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AFCI: EFC Response to Canadian Home Builders Association Analysis

Updated Review of Cost/Benefit Analysis for Expanding Application of Arc Fault Circuit Interrupter (AFCI) Technology in the CSA Canadian Electrical Code, Part 1: 2015

Article by Bill Bryans, VP Technical Services - Electrical

In a previous weekly EFC newsletter I shared that the **Canadian Home Builders Association (CHBA)** had submitted a proposal to the CE Code Part 1 committee to remove 'all' AFCI technology related rules from the next Code cycle (2018). In addition, CHBA have been actively campaigning in a number of provinces to not accept the rule changes to expand application of AFCI already accepted by consensus in the 2015 Code. CHBA had also contracted a consultant to conduct a literature review of the subject and develop estimates in a cost/benefit analysis.

The **CHBA** consultant concluded that the introduction of AFCI requirements in the 2015 Code would result in only a 1% reduction in home fires across Canada. They also developed a net benefit analysis result showing <u>costs to the consumer of **$77.4M** per Canadian life saved</u>. Interestingly, they didn't include their own estimated '*statistical value of a life'* saved in the comparison. CHBA then summarized the <u>cost of this rule change was 22 times more expensive than the benefits.</u>

That assessment is a far more dyer result than anything our members, along with the independent analysis on 12 years of Ontario Fire Marshal (OFM) data by the Electrical Safety Authority (ESA), found and presented to the Part 1 Code technical committee in 2014. As such, we investigated the CHBA consultant's analysis and received updates from ESA, who now has two more years of data.

The following is a highlight analysis of the CHBA rational document.

1. The author selectively chose various American, often dated, studies to establish percentage reduction methodology to determine potential AFCI effectiveness. Considering the USA NEC electrical distribution wiring requirements are based on an unharmonized standard, the adoption rate across the country can be decades behind the most current version of the NEC. Moreover, they do not have a facilitated training package for the Trades as we have in Canada, we do not believe such a methodology is the most reasonable predictor for Canada. On the other hand, we do have current Canadian data specifically scrutinized for just this purpose!
2. The analysis also assumed all housing stock remains 'new' forever. Obviously they become progressively 'older', susceptible to wear and tear on the electrical system through material aging, stress from renovations, vibration etc., thus increasing the probability of an arc fault occurring. Meanwhile without benefit of available safety technology now, those new homes remain unprotected for up to the next 40 years. The analysis also totally ignored the substantial home renovation market, requiring relevant branch circuits from being brought up to current Code requirements.

   The one additional 'cost' factor the CHBA study identified that had not previously considered was the 7/24/365 energy use by the AFCI technology. Even there the annual cost to Canadians was overstated at $685k. The actual number is about $100k less.

3. Regarding the CHBA assertion that ACFI technology will be 22 times more expensive to install than the benefits returned, there was a fundamental error in their analysis, comparing their version of '40 years' of benefits against 'one year' of installation costs. The author's ratio should have been an unbelievable negative ratio of 208 to one! The consulting author did perform a very detailed analysis to estimate the additional construction costs, but made a significant calculation error for 2100 sq ft houses in Edmonton, and extrapolated that inflation error for all of Alberta for both 2100 and 3500 sq ft dwellings. In addition, the equipment costs applied were retail prices, not wholesale packs available to every new home builder of any size. Another significant factor the author ignored was the impact the new Code would have on the renovation market, which our members have estimated to be approximately another 50% in addition to the 'new home' market, based on number of load-center sales.

A More Realistic Full Cost/Benefit Analysis Using Canadian Data

Considering ESA's expanded analysis to 14 years of Ontario Fire Marshal data, the following is a much more realistic, yet still very conservative, cost/benefit assessment for AFCI technologies in Canada. This analysis does not include estimated saving corresponding to fewer fires serviced by First Responders (fire and police), lost family income, reduction in insurance cost, or many other indirect costs associated with burn victims I'll identify later.

According to Statistics Canada[1] there were 189,619 housing starts in 2014. A summary of the 3 key indicators for projected fire prevention by the CE Code Part 1:2015 installed AFCI technologies, the conservative annual savings across Canada amounts to:

- **$ 26.27 M** Canadian property damage
- **$ 3.94 M** Canadian health care costs
- **$76.48 M** Canadian death costs (VSL)

At minimum, the conservative annual benefit for Canada will exceed **$106.69 M** for new housing starts from property, injury and death avoidance. When you also include the estimated additional 50% for renovated dwellings, that saving becomes **$160 M** **total conservative saving from AFCI technologies per year**. Towards the end of this article, I'll show you early results (based on 2009-2013 OFM data) demonstrating the **effective mitigation rate is at least 76%, and could be as high as 99%!**

This is how the above conservative estimates were derived. As Ontario represents approximately 31% of the typical number of new dwelling built across Canada each year, we will apply this factor to each of the following criteria:

For the 14 years of Ontario data analysis (2000 to 2013 inclusive), ESA determined there were 6816 Electrical Distribution (ED) initiated fires. Of those, there were 4739 incidences associated with arc faults (AF) that an AFCI technology may have mitigated. Applying a conservative statistical value of only 50% mitigation success rate:

4739 (AF fire) / 14 (yr) = **338.5** (average AF fires per year in Ontario)
338.5 x 50% = **169.25** (conservative assumed statistical effective mitigation)

[1] Statistics Canada Housing starts: http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/manuf05-eng.htm

169.25 / 31% = **546** (Canadian preventable fires per year)

For the 12 year period (2000-2011) there were **5667 (ED fires)** in Ontario resulting in **$272.8M** **property damages** in single and multi-unit dwellings. *(we don't have the 2012-2013 property data at the time of writing)*

$272.8M / 5667 = **$48.12k** (per fire average)
$48.12k x 546 (preventable Canadian AF fires) = **$26.27M** average preventable property damage per year.

For the same 12 year period there were 458 Ontario injuries from ED-initiated fires in single and multi-unit dwellings. Applying the 69.53% AF ratio (4739 AF / 6816 ED = 69.53% for 2000-2013), 50% (statistical effective) and the 31% ratio for Canada:

458 x 69.53% = **318.45** (AF Ontario fire injuries)
318.45 x 50% = **159.23** (statistical preventable AF injuries)
159.23 / 31% = **513.63** (preventable Canadian AF injuries)
513.63 / 12 (yr) = **42.8** (preventable Canadian injuries per year)

According to a 18 year study based article published in 2014 in the ***Journal of Burn Care and Research***[2] by the Ontario Provincial Burn Center for the period 1995-2012, as a direct result of flame and related smoke injuries occurring in the home, the **average direct health care costs were $84,678 (CDN) per patient**. When you include the known indirect costs for ambulance and their rehabilitation program $3,280 per patient, the conservative average totals $88,138. In 2015 dollars that becomes **$92.1k**. Therefore the Canadian average annual health care costs are $92.1k x **42.8** = **$3,941.9k**.

There were several limitations noted in their study. Patients under 16 years old were excluded and the measure of expenses was limited due to the scope of charge data available. Other **items of interest not presently included are** air ambulance, telemedicine, admissions to other hospitals, and long-term post-discharge costs (such as physical therapy, psychological therapy, prescription drugs, and home care). **In addition, there are greater consequences for the patient and society** such as pain and suffering, loss of productivity, and potential life years lost that are difficult to quantify in terms of cost.

From Table 1 from the same 18 year Ontario Provincial Burn Center (OPBC) study ending in 2012 they noted 170 patience of the 1139 total study eligible admissions died after admission, giving us a ratio of **14.9%** deaths per admission**.** These statistics are NOT included in the Ontario Fire Marshal (OFM) data studied by ESA. Applying this ratio to the above calculated 42.8 preventable Canadian estimated AF injuries we can deduce there would be **6.39 preventable Canadian hospital deaths** per year.

[2] "Healthcare Costs of Burn Patients from Homes without Fire Sprinklers", Joanne Banfield, RN, BA, Sarah Rehou, BSc, Manuel Gomez, MD, MSc, Donald A. Redelmeier, MD, FRCP(C), Marc G. Jeschke, MD, PhD, FACS, FCCM FRCS(C) http://journals.lww.com/burncareresearch/Abstract/2015/01000/Healthcare_Costs_of_Burn_Patients_From_Homes.28.aspx

From the 14 year (2000 – 2013) ESA study of OFM data, they found **41 ED-related residential deaths** in single or multi-unit dwellings that could be attributable to arc fault ignition sources, now mitigated by the CE Code Part 1:2015.

41 / 14 (yr) = **2.93** (OFM recorded ED deaths per year)
2.93 (OFM) + 6.39 (OPBC) = **9.32** (Ontario ED deaths per year)
9.32 (ED) x 69.5% (ratio of 4739 AF / 6816 ED) = **6.48** (AF potential avoidable deaths)
6.48 x 50% = **3.24** (preventable Ontario deaths)
3.24 / 31% = **10.45** (preventable deaths Canadian per year)

Applying the Health Canada[3] 2002 estimated *'value of a statistical life' (VSL)* in 2015 dollars ($5.8M at 1.80% average for 13 years = $7.318M), the average annual VSL is **$76.48 M** of avoidable death benefits in Canada per year.

Annex 1 – Indicator of AFCI Effectiveness

When consulting with Dr. Joel Moody at ESA, who conducted the earlier 2000-2011 analysis of OFM data presented to CE Code Part 1 last year, he provided me with the relevant death statistics as well as show me his database now containing additional data for 2012-2013. He noted that in 2009, OFM started to include the year of construction for residential home fires. This change now provides an opportunity for us to compare data for the rate of bedroom fires pre and post inclusion in the 2009 CE Code Part 1 cycle.

From the ESA/OFM database for the 9 year period of 2000-2008 before AFCIs were beginning to be installed in new bedroom branch circuits, there were **5075 ED fires**, **661 starting in bedrooms**, giving **13%** of the ED-initiated fires in bedrooms.

For the following 5 year period of 2009-2013 when the Code required AFCI breakers for bedroom circuits, there were a total of **1741 ED fires**, **213 of which started in the bedroom**. Of those 213, only **two** occurred in bedrooms of home constructed since 2010, giving a reduction to **12.2%** of ED fires occurred in bedrooms both protected and unprotected by AFCI breakers. *At this point it is also worth noting that the AFCI breakers installed during that time frame were typically NOT combination AFCI as now required by the 2015 Code. Meaning that older technology was not designed to protect against series arc faults in connected loads. As arc fault fires were still occurring in the US, their product safety standard was updated to include this additional protection, as has the Canadian standard recently.*

Applying the CHBA consultant model expecting 70% fewer fires for new construction, the number of bedroom fires expected should be: 213 x 30% x 13% = **8.3** bedroom fires in homes built from 2009 to 2013 in new dwellings.

[3] "Regulatory Impact Analysis Statement for the Proposed Cigarette Ignition Propensity Regulations and Proposed Regulations Amending the Tobacco Reporting Regulations. Health Canada, 2002

When you compare the ratio for the 2009-2013 data for protected bedroom fires with those AFCI unprotected, you find a failure ratio of 2 / 213 = **0.94%** failure. When applying the CHBA consultant rate of 70% deduction for fewer fires in new construction, the worst case failure rate should be 2 / 8.3 = **24%, meaning the older less effective than today's AFCI technology was at least 76% effective.**

Looking back at the estimated Canadian annual benefit savings of $106.69 M at only a 50% assumed mitigation success rate, when adjusted with the conservative CHBA consultant calculations at 76% effective, the annual minimum total benefit becomes **$162.17 M** for new builds only. When you also include the estimated annual 50% upgraded load-centers for the renovation market, the **total annual Canadian market savings benefit could be $243.25 M**.

On the other hand as we move forward, should the AFCI technology actually achieve anywhere near the early measured **99% success rate**, then the **Canadian annual benefit could reach as high as:**

- **$162.17 M for new builds only becomes $211.24 M**
- **$243.25 M including annual renovation becomes $316.87 M**

Compared to the estimate installation cost of $56.9 M + $0.587 M (energy) = **$57.5 M** for new builds only, the **positive benefit for use of AFCI is likely somewhere between $2.82 and $3.67 saving for every $1 spent**.

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