Public Consultation on the proposed amendments to Rule 8-102 “Voltage Drop”

ESA conducted a public consultation regarding Proposed Amendments to voltage drop requirements under the Ontario Electrical Safety Code, Rule 8-102 – “Voltage Drop” from February 7th to March 26th, 2013. During this process, stakeholders were asked to provide their feedback on a proposal to change the voltage drop limits requirements in single dwelling units.

During the public consultation period ESA received a variety of questions, comments, and feedback from external stakeholders. In response to the feedback received, the proposal has been revised to address the comments and ensure that the intent is clear.

ESA would like to thank all participants for taking the time to submit comments into the Voltage Drop Public Consultation.

Responses to specific comments are included below. Also, the revised proposal is included at the end of this document.

<table>
<thead>
<tr>
<th>Company / Organization / Individual</th>
<th>Stakeholder Comment / Feedback Submitted to ESA &amp; Suggestions for Improvement / Alternatives</th>
<th>ESA Response</th>
</tr>
</thead>
</table>
| Professional Home & Property Inspectors of Canada | **Comment:** The voltage drop in residential homes is not understood by the general public and most home inspectors. I agree that voltage drop should be checked and noted. Since the average drop from the service providers ranges from 5 to 7 volts depending on the time of day plus the voltage drop within the residence between outlets adds another 5 to 8 volts of drop it serve the public better if there was a stated allowable drop posted.  

- I support the proposal with an understanding that the public be informed of how this drop effects the appliances and equipment in their homes.

- **Suggestion for improvement:** The code states now the recommended voltage drop and what conductor sizes should be used. It might be better to state that all branch lines be wired with a minimum of 12/2 wire in residential homes to help prevent voltage drop. This would make it simple and easy for consumers to understand. | Thank you for your feedback.

Based on the feedback provided, the proposal has been revised to exclude the 10% allowance and introduce maximum wiring runs for branch circuits of lighting and general use receptacles only. These maximum permitted runs are based on typical distributed loads on a fully loaded lighting and/or general use branch circuit, which will yield a voltage drop complying with requirements for Rule 8-102 (3-5%) for the majority of scenarios. Hence, the voltage will be within the range that the household equipments are tested for.

ESA will be requesting feedback on the revised proposal prior to determining whether to move forward with this change. Once a decision is made, ESA will communicate the decision to stakeholders.

Thank you for your suggestion to amend the code requirements to have #12AWG as the minimum wire size for residential wiring.

In reviewing your suggestion, ESA must consider the full impact of such a proposal. First and foremost, safety is of the utmost concern for ESA; in addition, ESA must consider the
Public Consultation on the proposed amendments to Rule 8-102 “Voltage Drop”

Impact of such a change, including the impact on the residential construction industry, the added cost and the potential safety benefit.

Taking into account the safety measures currently in place, the technological advancements and efficiencies in electrical equipment and devices, as well as anticipating future needs, it can be concluded that raising the minimum requirement from #14AWG to #12 AWG wires in residential homes would result in additional cost with little or no incremental safety value. There is no evidence of safety risk to justify a change at this time.

Utility 1

- **Comment:** ESA’s proposed change may not assist with the compounded voltage drops to ensure correct equipment operation or protection from damage. LDC’s are typically the first entity responding to system power quality issues such as low voltage.

- We have a concern about the proposed ESA voltage drop amendment to the OESC. ESA is correct that their mandate is public safety but equipment damage should also be a consideration with the OESC. The proposed lowering of the voltage drops in branch circuits up to 10% will have a compound affect from voltage levels provided from the grid. The utility provides the minimum normal steady state (periods greater than 10 seconds) voltage at the customer’s Supply Point (typically at the spades of the supplying transformer) as per CSA-C235-83 standard. IESO can also impose a 5% voltage reduction to maintain the electrical grid stability.

Thank you for your feedback.

Based on the feedback provided, the proposal has been revised accordingly to exclude the 10% allowance.

In addition, the revised proposal has been modified to specify the maximum length of run for branch circuits of lighting and general use receptacles only. These maximum permitted runs are based on a typical distributed load of a fully loaded lighting and/or general use branch circuit, which will yield a voltage drop complying with requirements for Rule 8-102 (3-5%) for the majority of scenarios.

ESA will be requesting feedback on the revised proposal prior to determining whether to move forward with this change. Once a decision is made, ESA will communicate the decision to stakeholders.

The maximum permitted lengths in the revised proposal are not applicable to:
- Household appliances (such as refrigerators, washing machine, central vacuum and other receptacles as per
Based on our analysis, these changes would not impede the operation of the over-current device protecting the circuit and therefore would not compromise electrical safety. In addition, these changes further clarify the application of the proposed change; take into account the safety measures currently in place, the technological advancements and efficiencies in electrical equipment and devices, as well as, anticipating future needs.

Utility 2

**Comment:** In general, Utilities such as us typically design our system to perform in compliance with CSA CAN-3-C235. According to this standard we supply a minimum of 110V at the service entrance under normal conditions and 106V under extreme conditions. Are you proposing that the voltage could drop an additional 10% from the service entrance to the point of utilization within the house? Would this mean that under normal conditions the customer could be receiving (110V - (0.1*110)) = 99V or (110V - (0.1*120V)) = 98V at the point of utilization? The voltage would be even lower during extreme conditions. If so, this would create problems for the safe operation of electrical devices (e.g. heating of small motors such as bar refrigerators, fans, etc).

- I am concerned that the application of these two codes may present the public with an unacceptable product which could present a safety concern.

Thank you for your feedback.

Based on the feedback provided, the proposal has been revised accordingly to exclude the 10% allowance.

In addition, the revised proposal has been modified to specify the maximum length of runs for branch circuits of lighting and general use receptacles only. These maximum permitted runs are based on a typical distributed load of a fully loaded lighting and/or general use branch circuit, which will yield a voltage drop complying with requirements for Rule 8-102 (3-5%) for the majority of scenarios. Hence, the voltage will be within the range that the household equipments are tested for.
Public Consultation on the proposed amendments to Rule 8-102 “Voltage Drop”

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The maximum permitted lengths in the revised proposal are not applicable to:
- Household appliances (such as refrigerators, washing machine, central vacuum and other receptacles as per Rule 26-720);
- Kitchen receptacles (Rule 26-722(b) and (e));
- Outdoor receptacles (Rule 26-714(a));
- Electrical heating and cooking appliances (Rule 26-744); and
- Other receptacles installed in single dwellings for Section 24.

Based on our analysis, these changes would not impede the operation of the over-current device protecting the circuit and therefore would not compromise electrical safety. In addition, these changes further clarify the application of the proposed change; take into account the safety measures currently in place, the technological advancements and efficiencies in electrical equipment and devices, as well as, anticipating future needs.

COAC Member
- Comment: engineer’s calculations are coming up with a different answer than identified in the consultation. On long runs it can take 3-7s to trip, and the individual is not convinced ESA’s calculations are accurate

Thank you for your feedback.

Based on your comment, ESA has reviewed the calculations again in detail and after careful analysis of the calculations and discussion with the comment submitter, it was revealed that the concern on circuit breaker tripping time is for lengths far exceeding the maximum runs permitted and stated under
Public Consultation on the proposed amendments to Rule 8-102 “Voltage Drop”

Industry 1 - Comment:

(1) Throughout the Paper reference was made to Performance vs. Safety, specifically that this Proposal would not knowingly affect safety, with reference to products that operate within a range of voltages. Many domestic products are designed to operate within a "nominal" voltage range such as kitchen appliances, ceiling fans, dishwashers, coffee makers, pot lights, dehumidifiers, coolers, toasters, refrigerators, CFL and other types of lighting products. For products with multiple range power supplies [computers, monitors, etc.], the Certification Bodies typically test products based on highest current draw over the nameplate voltage range, and not -10% voltage rating. As an investigator of failed products for an AHJ, testing organizations, and Retailers, I have not seen an in-depth study that clearly explains what the long term effect is on products that were subjected to either over or under voltages. More and more products are increasing in sophistication and perhaps may be sensitive to prolonged over and under voltage scenarios.

(2) Comments were also made that it is not expected that this Proposal will affect Energy Efficiency of appliances. Although appliances may be rated for a range of voltages [most are not], they are indeed only tested at one specifically rated voltage, regulated to within a specific voltage tolerance. Is ESA aware of the impact on Energy Efficiency by having appliances subjected to a -10% voltage drop? What about the combined possible impact of components such as compressors / heaters, etc. to prolonged application of -10% voltage and the overall Energy Efficiency rating of the appliance?

- Opposition until further testing / research is conducted to understand the possibility of “Performance” issues potentially becoming “Safety” issues. Without proper information, a comprehensive due diligence process and objective evidence it is possible that the savings to contractors will be passed on to consumers with possible inefficient products, premature component failure and possible fire and shock hazards.

Thank you for your feedback.

Based on the feedback provided, the proposal has been revised accordingly to exclude the 10% allowance.

In addition, the revised proposal has been modified to specify the maximum length of runs for branch circuits of lighting and general use receptacles only. These maximum permitted runs are based on a typical distributed load of a fully loaded lighting and/or general use branch circuit, which will yield a voltage drop complying with requirements for Rule 8-102 (3-5%) for the majority of scenarios. Hence, the voltage will be within the range that the household equipments are tested for.

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Public Consultation on the proposed amendments to Rule 8-102 “Voltage Drop”

- **Suggestion for improvement**: Develop a joint research / test program with funding and cooperation by Retailers, a test lab, ESA / other AHJ’s, a Manufacturer’s representative association such as Electro-Fed and the contractors Association to conduct a long-term, in-depth study of typical domestic products that perhaps currently have somewhat high return rates to Retailers, for the end purpose of knowing the performance and possible safety effects of the Proposed 10% voltage drop. I assume that the 10% is under ideal conditions. In applied reality, it perhaps is possible that the drop can be higher due to multiple junction points in a branch circuit, time of day / year usage, prolonged utility imposed power sags / brown-outs, dwellings being powered by non-sinusoidal power sources such as back-up generators, solar / wind inverter installations and other factors that potentially have negative effect on electronic products. I would be pleased to assist ESA in such a program proposal and developing the testing protocols.

Section 24.

Based on our analysis, these changes would not impede the operation of the over-current device protecting the circuit and therefore would not compromise electrical safety. In addition, these changes further clarify the application of the proposed change; take into account the safety measures currently in place, the technological advancements and efficiencies in electrical equipment and devices, as well as, anticipating future needs.

Private Sector – Electrical Designer

- **Comment**: I have experience in commercial, institutional, government (DND, PWGSC), offshore and industrial. These comments are my own, and are not on behalf of my employer. The proposed changes are incomplete, only related to residential construction, and will negatively impact commercial, institutional and industrial design. Revising 8-102 (2) to remove calculation based on known connected load will increase the size of conductor(s) required for designed or dedicated circuits in many cases.

- I do not support the proposal as written. Calculations based on known connected load should continue to be permitted. The current proposal only considers residential installations, and does so at the expense of non-residential installations.

Commercial, institutional and industrial installations can easily have a large number of circuits that are either designed or dedicated for loads much smaller than 80% of an overcurrent device. Examples that come to mind include instrumentation power supplies, data equipment, small HP motor circuits, heat tracing and lighting.

Thank you for your feedback.

The deletion of the provision to consider a voltage drop calculation based on the known connected load was intended for residential homes only (i.e. intended to be applicable to new proposed Subrule 3 only). The proposal is not intended to apply to commercial or industrial installations.

However, based on the feedback received, the proposal has been revised to address your concern.

ESA will be requesting feedback on the revised proposal prior to determining whether to move forward with this change. Once a decision is made, ESA will communicate the decision to stakeholders.
Public Consultation on the proposed amendments to Rule 8-102 “Voltage Drop”

Suggestions for improvement:

1) Maintain 8-102 (2) as written, or add a separate item, permitting the use of known connected load in non-residential applications.

2) Ensure that Appendix B or a related Bulletin explains how overcurrent device operation can be affected. Many designers and electricians could be unaware/have forgotten that high impedance circuits can affect circuit breaker operation.

3) Allow the use of designed circuits considering device and equipment ratings similar to the Round 3 proposed changes to 8-102 of the Canadian Electrical Code which says: (2) Notwithstanding the requirements of Subrules (1), at industrial establishments where conditions of maintenance and supervision ensure use by qualified persons, the design shall ensure the overcurrent device will operate during a short circuit, and ensure the voltage at the point of utilization is within the rating or voltage tolerance of the connected device or devices.

The term industrial could be removed, and still require establishments to have appropriate conditions of maintenance and supervision.

Office of the Fire Marshall

- Comment: The OESC proposal to permit a slight increase in voltage drop in newly constructed single family homes will mean a slight reduction in voltages entering these buildings. Reduced voltages should not impact fire safety.

Thank you for your feedback.

The proposal has been revised to exclude the 10% allowance. In addition, the revised proposal has been modified to specify the maximum length of runs for branch circuits of lighting and general use receptacles only. These maximum permitted runs are based on a typical distributed load of a fully loaded lighting and/or general use branch circuit, which will yield a voltage drop complying with requirements for Rule 8-102 (3-5%) for the majority of scenarios. Hence, the voltage will be within the range that the household equipments are tested for.

ESA will be requesting feedback on the revised proposal prior
Public Consultation on the proposed amendments to Rule 8-102 “Voltage Drop”

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<tr>
<th>Electricity Distributors Association</th>
<th>Comment: The EDA understands that amendments to Rule 8-102 are proposed because the existing rule was seen as overly restrictive and not justified by safety or performance. Distributors presently follow CSA Standard CAN3-C235 83 Preferred Voltages for service entrance variation, and experience to date has been that customers at the lower end of these ranges can experience equipment performance issues. EDA members are concerned that allowing greater voltage drops with a single dwelling will increase the potential for customer complaints. Distributors believe that customers will first contact their distribution company if they experience problems. There is a concern that distributors will be burdened with explaining to customers that the problem is not the distributor’s fault and that costly changes may need to be made to their dwelling by a qualified electrician. There is a concern that the savings to builders due to the increased voltage drop will be significantly less than the potential cost to correct a future equipment performance problem in a dwelling after the fact. The EDA is concerned about how customers will be protected from builders not providing the adequate voltage drops.</th>
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public consultation on the proposed amendments to rule 8-102 “voltage drop”

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esa will be requesting feedback on the revised proposal prior to determining whether to move forward with this change. once a decision is made, esa will communicate the decision to stakeholders.

uac council members

- comment: there is a concern that expanding the acceptable voltage drop range is not the right way to go and may have the reverse effect of contractors attempting to push the limits further. volatges lower than normal levels may adversely affect appliances with motors (like refrigerators).

  if consumers experience a performance issue they will first contact/complain to their local utility. concern was raised that this could increase customer service inquiries to the utility to check voltage levels for the consumer service.

- suggestions for improvement: it was suggested that a larger sample of single family dwellings should be considered to determine the impact of this proposed code change.

thank you for your feedback.

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Public Consultation on the proposed amendments to Rule 8-102 “Voltage Drop”

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ESA will be requesting feedback on the revised proposal prior to determining whether to move forward with this change. Once a decision is made, ESA will communicate the decision to stakeholders.

Below is the revised proposal

(A) Add new Subrule (3) to Rule 8-102 as follows:

(1) Voltage drop in an installation shall
   (a) be based upon the calculated demand load of the feeder or branch circuit;
   (b) not exceed 5% from the supply side of the consumer’s service (or equivalent) to the point of utilization; and
   (c) not exceed 3% in a feeder or branch circuit.

(2) For the purposes of Subrule (1), the demand load on a branch circuit shall be the connected load, if known; otherwise it shall be 80% of the rating of the overload or overcurrent devices protecting the branch circuit, whichever is smaller.

(3) Notwithstanding Subrule (1), wiring for lighting and general use branch circuits in single dwelling units with the distance from the overcurrent protection to the furthest point of utilization in accordance with the values in Table XX are acceptable.

(B) Add the following Appendix B note to Rule 8-102(3)

Considering distributed load on typical lighting and/or general use branch circuits, it had been found that these values in Table xx for maximum distance between the branch circuit overcurrent protection device and the furthest utilization point on that circuit are in compliance with requirements for Rule 8-104.
Since this rule is for branch circuits supplying general lighting and/or receptacles only, it is not applicable for branch circuits identified in the following Rules:
- Household appliances (such as refrigerators, washing machine, central vacuum and other receptacles as per Rule 26-720);
- Kitchen receptacles (Rule 26-722(b) and (e));
- Outdoor receptacles (Rule 26-714(a));
- Electrical heating and cooking appliances (Rule 26-744); and
- Other receptacles installed in single dwellings for Section 24.

For the above excluded installations, Rule 8-104 and Table D3 are applicable, based on either the connected load or one load equal to 80% of the rating on the overcurrent device, plugged at the furthest point.

Further analysis had shown that these values will not affect the operation on the branch circuit overcurrent protection in case of bolted fault.

(C) Add the following Table

<table>
<thead>
<tr>
<th>AWG (Cu)</th>
<th>Overcurrent Protection Setting/Rating</th>
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<tbody>
<tr>
<td></td>
<td>15A</td>
</tr>
<tr>
<td>14</td>
<td>38</td>
</tr>
<tr>
<td>12</td>
<td>60</td>
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<tr>
<td>10</td>
<td>96</td>
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</table>

Table XX

Maximum distance (meter) from overcurrent protection to the furthest point of utilization on a circuit using 90°C rated copper conductor at 30°C ambient temperature for 120V single phase ac circuits (2 wire circuits)