`

2011 Annual Technical Conference

Agenda item # 2011ag-01 **<u>2-024 (or Section 70) Relocatable structures</u> (such as school portable classrooms)**

Submitted by: City of Lethbridge

Question/enquiry:

From Lethbridge - Are inspections conducted by an Inspection Authority in another jurisdiction an acceptable method for approval of an (Alberta) factory- built relocatable structure such as a school portable?

Second submitter question - Are tests required to be done at the factory under 70-130 being done and how are they documented and proven to the jurisdiction where these structures land?

Recommendation:

For discussion. Because they are being built to Part 3 of the building code we should be able to accept a rough in inspection as a method of approval from an Inspection Authority.

<u>Background information</u>:

This issue is not just related to school portables but to relocatable industrial accommodation, manufactured homes, skids, commercial kitchens on wheels and any kind of building constructed off site. With no" Provincial" inspection system this creates barriers to moving these structures around.

Schools fall under ABC Part 3 Group A Division 2 Assembly Occupancies

70-130 Tests (see Appendix B)

(1) The following tests shall be performed on the complete assembly at the factory:
(a) Continuity — All circuits, including grounding or bonding circuits, shall be tested for continuity.
(b) Insulation resistance — The insulation resistance between live parts and ground at the completion of a 1 min application of a 500 V dc test voltage shall be not less than that specified in Table 24.
(2) As an alternative to the insulation resistance test specified in Subrule (1)(b), an ac dielectric strength test shall be permitted to be performed, in which case an ac voltage of 900 V shall be applied for 1 min (or 1080 V for 1 s) between all live parts and non-current-carrying metal parts without breakdown occurring.
(3) In performing either the insulation resistance or the dielectric strength test, the neutral shall be disconnected from ground for the test and be reconnected afterwards.

`

There was a recent multi-discipline STANDATA on the building side of relocatable industrial accommodation. Here is some information clipped from that STANDATA. Note this is for relocatable industrial accommodation only. Note this STANDATA is for Part 10 of the ABC (relocatable industrial accommodation) which does not apply to other types of prefabricated or manufactured buildings.

Relocatable Industrial Accommodation

Recent changes have been made to the Part 10 Quality Management System for factory-built relocatable industrial accommodation units for all out-of-province and out-of-country manufacturing facilities. These changes provide the capacity for national and international on-site factory inspection for compliance to the Part 10 Quality Management System and the *Safety Codes Act* by third party certification bodies accredited by the Standards Council of Canada.

All in-province manufacturing facilities will continue under the existing Part 10 quality management system. Consultation with municipalities and stakeholders will take place at a future date with regard to the quality management system for in-province manufacturing facilities.

Please direct your questions to the Safety Services Branch, Alberta Municipal Affairs

For more detail:
http://municipalaffairs.alberta.ca/documents/ss/Part10ProgramChanges3rdPartyCertificationCSA-A277.pdf

From this document:

Authority for the development and implementation of a quality management system to ensure compliance with the Safety Codes Act and the appropriate regulations for factory-built structures comes from Section 39 of the Safety Codes Act.

Structures that are brought into Alberta must be certified according to CSA A277-08, "Procedure for Factory Certification of Buildings." CSA A277-08 is a national standard published by the Canadian Standards Association. This standard provides a framework for quality management systems for factory-built buildings and building components. It applies to both residential and non-residential buildings.

`

2011 Conference conclusion:

It is up to the AHJ's as to what they are willing to accept. You could accept:

1) a unit previously inspected by another AHJ in Alberta, but it was cautioned to ensure any previous inspections were done by an SCO that has designation of powers certification.
2) You could also accept special inspection of these units but the unit must have a label attached.
3) You can accept a unit constructed under a CSA program and labeled as such.

There is a STANDATA being considered to address these types of structures and will include all types of structures. The program will include testing, certification under the CSA certification standard. The new standard will include the gas, plumbing and electrical.

On the second question – are insulation resistance tests being completed at the factory as required under 70-130 – there appeared to be no indication one way or another whether these tests were being performed. The AHJ has the right to request these test results.

Action: Information only, item closed

`

2011 Annual Technical Conference

Agenda item # 2011ag-02 **<u>2-022 Electrical remediation of Grow Ops</u>**

Submitted by: EIAA south chapter

Question/enquiry: How are jurisdictions handling remediation of Marijuana Grow Op houses

Recommendation: We should have the goal of being consistent in all jurisdictions – we don't want the bad guys moving around because it's easier in one area vs another. Hopefully we can harmonize what we are asking for when remediating these grow op houses. The second goal is to ensure these houses are safe for the next owner or tenant. We do not want to get into anything that might be considered punishment – that is not our role. The owners of these houses are often the victims of crime, but we do not want the next occupant to become another victim.

<u>Background information</u>:

C.E. Code rules

2-022 Renovation of Existing Installations
The inspection department may require such changes as may be necessary to be made to existing installations where, through hard usage, wear and tear, or as a result of alterations or extensions, dangerous conditions have developed.

2-300 General Requirements for Maintenance and Operation
(1) All operating electrical equipment shall be kept in safe and proper working condition.

Here is one municipalities draft policy for grow op remediation. It is a bit difficult to apply a blanket policy as each one has different circumstances – length of time the operation has been running, the amount of physical and environmental damage, the of utilization of existing vs temporary wiring and the style of power theft and how it has been used.

<u>Sequence of remediation and conditions for entering premises to proceed only as directed under the Alberta Health Services Order issued to the owner</u>

Electrical Service:

- Electrical service restoration work may start only once an electrical permit is issued. Power is required prior to water and heat restoration as well as for environmental testing and remediation/cleanup required by the AHS order.

`

- The only acceptable repair to a service cable tap is a full re-excavation of the cable in the area of the tap and a repair utilizing an approved splice kit for USEB cable. If the service cable has not been tapped but the electric utility meter has been bypassed, replacement of the meter base is required. *Currently under consideration is the requirement for having the cable tested right back to the distribution transformer and signed off by an Electrical Engineer.*
- The service repair requires inspection prior to energizing and backfill. Note that a Building Inspection is also required for any foundation repairs prior to backfill.
- Circuits on the house panel must be tested (see below) before energizing.

Interior Wiring:

- Each affected house will be treated like a fire restoration with full examination of the electrical installation for potential damage. Components must be confirmed safe or must be replaced.
- <u>All</u> wiring to be insulation tested (meggered) and confirmed safe prior to re-utilizing. There is a relaxation to this requirement - if an Electrical Safety Codes Officer has gone through the grow op before it has been fully disassembled, the remediation electrical contractor may use the Electrical Inspectors report as a guide to identify areas not used for the grow system. In that case only the circuits from the house panel have been utilized (in any way) for the grow system need insulation testing. Test results will dictate replacement or reutilization.
- All damaged and altered equipment and fixtures are to be replaced. Damage may be due to condensation, humidity, air contaminants, mould or by physical modification or tampering such as oversized breakers.
- In all cases, smoke and carbon monoxide alarms are to be replaced.
- When the panel is in an area utilized for the grow system, every breaker is to be replaced (due to their potential exposure to excessive humidity and corrosive environment) and the panel inspected for damage or replaced.
- For final inspection - the Master Electrician named on the permit must provide a signed declaration that all circuits required to be tested are confirmed in operable condition and all equipment requiring replacement has been removed and destroyed.

Insulation Resistance Testing:

With all wiring devices (receptacles, switches, etc.) connected, each branch circuit shall be tested and have an insulation resistance value as specified in Table 24.

Testing Guideline (adapted from 70-130)

(1) The following tests shall be performed on the existing wiring:
(a) Continuity — All circuits, including grounding or bonding circuits, shall be tested for continuity.
(b) Insulation resistance — The insulation resistance between live parts and ground at the completion of a 1 min application of a 500 V dc test voltage shall be not less than that specified in Table 24.

`

(2) As an alternative to the insulation resistance test specified in Subrule (1)(b), an ac dielectric strength test shall be permitted to be performed, in which case an ac voltage of 900 V shall be applied for 1 min (or 1080 V for 1 s) between all live parts and non-current-carrying metal parts without breakdown occurring.
(3) In performing either the insulation resistance or the dielectric strength test, the neutral shall be disconnected from ground for the test and be reconnected afterwards.

Note:

When insulation resistance or ac dielectric strength tests are performed, precautions should be taken to ensure that voltage-sensitive devices such as ground fault circuit interrupters are not subjected to voltages that will damage the device.

2011 Conference conclusion:

Remediation of Grow Ops is a huge problem and a significant burden on Municipalities including inspection departments. For example, the City of Calgary has been doing 3 cases per week for the last 6 years. The Calgary Police department has 450 cases waiting for investigation.

A Provincial committee was examining the issue of grow op remediation. The committee was made up of representatives from 4 or 5 ministries with a final report with recommendations presented to their Ministers. The draft report is at the respective Ministers office and nothing has been released yet. We will know more when the Ministers accept the recommendations and make them public.

Action: For information only

`

EIAA

ELECTRICAL INSPECTORS ASSOCIATION OF ALBERTA 2004

2011 Annual Technical Conference

Agenda item # 2011ag-03 **<u>2-206 powers of rejection</u>**
(terms of approval agreement are not being met)

Submitted by: Don Bradshaw – City of Airdrie

Question/enquiry: Do we need to introduce a separate rule for the proper application of torque to fasteners or is 2-206 adequate? Of particular concern is the termination of conductors at service lugs and panelboards.

For proper termination of conductors it is very important that field connections be properly tightened. In the absence of manufacturer's instructions on the equipment, the torque values given in Tables D6 and D7 should be followed utilizing proper torque wrenches.

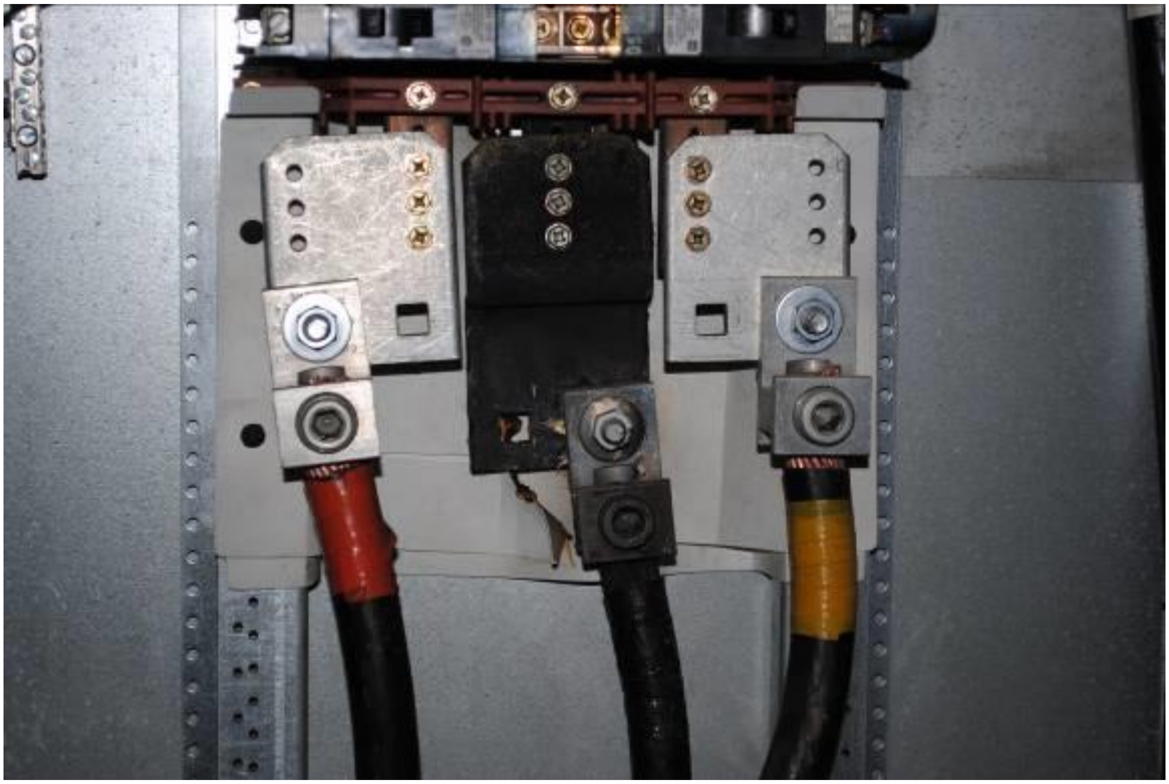
Recommendation:

For discussion. As a minimum we need to draw attention to this important requirement.

<u>Background information</u>:

`

Note – thermal imaging testing was done annually here. This installation is 5 yrs old



The Difference between Success and Failure — How a Torque Wrench Improves System Reliability

IAEI Magazine July 2010 | Author: Christel Hunter

In NASCAR, pit crew members use impact wrenches with preset torque values to install lug nuts during a wheel change. A loose lug nut can mean the difference between winning and losing, as Greg Biffle found out in 2005 when loose lug nuts on the left rear tire caused vibration and forced him to take an extra pit stop at the Texas Motor Speedway. Biffle lost a lap and finished 20th, which cost him enough points to lose the Chase for the Nextel Cup to Tony Stewart.

No race car driver or their pit crew would question the importance of using the proper tool and the proper torque on lug nuts. Yet many electricians go to work every day and tighten electrical connections with no more than a folding Allen set.

Every electrician has a responsibility to understand how to install conductors and make connections according to manufacturer instructions. Equipment, including conductors and connectors, is manufactured, tested and listed to be installed as specified by the manufacturer. When a manufacturer designs a connector, it is designed to work with prescribed conductor(s) and a specific installation method, whether it is a set-screw or compression connector.

`

Set-screw connectors (photo 1) are very common in electrical equipment, including panelboards, switchboards, and meter bases. For field installation, the connector manufacturer usually publishes a set of installation instructions on the packaging. For terminations in equipment, the equipment manufacturer labels the equipment with the recommended installation torque and any other special instructions. If for some reason the recommended torque is not available on the connector or equipment, there are published tables of “default” torque values included in National Electrical Contractors Association (NECA) and Underwriters Laboratories (UL) standards and online in manufacturer catalogs. (“Default torque values” are not meant to override manufacturer’s recommended torque values; rather, they are to be used in the absence of manufacturer’s recommended values.) NEC Code-making Panel 1 has recently accepted a proposal to include torque tables in an Annex in the 2011 NEC

It is common practice for most electricians to tighten mechanical set-screw connections without a torque wrench. Many good installers believe that they know how much to tighten set-screw connections without using a torque wrench because everything works when energized. What they rarely see is what happens a year or a decade down the road when the connection that was not properly installed begins to overheat and fail. Then the service electrician comes in, repairs the problem and tightens the new connector —without a torque wrench. These electricians aren’t intentionally doing inferior work; they simply do not understand how important correct torque is to the safety and long-term integrity of the electrical system. It has been estimated that 90% of electrical failures occur at connections. [1] How many of those connections would never have failed if properly tightened in the first place?
To determine how accurately installers tighten set-screw connectors without a torque wrench, a test assembly was designed using aluminum bar stock and BURNDY® K2A31U-2N lugs (photo 2). These lugs have a recommended tightening torque of 275 lb-in, or 22.9 lb-ft. Participants were given a choice of tools, either a 12-inch ratchet drive or a folding Allen set. The tightening torque applied was measured with a transducer and read from a remote digital meter, so only the test administrator could see the peak torque applied .

Results from testing at four different electrical industry events were collected in 2009: The NJATC National Training Institute (NTI) Show in Ann Arbor, The NECA show in Seattle, an IAEI Chapter meeting in Las Vegas and the IAEI Southwestern Section meeting in Honolulu. Data was also collected from Mojave Electric service electricians in Las Vegas, Nevada. In all, there were 402 participants.

Many of the participants predicted they would over tighten the connections, but very few did. Table 1 summarizes the results of the overall study. The breakdown assumes that set-screw connections tightened to within +/- 20% are adequate, based on a study performed by the Georgia Power Research Institute (now known as NEETRAC. [2]

Not all of the test participants were electricians. To find out if electricians did any better making connections, participants at three of the events were asked if they were employed or trained as an electrician. Of the 208 participants who answered the question, 172 indicated yes. The results of the subset of participants who were employed or trained as an electrician are also shown in Table 1.

Table 1: Torque Test Results, 2009

Torque Value	Percentage of Participants*					
	Overall (402)	Electrician (172)	Copper conductor (149)	Aluminum conductor (253)	Allen set (61)	Ratchet drive (341)
More than 20% **below** recommended torque	56%	53%	55%	56%	75%	52%
Within +/- 20% recommended torque	25%	25%	21%	26%	20%	26%
More than 20% **above** recommended torque	20%	22%	23%	17%	5%	22%

Table 1. Torque Test Results, 2009

`

While the electricians were slightly more likely to over tighten connections than the entire group of participants, it is clear that they are no better at achieving a proper connection than someone with no experience as an electrician. Anecdotally, it was obvious during the test that people who had never made an electrical connection before had as much chance of getting it within 20% as an electrician with decades of experience. This indicates that achieving recommended torque is nearly independent of training and experience, and requires the use of a torque wrench to properly tighten a connection.

The connectors used for the test are listed for use with copper and aluminum conductors. To determine if the conductor used would make any difference, the test was performed with electrically equivalent 2/0 AWG copper and 4/0 AWG STABILOY® aluminum alloy building wire. These conductor sizes would typically be used for a 200-amp residential service according to the 2008 NEC Table 310.15(B)(6). The results using each conductor material are shown in Table 1. It appears that the tendency to under tighten the connection for both materials is virtually the same, and it is slightly more likely that copper conductors will be over tightened.

Over tightening a set-screw connection does not increase its reliability. It can, however, damage the lug or the equipment to which it is attached. It can even break conductor strands. Under tightening connections can lead to overheating and failure at the connection.

Very few of the participants chose to use an Allen set instead of the ratchet, and Table 1 shows that those using the Allen set overwhelmingly under tightened the connections. Considering the prevalence of electricians using Allen sets in the field, the findings are disturbing, and may explain many of the connection failures we see in the field that occur within a few years after an installation is energized.

While this testing was performed on 2/0 AWG copper or 4/0 AWG aluminum conductors, smaller connections (such as those found on receptacles) also have a recommended installation torque. For example, UL Standards 20 and 1567 covering snap switches and receptacles call for binding wire screws to be tightened to 12 in.-lbs. Torque screwdrivers are available (photo 4), but very few electricians use them. Electricians indicated that they were more likely to use a torque wrench on larger conductors, such as those found on transformers or switchboards, but not on branch circuit connections. Only 36 of the 402 participants indicated that they always use a torque wrench or screwdriver to make electrical connections, while 247 answered that they sometimes use a torque wrench or screwdriver to make electrical connections

So why don’t we have more failed connections if most electricians appear to be doing such a poor job tightening them? The fact is that our electrical system has built-in safety factors, and circuits are rarely fully loaded. Lightly loaded circuits put less stress on weak connections, so they may perform satisfactorily for many years before experiencing a problem, if ever. This is no justification to ignore basic installation instructions. Bottom line, a torque wrench is an easy and inexpensive way to improve the reliability and safety of an electrical system.

Connector Testing

In the U.S., electrical connectors are tested according to standards published by Underwriters Laboratories. The connectors used in this test assembly were listed to UL Standard 486A-B. When tested according to this standard, the recommended installation torque must be applied. The standard also states that the test conductor shall not be wire-brushed, and oxide inhibitor can only be used if it is pre-filled in the connector. This is only true for the certification testing, and is intended to ensure accurate and repeatable results across a wide range of connectors. For field installations, the connector or equipment manufacturer will usually provide installation instructions on the packaging or an equipment label, including recommended torque and any requirement for wire brushing or oxide inhibitor application. NEC-2008 requires in 110.3(B) that “Listed or labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling.”

Connector Theory

For an electrical connection to achieve its objective of providing a low resistance, conductive path between two conductive elements, tightening the connector must create as many points of contact with the conductor as possible during initial installation. Every set-screw termination has an optimum value of tightening torque that produces the most reliable, low resistance joint. Torque (a force applied to a lever arm multiplied by the distance measured from the pivot point) on the set-screw creates pressure between the connector and the

`

conductor. If too little torque is applied, the connection may not have sufficient pressure to create enough contact points to maintain a low resistance, conductive path over the life of the installation.

Contrary to common belief, set-screw connections do not require periodic retightening, whether installed on aluminum or copper wire. Once the connector is installed with the proper torque, repeated tightening could actually damage the connector and/or conductor and eventually lead to failure. Better practice is to make the initial connection with the recommended torque value, then periodically check for signs of loose connections or overheating (using visual inspections and thermal imaging) before making any adjustments.

2011 Conference conclusion:

There was not enough support from the floor to pursue addition of a new CE Code rule to deal with proper torque application. This situation can fall under an existing rule 2-206 - powers of rejection when the terms of approval agreement are not being met. One must use the manufacturers torque specifications for each piece of equipment or in their absence, one can use torque values from Tables D6 or D7. Note that D6 and D7 have been updated for the 2012 code.

The industry needs to be aware of the importance of proper torque application procedures. SCO's could ask for confirmation that proper torque procedures have been followed.

Action: For information, item closed

`

2011 Annual Technical Conference

Agenda item # 2011ag-04 **4-004 conductors in free air**

Submitted by: Dwayne Goosen SAIT

Question/enquiry: Table 5B states correction factors for single conductors in contact in free air up to four conductors. The foot note states that more than four conductors in contact should be referred to the ratings for conductors in raceways. Is this a table look up or do we apply Table 5C as well?

Recommendation: For discussion.

Background information:

4-004 Ampacity of wires and cables
(9) ….. where single conductors having a free air rating are run in contact with each other, the ampacity shall be corrected by applying the factors in Table 5B for up to four cables in contact, and by utilizing the ampacity of Table 2 or 4 where there are more than four in contact.

Table 5B
Correction Factors for Tables 1 and 3
(Where from two to four Single Conductors are Present and in Contact)

Number of Conductors	Correction Factors
2	0.90
3	0.85
4	0.80

Notes:

(1) *Where four conductors form a 3-phase-with-neutral system, the values for three conductors may be used. Where three conductors form a single-phase, 3-wire system, the values for two conductors may be used.*

(2) *Where more than four conductors are in contact, the ratings for conductors in raceways shall be used.*

Table 5C
(See Rules 4-004 and 12-2210 and Tables 2 and 4)
Ampacity Correction Factors for Tables 2 and 4

Number of Conductors	Ampacity Correction Factors
1 – 3	1.00
4 – 6	0.80
7 – 24	0.70
25 – 42	0.60
43 and up	0.50

`

2011 Conference conclusion:

Use Table 2 & 4 lookup values and do not apply any further correction factors.

There will be a change to rule 4-004 in the 2012 code reads that may help clarify this issue.

Action: For information, Item Closed

`

2011 Annual Technical Conference

Agenda item # 2011ag-05 **6-302 overhead services**

Submitted by: Dennis Smith

Question/enquiry: Why are utility companies allowed to run "un-fused cables within 450 to 600mm above the ground without mechanical protection?

Recommendation:

The un-fused cables should enter the top or top portion of the meter socket.

Background information:

These cables are accessible to children and or animals. Also, the utility companies always used to enter the top but now favor entering the bottom. For this reason, some electricians fail to understand why they should install a conduit over the fused conductor below the pole service. (Attached is an example photo)

`

2011 Conference conclusion:

Note that this installation is being done by a utility company so it falls under Part 3.

The un-fused cables should enter the top or top portion of the meter socket. It looks like the utility companies now have a new box and it looks like they do not want to run their conductors in the top or the side of the box. The utility felt that the cable on the pole is protected by location.

Mike Gardner talked to ATCO regarding this issue and the utility will be looking at running the cable to the top of the meter again. Mike will bring this up at a utility meeting he is attending late February 2011. There is some concern of climbing hazards for their climbing crews.

Action: Mike Gardner (Utilities committee Chair) is to bring this up to the utilities and report back to this group.

`

2011 Annual Technical Conference

Agenda item # 2011ag-06 **<u>8-104 oversized panels on services</u>**

Submitted by: EIAA Calgary Chapter

Question/enquiry: A rule is required to have matching components in a residential service entrance. Existing rules only specify the "circuit rating" and does not recognize all the service entrance components.

Recommendation:

Except as provided for by other Rules of this Code, all service equipment shall have a nominal system voltage and ampere rating corresponding to the ampere rating of the service.

Example: A 200A combination service entrance panel with a 200A breaker on a service fed with a 1/0 USEB (rated 120A) cable and a 100A meter base.

<u>Background information</u>:

8-104 Maximum circuit loading

(1) The ampere rating of a consumer's service, feeder, or branch circuit shall be the ampere rating of the overcurrent device protecting the circuit or the ampacity of the conductors, whichever is less.
(2) The calculated load in a circuit shall not exceed the ampere rating of the circuit.

It is clear the connected load cannot exceed the ampere rating of the service. It is rare that load calculations are done every time a system is added to. If the service equipment does not reasonably match, there is potential for problems – owners believe their service is the size of the main breaker (and this submission is suggesting it should be).

There are no rules to disallow the installation in the above example. With a 120A cable and a 100A meter base and a 200A panel, the "ampere rating" would be 120A, with potential for overloading the meter base because only the o/c device and conductor ampacity are considered – unless we consider the meter components to be conductors. Existing rules would allow us to load this system to 120A connected load. One more twist …should the 200A breaker even be considered as it is not protecting the service conductors but is protecting the panelboard?

2011 Conference conclusion:

This is an unusual situation. All equipment must be suitable for the application and current rules may be utilized to enforce this requirement.

Action: For information only - closed

`

2011 Annual Technical Conference

Agenda item # 2011ag-07 **<u>8-200 and 8- 300 Electric Ranges</u>**

Submitted by: EIAA South Chapter

Question/enquiry: Are these rules becoming out of date?

New induction ranges (and cooktops) are challenging the circuit capacity, particularly in renovations. We are now seeing nameplate ratings up to 16 KW for these type of ranges.

100A Services are already being strained by electric hot water tanks especially if there are air conditioning loads. We have not yet considered the potential impact of electric vehicle charging on service capacity.

Recommendation:

For discussion.

<u>Background information</u>:

8-200 (1) (iv) For the Service (single family)

Range is taken at 6000W + 40% of its rating above 12 Kw

8-300 (1) For a Range Branch Circuit

Range is taken at 8000W + 40% of its rating above 12 Kw

Installation manuals often say " install as per the CE Code", and do not give specific wiring requirements, and some manuals show a 50A breaker required.

Often the appliance is not installed when final inspection is called

2011 Conference conclusion:

The table for conductor ampacities will be changed in the 2012 code and this may take care of ampacity concerns for the cable and breaker size to larger ranges. It is anticipated the #8 copper conductor allowable ampacity will increase from 45 to 55 amperes in a 90 degree rated cable.

Comments indicated that the Section 8 committee will be reviewing and updating as necessary all rules in that section.

Action: For information only – item closed

Agenda item # 2011ag-08 **<u>8-400 Automobile heater receptacles</u>**

Question/enquiry: 8-400 places a maximum allowable branch circuit overcurrent device rated or set at not more than 15A. This does not allow for 20A receptacles that are becoming more common (and perhaps necessary for electric vehicle charging).

Recommendation:

For discussion. Change wording of 8-400 (2) to allow 20A circuit configurations.

<u>Background information</u>:

8-400 Branch circuits and feeders supplying automobile heater receptacles

(2) At least one branch circuit protected by an overcurrent device rated or set at not more than 15 A shall be provided for each duplex receptacle or for every two single receptacles.

2011 Conference conclusion:

This rule is specifically set up for automobile block heaters. There was support from the floor to change wording of 8-400 (2) to allow 20A circuit configurations.

Action: forward to electrical code advisory, then to Part 1

`

2011 Annual Technical Conference

Agenda item # 2011ag-09 **<u>12-902 – Equipment Wire in raceways</u>**

Submitted by: Dwyane Goosen SAIT

Question/enquiry: Can SEW-2 equipment wire listed in Table 11 be pulled into conduit from a motor starter to the motor junction box for a motor with class H insulation? (the question is can it be installed in a raceway not if it is temperature suitable)

Recommendation: For discussion.

<u>Background information</u>:

It is generally accepted that Table 11 wiring cannot be installed in a raceway unless there are specific allowances in the rules for that wire or cable (for example in the footnotes); Table 19 cables must be specifically listed for use in raceways.

12-902 Types of conductors (Raceways – general)
Conductors shall be of types suitable for use in raceways as indicated in `Table 19`.

4-018 Equipment wire

(1) Equipment wire shall be of a type specified in `Table 11` for each specified condition of use.

4-006 Insulated conductors

(1) Insulated conductors shall be of the types specified in `Table 19` for each specific condition of use, except as may be otherwise required by other Sections of this Code. (so equipment wire is not considered an insulated conductor)

Note: The raceway articles in the NEC state that cables shall be permitted in the raceway as long as the appropriate cable article does not prohibit the practice.

Manufacturers Information:

SF-2 Wire / SEW-2 Cable Construction:

`

Rubber Leadwire - 200º Motor SRML

Stranded tin coated copper conductor Insulated with extruded silicone rubber Covered with a high temperature impregnated fiberglass braided jacket

200° Motor Leadwire SRML; • 600 Volt Flame Resistant; • UL, CSA Labeled 200ºC

Applications as outlined on 3 different manufacturers specification sheets:

- Described as hookup and lead wire for internal wiring of electrical equipment
- Recommended for high temperature applications: motors, lighting fixtures, clothes dryers, stoves, therapeutic and electronic devices.
- For motors or high temperature lead wire and can also be applied in appliances, lighting fixtures and electronic leads.

2011 Conference conclusion:

SEW-2 equipment wire may not be pulled into a raceway. Discussion from the floor suggested that reason behind this limitation is that the cable is not suitable for pulling into a raceway.

Action: for information only, item closed.

`

Agenda item # 2011ag-10 **12-3000 (1) (4)**

Submitted by: City of Calgary

Question/enquiry: Can splices be made in a fitting (such as an LB)?

Recommendation: the STANDATA be re-written to synchronize with the NEC to clarify that splices are allowed in the conduit bodies that are marked by the manufacture with their volume and is limited in accordance with Rule 12-3034. Rule 12-910 states that splices can be made in surface raceways with removable covers.

Background information:

Some jurisdictions have been allowing splices in LB's as long as the volume is marked on the fitting and the box fill rule is satisfied. The STANDATA for rule 12-3000 implies that conduit fittings are not to be used as a junction box except for special applications (ie connection to solenoids, photocells etc.) It also goes on to say that the fitting must comply with Rule 12-3034 & Table 22 (max # of conductors in a box)

Other jurisdictions do not allow this practice and would contend:

- that the STANDATA is very clear and correct- no splices in this type of fitting.
- The correct rule to be referencing here is 12-3004 Terminal Fittings and not 12-3000 Outlet Boxes. An LB is a terminal fitting. If you look at the term raceway in Section 0 you will find that the definition does NOT include LB's and such.

From STANDATA – CEC-12 (rev 5)

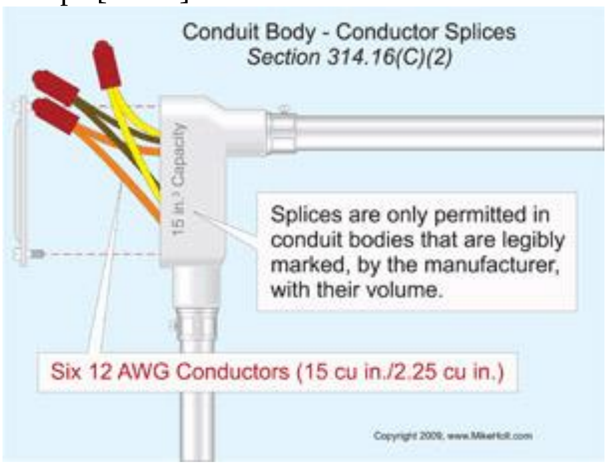
Rule 12-3000 Outlet Boxes & 12-3004 Terminal Fittings

The Code does not permit "conduit fittings" to be used as a junction box. However, in Alberta we have interpreted the term "equivalent device" in 12-3000(1) to include "conduit fittings" in special applications (i.e., connection to solenoids, photocells, etc.). Wire leads from these devices must be integral to the device. Where the device has a bonding conductor and the conduit fitting has no provisions for attaching a bonding conductor, a separate bonding conductor must be provided in the conduit system to the fitting. The fitting must also comply with the requirements of Rule 12-3034 and Table 22.

`

The following interpretation from the NEC:

Q. Is it legal to splice conductors in an "LB" fitting?
A. Splices are only permitted in conduit bodies that are marked by the manufacturer with their volume; and the maximum number of conductors permitted in a conduit body is limited in accordance with 314.16(B) [314.16(C)(2)]. Short-radius conduit bodies, such as capped elbows, handy ells, and service-entrance elbows must not contain any splices or taps [314.5].



2011 Conference conclusion:

It was concluded that a splice in an LB is allowed only as per the STANDATA. The recommendation to synchronize with the NEC to allow splices cannot be allowed due to differences in standards.

Discussion from the floor indicated that some SCO's are allowing any type of splice in an LB while the other half does not allow it. There is a STANDATA that allows it for some installations such as for the connection of an end device. (photo cells etc).

The Standard under which splices are allowed in an LB in the USA (and Mexico) does not apply in Canada. Standard Z22.2 18.1 definition for conduit body a means for providing access to a conduit or conduit system through one or more removable covers at a junction of two or more conduits or tubing sections at a terminal point of a conduit or tubing. In Mexico and the USA a conduit body is investigated as an outlet box. In Canada a conduit body is not investigated as an outlet box, it is a fitting, requirement in this standard or conduit body intended for use as an outlet box do not apply in Canada.

Action: for information only, item closed

`

2011 Annual Technical Conference

Agenda item # 2011ag-11 **24- 114 receptacles in Doctors offices**

Submitted by: Don Bradshaw City of Airdrie

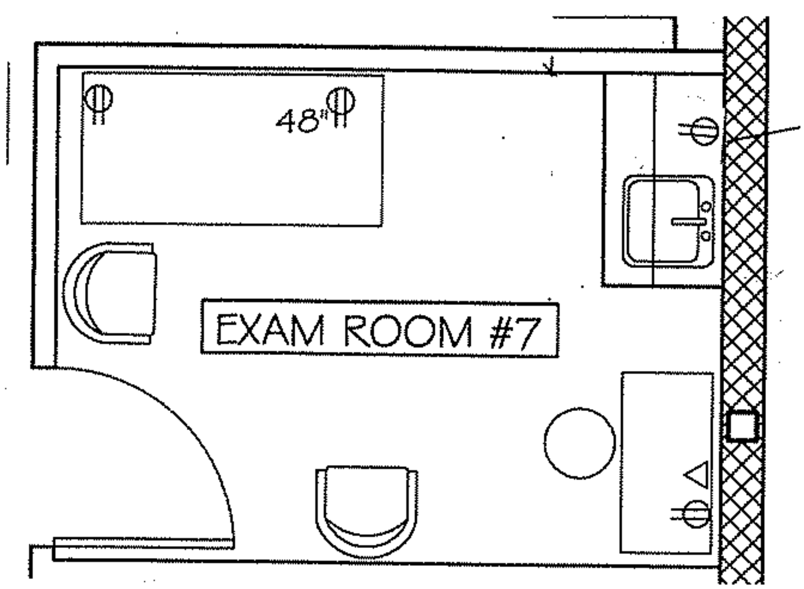
Question/enquiry: This question surrounds the receptacle located near the sink in a Doctor's office examination and treatment room. Where and on what circuits can GFI receptacles be used in a doctor's office examination room which under Z32 is an intermediate care area?

With the harmonization of CSA Z-32 and the CE Code, circuit layout and the installation of GFI protection must be looked at more carefully. Often there is a receptacle on a counter next to the exam room sink which is in the "patient care area" and when <1.5m from the sink must be GFI protected. CSA Z-32 limits the use of GFI protection. Designers are often using just one circuit for each room which results in sharing circuits between the patient care environment with the patient care area (and sometimes the hallway outside) which is not allowed by 24-102 (3).

Recommendation:

Designers need to follow the circuit and receptacle layout criteria of CSA Z32 and Section 24. Receptacles located < 1.5m from wash basins in intermediate care areas such as Doctor's office treatment and exam rooms need to be hospital grade, GFI protected and on a patient care area circuit. Treatment rooms must have different circuits for the patient care area and the patient care environment.

Background information:



`

Patient care area - an area intended primarily for the provision of diagnosis, therapy or care (this is the exam and treatment room)

Patient care environment - a zone in a patient care area that has been pre-selected for the accommodation of a patient bed, table or other supporting mechanism, and for the accommodation of equipment involved in patient treatment, and that includes space within the room 1.5m beyond perimeter of bed and to within 2.3m above the floor. (The patient care environment is a specific zone within the patient care area)

CSA Z-32 5.12.2 Ground fault circuit interrupters

5.12.2.1
Ground fault circuit interrupters (GFCIs) shall comply with the requirements specified in CAN/CSA-C22.2 No. 144. Installation of GFCIs in patient care areas shall be undertaken in accordance with the requirements specified in Section 24 of the Canadian Electrical Code, Part I.

5.12.2.2
GFCIs shall be used only in solidly grounded power distribution systems and only in areas specified in Rule 24-106 of the Canadian Electrical Code, Part I. GFCIs shall not be used in locations where sudden, unplanned power interruptions cannot be tolerated.

CSA Z-32 5.6.1 General requirements (for receptacles)

5.6.1.1 General
The minimum number and general arrangement of receptacles in patient care areas should be as specified in Table 7. Additional receptacles and circuits shall be provided for equipment placed in a patient care environment more or less permanently (e.g., patient monitors and bedside computer terminals). When a non-medical computer communications outlet and power receptacle are provided in a patient care area, the receptacle shall be located outside the patient care environment and carefully positioned and identified so that it cannot be inadvertently used for equipment that will be connected to the patient….

24-102 Circuits in basic care areas

(3) A branch circuit that supplies receptacles or permanently connected medical electrical equipment, including parts of the essential electrical system within a patient care environment, shall supply loads only within such environments.

24-106 Receptacles in basic care areas *(note Dr. office is intermediate care area – same rules apply + 24-114, 24-116)*

`

(1) Receptacles intended for a given patient care environment shall be located to minimize the likelihood of their inadvertent use for a patient care environment for which they are not intended.
(2) Receptacles located in areas that are routinely cleaned using liquids that normally splash against the walls shall be installed not less than 300 mm above the floor.
(3) Receptacles located in bathrooms or washrooms shall be
(a) located within 1.5 m of the wash basin; and
(b) located outside of any bathtub enclosure or shower stall.
(4) Receptacles intended for housekeeping equipment and other non-medical loads shall be so identified.
(5) Except for receptacles described in Subrule (3), all 15 A and 20 A non-locking receptacles shall be hospital grade.
(6) All receptacles that are part of an essential electrical system shall be coloured red, and no other receptacles shall be so coloured.

Apx B on Rule 24-106(3)

Rule 26-700(11) requires that receptacles installed within 1.5 m of wash-basins, bathtubs, or shower stalls be protected by a ground fault circuit interrupter of the Class A type.

2011 Conference conclusion:

Comments from the floor agreed that designers need to follow the circuit and receptacle layout criteria of CSA Z32 and Section 24 for the entire facility. In regards to the specific issue, GFI Receptacles located < 1.5m from wash basins in intermediate care areas such as Doctor's office treatment and exam rooms need to be hospital grade, GFI protected and on a patient care area circuit. Treatment rooms must have different circuits for the patient care area and the patient care environment.

Discussions also touched on the use of AC90 and IsoBX (an armoured cable with a black, white, bare bond and a green insulated bonding conductor the same size as the conductors). Conventional AC90 - 3 wire cannot be used in section 24 wiring– you cannot apply green tape to a red conductor to use it as the insulated bond. 4-036 (1) (a) requires that an insulated bonding conductor in a cable must be coloured green the entire length.

Discussion also questioned the correct method for connecting the IsoBX bare bond to a hospital grade receptacle. A hospital grade receptacle in a patient care area <u>is not</u> an isolated ground receptacle. Z32 5.6.3 indicates islolated ground receptacles not to be used in patient care areas. Z32 5.6.2 indicates the insulated bonding wire is to be connected to the box bonding screw. It was suggested the bare bonding conductor in an IsoBX would be abandoned and the insulated bond picks up the box and the receptacle.

Action: for information only, item closed.

2011 Annual Technical Conference

Agenda item # 2011ag-12 **<u>26-710 bathroom TV receptacle</u>**

Submitted by: Major Municipalities Meeting

Question/enquiry: Receptacles intended for installation of a TV on the wall of a bathroom above the tub. Can we introduce a rule that will allow this practice in a location above the tub that places the receptacle < 500 mm horizontally from the tub.

Recommendation:

For discussion.

<u>Background information</u>:

26-710 General

(g) receptacles installed in bathrooms shall, where practicable, be located at least 1 m but in no case less than 500 mm from the bathtub or shower stall, this distance being measured horizontally between the receptacle and the bathtub or shower stall, without piercing a wall, partition, or similar obstacle;

Note: some bathrooms have gas fireplaces installed at the end of the tub with a fan receptacle that may fall into this discussion as well. The usual configuration for this is a double sided fireplace – one side faces the tub needing GFI protection and the other side faces the bedroom requiring AFCI protection. Yet the receptacle is located inside the appliance.

2011 Conference conclusion:

There was no support from the floor to request a code change to allow receptacles <500 mm horizontally from a tub to accommodate TV installations. Individuals, including contractors trying to install receptacles within this area have the option to make a submission to Part 1 to change the rule.

Action: for information only, item closed.

`

2011 Annual Technical Conference

Agenda item # 2011ag-13 **30-910 access to wiring in recessed luminaires**

Submitted by: Dennis Smith

Question/enquiry: How can the recessed fixture be serviced and the insulation value be maintained without a vapour barrier above?

Recommendation:

For this junction box to be accessible, especially when the recessed fixture is mounted where the roof line is lower, a vapour cap is important! Without the insulation above the fixture condensation will form and the fixture will drip water. (See fig. 1)

Background information:

30-910 Wiring of recessed luminaires

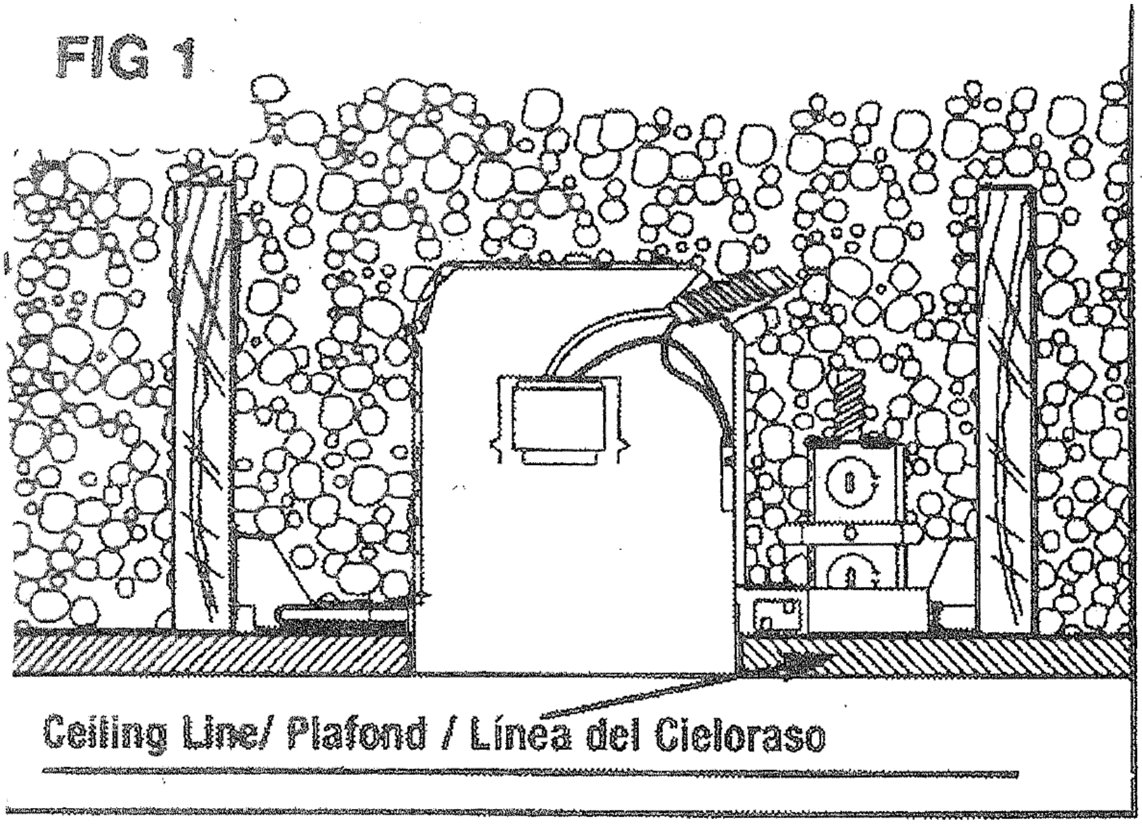
(7) A supply connection box that is an integral part of the luminaire shall
(a) be accessible in accordance with Rule 12-3014; and
(b) if access is through the opening for mounting the luminaire, meet the following requirements:
(i) the electrical components of the luminaire shall be capable of being extracted through the opening for service, and the components shall include ballasts, transformers, thermal protectors, and wire connections in the supply connection box; and
(ii) the cover of the supply connection box shall be capable of removal by hand tool, held below the ceiling.

12-3014 Accessibility of junction boxes

(1) Pull-in, junction, and outlet boxes, cabinets and gutters, and joints in wires and cables shall be accessible.
(2) A vertical space of 900 mm or more shall be required to provide ready access.

`

FIG 1



COOPER Lighting

`

2011 Conference conclusion:

The acceptable methods for installing insulation contact (IC) recessed luminaires in insulated ceilings was discussed at the 2010 EIAA conference which required further research into this subject by the EIAA conference committee. The findings were taken to the Alberta Building Officials Association (ABOA) for further discussion. Agreement was reached with the building officials on 3 acceptable installation methods. See EIAA2004.com website under "installing airtight recessed luminaires" for the research doccument. There are three acceptable methods, but one includes a method with no poly hats or vapour barrier above.

Access to the connections is allowed through the ceiling opening. Batt or loose insulation can be pushed aside for access to the junction boxes. Spray foam encapsulating the luminaire as shown in the photo is not acceptable for two reasons – (1) the spray foam listing documentation typically requires 3" clearance from any heat source including a luminaire (including an IC rated luminaire) (2) the spray foam encapsulating the junction box would render the connections inaccessible.

There remains a concern about loss of insulation value when servicing a luminaire without a poly hat or sheet of vapour above it, but this is only an issue where there is no access from above.

Action: for information only, item closed.

`

2011 Annual Technical Conference

Agenda item # 2011ag-14 **30-320 GFI protection of luminaires (in bathrooms)**

Submitted by: EIAA Calgary Chapter

Question/enquiry: Why do we not require luminaires in bathrooms to be GFI protected? If the switch is located < 1m from the tub or shower the switch circuit is required to be GFI protected, but if we hang a chandelier over a tub and the switch is >1m away no GFI protection is required.

Recommendation:

Luminaires installed in bathrooms to be GFI protected. This is common practice in the trade anyway.

Background information:

30-320 Lighting equipment in damp locations or near grounded metal

(1) Where luminaires are installed in damp locations or within 2.5 m vertically or 1.5 m horizontally of laundry tubs, plumbing fixtures, steam pipes, or other grounded metal work or grounded surfaces, the luminaires shall be controlled by a wall switch, except as permitted in Subrule (2).
(2) Outlet-box-type luminaires marked for use in damp locations and luminaires marked for use in wet locations, with an integral switch, shall be permitted to be installed under the conditions of Subrule (1).
(3) Switches (including wall switches) controlling luminaires covered by Subrules (1) and (2) shall
(a) be located not less than 1 m from a bathtub or shower stall (this distance measured horizontally between the switch and the bathtub or shower stall) without piercing a wall, partition, or similar obstacle; or
(b) if the condition in Item (a) is not practicable, be located not less than 500 mm from a bathtub or shower stall and be protected by a ground fault circuit interrupter of the Class A type.

STANDATA CEC-30 [REV 5] has a line for 30-314 minimum height of low luminaires

"A luminaire over the vanity in a bathroom should be kept at least 1m from the tub or shower enclosure"

2011 Conference conclusion:

There was no support from the floor to request a code change. Comments from the floor suggested that this is not a good idea because if the circuit trips while you are in the tub, the room becomes totally dark and could cause a hazard for anyone fumbling around in a dark room. It could be considered a best practice to GFI protect a luminaire if a person can touch it while standing in a tub or shower.

Action: for information only, item closed.

`

2011 Annual Technical Conference

Agenda item # 2011ag-15 **60-704 grounding communications systems**

Submitted by: Pierre McDonald Alberta Municipal Affairs

Question/enquiry: Re. Section 10 mandates that grounding conductors of a wiring system, whether it is also used for grounding electrical equipment or not, can be bare or insulated as per Rule 10-802 (bonding conductors 10-804). However, in Section 60, Rule 60-704 (a) mandates that the primary protector grounding conductor be insulated.

Recommendation:

Consistent enforcement of the CEC rules (SCO's enforce rule 60-704 when noted)

Background information:

60-704 Primary protector grounding conductor (see Appendix B)

The grounding conductor used to ground primary protectors specified in Rule 60-202 shall be copper and shall

a. have rubber or thermoplastic insulation;

60-704 Primary protector grounding conductor (see Appendix B)

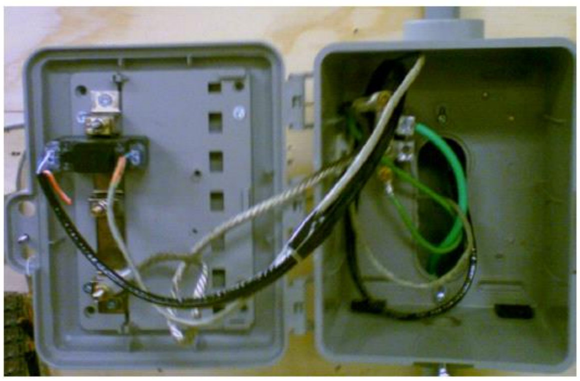
The grounding conductor used to ground primary protectors specified in Rule 60-202 shall be copper and shall
(a) have rubber or thermoplastic insulation;
(b) be not smaller than the required grounding conductor specified in Table 59;
(c) be run from the primary protector to the point of connection described in Rule 60-706 in as straight a line as possible; and
(d) be guarded from mechanical injury, where necessary.

Apx B note Rule 60-704(c)

The wave front of a lightning surge has a rise time in the order of microseconds and is approximated by equivalent frequencies between 25 and 250 kHz. As a result, the self-impedance of the grounding conductor to the wave front of a lightning surge is very significant. For this reason it is paramount to keep the length of the grounding conductor as short as practicable to guarantee the effectiveness of the protector. As a guideline, it is suggested that the length of the grounding conductor be limited to 6 m maximum.

`

Notice grounding conductor is bare as per the rules of Section 10, violating the rule in Section 60.



Grounding conductor visibly insulated.

2011 Conference conclusion:

This subject is brought up to ensure consistent enforcement of the CEC rules (SCO's enforce rule 60-704)

Action: A STANDATA will be issued to raise the awareness of the insulated grounding conductor requirement.

`

2011 Annual Technical Conference

Agenda item # 2011ag-16 **Section 86 Electric Vehicles**

Question/enquiry: Is Alberta prepared for the impact of Electric Vehicles?

Recommendation: For discussion.

Background information

Must reading - "BC Hydro EV Charging Infrastructure Guidelines" – get it free from the internet. These are clips from this document:

Utility Integration

Electric utilities are under significant pressure to maintain a dependable, clean and low cost electrical supply to their customer base. In order to achieve these goals, utilities are evaluating and in some cases implementing "Smart-Grid" technologies that allow them to control various electrical loads on their system. Through these Smart-Grid technologies, utilities can minimize new power plant, and electrical distribution and transmission investment by shifting and controlling load while minimizing the impact to the customer. Advanced Metering Infrastructure (AMI) or what is referred to as "Smart-Meters" are being deployed by utilities that see an immediate benefit. One of the immediate benefits is remote meter reading, eliminating the need to manually read thousands or in some cases millions of meters every month for billing purposes. These smart meters also have the ability to control various customer loads which is an important piece in implementing the overall Smart-Grid system. There have been significant advances in computer control of lighting, thermostat, appliances and energy management systems that make the communications with the smart meter possible. Electric vehicles are one of the better loads to control for the utilities because EVs have an on-board storage system unlike lighting or air-conditioning load which can have an immediate impact on the customer when turned-off. For residential EV charging, the ability to move the charging times into the off-peak time of day could delay distribution system upgrades by several years. For example, local neighborhood transformers may not be sized for every customer on that transformer to be charging at the same time. The ability to schedule the EV charging connected to a neighborhood transformer could significantly extend the life of that transformer or even delay or remove the requirement to replace the transformer with a larger size.

Planning for Residential Charging

For a pure Battery Electric Vehicle, the preferred method of residential charging will be Level 2 (240VAC/Single phase) in order to provide the EV owner a reasonable charge time and to also allow the local utility the ability to shift load as necessary while not impacting the customer's desire to obtain a full charge by morning. For Plug-in Hybrid Electric Vehicles, a dedicated Level 1 circuit may adequately meet the PHEV owner's needs. Cost considerations relative to charger performance need to be well understood by the plug-in vehicle owner in order to make the right decision for their particular situation.

`

Level 1

Power Requirement: Dedicated branch circuit with NEMA 5-15R or 5-20R Receptacle.

Level 2

Power Requirement: Dedicated branch circuit hardwired to a permanently mounted EVSE with the following specifications: 240VAC/Single Phase, 4-wire (2 Hot, GND, Neutral), 40Amp Breaker

Level 2 Notes:

1. The breaker size recommended will meet the requirements of most all BEVs and PHEVs. Some PHEVs with small battery packs (See Table 3.1) may only require a 20 or 30Amp breaker for their recommended EVSE in which case the breaker can be easily changed.
2. The Neutral may not be required by some EVSE but since it is inexpensive to include and may be required at some point in the future if a different vehicle is purchased it is recommended.
3. For new construction, bring the circuit to a dual gang box with a cover plate for future installation of EVSE.

Communication Requirement: For new construction that is incorporating an advanced internet network within the home, an internet connection at the EVSE location would be advisable. For existing homes, the value of providing an internet connection at the EVSE location is unknown at this time and is left up to the individual homeowner. It is likely that wireless methods will be available where a hard connection is not available.

- **Level 1 – 125 volt AC details:**

The Level 1 method uses a standard 125VAC branch circuit. Typical amp ratings for these receptacles are 15 or 20 amps. Level 1 charging is an important aspect of the infrastructure because of the widespread availability of these circuits. Consequently, companies that currently provide vehicle conversions to electric and future EV and PHEV suppliers will likely provide a Level 1 Cord Set (125 VAC, 15/20 amp) with the vehicle. With a rating of 15 amps, the actual current draw is limited to 12 amps so the Cord Set will draw approximately 1.4 kW of power.

Level 1 charging typically uses a standard 3 prong electrical outlet (NEMA 5-15R/20R). The Cord Set uses a standard 3-prong plug (NEMA 5-15P/20P) with a charge current interrupting device (CCID) located in the power supply cable within 12 inches of the plug. The vehicle connector at the other end of the cord will be the design approved by the Society of Automotive Engineers in their Standard J1772. This connector will properly mate with the vehicle inlet also approved by J1772. The J1772 standard is the subject of a harmonization project with the Canadian Electrical Code Part II Standards.

Level 1 charging at 20 amps is specifically recognized in the CEC Section 86 for dedicated EV charging. (Note that the CEC derates branch circuits to 80% for continuous duty so the usable capacities for the above circuits would be 16 amps.) The dedicated circuit requires the use of NEMA 5-20R for the premises receptacle. Many electrical utilities provide a rate structure that considers on-peak and off-peak hours. Home owners may desire to install a timer device in this circuit to control charging to off-peak times. Because charge times can be prolonged at this level, many EV and PHEV owners will be more interested in Level 2 charging. Some EV providers suggest their Level 1 cordset should be used only during unusual circumstances when the Level 2 EVSE is not available, such as when parked overnight at a nonowner's home.

`

Level 2 – Greater than 125 volt AC or greater than 20 amps

Level 2 is typically described as the “primary” and “preferred” method for the EVSE both for private and public facilities and specifies a 240 VAC, single phase branch circuit. The J1772 approved connector allows for current as high as 80 amps AC (100 amp rated circuit). However, current levels that high are rare and a more typical rating would be 40 amps AC which allows a maximum current of 32 amps. This provides approximately 7.7 kW.

This level of charge provides the higher voltage that allows a much faster battery charge restoration. The Level 2 method also employs special equipment to provide a higher level of safety required by the CEC and NEC. The Society of Automotive Engineers (SAE) has been working to standardize the method of coupling for automakers and EVSE suppliers. A standard EV Coupler will be used by EV and PHEV suppliers following the final acceptance of this approved standard. The Coupler and EV Inlet will be the same for both Level 1 and 2 charging. The onboard charger will measure the inlet voltage and determine the available current from the EVSE through the pilot signal and adjust accordingly.

J1772 identifies specific requirements for Level 2 charging. As J1772 is a harmonization project, it is expected these requirements will be included in CSA and CEC requirements. These requirements provide:

- The EV Coupler (EVSE connector and vehicle inlet) must be engineered to prevent inadvertent disconnection,
- The EV Coupler must have a grounded pole that is first to make contact and the last to break contact,
- A charge current interrupting device (CCID) must shut off the electricity supply if it senses a potential problem that could result in electrical shock to the user,
- The EV power inlet must be de-energized until it is attached to the EVSE,
- The EV Coupler must contain an interlock device which prevents vehicle startup while connected,
- The vehicle inlet must de-energize prior to removal of the connector,
- The EV Coupler is unique to EV and EVSE charging and cannot be used for other purposes,
- The EVSE must be tested and approved for use by Underwriters Laboratory Canada (ULC) or Underwriters Laboratory (UL), or a similar nationally recognized, independent testing lab.
- The EVSE must be able to initiate area ventilation for specific batteries that may emit potentially explosive gases.

Companies designing Level 2 EVSE will incorporate these requirements. As noted above, many electrical utilities provide a rate structure that considers on-peak and off-peak hours. Many Level 2 EVSE suppliers will provide controls in the EVSE to control charging to programmable times but if not, home owners may desire to install a timer device in this circuit to control charging times.

- **Level 3 Charging**

Level 3 charging or “Fast Charging” is for commercial and public applications and is intended to perform similar to a commercial gasoline service station in that charge return is rapid. Typically, this would provide a 50% recharge in 10 to 15 minutes. Level 3 typically uses an off-board charger to provide the AC to DC conversion. The vehicle’s on-board battery management system controls the offboard charger to deliver DC directly to the battery.

This off-board charger is serviced by a three phase circuit at 208, 480 or 600VAC. The SAE standards committee is working on a Level 3 connector, but has placed the highest priority in getting the Level 1 & 2 connector approved first.

`

The Canadian Electrical Code (CEC) provides the standards to which EVSE equipment is designed and electrical contractors must follow when installing electrical components. CEC 2009 provides:

- ***Approved:*** Couplings and inlets shall be specifically approved for the purpose and marked accordingly (CEC 86-202).
- ***Branch Circuit****:* The EVCE branch circuit must be a dedicated circuit and sized for continuous duty of the EVCE and related ventilation equipment. (CEC 86-300, 302)
- ***Disconnect Means:*** A separate disconnecting means shall be provided for each installation of EVCE rated at 60 amps or more or more than 150 volts– to-ground. This disconnect means must be on the electrical supply side to the EVCE, within sight of and accessible to the EVCE and capable of being locked in the open position. (CEC 86-304).
- ***Receptacle and Wall Plug – Level 1****:* A standard 20 amp residential wall plug and receptacle are acceptable for Level 1 charging (CEC 86-306 1 (a)).
- ***Receptacle and Plug – Level 2:*** Receptacles identified in the CEC will be acceptable (CEC 86-306 1 (b)).
- ***Markings****:* All electric vehicle charging receptacles must be clearly and permanently marked (CEC 86-306 (1)).
- ***Ventilation****:* Where the EV battery requires ventilation, adequate ventilation shall be provided in the indoor charging site; the EVSE shall be electrically interlocked with the ventilation so that the ventilation equipment operates with the EVCE; and if the supply to the ventilation equipment is interrupted, the EVCE shall be made inoperable. (CEC 86-400 (2)).
- ***Warning Sign:*** A permanent sign shall be installed at the connection of the EVCE to the branch circuit warning against operation of the equipment without sufficient ventilation (if required by the manufacturer's installation instructions). (CEC 86-200).
- ***Ground Fault Interrupter:*** The receptacle for Level 1 shall be protected with a ground fault circuit interrupter when the receptacle is installed outdoors and within 2.5 m of finished grade (CEC 86-306 (2)).
- ***Hazardous Locations:*** When EVCE is installed in hazardous locations as defined elsewhere in the Code, those sections apply. (CE 86-102)

2011 Conference conclusion:

This subject is brought up to raise the awareness of what is happening in other jurisdictions to prepare the electrical system for the arrival of electric vehicles. In speaking with an official from BC Hydro, if they had to pick one area that is their greatest concern, it would be the size of the distribution transformers in neighbourhoods being able to handle the increased demand.

There has not been a push for an electric vehicle implementation plan in Alberta at the Provincial level, there have been proposals at the CSA Part 1 to mandate Electric Vehicle Infrastructure, but they are early proposals. Electric Vehicles are not on the market in Canada yet, they probably will be expected probably 3rd quarter 2011 and they are appearing in the US now. This is something that will evolve gradually.

Action: For information only.

Agenda item # 2011ag-50-01 **Section 50 – plan reviews**

Question/enquiry: How many AHJ's are conducting plan reviews on Solar PV systems prior to permit issuance and what information are they asking for?

Recommendation:

As a minimum permit issuers should be asking for an equipment list and specifications. This list should include the major solar PV specific equipment, such as solar PV modules, inverter(s) and combiner boxes. Factory sheets or pages from instruction manuals could be an acceptable way of presenting this information.

Background information:

Alberta Regulation 204/2007 - Permit Regulation

Part 2, section 20 requires the permit applicant to provide information for the undertaking.

(e) describe the undertaking, including information satisfactory to the permit issuer, regarding the technical nature and extent of the undertaking
(i) including any further information that the permit issuer considers necessary, including the provision of copies of plans and specifications for the proposed undertaking and documentation required to verify information provided by the applicant

Note – long gone is the old Electrical Permits and Inspection Fees Regulation AR 61/82 which placed a requirement for submission of plans and specifications for "any proposed electrical installation but in any case plans shall be submitted when the cost of the installation is more than $10,000".

CE Code 2-014 - Plans and specifications

Plans and specifications in duplicate, or in greater number if required by the inspection department (one copy to be retained by the inspection department), shall be submitted by the owner or an agent to, and acceptance obtained from, the inspection department before work is commenced on
(a) wiring installations of public buildings, industrial establishments, factories, and other buildings in which public safety is involved;
(b) large light and power installations and the installation of apparatus such as generators, transformers, switchboards, large storage batteries, etc.; or
(c) such other installations as may be prescribed by the inspection department.

`

2011 Conference conclusion:

As a minimum permit issuers should be asking for an equipment list and specifications. This list should include the major solar PV specific equipment, such as the modules, inverter(s) and combiner boxes. Factory sheets or pages from instruction manuals could be an acceptable way of presenting this information.

EPCOR is reviewing all drawings that are connected to the grid and are asking for drawings on all PV installations. City of Airdrie is asking for single line diagrams and specifications on the major components being installed. The oilfield installations that are using PV connections to run their RTU systems, these are small loads and drawings are not asked for on these systems. In Ontario if the system is not interconnected to the utility, if it is 3 phase 400 amp, or larger, a drawing is required, if it is single phase 600 amp a plan review is required, if it is a utility interconnected system over 10 KW a plan review would be required. The 10 KW level would make a logical full plan review implementation point.

It was agreed by the group that there should be at a minimum, a single line diagram of the photo voltaic system and information on components to be installed.

Homeowner permits for utility interconnected systems were also discussed under this item. Previous information provided to the (2008) conference indicated that a request for interpretation of the Permit Regulation was sent to Safety Services questioning homeowner eligibility for a permit for a utility interconnected solar PV system.

The issue surrounds whether this type of installation meets the permit eligibility restrictions. A homeowner is eligible for a permit only “where the electrical system serves that dwelling”. A grid tied system could be looked at as if it served more than that dwelling. The answer came back (in 2008) from Safety Services that a grid tied solar PV system serves more than that dwelling and as such, would not qualify for homeowner permit.

The Administrator indicated that he was unsure where that interpretation came from and was comfortable that a permit could be issued to a homeowner for such a system. Municipalities that did not issue Homeowner permits under these conditions indicated they would reverse their policy based on this new information and would allow homeowner permits for utility interconnected systems.

Action: For information only.

`

2011 Annual Technical Conference

Agenda item # 2011ag-50-02 **<u>Section 50 PV System Grounding ac side</u>**

Question/enquiry: Is the connection of the AC output of the inverter to the neutral bar in the panelboard adequate means to provide the grounding required for the ac system?

Recommendation: for discussion

<u>Background information</u>:

In a typical PV system there are 2 distinct circuit sections – the dc section and the ac section. Rules must be observed for each section. The fact is that most PV systems installed today have dc circuits and ac circuits and both must be properly grounded. Although the CE Code section 10 deals with grounding of ac systems and has sections to deal with the proper grounding of dc systems, it does not specifically deal with systems that have both ac and dc components.

Rules that apply to grounding the ac side:

CE Code rule 10-106 requires ac systems to be grounded or have a ground detection device when their voltage-to-ground is 150 volts-to-ground or less, or when an electrical system has a neutral conductor. In either case it is most common to ground the system. Ground detection systems are expensive and do not provide the same level of protection (e.g from lightning or static charge).

CE Code rule 10-206 requires when there is another system supplying the facility in addition to the consumer service, each different system shall be connected to a separate grounding conductor at the source of supply or at the first switch controlling the system. A separate grounding conductor is not required to be installed as CE Code rule 10-206 (2) allows the conductor to be grounded from the two systems to terminate at a single connection to the grounding conductor at a common tie point. **The question is does terminating the identified conductor of the inverter's ac output at the neutral bar in the main panelboard meet this requirement?**

Can grounding the AC side of the system be summarized as:

The PV system ac identified (white) conductor is required to be grounded as the PV ac output is "another system supplying the facility". In most cases, for inverters less than about 15 KW, there is no internal bond between the ac identified conductor and the grounding system. This bond is made at the main panelboard to which the inverter is connected when the identified conductor is terminated on the neutral bar. No additional ground electrode or grounding conductor is required for the ac side. Each inverter may have a unique method of grounding the ac output, and the manufacturer's instructions should be followed.

`

2011 Conference conclusion:

The connection of the AC output of the inverter to the neutral bar in the panelboard is the most common method for grounding ac side of the system but ensure the method of grounding the ac output outlined in the manufacturer's instructions is followed. The members of Section 50 are currently working on clarifying the CEC rules which are to be in the 2012 edition of the code and all are asked to review the proposed rules when they come out for consultation, including new rule 50-204 (4)

Action: For information only.

`

2011 Annual Technical Conference

Agenda item # 2011ag-50-03 **Section 50 PV System Grounding dc side**

Question/enquiry: Is there a requirement to ground the dc side of the system when it operates over 300V dc? Why does 10-102 not address systems operating over this level?

Rule 10-102 (2). This rule states "if such a circuit operates at more than 300 V between conductors and a neutral point can be established so that the maximum difference of voltage between the neutral point and any other point on the system does not exceed 300 V, the neutral shall be permitted to be grounded."

Recommendation: Insert a rule in Section 50 that parallels the NEC requirements (and perhaps references any system not identified in Section 10)

NEC (690.41) requires all PV systems operating over 50v to be grounded. When these products are manufactured and listed for the North American market, the inverter typically requires grounding of the dc system when it falls into this voltage range. Product evaluation listings specify the ways in which the products were tested and are to be installed and used - they must be installed under the same conditions of the evaluation to be valid and to be acceptable. We should not need to rely on the listing materials alone to determine grounding requirements.

Background information:

CE Code rule summary that apply to grounding the dc side:

- All 2-wire DC systems operating at between 50V and 300V must be grounded
- If a 2-wire DC system operates below 50V, it is not required to be grounded unless run overhead outside of buildings, however we can ground it if we choose.
- If a 2-wire DC system operates above 300V, it is not required to be grounded, however we can ground it if we choose.
- All 3-wire DC systems must be grounded if they supply interior wiring therefore, one can rationalize that a 3-wire system that does not supply interior wiring, despite not being required to be grounded, can be if one chooses.

`

Two wire dc systems:

Circuits of less than 50 volts shall be grounded:

Rule 10-114 (a) applies to PV installations running at under 50 volts and if any part of the circuit is run overhead outside of buildings. Note wiring outdoors on the roof is widely considered as overhead wiring but this interpretation may be controversial. If no part of the system is run overhead (e.g ground level array) grounding the dc side of the system is optional. Inverter's listing requirements may have the requirement to ground.

50 – 300v dc - Rule 10-102 (1). This rule requires one leg of a 2 wire system to be grounded if operating voltage is between 50 v and 300v. This rule is self-explanatory… on a 2-wire system, everything between 50V and 300V must be grounded.

Over 300v dc - Rule 10-102 (2). This rule states "if such a circuit operates at more than 300 V between conductors and a neutral point can be established so that the maximum difference of voltage between the neutral point and any other point on the system does not exceed 300 V, the neutral shall be permitted to be grounded."

- There is little information on why the 300V break for this rule and why subrule (1) stops the requirement for grounding at 300v.
- By definition a 2 wire system does not have a neutral so it appears this relates to multi wire systems.
- This is really a permissive rule and provides some options: where the 2-wire system exceeds 300V, you can (perhaps this is a recommendation) create a 3-wire system whereby the neutral may be grounded (not mandatory)… and this would apply to systems up to 600 VDC (300 V between any point on the system and neutral).
- The exception to this rule is if the 3-wire dc system supplies interior wiring: 10-104 – all 3-wire DC systems supplying interior wiring must be grounded… regardless of voltage.
- The term "interior wiring" is not defined and therefore open to interpretation. (e.g., if the dc circuit supplies an inverter that in turn supplies interior wiring, is the dc system supplying interior wiring?
- There is nothing in the CE Code section 10 that forbids any DC system exceeding 300 V from being grounded.

Three wire dc systems:

Rule 10-104 – systems utilizing a 3 wire system (three conductors - positive, negative, neutral) this rule requires the neutral conductor of all 3 wire dc systems (supplying interior wiring) to be grounded.

In PV systems, one conductor (normally the negative) of a two-conductor system or the center-tapped conductor of a bipolar system is grounded.

`

NEC 690.41 System Grounding.

For a photovoltaic power source, one conductor of a 2-wire system with a photovoltaic system voltage over 50 volts and the reference (center tap) conductor of a bipolar system shall be solidly grounded or shall use other methods that accomplish equivalent system protection in accordance with **250.4(A)** and that utilize equipment listed and identified for the use.

*Exception: Systems complying with **690.35**.*

Low-voltage systems that are not grounded are required by **690.41** to be solidly grounded, having overcurrent protection in each of the ungrounded conductors, as required by **240.21**. Other methods that employ available equipment may be used to achieve objectives contained in **250.4(A)**, thereby providing protection for the PV power source circuits equivalent to solid grounding.

2011 Conference conclusion:

The rule for 300V has been in the CE Code since the 1927 code 1st edition. When the rule dates back so far, it is hard to answer why it is laid out as it is. The members of Section 50 are currently working on clarifying the CE Code rules which are to be in the 2012 edition and all are asked to review the proposed rules when they come out for consultation. Currently under development are new rules (50-200 series) to deal with system grounding for ac systems, dc systems over 50 volts and for ungrounded systems.

In the mean time, follow the installation instructions from the manufacturer of the products particularly for systems over 300V. They must be installed under the same conditions of the product certification. Normally this involves grounding.

Action: For information only.

`

Agenda item # 2011ag-50-04 **PV System Grounding**

Question/enquiry: Does grounding of the DC system require its own grounding conductor and separate ground plate or can one tap into the existing AC system grounding conductor?

Recommendation: For discussion

Background information:

Grounding Conductor Size and Type for DC Circuits - CE Code Rule 10-810:

"1) The ampacity of the grounding conductor for a direct-current supply system or generator shall be not less than that of the largest conductor supplied by the system...
(2) The system grounding conductor shall be copper and in no case smaller than No. 8 AWG."

Note on 10-810:

- Subrule 1 references the largest conductor supplied by the system is the conductor that runs from the PV output circuit to the system. If parallel output conductors are used, the total ampacity of the parallel conductors would apply in choosing the size of the grounding conductor.
- A #8 AWG copper wire is the smallest grounding conductor allowed by 10-810 (2) but typically a #6 AWG copper wire is used. If it is run free from mechanical injury it can be run along the surface of a building without protection.

Grounding the DC side of the system - the inverter end:

Most solar PV arrays must have one of the array dc circuit conductors grounded. On most PV systems, the dc negative conductor is grounded. There are some ungrounded and some positive grounded systems, but these are less common.

It is important to review the installation manual as the inverter may have a unique method of grounding the dc system and the manufacturer's instructions should be followed. Some manufacturers will provide for grounding the dc negative either on a lug on the inverter, on a factory wired PV ground fault protection breaker or factory installed grounding block.

`

The grounding and bonding requirements will call for each inverter to have a minimum of three terminals available for making the proper connections. (ac equipment bond, dc equipment bond, dc grounding electrode conductor). All three terminals may be on a common bus bar or mounted separately in the inverter. They will normally be connected (bonded) together electrically in the inverter and they will be connected to the inverter chassis.   Since the inverter is the common element between the dc portion of the system and the ac portion, its enclosure is common to both equipment grounding systems and keeps the exposed metal surfaces at the same potential.

Grounding the DC side of the system - the electrode end:

Grounding of the dc negative conductor is typically accomplished with a copper grounding conductor (usually #6 AWG) run from the designated "grounding electrode conductor" terminal (or similarly named) on the inverter to connect to the grounding conductor of the house service. The dc negative is normally bonded internally within the inverter to this terminal achieving the requirement to ground the dc system.

CE Code Rule 10-206 indicates that the dc grounding conductor and the ac grounding conductor may be connected to a single common grounding electrode. This is accomplished by crimping the dc grounding conductor on to the existing system grounding conductor using a compression splice. It is best practice to place the crimp at a location as close as possible to the ground electrode. If the ground electrode happens to be accessible, direct connection to the ground electrode is best.

If the installer chooses to ground the dc system at a separate grounding electrode, both ground electrodes would need to be interconnected anyway (CE Code 10-702) so most often the PV system grounding conductor will terminate at the service equipment of the main panel, rather than at a separate ground electrode.

2011 Conference conclusion:

The members of Section 50 and (new) Section 64 are working together to clarify and write these rules so that they would properly work for PV systems. Currently under development are new rules (50-204 series) to deal with Grounding electrodes and Grounding conductors. The new rule series will reference 10-810 and 10-812.

Action: For information only.

Agenda item # 2011ag-50-05 **<u>Module Frame bonding</u>**

Question/enquiry: Would the frame of PV modules on Enphase inverters need to be bonded to ground?

Enphase inverters are only fed from one module. It would appear that the DC circuit from each module is a Class II circuit as per Rule 16-200(1)(c). The inverters are mounted behind the PV modules on the same rail on which the PV modules are mounted. Would the frames of the PV modules then need to be bonded to ground since they are only running at 36 VDC?

Recommendation:

For discussion

<u>Background information</u>:

`

CE Code Rule 10-400 - Equipment Bonding - applies

"Exposed, non-current-carrying metal parts of fixed equipment shall be bonded to ground by methods outlined in CE Code Rule 10-618". This includes all equipment in exposed and wet locations.

The module listing material, based on the ULc standard under which the module was manufactured, requires bonding – at the designated bonding point.

Note: Enphase inverters have a continuous (#6) system grounding conductor running to a lug on each inverter to ground the dc system. This would be electrically continuous with the body of the inverter and thus the rail and the module, but would not meet the requirements of bonding the module at the designated point.

An Update on Microinverters and AC PV Modules http://www.iaei.org/magazine/?p=5260

As the microinverters, combinations of microinverters attached to PV modules, and the AC PV modules come to market, there will be and already has been some confusion about the code requirements for various products.

Both microinverters and microinverters attached to PV modules in the field or in the factory that have any exposed dc single conductor cables are required to meet all of the dc wiring requirements in the NEC. These may include 690.5 ground-fault detector requirements, dc and ac disconnect requirements (potentially handled by connectors listed as disconnects), and inverter dc grounding electrode requirements. Confusion arises when these are called AC modules. They are not AC PV modules.

True AC PV modules, as defined in NEC 690.2 and 690.6, have a module and inverter assembled as one environmentally protected unit in the factory, and there is no accessible dc wiring.
None of the dc wiring requirements in the Code applies, because there is no dc wiring outside the listed unit. A single equipment-grounding connection will usually be the only requirement to properly ground the combined module/inverter assembly.

2011 Conference conclusion:

The answer to the question is yes – the frames of PV modules need to be bonded to ground. This must be done utilizing approved methods, materials and at the locations marked on the frame by the manufacturer. Typically this has involved running a bonding conductor to a lug bolted to the designated bonding point(s) on the PV module.

A question from the floor brought up WEEB grounding clips that are now being used to bond PV modules to the mounting rails. These are acceptable for use if approved for the use in Canada.

`

Post conference information:

What is a WEEB grounding clip? This stands for Washer Electrical Equipment Bonding and they are a product of Wiley Electronics (www.we-llc.com). They are barbed washers that bite into the module and the rail. These replace the need to run bonding conductors to each of the module frames. Instead the (usually #6 AWG bare) grounding conductor connects to the mounting rail, the PV modules are then bolted to the rail using at least 2 of these grounding clips. (Sorry to mix grounding and bonding terms, but when these are used on Enphase inverters the #6 is actually the dc system grounding conductor not a bonding conductor …more on that to come).

Important: - These cannot be used on every brand of rail or module. On the Wiley Electronics website it indicates there are specific parts to be used for each rail manufacturer's products, including the WEEBLug that connects the grounding conductor to the rail. There is also a list of PV module manufacturers that allow their modules to be bonded using these clips, along with a list of which parts must be used. Module manufacturers may reference use of grounding devices listed to UL467 when describing module bonding methods using grounding clips.

There is another practice that utilizes WEEB clips -for grounding Enphase microinverters. These microinverters bolt to the rail behind the PV module. On the face of the microinverter is a Grounding Electrode Conductor (GEC) termination lug designed to connect the DC system grounding conductor. Enphase allows the use of WEEB grounding clips (at least one) to bolt their inverters to the rail, thus eliminating the need to daisy chain the system grounding conductor to each inverter's GEC terminal. The DC grounding conductor must connect to the rail with a WEEBLug. There are specific WEEB clips for specific rails when mounting Enphase microinverters – see the Enphase website for more information under "application note - Grounding washer installation procedure for Enphase microinverters".

So with WEEB clips, the installation may only have a DC grounding conductor run to the rail, with WEEB clips providing the grounding for the DC system and could also be used for bonding the modules. This is being marketed as one of the major benefits of this product – a clean installation with fewer connections subject to long term corrosion or breakdown.

It has been confirmed that the clips have Canadian approval by Intertek. A link to the approval document is on the Wiley website.

There is some controversy, despite being approved for the application, whether these clips meet the criteria of the electrical codes. The CE Code has bonding methods outlined in 10-618, which requires equipment to be bonded using specific methods and with materials as outlined in 10-804. For two sides of this debate (in the US), Google "a progressive look at PV module grounding" by Brian Wiley. In this article he takes on a published article by Thomas Bowes questioning this type of bonding method. (There is a link to Mr. Bowes article in the first paragraph Mr. Wileys article).

Action: For information only.

`

2011 Annual Technical Conference

Agenda item # 2011ag-50-06 **50-014 Wiring Method**

Question/enquiry: Does section 50 need to be revised to require DC PV source and output circuits running to the inside of a building to be in metallic conduit or metal armoured cable to parallel the requirements of the NEC?

NEC requires the solar PV array's dc output circuit conductors to be run in armoured cable or metallic conduit when run inside the building until the disconnect is reached.

This requirement is to provide mechanical protection for these cables which among other things improves protection of Fire Responders

Recommendation: For discussion.

Background information:

Terminology:

Photovoltaic output circuit - circuit conductors between the photovoltaic source circuit(s) and the power conditioning unit or direct-current utilization equipment. If a combiner is utilized, this is the output from the combiner.

Photovoltaic source circuit - conductors between modules and from modules to the common connection point(s) of the direct-current system. (the common connection point is a combiner)

Wiring methods from solar PV array to the combiner box and to the dc disconnect

CE Code Section 12 applies to all wiring methods for solar PV systems – CE Code has no special or separate rules other than 50-014 for flexible cords between modules within an array.

- Due to the exposed, outdoor location and high operating temperatures, all conductors are required to have insulation rated for 90°C (194°F) and wet locations.
- Non-metallic sheathed cable (NMD90) cannot be used if the system exceeds the cables 300 V rating.
- Any exposed conductors and non-metallic raceways must be sunlight resistant as required by CE Code 2-130. Insulated electrical wiring and cables and totally enclosed non-metallic raceways installed and used where exposed to direct rays of the sun shall be specifically approved for the purpose and be so marked.

Some installers run conductors on the outside of the building for as long as possible, though this compromises on wiring energy losses and inverter run-time (due to the voltage drop) which is very important in a solar PV system. Though running the conductors in a visible location on the outside might help in an emergency situation, particularly in a fire, the best practice from countries with a lot of experience with solar PV is to require that the wiring from the solar PV array to inverter be protected rather than placing restrictions on wire routing.

`

NEC 690.31 Methods Permitted.

(A) Wiring Systems. All raceway and cable wiring methods included in this *Code* and other wiring systems and fittings specifically intended and identified for use on photovoltaic arrays shall be permitted. Where wiring devices with integral enclosures are used, sufficient length of cable shall be provided to facilitate replacement.

Where photovoltaic source and output circuits operating at maximum system voltages greater than 30 volts are installed in readily accessible locations, circuit conductors shall be installed in a raceway.

Most PV modules do not have provisions for attaching raceways. These circuits may have to be made "not readily accessible" by use of physical barriers such as wire screening.

> Informational Note: Photovoltaic modules operate at elevated temperatures when exposed to high ambient temperatures and to bright sunlight. These temperatures may routinely exceed 70°C (158°F) in many locations. Module interconnection conductors are available with insulation rated for wet locations and a temperature rating of 90°C (194°F) or greater.

(E) Direct-Current Photovoltaic Source and Output Circuits Inside a Building. Where dc photovoltaic source or output circuits from a building-integrated or other photovoltaic system are run inside a building or structure, they shall be contained in metal raceways, Type MC metal-clad cable that complies with **250.118**(10), or metal enclosures from the point of penetration of the surface of the building or structure to the first readily accessible disconnecting means. The disconnecting means shall comply with **690.14(A)**, **(B)**, and **(D)**. The wiring methods shall comply with the additional installation requirements in (1) through (4)

The use of metallic raceways, Type MC metal-clad cable, or metal enclosures inside a building provides additional physical protection for these circuits. Metallic raceways also provide additional fire resistance should faults develop in the cable, and they provide an additional ground-fault detection path for the ground-fault protection device required by **690.5**.

(F) Circuit Routing. Photovoltaic source and PV output conductors, in and out of conduit, and inside of a building or structure, shall be routed along building structural members such as beams, rafters, trusses, and columns where the location of those structural members can be determined by observation. Where circuits are imbedded in built-up, laminate, or membrane roofing materials in roof areas not covered by PV modules and associated equipment, the location of circuits shall be clearly marked.

The general requirement covering the location of the photovoltaic disconnecting means in **690.14(C)(1)** specifies that it be located nearest to the point where the PV circuit conductors enter a building or structure. The distance between the array and the disconnecting means is not limited by the *Code.* The PV circuit conductors between the photovoltaic power source and the PV disconnecting means are energized whenever the source is producing power. Because of this potential exposure to energized conductors, a marking is required to warn roofers, other tradespersons, or first responders of the location of energized PV conductors where PV source or output circuits are "imbedded" or concealed by the roofing material. This requirement does not apply to conductors installed in areas of the roof covered by PV modules or other associated equipment.

NEC Definitions. Although MC resembles its close relative, armored cable, there are some distinct differences. Whereas armored cable has a grounding strip in intimate contact with the inside of the metallic sheath, which can then serve as the equipment grounding conductor, MC cable has no such strip. Therefore, the outer sheath of MC cable does not qualify as an equipment grounding conductor. MC cable contains an insulated grounding conductor which, when properly terminated at both ends, makes a reliable return path for fault current, enabling the overcurrent device to perform its protective role. The metal jacket serves to supplement the equipment grounding conductor since it is firmly clamped to grounded metal enclosures at both ends — so that the unit cannot become energized without instantly causing the overcurrent device to trip out. MC cable comes in various versions such as with corrugated copper armor or with an outer supplementary corrosion-resistant material. Conductors are copper, aluminum, or copper-clad aluminum (solid or stranded).

Photo 1. The only specialized tool needed to work with MC cable is an MC cutter. Two or three turns of the handle, and the metal sheath is cleanly severed without compromising the enclosed conductors.

Available for free download – recommended reading:

Fire Fighter Safety and Emergency Response
for
Solar Power Systems

Final Report

A DHS/Assistance to Firefighter Grants (AFG) Funded Study

Prepared by:
Casey C. Grant, P.E.
Fire Protection Research Foundation

THE
FIRE PROTECTION
RESEARCH FOUNDATION

FIRE RESEARCH

The Fire Protection Research Foundation
One Batterymarch Park
Quincy, MA, USA 02169-7471
Email: foundation@nfpa.org
http://www.nfpa.org/foundation

© Copyright Fire Protection Research Foundation
May 2010

`

2011 Conference conclusion:

There are a number of items that require attention, which are: the Scope of Section 50 and 64, the definitions, (i.e.; panels versus modules) most of these will be looked at, but the ones that do get missed will be taken care of in the 2015 edition of the code. It is difficult to change rules until the correct terms are set out in the standards.

Question asks for metal - why not in PVC? The new proposal is that the wires are to be in a raceway, metallic is not specified.

Currently under development is a proposal to deal with this issue Part 1 Subject 3582

Action: For information only.

`

Agenda item # 2011ag-50-07 **2-130 sunlight resistance requirements**

Question/enquiry: There is a lot of confusion over the markings for sunlight resistance requirements – what is acceptable?

Recommendation: For discussion.

Background information:

2-130 Sunlight resistance requirements (see Appendix B)

Insulated electrical wiring and cables and totally enclosed non-metallic raceways installed and used where exposed to direct rays of the sun shall be specifically approved for the purpose and be so marked.

Apx B note to Rule 2-130

It is the intent of this Rule to protect totally enclosed non-metallic raceways as well as the jackets and/or insulated conductors of wire and cable against adverse effects caused by direct exposure to rays of the sun. Electrical conductors and non-metallic raceways marked for this application are suitable for installation and use for direct exposure to rays of the sun.

Wire and cable products marked "SR", "Sun Res", "Sunlight Resistant", "CMX-Outdoor" (for communications cable), and outdoor cords and equipment wire listed in Table 11 for wet locations have been found to meet the standard criteria for sunlight resistance.

Rigid RTRC conduit marked "RTRC Type AG" and totally enclosed non-metallic raceways marked "SR", "Sun Res", "Sunlight Resistant", or "Outdoor" have been found to meet the standard criteria for sunlight resistance.

2011 Conference conclusion:

If you have a flexible cord that is marked as SOW, the W at the end of the marking indicated that it is approved for the weather and would be approved for installation in direct sunlight along with other types as outlined in the background information.

Action: For information only.

`

2011 Annual Technical Conference

Agenda item # 2011ag-50-08 **<u>Wire correction factors</u>**

Question/enquiry: What correction factors should be applied to the conductors in a PV installation? What is expected rooftop ambient temperature?

Recommendation: For discussion.

<u>Background information</u>:

The current ratings of the solar PV source and output circuits are used in calculations to select the required conductor sizes.

CE Code rule 4-004 contains several factors in determining the allowable current carrying capacity. Wire size selection is based on a conductor's allowable current-carrying capacity with the appropriate factor(s) applied for operating conditions such as ambient and operating temperature. CE Code rule 8-104 also required for continuous loads. Not all correction factors are applied at once. Conductor correction factors are applied in various Sections of the Code. 8-104 (6) requires that only the greatest correction factor be applied to any one conductor to reduce its ampacity. For example if the conductor ampacity is reduced to 70% due to ambient temperature conditions, you can ignore the 80% required for continuous load and only apply the 70%.

Wire sizes recommended by the inverter manufacturer are often related to the size of the terminal in the inverter and a strong encouragement to minimize wire heating losses. Wire sizes selected by applying CE Code rules may not match the minimum size required by the inverter manufacture. It is recommended that the solar PV system designer check the inverter installation manual for minimum wire sizes and choose the largest conductor from all of these factors.

<u>Factors in a conductor's current-carrying capacity :</u>

Conductor ampacity from Tables 1 - 4 must (from rule 4-004) have correction factors applied for conditions of use as follows:

- A conductor's current-carrying capacity is reduced when multi-conductor cables are run together in contact or when there are multiple conductors in a raceway. These environments are not common in small solar PV installations.
- The most important conductor ampacity correction factor applied to solar PV system wiring is for high temperatures. CE Code Rule 4-004 (8) requires conductors installed where ambient temperatures exceed 30°C to have the correction factors from Table 5A applied. For example, due to high ambient temperatures anywhere near a solar PV module (because it can often operate at 50°C), at 50°C a correction factor of 0.80 is applied.

`

– CE Code Rule 8-104 requires the calculated load in a solar PV circuit to be treated as a continuous load. The continuous load on any wire, breaker or fused switch cannot exceed 80% of the circuit's calculated current-carrying capacity. A wire's current-carrying capacity has a correction factor of 0.80 applied. This applies to all the wiring in the solar PV system, from the dc array to the ac breaker in the house panelboard.

Note 1. For the wiring on the array, suggested temperature correction factors for solar PV module conductors are 65°C in installations where the backs of the solar PV modules receive cooling air 150 mm (6") or more from surface and 75°C where no cooling air can get to the backs of the modules. This means these conductors are only allowed to carry less than 50% of the Table 1 – 4 ampacities. Wiring and module operating temperatures depend on ambient air temperature.

Note 2. It is recommended that these temperature factors be considered for all the wiring on the roof, and not only to solar PV array wiring. In many cases where there are high daytime temperatures and wiring is close to a surface (12 mm (1/2") or less) a 65° to 75°C correction factor applies to ensure that the insulation does not suffer premature degradation. The rule of thumb for a wire's current-carrying capacity (after it leaves the array) is to apply 125% to the rated maximum power point current (I_{MP}). This covers the above CE Code requirements and ends up with a rating identical to that required by the NEC, which requires minimum wire capacity of Isc x 1.25 x 1.25 (= Isc x 1.56).

2011 Conference conclusion:

We do not de-rate conductors, we apply correction factors. In most cases you wouldn't have a problem with the ampacity of a conductor until it was added together in the combiner box. The ampacity up to that point would be fairly low. In most cases this is not an issue. Most of these conductors are run in free air, so there is some natural heat dissipation through the air.

Action: For information only.

Agenda item # 2011ag-50-09 **Building Code Requirements**

Question/enquiry: What are the Alberta Building Code requirements for roof mount PV Systems?

Recommendation: For information.

The solar PV system must meet the requirements of the Alberta Building Code. The solar PV array will add forces (such as from its weight and from wind) onto the building onto which it is installed.

BUILDING STRUCTURAL CONSIDERATIONS

Structural Loads:

Solar PV arrays mounted on buildings need to be designed so that they do not blow away and do not cause the building structure or envelope to fail.

ABC Section 9.4 outlines the Structural design requirements allowing design to be according to published and recognized good engineering practice or designed by a structural engineer. Most roofs in recent years have been built using span tables from the building code or using trusses designed by professional engineers. Solar PV modules can add 11 to 12 kg per square metre (2.5 lbs per square foot) of dead weight to the roof structure members. The rack holding the solar PV arrays will increase this to perhaps as much as 19 to 25 kg per square metre (4-5 lbs per sq ft). This weight will either be concentrated through array rack mounting feet or solar PV module roof attachment clips (in the case of a metal roof). The solar PV array will also be subjected to both uplift and down-force wind loadings – again concentrated through the rack mounting feet or module clips. Though this is not normally an issue, in some situations, the structural limit of the roof may be approached and so is recommended to be checked. It is recommended that a structural engineer be consulted to confirm that the structural loads imposed by the installation are properly supported by the size and spans of the existing roof members. A building permit is required for any changes that may be required to the roof structure to meet these loading requirements.

In addition, the solar PV array needs to be properly positioned on the roof in order to keep any edge-generated uplift forces within the strength of the mounting rack and roof attachment clips. If the solar PV array is to be attached to a metal roof, it is also important that the metal-roof clips, the clip screws and the underlying roof sheeting be sufficiently strong to withstand any solar PV array uplift. The structural engineer can advise on any clearance requirements away from the edges at the same time as checking the roof sheeting, and fastener strength and the array weight on the roof.

`

Roof Penetrations:

The building owner should be concerned with roof penetrations caused by the mounting of the solar PV array and wiring – that they are secure, corrosion resistant, and water tight.

ABC 9.26.4.9 outlines the requirements when a pipe or duct penetrates a roof the joint between the roof and the pipe shall be flashed and watertight. Solar PV array racks should be attached to structural elements of a roof (trusses or rafters), which will require penetrating the roof surface material in a manner that is watertight for the life of the roof.

ABC is silent on hardware requirements. Stainless steel hardware is usually used to connect the solar PV modules to the racks. Galvanized hardware is frequently used to bolt the racks to the roof. In both cases, the fasteners should be resistant to corrosion.

Roof Mounting Clearance:

Although not a code or safety matter, in order to maximize solar PV system efficiency and thus performance, it is important that solar PV modules be installed in such a way to keep them as cool as possible. To this end, air circulation underneath the solar PV modules is important, though not critical. It is recommended that solar PV modules mounted on a roof have at least 25 mm (1"), and preferably 50 to 75 mm (2" to 6"), clearance between the bottom of the module frame and the roof. This allows for some air circulation under the modules to help cool them. Since solar PV modules are rated to operate as high as 85°C, the high temperatures are not a safety factor, but just a matter of efficiency.

2011 Conference conclusion:

The solar PV system must meet the requirements of the Alberta Building Code. The solar PV array will add forces (such as from its weight and from wind) onto the building onto which it is installed. The key to this issue is the owner is responsible and should be aware of the forces the new system is applying to the building and take actions required to protect the structure from failure.

There were opinions from the floor that the building discipline and a structural engineer should be involved in every installation because of the added weight on the roof, the sail effect (wind loads) and the potential increased snow load from the array acting as a snow fence.

The group suggested this be taken forward to the Building Discipline for further discussion and agreement from Building Officials about their level of involvement in these installations. It was agreed that there needs to be some education, training and awareness of the PV installation for SCO's in both the building and electrical disciplines.

Action: Carry Forward to Building Discipline .