) Batteries shall be suitable for the purpose.

2) Batteries with exposed energized parts shall be kept in a room or enclosure accessible only to authorized personnel.

3) Batteries installed in a dwelling unit shall be connected with an output voltage not exceeding 50 V dc.

4) Energized parts of batteries installed in dwelling units shall be guarded to prevent accidental contact by persons or objects, regardless of voltage or battery type.
5) Battery trays, racks, and other surfaces on which batteries are mounted shall be
   a) level;
   b) protected against corrosion from the battery electrolyte, if corrosive;
   c) covered with an insulating material having a dielectric strength of at least 1500 V;
   d) of sufficient strength to carry the weight of the batteries; and
   e) designed to withstand vibration and sway where appropriate.
6) Batteries shall be spaced in accordance with the manufacturer's installation instructions.
7) For lead-acid type batteries, no conductive materials shall be located within 150 mm of the tops of the non-conductive cases.

64-806 Current-limiting overcurrent devices (see Appendix B)

A current-limiting overcurrent device shall be installed in each battery circuit where the available short-circuit current from a battery or battery bank exceeds the short-circuit current ratings of other equipment in that circuit.

64-808 Disconnection of series battery circuits

Battery circuits subject to field servicing, operating at more than 50 V dc shall have provisions for disconnecting the

a) series-connected strings; and
b) grounded circuit conductor(s) in the battery electrical system for maintenance without disconnecting the grounded circuit conductor(s) of other circuits in the system.

64-810 Bonding of battery installations

Bonding of battery installations shall be in accordance with Section 10.

64-812 Battery interconnections (see Appendix B)

1) Insulated conductors and cables used to terminate to battery terminals shall be of a fine strand type.
2) The connection method between batteries shall be permitted to be insulated or bare busbars.
3) Flexible metal raceways shall not be permitted for battery interconnections.
4) Conductors shall have sufficient ampacity for the maximum load.

64-814 Wiring from batteries to other equipment

1) Conductors for connection from battery terminals to other equipment shall
   a) be installed in accordance with Rule 64-812;
   b) be sized in accordance with the load but not less than 2/0 AWG; and
   c) extend not less than 300 mm from battery terminals.
2) Conductors that extend more than 3 m from battery terminals shall be
   a) in a wiring method in accordance with Section 12; and
   b) in accordance with Rule 14-100 b).
3) For batteries containing corrosive electrolyte, insulated conductors between batteries and other equipment shall be permitted to be installed in a raceway, provided the raceway
   a) is of corrosion-resistant material or other materials suitably protected from corrosion;
   b) is tightly sealed with sealing compound, rubber tape, or other material to resist the entrance of electrolyte by spray or creeping;
   c) has an insulating bushing where the conductor emerges for connection to the battery, or be a non-metallic raceway with a suitable fitting; and
   d) is located at least 300 mm above the highest battery terminal to reduce electrolyte creepage or spillage entering the raceway.
4) Flexible metal raceways shall not be permitted to connect batteries to other equipment.

5) For batteries containing corrosive electrolyte, cable shall be permitted to be installed for connection to other equipment provided
   a) the cable is of corrosion-resistant material or other materials suitably protected from corrosion;
   b) the end of the cable is tightly sealed with sealing compound, rubber tape, or other material to resist the entrance of electrolyte by spray or creeping;
   c) the conductor issues from a cable through an insulating bushing or inner jacket where a metal armoured cable is used;
   d) at least 300 mm of free conductor extends from the cable where connected to a battery terminal; and
   e) the cable exit is located at least 300 mm above the highest battery terminal to reduce electrolyte creepage or spillage entering the raceway.

64-816 Wiring methods and installation of equipment in battery rooms

The installation of wiring and equipment in a battery room, which is not part of the wiring of the batteries, shall be in accordance with the requirements for an ordinary location.

64-818 Charge control (see Appendix B)

1) Equipment shall be provided to control the charging process of the batteries.
2) Notwithstanding Subrule 1), charge controller equipment shall not be required where the design of the renewable energy source circuit is the only supply and is matched to the voltage rating and charge current requirements of the interconnected battery cells, and the maximum charging current multiplied by 1 h is less than 3% of the rated battery capacity.
3) All adjusting means for control of the charging process shall be accessible only to qualified persons.

64-820 Diversion charge controller (see Appendix B)

1) Systems employing a diversion charge controller as the sole means of regulating the charging of a battery shall be equipped with an additional, independent means to prevent overcharging of the battery.
2) Circuits containing a dc diversion charge controller and a dc diversion load shall comply with the following:
   a) the current rating of the diversion load shall be less than or equal to the current rating of the diversion load charge controller;
   b) the voltage rating of the diversion load shall be equal to or greater than the maximum battery voltage;
   c) the power rating of a diversion load shall be at least 150% of the power rating of the charging source; and
   d) the conductor ampacity and the rating of the overcurrent device for the circuit shall be at least 150% of the maximum current rating of the diversion charge controller.
3) Renewable energy systems using interactive inverters to control battery state-of-charge by diverting excess power into the utility system shall have an additional, independent means of controlling the battery charging process for use when the utility is not present or when the primary charge controller fails or is disabled.

Δ Energy storage systems

64-900 Scope (see Appendix B)

Rules 64-902 to 64-928 apply to the installation of self-contained and field-assembled energy storage systems.

64-902 Marking

1) In addition to the requirements in Rule 64-074, a plaque or directory shall be provided to indicate the building or structure contains an energy storage system and the location of all energy storage system disconnecting means.
2) Field-assembled energy storage systems shall include permanent markings in accordance with Rule 2-100 at a readily accessible location at the disconnecting means for the energy storage system.

64-904 Voltage of energy storage systems

1) Batteries forming part of a field-assembled energy storage system installed in or on a dwelling unit shall be connected so as not to exceed 50 V dc.
2) Self-contained energy storage system output circuits for installations in or on a dwelling unit shall be permitted to have a voltage not exceeding 600 V, provided that all energized parts in the energy storage system circuits over 150 volts-to-ground are accessible only to qualified persons.
3) The dc portion of energy storage systems with maximum voltages higher than 750 V dc but not exceeding 1500 V dc shall not be required to comply with Rules 36-204, 36-208, and 36-214 provided that
   a) the installation is serviced only by qualified persons;
   b) the part of the installation exceeding 750 V dc is inaccessible to the public; and
   c) enclosures in which circuits exceeding 750 V dc are present are marked with the word "DANGER" followed by the maximum rated circuit voltage of the equipment.

64-906 Insulated conductors and cables

Insulated conductors and cables for interconnection and connection of energy storage systems shall have a temperature rating of not less than 90 °C.

64-908 Insulated conductors marking or colour coding

Insulated conductors for dc circuits shall be colour coded or marked as follows:

a) for a 2-wire circuit,
   i) red for positive and black for negative;
   ii) insulated conductors, other than green or white, with permanent marking at terminations and splices in accordance with Item i); or
   iii) insulated conductors manufactured with permanent surface printing indicating the polarity on the insulated conductor; and
b) for a 3-wire circuit (bipolar circuit),
   i) white or white with a coloured stripe for the mid-wire (identified as the centre tap), red for positive, and black for negative;
   ii) insulated conductors, other than green or white, with permanent marking at terminations and splices in accordance with Item i); or
   iii) insulated conductors manufactured with permanent surface printing indicating the polarity on the conductor insulation.

64-910 Installations

1) Self-contained energy storage systems shall be installed in accordance with the manufacturer's installation instructions.
2) Mechanical protection shall be provided where an energy storage system is subject to the risk of vehicular impact or other physical damage.

64-912 Overcurrent protection (see Appendix B)

1) Where the available short-circuit current exceeds the ampacity of the conductor, each ungrounded conductor of an energy storage system shall be protected in accordance with Rules 14-100 and 14-104.

2) Equipment and conductors that are energized from both directions shall be provided with overcurrent protection from each source of supply in accordance with Subrule 1).
3) Overcurrent devices used in any dc portion of an energy storage system shall be marked for the purpose.

64-914 Disconnecting means for energy storage systems (see Appendix B)

1) Disconnecting means for energy storage systems shall be in accordance with Subrules 2) to 9).
2) A disconnecting means shall be provided to disconnect simultaneously all ungrounded conductors supplied from an energy storage system.
3) The disconnecting means for a field-assembled energy storage system shall
   a) be capable of being energized from both sides;
   b) indicate whether it is in the open or closed position;
   c) have provision for being locked in the open position;
   d) be in accordance with Section 14;
   e) be capable of being opened at rated load;
   f) be capable of being closed with a fault on the system; and
   g) be located within sight of and within 9 m of the equipment or be integral to the equipment.
4) Where a self-contained energy storage system does not include an integral output disconnecting means, a disconnecting means shall be installed in accordance with Subrule 3).
5) The disconnecting means required by this Rule shall not be connected in any grounded conductor if operation of that disconnecting means would cause the grounded conductor to be in an ungrounded and energized state.
6) The disconnecting means shall comply with Rules 14-414 and 14-700.
7) As required by Rule 14-402, disconnecting means shall be provided to disconnect a fuse from all sources of supply if the fuse is energized from both directions, unless the fuse can be readily and safely de-energized.
8) Disconnecting means provided on dc circuits shall be rated for dc applications.
9) The disconnecting means shall bear a warning to the effect that the terminals on both the line and load sides could be energized when the disconnecting means is open.

64-916 Bonding (see Appendix B)

1) Non-current-carrying conductive parts of electrical equipment shall be bonded in accordance with Section 10.
2) In addition to the bonding requirements of Section 10, metal objects such as battery racking, cable management systems, structures and enclosures housing field-assembled energy storage equipment, etc., shall be made electrically continuous and bonded to non-current-carrying conductive parts of electrical equipment.
3) Bonding conductors shall be sized in accordance with Section 10 based on the largest overcurrent device protecting the circuit conductors.

64-918 Location and separation requirements for energy storage systems (see Appendix B)

1) Self-contained energy storage systems shall be installed in accordance with the manufacturer's installation instructions.
2) Energy storage systems utilizing batteries shall not be installed where the floor is
   a) higher than 23 m above grade; or
   b) below grade.
3) Notwithstanding Subrule 2), energy storage systems utilizing batteries shall be permitted to be installed in an electrical equipment vault.
4) Energy storage systems with a storage capacity greater than 1kWh or utilizing lithium-ion batteries shall not be installed in
   a) dwelling units; and

b) any living space of a residential occupancy including clothes closets, storage rooms, bathrooms, stairways, or any other similar undesirable places.

5) Energy storage systems installed outside of a dwelling unit shall not be installed within 1 m of any window, door, or ventilation opening.

6) Notwithstanding Subrule 4), residential use energy storage systems shall be permitted to be installed in garages of dwelling units, provided that the
   a) storage capacity of any single energy storage system does not exceed 20 kWh; or
   b) aggregate storage capacity of multiple energy storage systems does not exceed 40 kWh and the energy storage systems are spaced not less than 1 m apart.

7) Energy storage systems
   a) directly mounted to a building surface shall have
      i) for a single energy storage system, a storage capacity not exceeding 20 kWh; and
      ii) for multiple energy storage systems, a spacing of not less than 1 m apart and an aggregate storage capacity not exceeding 40 kWh; or
   b) installed in or on a detached garage, storage building, or free-standing structure, shall have
      i) for a single energy storage system, a storage capacity not exceeding 20 kWh; and
      ii) for multiple energy storage systems, a spacing of not less than 1 m from a dwelling unit and an aggregate storage capacity not exceeding 80 kWh.

8) Energy storage systems marked with "THIS EQUIPMENT MEETS THE CELL LEVEL PERFORMANCE CRITERIA OF UL 9540A" shall be permitted to exceed the limitations of Subrules 6) and 7).

9) The location of energy storage systems shall not impede egress from a building and shall not be located closer than 3 m from
   a) a path of egress; and
   b) entrance or exit doors.

10) Energy storage systems shall be installed in accordance with Rule 2-326.

64-920 Battery installations

1) Batteries installed as part of self-contained energy storage systems shall be installed in accordance with the manufacturer's installation instructions.

2) Batteries installed as part of field-assembled energy storage systems shall be installed in accordance with Rules 64-800 to 64-820.

64-922 Diversion load controllers

A diversion load controller used as the primary means of regulating the stored kinetic energy of an energy storage system shall not use the supply authority system as a diversion load.

64-924 Ampere rating of energy storage system circuits

1) The maximum current for energy storage system circuits shall be determined as follows:
   a) for an inverter output circuit, the inverter continuous output current rating;
   b) for an inverter input circuit, the continuous inverter input current rating when the inverter is producing rated power at the lowest input voltage;
   c) for the output of a dc-to-dc converter, the dc-to-dc converter continuous output current rating;
   d) for a charge controller, the input current while charging; and
   e) for a self-contained system, the rated current indicated on the energy storage system nameplate(s).

2) Where interconnected with the supply authority system, the current referred to in Subrule 1) shall be considered a continuous load for the application of Rule 8-104.

3) Where the output supplies dedicated loads or other power systems, the continuous load shall be determined in accordance with Rule 8-104 3).

64-926 System charge control (see Appendix B)

1) Equipment shall be provided to control the charging process of an energy storage system.
2) Adjustable settings for control of the charging process shall be accessible only to qualified personnel.
3) A diversion charge controller installed as part of an energy storage system shall be in accordance with the requirements of Rule 64-820.
4) A self-contained energy storage system shall be deemed to meet the requirements of this Rule.

64-928 Working space and accessibility to energized parts

1) Self-contained energy storage systems shall be
   a) installed in accordance with the manufacturer's installation instructions; and
   b) permitted to have working space within the energy storage system equipment in accordance with the manufacturer's recommendation.
2) Field-assembled energy storage systems installed in dwelling units shall have no exposed energized parts.
3) Energy storage systems shall be installed in accordance with Rules 2-202, 2-308, 2-310, and 2-312.