

UTILITY “SMART METERS”

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Outline

- Background of Smart Meters
- Why the Office of the Ontario Fire Marshal (OFM) became interested
- Current Incidents
- Code Review
- Installation review



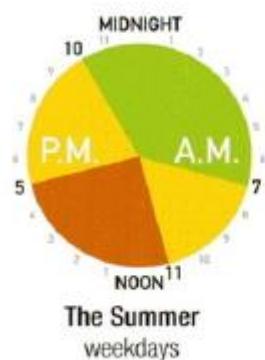
BACKGROUND

- Rolling out in 2009, local utilities started to install smart meters in every home and small business throughout Ontario
- Smart meters were a part of a new “Advanced Metering Infrastructure (AMI)” a part of the new electrical system in Ontario, which is anticipated to be completed by 2025.



Advanced Metering

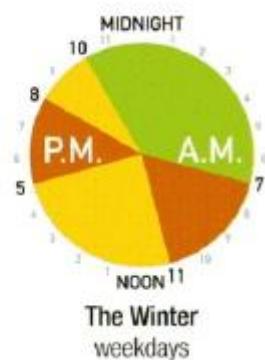
- Consists of two parts
 - “Smart Meters”
 - a “time-of-use” electricity price structure
 - Most recent update May 2012



The Summer
weekdays



Weekends and
Holidays



The Winter
weekdays

█ On-peak (¢¢)
– demand is highest

█ Mid-peak (¢¢)
– demand is moderate

█ Off-peak (¢)
– demand is lowest



Our Interests

- The new Smart Meters, which are also referred to as watt/hour meters record electrical consumption data with reference to time.
- The new meters internally store data, using **Electrically Erasable Programmable Read Only Memory (EEPROM)**. As such if power is lost or cut (due to a fire or the meter being disengaged) the data would still be preserved.
- The OFM wanted to see how we could use this new recorded information for fire investigations and public safety.



Our Interests

- We were informed that the new meters were built with future technologies in mind. In addition to traditional watt hour metering, the new meters were designed to record other data in reference to time.
- Some of the capabilities include recording both voltage and current per separate leg.
- The OFM wants to explore the recording of both current and voltage readings in order to identify arc faults occurring before or during fire incidents



Current Technologies

- Currently we are aware of seven different AMI technologies being deployed in Ontario.
 - Elster's EnergyAxis AMI, which is a controlled mesh network system.
 - Trilliant meter, which also is based on controlled mesh technology
 - Sensus Metering Systems' AMI, which is a point-to-point long range radio system
 - Tantalus Systems' TUNet technology, which is a hybrid wireless communication system that operates on a variety of meter manufacturers device types and can be retrofitted to existing electromechanical meters.
 - GE Energy, Itron, Landis + Gyr, Schneider Electric USA Inc., Triacta Power Technologies



[Elster's EnergyAxis AMI]

- While there are many technologies we are going to discuss the Elster meter as an example
- 1. Elster's meters measure and store consumption data in the meter (registers and interval data) and make the data available to the Gatekeeper (GK) to which it is registered on request.
- 2. Based on a schedule configured in the GK, the GK retrieves data from the meters that are registered to it and stores the data.



Elster's EnergyAxis AMI

- 3. The EnergyAxis Management System (EA_MS) retrieves the data from the GKs based on schedules. EA_MS gives the customer flexibility as to what data is collected and when it is collected. EA_MS then exports the data in standard XML format with the files to be processed by downstream utility systems such as MDM, CIS, Outage Management Systems, etc.



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- During our initial research of the new meters we encountered an unusual amount of fire incidents involving smart meters
- After discovering these incidents our main question was:
 - were they one off incidents or was there a similar systemic root cause
- Anecdotal information supported problems occurred after the old analog meters were updated to the new digital Smart Meters



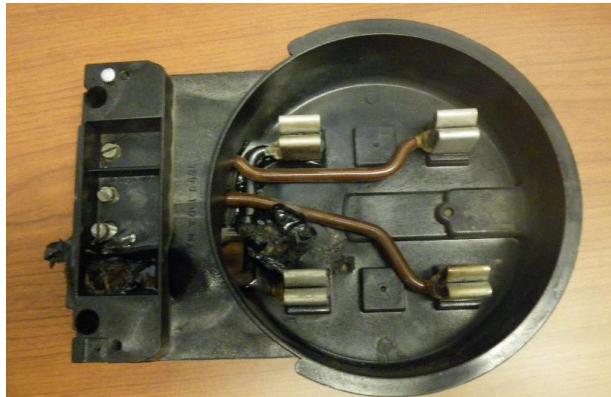
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- One report in particular included a number of meters in the Cobdin area of Eastern Ontario where the meters had experienced overheating
- However prior to any proper investigation the utility company had removed and replaced the meters from the effected areas
- Other reports indicate problems with metal-oxide varistor (MOV) overheating and initiating fires



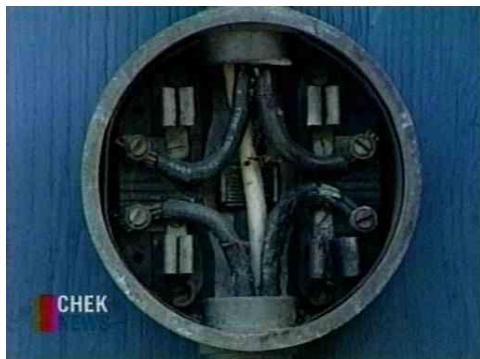
Fire Incidents Occurring around Hydro Meters



Deep River, ON



Pickering, ON



Nanaimo, BC



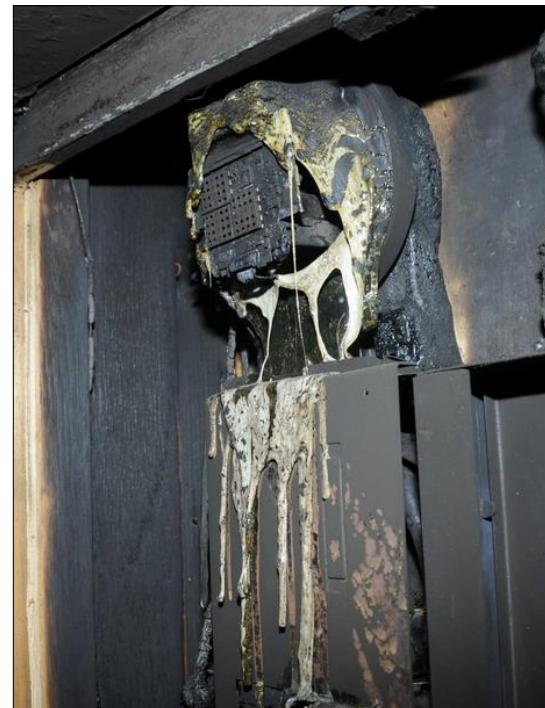
California



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- The OFM has observed drastic differences to how meters and the meter bases react in a fire .



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- Our first question was to identify the current safety standards for the meter bases and then the smart meters and see where they differed.
- First we needed to determine which part of the Electrical Code applied to each component
 - Part I is the safety standard for electrical installations.
 - Part II is a list of standards for the evaluation of electrical equipment or installations. (Part I requires that electrical products be approved to a Part II standard)
 - **Part III is the safety standard for power distribution and transmission circuits**
 - Part IV is set of objective-based standards that may be used in certain industrial or institutional installations.
 - Part V establishes standards for the inspection of electrical installation in residential buildings.



O Reg. 22/04 “Electrical Distribution Safety”

- O. Reg. 22/04 “Electrical Distribution Safety” establishes objective based electrical safety requirements for the design, construction, and maintenance of electrical distribution systems owned by licensed distributors. O. Reg. 22/04 was described by the ESA as an addition to part 3 of EC.
- O. Reg. 22/04 “Electrical Distribution Safety”
 - 2. Application
 - (3) This Regulation applies with respect to a distribution system as far as the **ownership demarcation point** and no further
 - (4) The ESC, and not this Regulation applies with respect to,
 - (a) electrical installations and electrical equipment located beyond the ownership demarcation point, **EXCEPT** for revenue metering equipment and associated equipment, current transformers, voltage transformers and remote terminal units;

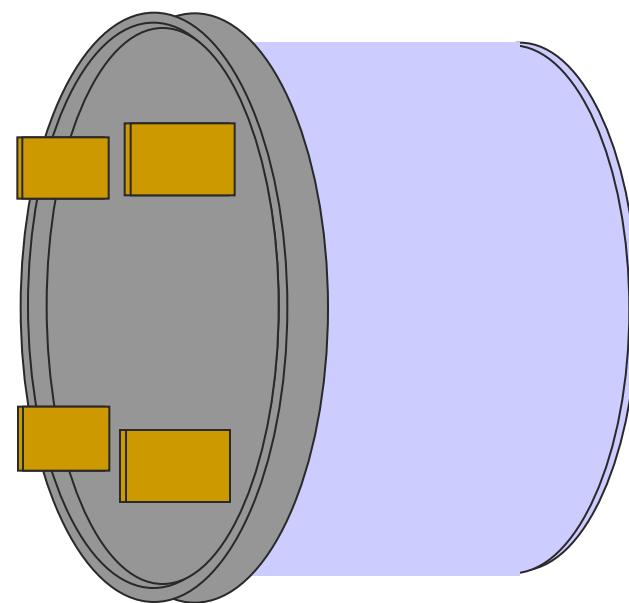
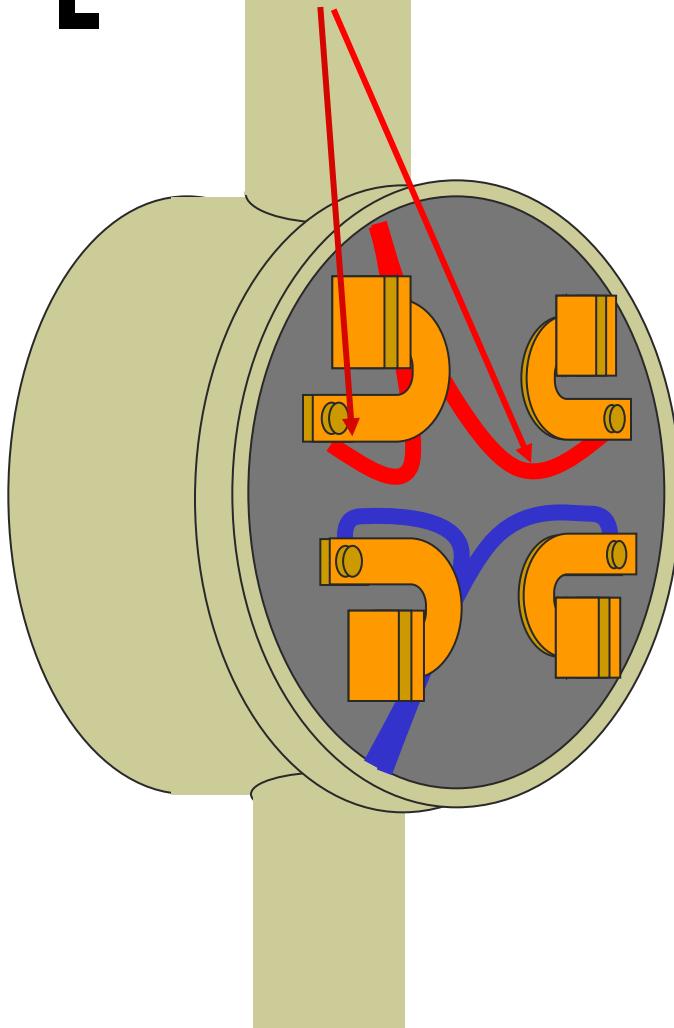


Demarcation Point

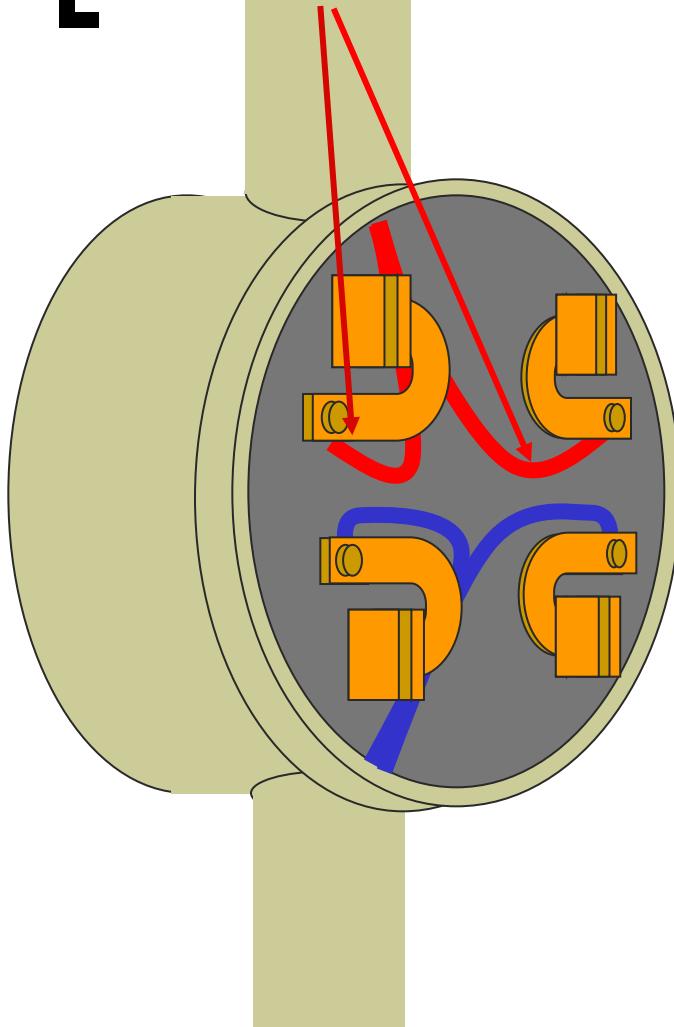
- “**ownership demarcation point**” means the point,
 - (a) at which the distributor’s ownership of a distribution system, including connection assets, ends at the customer, and
 - (b) that is not located beyond,
 - i. the first set of terminals located on or in any building, or
 - ii. an electrical room or vault in a building where the electrical room or vault is of tamperproof construction, bears a sign to indicate that it is an electrical room or vault and is accessible only to authorized persons (Reg.22/04)



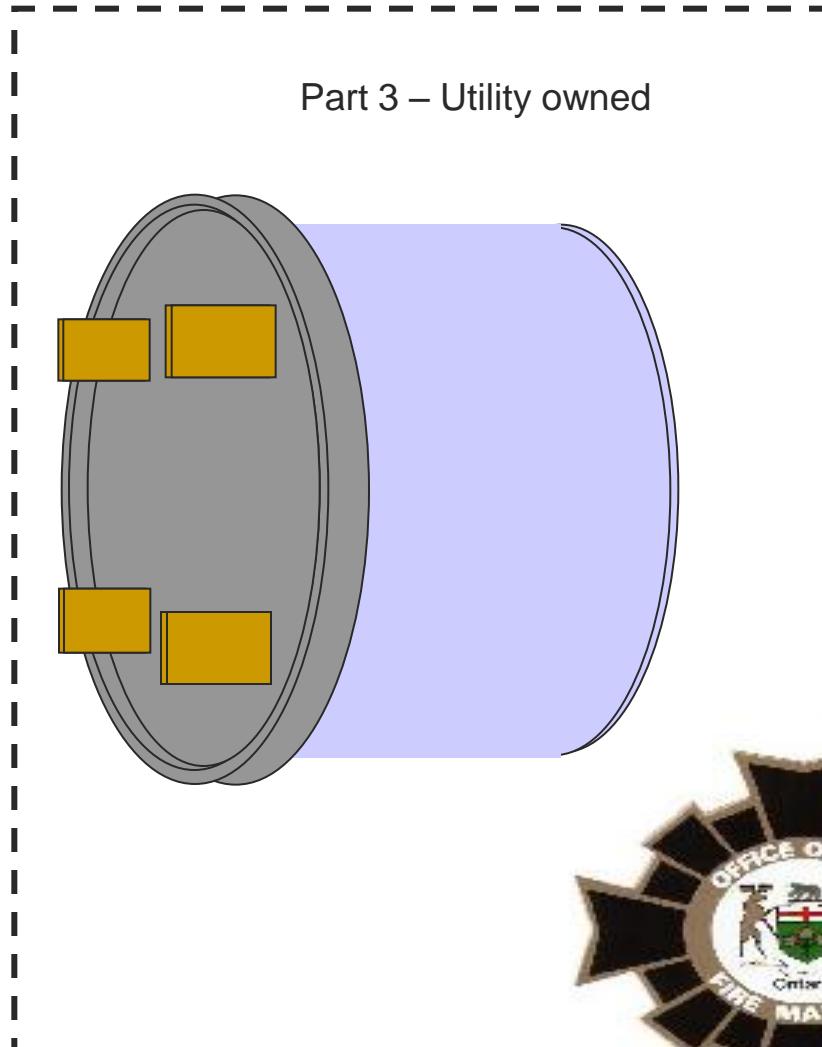
Ownership demarcation point



[Part 3 utility owned]

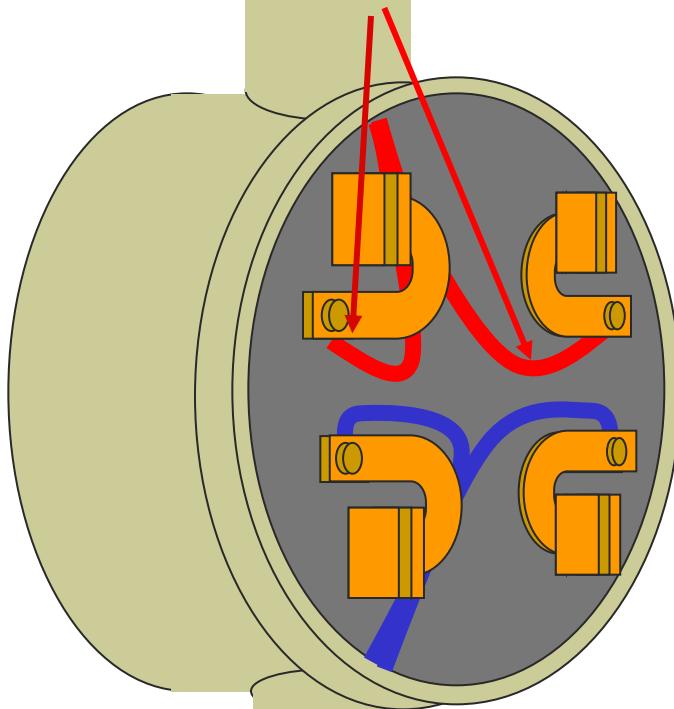


Part 3 – Utility owned



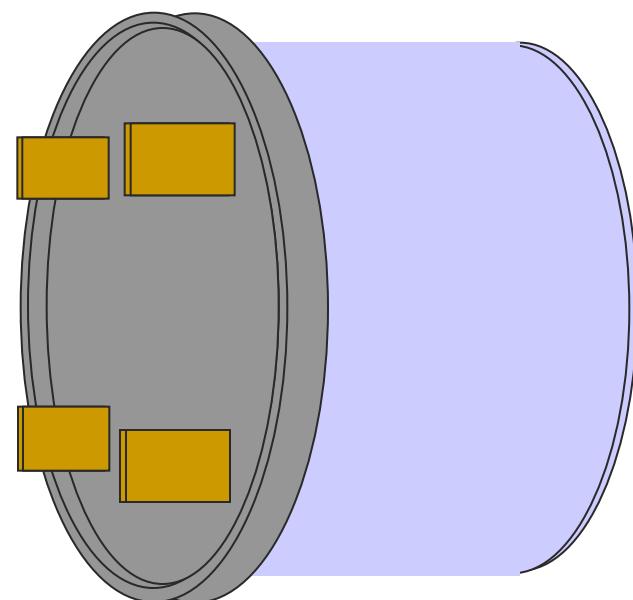
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Part 3 – Utility owned inside of a Part 2



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Part 3 – Utility owned



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- Considering the meter base fell under part II of the EC we were easily able to find the CSA standard which applied, C22.2 No 115-M1989
- For the meters however it wasn't really obvious which construction standards applied to them
- Both CSA and ESA were uncertain as meters fell in Part 3



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- The original design specification for Ontario was:
- Electricity Act
 - O Reg. 440/07 “Functional Specification for an advanced metering infrastructure”
 - Only specifies minimum functionality requirements
 - ie:
 - (YYYY-MM-DD hh:mm)
 - Meters must have the ability to store the data
 - Successfully transmit at least 98.0% of all meter reads in any daily period
 - O Reg. 425/06
 - Adoption of O Reg. 440/07





- Going back to O. Reg. 22/04 “Electrical Distribution Safety”
- 6. Approval of electrical equipment
 - (1) Electrical equipment that is part of a distribution system is approved if,
 - (a) its design and construction meet any of the standards for approval of equipment set out in Rule 2-024 of the EC; or
 - (b) its design and construction comply with a code or standard under a rule of the distributor that provides an assurance of safety of the equipment that is the equivalent of the assurance of safety provided by the standards referenced in clause (a).



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- Rule 2-024
 - 2-024 Approval of electrical equipment
 - (1) Electrical equipment shall be deemed to be approved if it has been approved according to the process set out in section 2 of Ontario regulation 438/07





- O. Reg. 438/07
 - 2. An electrical product or device that falls into one of the following categories is deemed to be approved:
 1. An electrical product or device for which a certification body has issued a report certifying that the electrical product or device conforms to the applicable standards for the electrical product or device
 2. An electrical product or device, if a field evaluation agency has examined the electrical product or device or a sample and issued a report confirming that product or device conforms to the applicable standards for the electrical product or device and presents no undue hazard to persons or property and,
 3. An electrical product or device, if Authority has examined or tested the electrical product or device or a sample and determines that it presents no undue hazard to persons or property
- **Bottom line: Either there is a certified standard or an authority has performed a field evaluation**

- During our discussions with Elster they informed us that they built to the Measurement Canada LMB – EG – 07 Specification of approval of type of electricity meters, instrument Transformers and Auxiliary Devices





- Measurement Canada LMB – EG – 07 Specification of approval of type of electricity meters, instrument Transformers and Auxiliary Devices
 - Dated 1986
- Amendments made in 2011 in S-E-06—Specification for the Approval of Type of Electricity Meters and Auxiliary Devices - Amendments to Measurement Canada Specification LMB-EG-07
- In reviewing LMB – EG – 07 we observed that the majority of the standard was designed to outline the requirements of meters accuracy. With only 2 real references to structural integrity.
 - The construction shall be mechanically and electrically sound, and materials, finish etc., shall be such as to provide assurance of long life and sustained accuracy
 - The meter or device shall be sufficiently shock proof



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- The Measurement Canada LMB – EG – 07 specification used wording like **shall be mechanically and electrically sound, and sufficiently shock proof.**
- What does that mean?
- Compared to the C22.2 No 115-M1989 Meter-Mounting Devices it was extremely lacking in defining safety specific construction



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- The following comes from the C22.2 No 115-M1989 Meter-Mounting Devices standard
 - Dated 1989
- Enclosures shall completely encase all current-carrying parts when meters or other devices of proper types are mounted in position. Enclosures shall be so formed and assembled that they will have the strength and rigidity to resist the normal abuses to which they may be subjected without increasing their fire or accidental hazard due to partial collapse with resultant reduction of spacings, Loosening or displacement of parts, or other serious defects.
- Enclosures shall be of metal or other suitable material which, by investigation, has found to be satisfactory for the conditions of use
- Further states materials thickness. Types of connections. Torques applied to connections
- Additionally there are outlined Mechanical Strength tests
 - Metering connections shall be capable of withstanding the application of torques....
- Humidity, corrosion and weather tests



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- Both standards state the components must be able to withstand abuse, have performance requirement tests (accuracy tests), require current carrying parts be separated along with temperature rise tests.
- However the meter base standard has additional simulation tests to ensure the structural integrity of all components
- Why was that missing from the Measurement Canada LMB – EG – 07 specification.
- Well simply it was because the mandate of Measurement Canada was only to ensure accuracy.





- This was confirmed by the Measurement Canada Utility Metering Division Manager, who stated that Measurement Canada was only tasked with ensuring the accuracy of the meters.
- Further any references to the construction in the specification was only there to ensure accuracy over the life-span of the meter not to ensure that it operates safely during that life-span.
- During our discussion with the Metering Division Manager we asked him if he knew who was responsible for ensuring the safety of the meters and/or any standards which applied to the meters and he wasn't sure but indicated that only some had UL symbols on them





- Checking on the UL website we found that only two companies were listed which produced meters for the use in Canada
 - Schneider Electric USA Inc.
 - Triacta Power Technologies
 - Where are GE, Sensus etc....?
- On the UL website we found a whole division which is devoted to Global meter testing and performance.
- On their website they state: UL tests for electronic electricity meters and their smart features to the requirements of the United States, Asia, Australia, Europe and South Africa
- While they don't say Canada it would make sense that they are testing ours as well?





- From the UL website, UL evaluates meters to the following standards:
 - ANSI (American National Standards Institute)
 - As/NZS (Australian and New Zealand Standards)
 - IEC (International Electrotechnical Commission)
 - EN (European Standards)
 - UL Safety Standards
- Additionally UL has a summary of standards which specify exact:
 - General Mechanical requirements
 - Environmental protection
 - Resistance to heat and fire...



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- So we found what we were looking for; that listed smart meters are being designed to specifications and tested to standards. Further, these tests and standards were very rigorous and thorough for each component of the meters
- But that doesn't change the fact that the meter bases and meters are reacting differently in fires.



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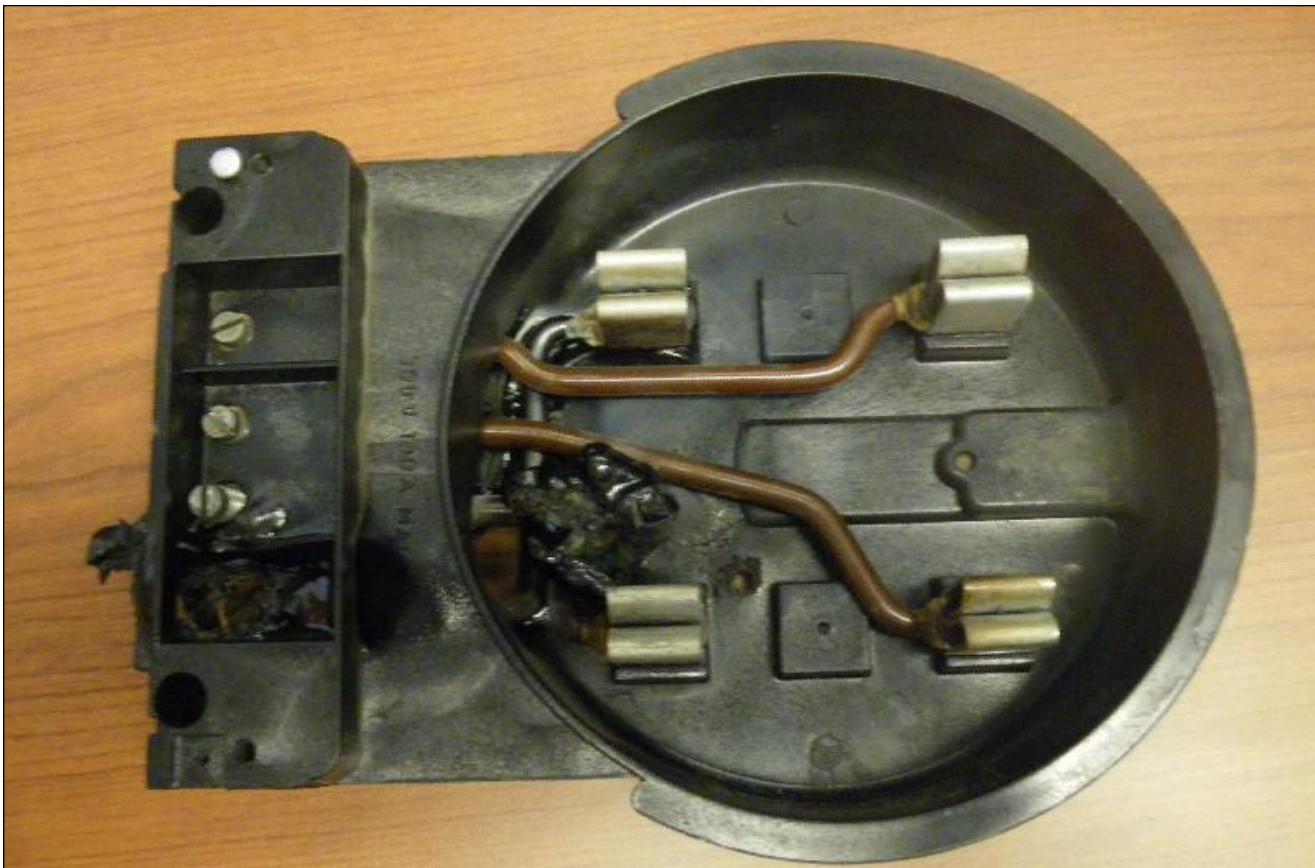
- Considering both the meter bases and meters are both current carrying components and literally plugged/meshed into one another shouldn't the way they react to heat in a fire be almost the same.
- In addition, we still have the anecdotal information supporting that the problems are occurring after the old analog meters are being updated to the new digital smart meters
- This would support that there is maybe something wrong with the installation



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- Lets look at this meter base failure in Ontario again



Possible Causes

- This failure occurred (resulting in a fire) due to a loose connection in the meter base
- What could be the reasons for this?
 - The old meter base connections may not have been in a condition for seamless exchange to a new meter
 - New meters may have defects that cause electrical failures or misalignment with old meter base
 - Careless installation during change over



[Video]

<http://www.torontohydro.com/sites/electricsystem/residential/smartmeters/Pages/SmartMetersFAQs.aspx#whatisasmartmeter>





■ Lets analyze the reason again

- The old meter base connections may not have been in a condition for seamless exchange to a new meter
 - This should have been detected by the technician during the change over
 - Would installation guidelines help fix this?
- New meters may have defects that cause electrical failures or misalignment with old meter base
 - The meters are supposedly being designed and tested to specific standards to ensure safety
 - Do we have any policing bodies ensuring (like the CSA with Part II products) that the meters are designed correctly
- Careless installation during change over
 - Would installation guidelines help fix this?



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- Considering the new smart meters fall under part 3 of the EC their installation has been left up to the utilities to determine. However they are directly plugged/meshing with a single component which falls under Part 2 which has to be installed in accordance with the requirements of part 1

- Therefore, when a utility owned (Part 3) component is directly meshed into a Part 2 component, would it make for more consistent connection, to have both components be scrutinized to the same standards and tested together and fall under the same installation guidelines



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- For further detailed information call
- Steven Silver 705 818-1587
- Office of the Ontario Fire Marshal

