Canadian Electrical Code, Part I
Full Impact Assessment

Subject 3569
Arc-fault circuit interrupters (AFCIs)

CONTENTS

1 INTRODUCTION TO THE FULL IMPACT ASSESSMENT

The Full Impact Assessment follows the rationale of the Canadian Electrical Code Ranking Tool (CRT) and provides supporting information to validate the rankings of the CRT. It includes all the questions of the CRT either verbatim or modified. However, the scope of the Full Impact Assessment extends beyond that of the CRT and, therefore, the assessment includes additional questions that may help to substantiate the rankings.

The CRT is referenced throughout the Full Impact Assessment. The questions from the CRT are identified in the Full Impact Assessment by numbers in parentheses. Whenever applicable, chapter titles also include references to the relevant sections of the CRT.

The Full Impact Assessment follows the sequence of the CRT as closely as possible but, to enhance the analytical function of the document, risk-related and benefits-related questions have not been separated in the Full Impact Assessment.

2 PURPOSE OF THE FULL IMPACT ASSESSMENT

The purpose of the Full Impact Assessment is to provide the provinces and territories with an enhanced rationale and detailed assessment of a particular change to the *Canadian Electrical Code, Part I* (*CE Code, Part I*). This assessment is submitted for review to provincial and territorial regulatory authorities to aid with their adoption process for the Code. Jurisdictions may decide to conduct further analyses or to hold additional consultations.

3 BACKGROUND OF THE CHANGE

Section 26 of the *CE Code, Part I*, **Installation of electrical equipment**, requires residential occupancies to have a sufficient number of branch circuits to supply the needs of the electrical appliances normally used in such occupancies and to be provided with receptacles as required by the Section. It can be argued that limiting the number of outlets on a branch circuit is unnecessary because, if an overload occurs, the overcurrent device will operate. However, when fuses blow or circuit breakers trip too often, people tend to defeat the safety feature provided by the overcurrent devices, thereby creating a hazard. The Code, therefore, limits the number of outlets that are permitted to be connected to a circuit.

Rule 26-720 provides details on the branch circuit requirements for receptacles in residential occupancies, which include dwelling units and single dwellings. Requirements that are specific to dwelling units or single dwellings are addressed in other Rules.

4 THE NATURE OF THE CHANGE

4.1 The change

(A) Add a new Rule 26-720 as follows:

> **26-720 Special terminology**
> In this Subsection, the following definitions apply:
>
> **Arc-fault protection** — a means of recognizing characteristics unique to both series and parallel arc-faults and de-energizing the circuit when an arc-fault is detected.
>
> **Combination-type arc-fault circuit interrupter** — a device that provides both series and parallel arc-fault protection to the entire branch circuit wiring, including cord sets and power supply cords connected to the outlets, against the unwanted effects of arcing.
>
> **Outlet branch-circuit-type arc-fault circuit interrupter** — a device that provides both series and parallel arc-fault protection to downstream branch circuit wiring, cord sets, and power supply cords against the unwanted effects of arcing and also provides series arc-fault protection to upstream branch circuit wiring.

(B) Renumber Rules 26-720 and 26-722, and related cross-references, as 26-722 and 26-724.

(C) Revise (renumbered) Item 26-724(f) to read as follows:

> (f) each branch circuit supplying 125 V receptacles rated 20 A or less shall be protected by a combination-type arc-fault circuit interrupter, except for branch circuits supplying
> (i) receptacles installed in accordance with
> (A) Rule 26-710(f); or
> (B) Rule 26-712(d)(i), (iii), (iv), and (v); and
> (ii) a single receptacle for a sump pump where
> (A) the receptacle is labelled in a conspicuous, legible, and permanent manner identifying it as a sump pump receptacle; and
> (B) the branch circuit does not supply any other receptacles;
> ~~branch circuits that supply receptacles installed in sleeping facilities of a dwelling unit shall be protected by an arc-fault circuit interrupter;~~

(D) Revise Item 26-724(g) to read as follows:

> (g) notwithstanding Item (f), the entire branch circuit need not be provided with arc-fault protection where

(i) an outlet branch-circuit-type arc-fault circuit interrupter is installed at the first outlet on the branch circuit; and
(ii) the wiring method for the portion of the branch circuit between the branch circuit overcurrent device and the first outlet consists of metal raceway, armoured cable, or non-metallic conduit or tubing;

~~notwithstanding Item (f), a branch circuit that supplies a single receptacle utilized for a sump pump located in sleeping facilities shall not be required to be protected by an arc-fault circuit interrupter provided~~
~~(i) the receptacle is labelled in a conspicuous, legible, and permanent manner identifying it as a sump pump receptacle; and~~
~~(ii) the branch circuit does not supply any other receptacles located within the sleeping area; and~~

(E) Delete Item 26-724(h):

~~(h) for the purpose of Item (f), "arc-fault circuit interrupter" means a device intended to provide protection from the effects of arc-faults by recognizing characteristics unique to arcing and functioning to de-energize the circuit when an arc-fault is detected.~~

(F) Renumber Rule 26-724 to 26-726:

26-726 Branch circuits for single dwellings

(G) Add Appendix B Note to Rule 26-724(f) and (g) as follows:

Rule 26-724(f) and (g)
~~It is intended by this Rule to allow a cord-connected sump pump installed in a sleeping area to be connected to a branch circuit that is not protected by an arc-fault circuit interrupter in order to ensure uninterrupted performance of the sump pump.~~
The intent of these Subrules is to provide both series (also called low-level) and parallel (also called high-level) arc-fault protection downstream from the panelboard through the entire branch circuit wiring, including cord sets and power supply cords connected to the outlets.

Considering that the outlet branch-circuit-type arc-fault circuit interrupter does not provide upstream parallel arc-fault protection, Rule 26-724(g)(ii) requires mechanical protection for the portion of the branch circuit between the branch circuit overcurrent device and the first outlet. The mechanical protection minimizes the risk of direct contact and damage to the cable that could cause ignition due to an arc and spread of the flame should ignition occur.

4.2 How is the change different from the status quo?

Currently, Rule 26-720 reads as follows:

Branch circuits for residential occupancies

26-720 General

This Rule applies to branch circuits for all residential occupancies (including dwelling units and single dwellings) as follows:

(a) each receptacle installed for a refrigerator shall be supplied by a branch circuit that does not supply any other outlets, except a recessed clock receptacle intended for use with an electric clock;

(b) at least one branch circuit shall be provided solely for receptacles installed in the laundry room or in a space where the complete plumbing is installed to accommodate a washing machine;

(c) at least one branch circuit shall be provided solely for receptacles installed in the utility room;

(d) each receptacle installed in a cupboard, wall cabinet, or enclosure for the use of a microwave oven in accordance with Rule 26-710(h) shall be supplied by a branch circuit that does not supply any other outlets, and this circuit shall not be considered as forming part of the circuits required under Rule 26-722(b);

(e) a separate branch circuit shall be provided solely to supply power to each central vacuum system;

(f) the ampere rating of the branch circuit wiring supplying receptacles with CSA Configuration 5-20R shall be not less than 20 A; and

(g) a separate branch circuit shall be provided solely to supply power to each receptacle described in Rule 26-710(o).

5 PURPOSE/REASON FOR THE CHANGE

5.1 What is the issue that the change is intended to address?

Based on the latest Canadian fire statistics (*Fire Losses in Canada Year 2007 and Selected Years*, issued in 2011 by the Council of Canadian Fire Marshals and Fire Commissioners), there were 1350 residential fires caused by electrical distribution equipment, resulting in 15 deaths, 89 injuries, and $83M in property damage. (Electrical distribution equipment is defined as electrical equipment or devices carrying electricity from one point to another or connecting or disconnecting one conductor and another.) Over half (53%) of all home fire deaths were caused by fires that started in the living room or a bedroom. Standard circuit breakers are not intended to prevent such fires, and ground fault protection does not address this issue adequately. Such protection is of paramount importance in residential dwellings because they are, in most cases, of combustible construction. The intent of the change, therefore, is to prevent these fires.

5.2 How does the change accomplish the desired results?

The change specifies additional arc-fault protection for residential dwellings, which will result in enhanced fire safety. Typically, smoke detectors are activated by an existing fire, which is often started by an arc. With the change implemented, the breaker will be tripped before an arc can result in a fire, and the tripping will be based on the characteristics of an arc-fault. Combination-type arc-fault circuit interrupters are particularly sensitive to different types of faults and are, therefore, more effective at fire prevention.

5.3 What are the implications/consequences if action is not taken?

According to recent studies, there are still a significant number of fires in homes caused by electrical issues. If this change is not implemented, the opportunity to increase safety in new residential dwellings will be lost. The technologies referenced in the proposed change were previously implemented in circuits supplying outlets in bedrooms and found to prevent fires effectively.

6 WHY IS ACTION REQUIRED AT THIS TIME?

The advances in technology and the availability of combination-type arc-fault circuit interrupters, which are more sensitive to different types of faults, have made this change possible.

The change is also prompted by the need to correlate requirements with the *National Electrical Code* (*NEC*), which has mandated the expanded use of combination-type arc-fault circuit interrupters since 2008.

7 (14) PREVALENCE OF RULE USE IF ACCEPTED

The change will affect residential occupancies, including both dwelling units and single dwellings, and will, therefore, impact most new residential construction in Canada.

8 IMPACT ON KEY STAKEHOLDERS

8.1 (16) Largest type of stakeholder who would benefit

The change is being introduced for safety reasons, and the largest group who will benefit from it is the general public, homeowners, and residents, in particular the owners and residents of newly built houses and condominiums, as well as owners and residents of new prefabricated houses.

Manufacturers of combination-type arc-fault circuit interrupters will benefit from increased demand for such devices, which are more expensive than standard circuit breakers or

receptacles. Adoption in Canada will also mean less variation in product types, allowing for economies of scale.

8.2 (24) Largest type of stakeholder who would be negatively affected

In the short term, it is projected that the change will cost approximately $240 to $300 per home to implement, which impacts the cost of construction for a builder or real estate developer. In the long term, such additional construction costs are transferred to the homebuyer, for whom the additional costs are negligible. It should also be taken into account that combination-type devices better protect equipment plugged into an outlet, decreasing maintenance costs on household appliances in the long run, an additional benefit for homeowners.

The authority having jurisdiction (AHJ) will have to address the issue of extra costs versus enhanced safety through communications with their constituents.

8.3 (15) Other stakeholders affected on a frequent basis

The change will affect a broad range of stakeholder groups, as follows:

- **Engineers/Designers**: This stakeholder group will be directly affected by the change because it is their responsibility to specify arc-fault protection methods at the design stage. This group is interested in providing cost-effective and safe designs and installation requirements to minimize the risk of injury to personnel, damage to facilities, and insurance and legal costs. As such, engineers/designers will need to receive a communication about the change (e.g., a formal letter from the authority having jurisdiction).
- **Electrical contractors**: This group of stakeholders is responsible for the application of the Code. As such, they need to be informed about changes to it to help ensure full compliance with its requirements. The updates can be delivered through formal training or through industry literature, depending on current practices in a particular jurisdiction. It is the responsibility of individual contractors to keep themselves informed about changes to the Code.
- **Trainers:** This is a broad group that may include those providing training to other stakeholder groups, such as electrical contractors and installers of equipment as well as repair and maintenance personnel where applicable. Training programs and literature, including electronic content, will need to be updated to include the change.
- **Standards development organizations (SDOs)**: All references to the provisions of the Code that are being changed will need to be updated in documents published by CSA Group and other SDOs.

- **Provincial/territorial electrical regulatory authorities:** This group of stakeholders is responsible for enforcement of the Code and will, therefore, need to be informed of any changes to it.
- **Insurance**: Insurance policies contingent on following the Code will need to be updated.
- **Builders**: This group will need to be informed of the change because the new requirements will have to be implemented in new construction.
- **Inspectors**: This group of stakeholders is accountable for enforcing compliance with the Code and needs, therefore, to stay informed about any changes to it. It is the responsibility of a particular province or territory to make the information on Code changes available to electrical inspectors. Depending on the practice in a particular jurisdiction, changes can be communicated through training (provided by the jurisdiction or a third party) or through jurisdiction-specific or national industry literature.

8.4 Is the proposed change limited to a specific group/geographic area?

This change will have nationwide application.

8.5 What is the affected stakeholders' readiness to act on the change(s)?

Research has not revealed any evidence of the market not being ready to implement this change.

8.6 Recommended stakeholder management strategy

Not applicable.

8.7 Communication and implementation plan

Not applicable.

9 ANALYSIS OF ANTICIPATED ECONOMIC IMPACT

9.1 (20) The jurisdiction or stakeholder's ability to compete, based on incompatibility with other standards

The change should not affect a jurisdiction's competitive position.

9.2 (21) Complexity of implementation (is training required to implement the Rule?)

The change can be included as an update in existing training programs. No specific training is recommended to introduce the change.

9.3 (22) Total costs to implement (for example, cost to install, educate, manufacture, inspect, purchase additional product, and of increased use of electricity)

The change is expected to increase installation costs, driven by the additional equipment mandated by the change. The following methods can be used to implement the change; it is left to the discretion of the designer to specify the optimal one:

Method 1 — Arc-fault protection for more circuits: The change requires arc-fault protection for more circuits (approximately 5). The retail cost of an arc-fault current interrupter breaker is about $70, and the cost of a regular breaker is about $10, so the difference in price is about $60 (retail prices are used for this analysis; business/bulk prices may be lower). The net cost, therefore, of implementation by this method will be about $300 per house.

Method 2 — Protection through outlet branch-circuit-type arc-fault circuit interrupters (OBC AFCIs): In this method, an outlet branch-circuit-type arc-fault circuit interrupter is installed at the first outlet on a branch circuit. Each branch circuit typically consists of up to 12 outlets. Arc-fault protection of the outlet type protects the first outlet plus all remaining outlets connected downstream on the same branch circuit. Use of an outlet-type device requires protected wiring between the panelboard and the first outlet on a circuit, consisting of metal raceway, armoured cable, or non-metallic conduit or tubing.

With this method, the user will save the difference in cost between the combination-type arc-fault circuit interrupter and the outlet type. However, wiring methods required between the branch circuit overcurrent protection and the first outlet branch-circuit-type arc-fault circuit interrupter will add between 2 to 3 times the cost of the wiring method normally used in such a location. It is estimated that, like the first method, this method will increase installation costs by about $300.

It should be noted that higher production volumes and increased competition among manufacturers of arc-fault circuit interrupters will likely bring prices down in the medium term, which, based on cost considerations alone and assuming that labour costs do not increase, will favour the first installation method.

With regard to training, while it is important that the change be communicated to all the relevant stakeholder groups, this can be done in the course of routine training on changes to the Code. No dedicated training is necessary.

10 IMPACT ON BUSINESS: LARGE AND SMALL (IF APPLICABLE)

- **Compliance costs:** Compliance will increase project costs but, because there are several installation methods available to implement this change, costs can be optimized. Ultimately, the costs are transferred to the homebuyer.
- **Change of investment:** Not applicable.
- **Job creation/job loss:** Not applicable.
- **Labour mobility:** Not applicable.
- **Impact on import/export of goods:** Not applicable.
- **Certification and licensing:** Not applicable.
- **Insurance:** Not applicable.

11 WHAT IS THE PRACTICE/EXPERIENCE IN OTHER JURISDICTIONS?

11.1 Are standards consistent with (or lesser/greater than) other jurisdictions?

Currently, there are no deviations from this requirement of the national Code in provincial electrical codes. Input from other jurisdictions is pending.

11.2 (23) Conflict with other Ministries or Codes

No conflict has been observed.

11.3 Consequences for other Departments/Ministries, e.g., apprentice training

Not applicable.

11.4 Consequences for Codes in other jurisdictions (US, European standards)

Not applicable.

12 CONSULTATION PROCESS

Representatives from the following groups of stakeholders were involved in the consensus approval of this change as part of CSA Group's standards development process:
Note: *For details about the standards development process as it applies to the* CE Code, Part I*, please refer to Appendix C of the Code.*

- Regulatory authorities from various provincial, territorial, and municipal electrical inspection authorities

- Owners/Operators/Producers from groups with national stature, representing the viewpoints of electrical equipment manufacturers, electrical installation designers and installers, and electrical installation users
- General interest groups with national stature, representing the viewpoints of

  (a) fire chiefs;
  (b) electric utilities;
  (c) committees responsible for related electrical codes and standards;
  (d) fire insurers;
  (e) labour;
  (f) issuers of building codes; and
  (g) educators.

A regulatory/legislative body may want to hold additional consultations with all or some of these groups within its jurisdiction to clarify issues specific to the jurisdiction.

13 PROPOSED EFFECTIVE DATE OF CHANGES

The change will be included in the 2015 edition of the *CE Code, Part I*, to be published in January 2015.

APPENDIX 1 — CODE RANKING TOOL VALUES

Subject #	**3569**
Reason for Change	
Safety consideration (Severity)	8
Safety consideration (Frequency)	10
For clarity	7
Crucial to harmonize	7
Purely administrative	4
Community's desire to change - Environment, Health, Safety	7
Technological change/New Rule	9
Total Score for Reason for Change	52
Extent of Use & Value Add	
Prevalence of rule use if accepted	10
Number of stakeholders affected on frequent basis	10
Largest type of stakeholder who would benefit	10
Benefit to society	10
Total Score for Extent of Use	40
Risk for Changing Rule/Staying Status	
The jurisdiction or stakeholder's ability to compete based on incompatibility with other standards	0
Complexity of implementation	4
Total costs to implement, e.g. cost to install, to educate, to manufacture,or inspect, increased product cost, increased cost of electricity.	7
Conflict with other Ministries or Code	0
Largest type of stakeholder who would be negatively affected	8
Total Score for Risk of Changing Rule/ Staying Status Quo	19
Total	**111**