CROWN INVESTMENT CORPORATION

SASKPOWER SMART METER PROGRAM

ELECTRICAL

FIRE INVESTIGATION & REVIEW

PREPARED BY

ELECTRICAL CONSULTANT

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EXECUTIVE SUMMARY

SaskPower in 2012 implemented a plan to upgrade single phase, 240 volt meters for their customers in Saskatchewan. The majority of services affected are for residential customers although some are for small commercial customers. This upgrade did not encompass all residential customers. For example, residential customers located in large multifamily facilities utilize a different meter and were not included in this upgrade.

We have reviewed the SaskPower reports and other documentation. We have interviewed SaskPower personnel and inspected two of the failed meters and several meters returned to SaskPower through their internal Return Material Authorization (RMA) process. We have inspected new Sensus meters, a meter from Landis & Gyr and a meter from Itron. Our opinion is based on this information. To date we have not seen any information or reports from Kinetrics Inc. or Underwriter's Laboratory (UL).

After reviewing the information available, we are of the opinion that moisture and contaminants within the meter has been a major factor in the meter failures and ensuing fires. We have not found any issues with the new meter installation methods and practices.

1. INTRODUCTION

SaskPower in 2012 implemented a plan to upgrade single phase, 240 volt meters for their customers in Saskatchewan. The majority of services affected are for residential customers although some are for small commercial customers. This upgrade did not encompass all residential customers. For example, residential customers located in large multifamily facilities utilize a different meter and were not included in this upgrade.

The upgrade plan began in June 2013 and was halted in July 2014 after eight meters had been involved in fires. A total of approximately 142,000 meters were scheduled for upgrade and approximately 107,921 meters had been installed when the meter fires progressed into a trend that was disturbing. By August 9, 2014 eight meter fires had occurred.

Ritenburg and Associates Ltd. was retained by Robertson Stromberg LLP on August 21, 2014 to provide an independent review and assessment of the cause of Sensus USA Inc. meter fires and to review the product and its related uses and review all reports and information from Underwriters Laboratories and the testing organization, Kinectrics.

We have reviewed the SaskPower reports and other documentation. We have interviewed SaskPower personnel and inspected two of the failed meters and several meters returned to SaskPower through their internal Return Manufacturer Authorization (RMA) process. We have inspected new meters, a meter from Landis & Gyr and a meter from Itron. Our opinion is based on this information. To date we have not seen any information or reports from Kinetrics Inc. or UL.

2. TECHNICAL REVIEW

2.1 SMART METER IMPLEMENTATION

SaskPower intended to upgrade a variety of existing meters to the Sensus Generation 3.3 smart meter. The existing meters being replaced included old mechanical/electrical meters and electronic meters of differing manufacturer and age. This would be the first full scale meter modernization of a very large installed base for SaskPower. The single phase, 240 volt meters found on small electrical services throughout the SaskPower system represent the largest

number of meters but on the smallest customers. This class of customer does not represent large billing but are located throughout the province.

The meter upgrade began in the Regina and Saskatoon areas and was to shift to the smaller cities such as Moose Jaw, Yorkton, Weyburn, Swift Current, Prince Albert, etc. Some areas of the province such as the far north were not scheduled for an upgrade as part of this program.

The smart meter technology has been available for some time. Other utilities in Canada and the United States have implemented similar upgrades. There are many factors to consider in choosing a manufacturer. While most meters shared similar ability in accuracy of electricity measurement, how they accomplish this and the extra features varies between manufacturers. Sometimes terrain and geographic location are significant factors. SaskPower did find that Sensus was significantly less costly than other manufacturers. All smart meters utilize a digital radio frequency signal to communicate with a larger network.

Some of the more significant features of smart meters are as follows:

- Electronic measurement of power consumed.
- Transmission of measured data to central monitoring facility. This alleviates manual reads of meters.
- Ability to disconnect services for non-payment or safety issues such as overloads.
- Ability to detect meter tampering.
- Ability to determine extent of power failures and to identify restoration of power.
- Ability to measure a variety of other parameters and log data.

The Sensus smart meter technology uses an Advanced Metering Infrastructure (AMI) network that facilitates communications from the meters to AMI head end, through the Meter Data Management System (MDMS) servers and on to the SaskPower billing system. The MDMS and AMI head end equipment provide monitoring and the ability to interrogate and command the meter.

The AMI network is operating in some areas but is not fully functional. A great deal of data can be transmitted by the smart meters and the AMI in conjunction with the Regional Network Interface (RNI) network must record and manage the data. SaskPower must have an internal system and protocols for initiating a meter trouble call and reacting to the off normal data. This capability is not fully functioning.

2.2 DESTRUCTIVE EVENTS

The Sensus Generation 3.3 meters appeared to function correctly for several months. On June 16, 2014, the first meter fire was reported. Subsequently, there have been seven additional fires. All reported fires are shown below.

Fire Number	Date of Incident	Location	Install Date	Time in Service
1	16/06/2014	McLean NW28-17-15-W2	10/07/2013	11 months 6 days
2	30/06/2014	Pilot Butte - Crawford Developments 10 Bardel Crescent	26/07/2013	11 months 4 days
3	30/06/2014	Regina 1315 Maple Grove Crescent	02/04/2014	2 months 28 days
4	30/06/2014	Strasbourg - Earl Grey SW-26-21-20-W2	12/08/2013	10 months 18 days
5	09/07/2014	Pasqua First Nation House #16	03/04/2014	3 months 6 days
6	13/07/2014	Saskatoon 223 Marcotte Way	18/06/2014	0 months 25 days
7	26/07/2014	Saskatoon 1115 Shepherd Way	07/07/2014	0 months 19 days
8	09/08/2014	Regina 4510 Harbour Village Way	05/11/2013	9 months 4 days

Table 1: Fire Summary

The fires all occurred within two months and were located in Regina, Saskatoon, and their surrounding areas. Two of the meters had been in service less than a month. Four of the meters had been in service for more than nine months. The weather leading up to the failures is shown below.

Fire Number	Date of Incident	Location	Precip. that day	Precip. last 48 hours	Precip. last week	Precip. last month
1	16/06/2014	McLean NW28-17-15-W2	0.0mm	1.6mm	12.0mm	60.4mm
2	30/06/2014	Pilot Butte Crawford Developments 15 Bardel Crescent	12.1mm	92.0mm	101.9mm	175.1mm
3	30/06/2014	Regina 1315 Maple Grove Crescent	12.1mm	92.0mm	101.9mm	175.1mm
4	30/06/2014	Strasbourg - Earl Grey SW-26-21-20-W2	12.1mm	92.0mm	101.9mm	175.1mm
5	09/07/2014	Pasqua First Nation House #16	0.2mm	0.2mm	1.9mm	163.4mm
6	13/07/2014	Saskatoon 223 Marcotte Way	0.2mm	0.6mm	1.8mm	92.3mm
7	26/07/2014	Saskatoon 1115 Shepherd Way	3.0mm	12.9mm	26.6mm	52.1mm
8	09/08/2014	Regina 4510 Harbour Village Way	5.9mm	38.5mm	54.6mm	86.3mm

Table 2: Related Precipitation. Source: Environment Canada

There was significant precipitation in the previous thirty days for all of the fires. There was significant precipitation in five of the fires within the preceding two days. The remaining three fires had light precipitation within the preceding two days. There is evidence that moisture and contaminants have been getting into the meters and possibly being trapped.

The precipitation at several of the fire locations preceding the fires have been unusually heavy.

For the Regina area, the precipitation in the preceding months is as follows.

July 10 - July 31, 2013:	Total precipitation 41.3mm, highest daily rainfall July 23 @ 9.0mm
August 2013:	Total precipitation 23.5mm, highest daily rainfall Aug 06 @ 13.4mm
September 2013:	Total precipitation 39.6mm, highest daily rainfall Sept 18 @ 17.5mm
October 2013:	Total precipitation 1.7mm
April 2014:	Total precipitation 62.4mm, highest daily rainfall Apr 23 @ 20.2mm
May 2014:	Total precipitation 37.2mm, highest daily rainfall May 31 @ 12.9mm
June 2014:	Total precipitation 175.1mm, highest daily rainfall Jun 29 @ 79.9mm
July 2014:	Total precipitation 19.9mm, highest daily rainfall Jul 24 @ 11.8mm

August 2014: Total precipitation 134.8mm, highest daily rainfall Aug 24 @ 44.4mm, Aug 8 @32.6mm
September 2014: Total precipitation 30.7mm, highest daily rainfall Sept 30 @ 8.0mm

For the Saskatoon area, the precipitation in the preceding months is as follows.

July 10 - July 31, 2013: Total precipitation 19.1mm, highest daily rainfall July 21 @ 10.1mm
August 2013: Total precipitation 14.7mm, highest daily rainfall Aug 05 @ 5.3mm
September 2013: Total precipitation 14.9mm, highest daily rainfall Sept 26 @ 11.4mm
October 2013: Total precipitation 4.4mm
April 2014: Total precipitation 74.2mm, highest daily rainfall Apr 23 @ 23.9mm
May 2014: Total precipitation 61.1mm, highest daily rainfall May 26 @ 22.3mm
June 2014: Total precipitation 94.8mm, highest daily rainfall Jun 18 @ 23.7mm
July 2014: Total precipitation 44.5mm, highest daily rainfall Jul 24 @ 13.5mm
August 2014: Total precipitation 18.5mm, highest daily rainfall Aug 20 @ 10.4mm
September 2014: Total precipitation 10.7mm, highest daily rainfall Sept 8 @ 7.0mm

For three of the fires, the precipitation preceding the fires is the heaviest since the meters were installed.

As the precipitation leading up to the fires is substantial, we are of the opinion that moisture and contaminants within the meter has been a factor in the meter failures and ensuing fires. Refer to meter construction section.

As a result of the first six fires, SaskPower has produced four reports. These include the Preliminary Safety Report and the Preliminary Technical Report detailing the first six fires. The remaining two include: Meter Investigation 1115 Shephard Way Saskatoon Version 3 and Meter Investigation 4500 Harbour Village Way Regina Version 3. We recommend that SaskPower finalize these reports.

SaskPower have historically had meter incidents, regardless of the type of meter used. Meter incidents include fires and other failures with the criteria of burnt/melted/blackened meter, fire/arcing/sparking meter, and exploded/blown meter from premise or pole. The following table summarizes these meter incidents for the past five years and the first seven months of 2014. It should be noted that only eight Sensus meters have been shown and these represent the eight meter fires. However, in addition to the 8 Sensus meter fires there have been 10 other Sensus meters that were returned to SaskPower due to a problem classified as burnt meter not shown in the chart below, bringing the total to 2014 total to 37. This would indicate that the Sensus meter issues were a total of 18 out of 37 for the first seven months of 2014.

The Sensus meter issues represents a significant portion of the overall meter issues for 2014. The total noted above, 37 is the 27 failures noted in the following table plus the additional 10 Sensus meters that were not included in the table.

	TOTAL	Urban	Rural	Oil Field	Sensus	SaskPower customers	Failure rate
2009	50	24	5	21		467,329	0.011%
2010	45	14	12	19		473,007	0.010%
2011	90	48	16	26		481,985	0.019%
2012	148	82	28	39		490,611	0.030%
2013	23	11	5	7	0	500,879	0.005%
2014: first 7 months	27	9	7	10	8	511,362	0.005%
Average/year	**63.8**	**31.3**	**12.2**	**20.5**		**487,529**	**0.014%**

Table 3: Historical Meter Incidents. Source: SaskPower

2.3 METER CONSTRUCTION

The Sensus Generation 3.3 meter has cost SaskPower less than $100 each. To achieve this low cost, the meters have been streamlined to several modules that attach to the back plane and each other. The various modules are interchangeable. Assembly and disassembly is relatively easy requiring few tools. A typical meter is shown below.

Figure 1: Front face of assembled Sensus meter

Figure 2: Back plane of assembled Sensus meter

Figure 3: Holes in back facilitate mounting of various Sensus meter modules.

Several of the meters involved in the fires were intact enough to disassemble and compare to the new meter sample. The following photo from SaskPower shows the bus arrangement from the damaged meters at McLean (#1) and Pasqua (#5) as well as a meter that was returned through SaskPower's RMA process.

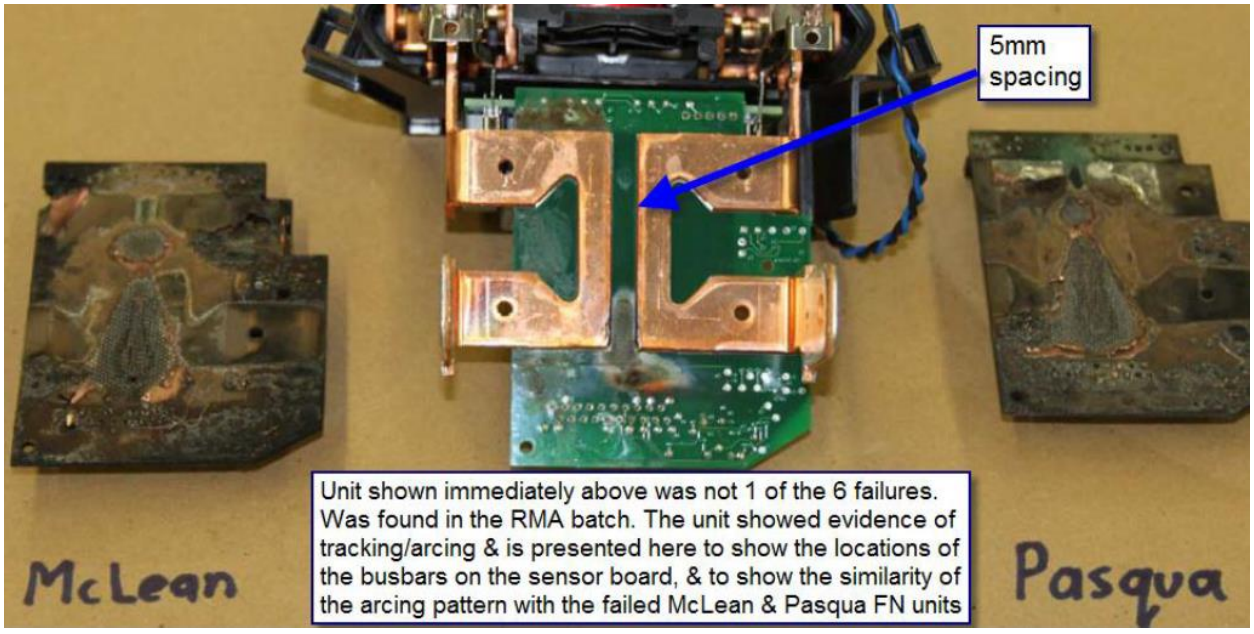

Figure 4: Comparison of burnt boards to RMA board. Source: SaskPower Preliminary Technical Report

The centre board shows clear evidence of arcing and tracking at the bottom of the bus that has resulted in a discoloration of the circuit board. On the left, the McLean board (#1) shows a similar pattern but has been damaged more. On the right, the Pasqua board (#5) shows a similar pattern but has been damaged more than the centre sample. The bus bars for both the McLean and Pasqua boards were vaporized in the destructive failure. However, the arcing and tracking pattern matches the sample.

From the inspection of two of the failed meters, we found no evidence of pitted or discoloured stabs on the meter. Pitted or discoloured stabs could be an indication of a hot socket problem. No indication has been found.

SaskPower found that the McLean board had increased levels of calcium, magnesium and aluminum suggesting the presence of dust within the meter.

The RMA process involves meters that have had issues in the field, and includes the eight meters involved in the destructive failures. The causes of these issues range from broken displays, overvoltage, communication issues, or simply the meters were dropped and no longer function properly.

SaskPower has dealt with 359 RMA cases so far since the inception of the smart meter program, and the symptoms have been recorded. The numbers are continually being updated, and may not include the most recent failures. Most of the RMA meters have not been fully investigated, and there are a large number of meters that have had issues but have not had the root cause identified. As the meters are inexpensive, it is often more efficient to issue new and return the problem meters to the manufacturer.

The category of failures can be summarized as follows:

- 18 meters have been burnt, and were no longer operational. This number includes 7 of the destructive meter fire failures.
- 3 more meters have had high temperature errors that were still functioning, but were discovered due to a burning plastic smell.
- 1 only had moisture as the cause.
- 107 meters had display problems, and 67 meters had error codes on their display.
- 35 RMA's had an unknown problem.
- 17 meters had no discernable issues.
- 20 had physical damage.
- 11 were sent to Sensus for special investigation.
- The remaining 47 RMA cases cover everything from communication loss to power issues.

These categories of failure only describe the symptoms. Unless the meter has been individually investigated, the underlying problem has not been documented. For instance, 107 meters had display problems, and 67 more had error codes on their display. The photos below show electrical arcing inside 3 of the meters that were RMA cases under the category “Display Error”. These RMA failures all exhibit electrical arcing in the same location as the destructive failure meters.

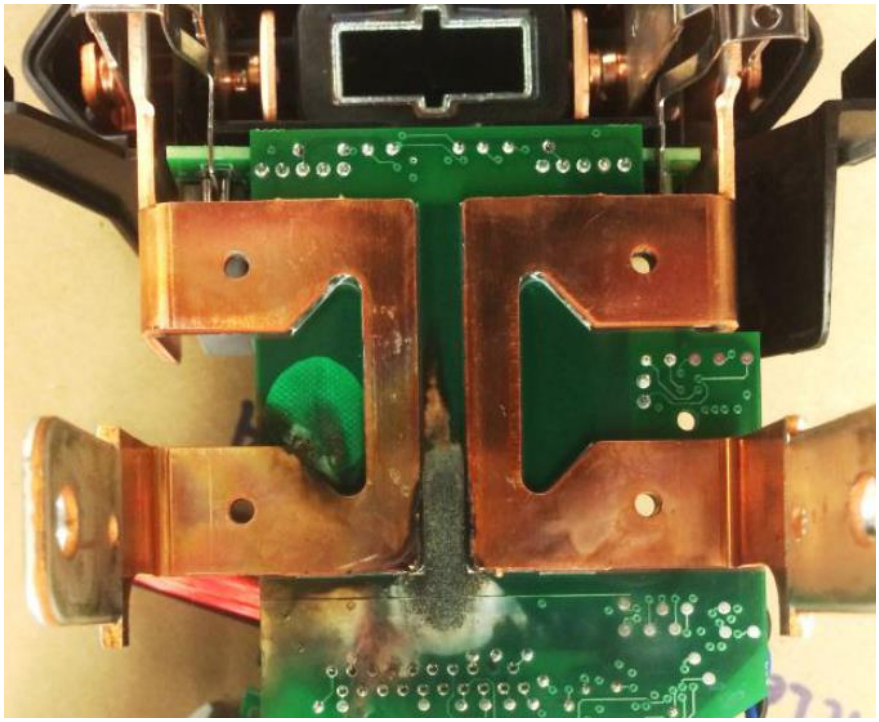

Figure 5: RMA Meter 997202 – Pilot Butte – Reported as meter display problem

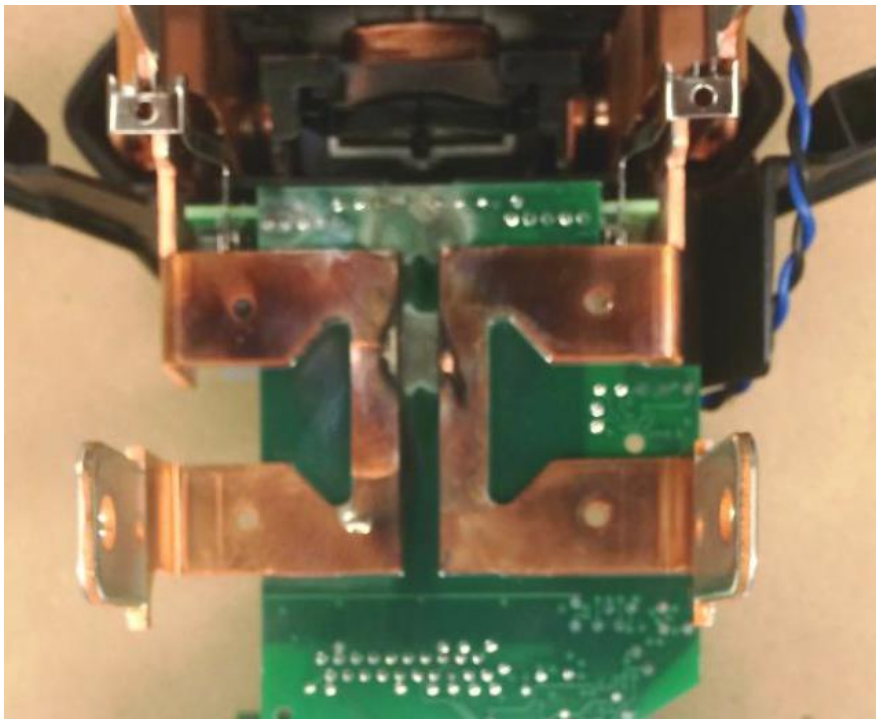

Figure 6: RMA Meter 998366 – Qu'Appelle – Reported as meter display problem

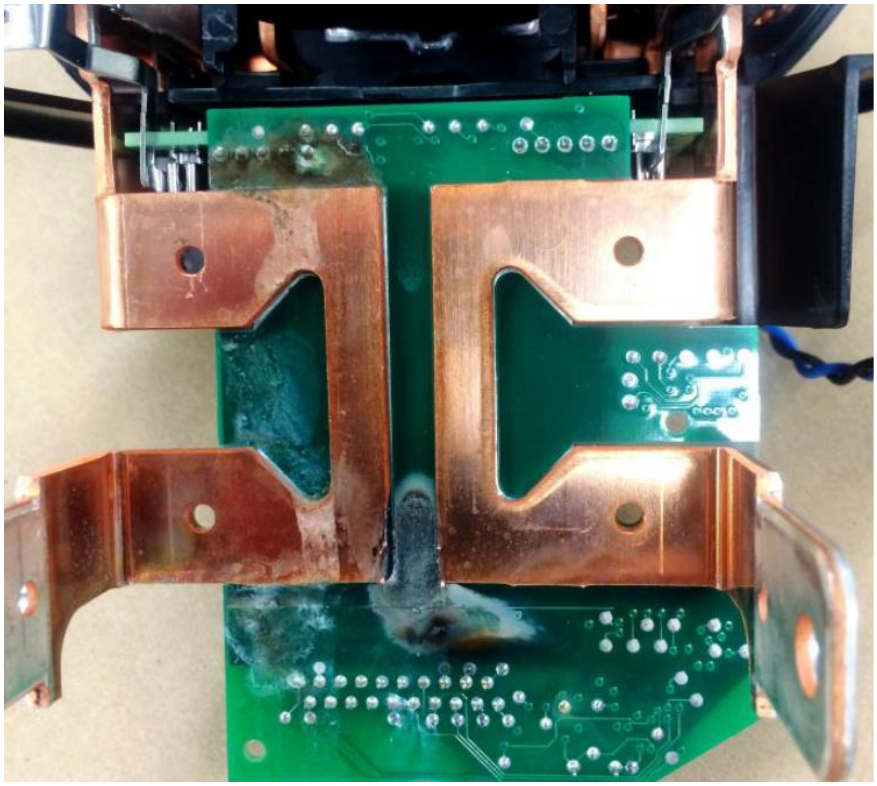

Figure 7: RMA Meter 1062400 – Moose Jaw – Reported as meter display problem

The three meters shown above were returned for reasons other than arcing and tracking. These meters may have functioned for some time despite the arcing problem or the arcing problem may have caused the display to fail. We are of the opinion that there may be meters in service that have had arcing issues and even if the display has failed. The problem would not be apparent to SaskPower until the next manual meter read. Several months could pass before SaskPower would become aware of the problem.

The following photo shows a meter that was returned through the SaskPower RMA process that has staining from smoke and evidence of moisture at the bottom of the meter.

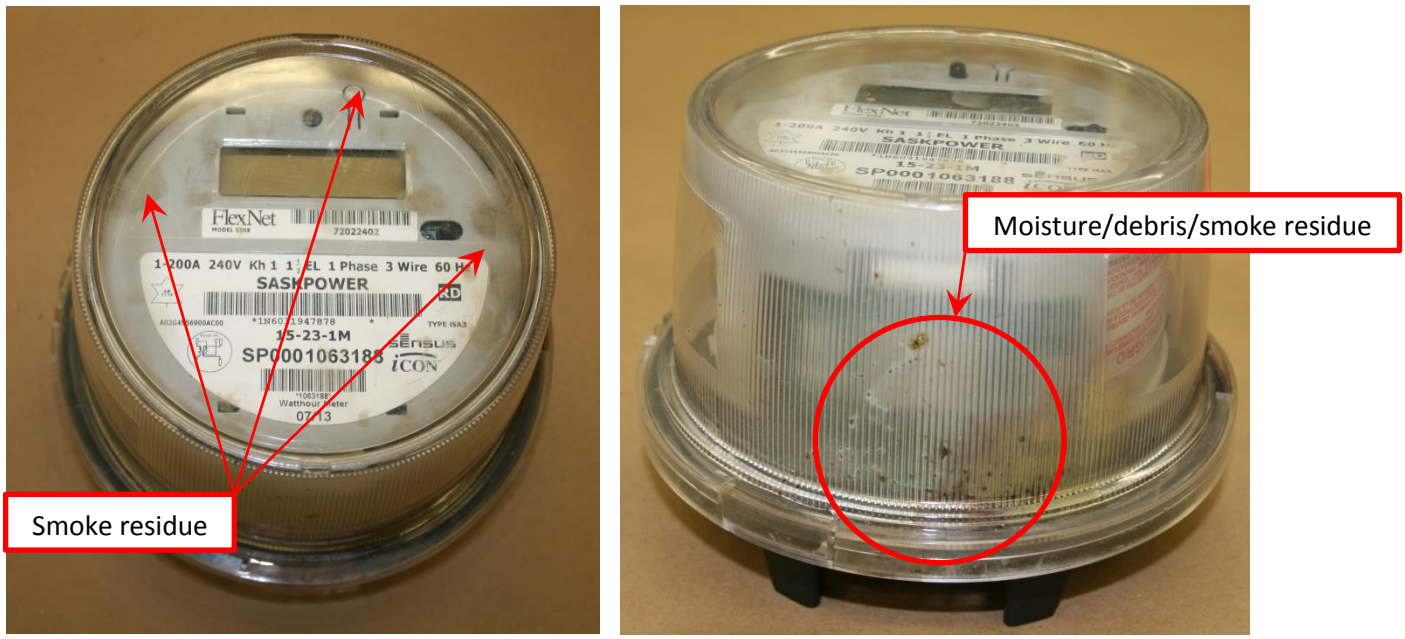

Figure 8: RMA Meter 1063188: Located at NE 301597828 – Reported as burnt meter

As indicated previously, significant precipitation occurred in the preceding days for several of the meter fires.

There is evidence that the Sensus Generation 3.3 meters are not very well sealed to keep moisture and dust out and includes the following.

- There is space around the stabs where they penetrate the back plane.
- There are several openings in the back plane which allow for the fastening of clips to mount internal components.
- There are several gaps in the clear enclosure cover where it meets the back plane.
- There is no gasket to seal the meter to the meter socket.

- When moisture is trapped within the meter, there is no path for it to drain away so the moisture and other contaminants remain inside the meter. This can also raise the relative humidity within the meter.

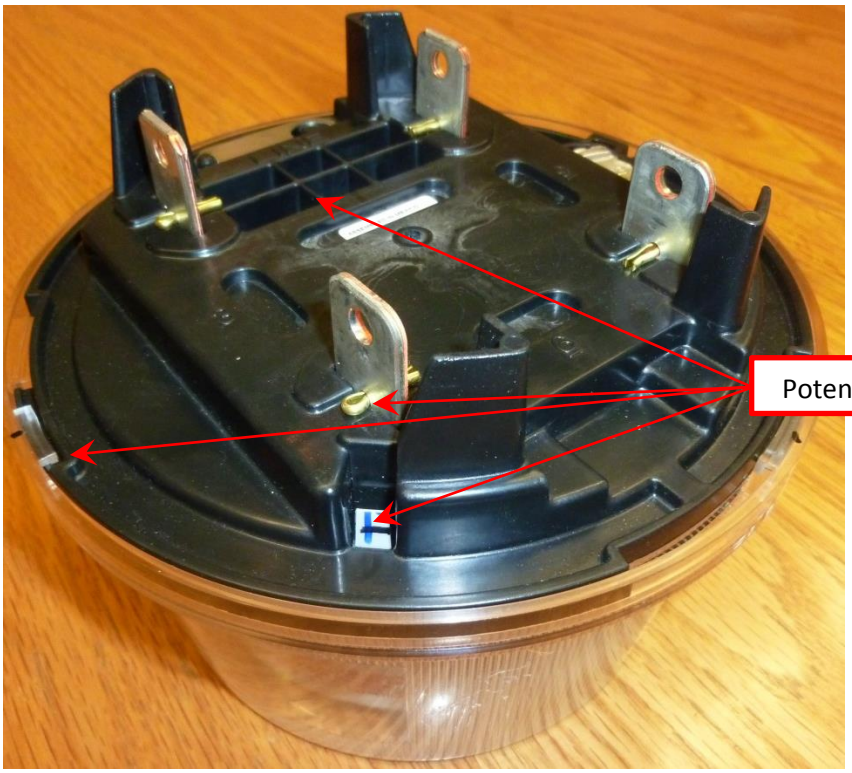

Figure 9: Backplane of Sensus meter

SaskPower have been using an Itron electronic meter, the Centron II for some time. This is the type of meter that was being utilized prior to the smart meter program and is the meter that is being used to replace the smart meters already in service. An Itron electronic meter was dismantled and the following photo shows the tubular bus.

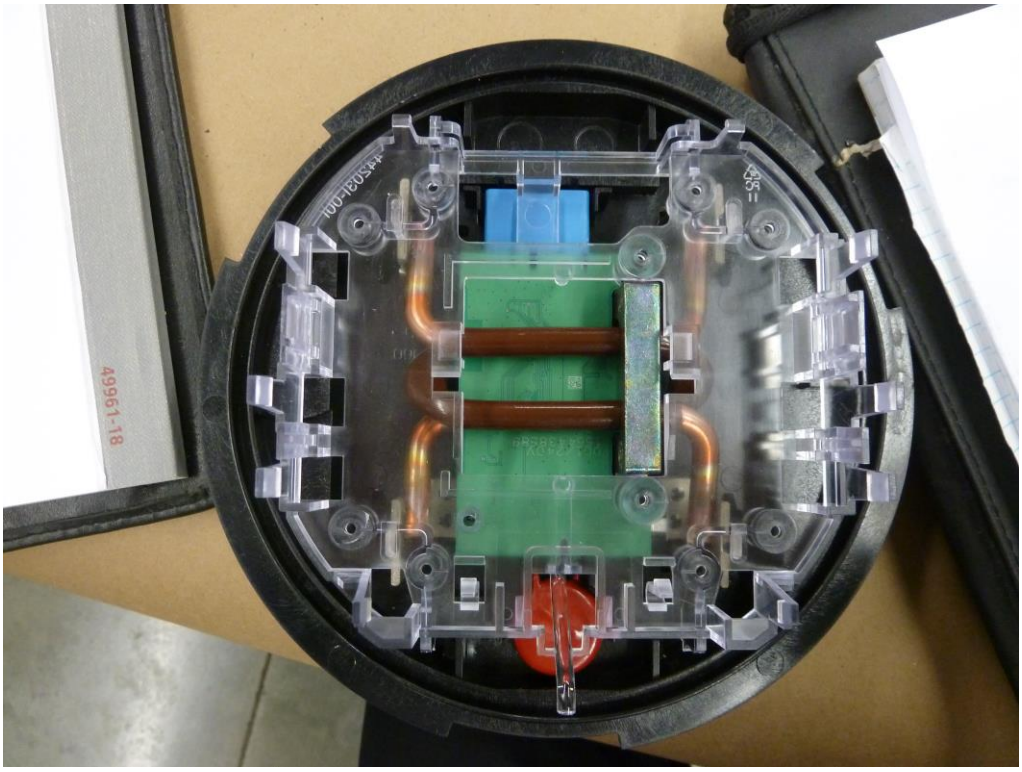

Figure 10: Backplane of Itron internal power board

Itron has used an insulating coating on the bus to ensure adequate insulation. There is no similar approach used by Sensus in their Generation 3.3 meter. However, the Generation 4 meter uses an insulated gasket under compression to improve the insulation system.

2.4 SENSUS GENERATION 4 METER

Sensus has provided an engineering sample to SaskPower of their Generation 4 meter. A number of changes have been observed when comparing the Generation 4 meter to the Generation 3.3 meter used in the upgrade program as follows.

- Tighter tolerances around openings in the back of the meter.
- The addition of a breather hole with a Gore-Tex filter to relieve humidity.

- The addition of a hole at the bottom of the meter clear cover to allow moisture to escape.
- A change in the type of plastic, possibly to reduce flame spread.
- An insulating gasket was added to provide further insulation over the bus bars on the printed circuit board.
- Sealing of slots in the plastic backplane so that water will follow the slot around to the bottom and drain water through the new drain hole.

These changes appear to focus on controlling entrance of water and water vapour into the meter as well as providing a means for trapped moisture or vapour to escape. These improvements also improve the insulation of the copper bus.

Landis & Gyr have used a gasket around the plastic cover to prevent moisture intrusion. The higher voltage components were separated from the micro-electronic components to provide a further degree of isolation. Generally the Landis & Gyr meter utilizes more robust materials than the Sensus meter although it lacks some of the electronic features offered by Sensus.

2.5 METER INSTALLATION

SaskPower utilized three groups of employees to complete the smart meter installation: Qualified Electrical Workers, Competent Electrical Workers, and SaskPower Exception Crew. All were involved in these installations, and were involved in at least one destructive failure event. The term Qualified Electrical Workers refers to an individual who has an electrician designation and may be employed by SaskPower or a private contractor. Competent Electrical Workers are those whom have completed a two week training course on installing electric meters. The SaskPower Exception Crew are SaskPower employed electricians who are usually dispatched to deal with special site problems.

Four of the fires occurred at sites where the meter had been installed by Qualified Electrical Workers. Three of them occurred at sites where the meter had been installed by Competent Electrical Workers, and one involved an installation by the SaskPower Exception Crew.

Due to the variance of installers at each fire site, simplicity of task, and qualification of workers, it is our opinion that there is no evidence to suggest that the installation caused any of the destructive failures.

2.6 MANUFACTURING AND FAILURE RATES

SaskPower indicated in their report, Residential Meter Failures, Preliminary Technical Report Distribution Services dated July 28, 2014, that of the first six meters that failed, three were from the same batch and lot. This means that three of the meters were manufactured at the same time. However, the remaining three meters of the initial six are from different batches and lots. The last two meters were also from different batches and lots. We have not been able to link the fire issues to variances in manufacturing.

SaskPower indicated in their report, Residential Meter Failures, Preliminary Technical Report Distribution Services dated July 28, 2014, that the rate of destructive failure for the first six meters is 0.006%, the non-destructive rate of failure is 0.252% and the total rate of failure is 0.258%. A total of 271 meters failed. The overall rate of failure appears to be within accepted industry standards. SaskPower has advised that as of Sept 2, 2014 that the number of failures has grown to 359. Many of the failures relate to minor problems such as a failed display. Some of the returned meters were found to be fully functional. In some cases, there was evidence that the meter had been dropped. These are described in more detail in the RMA cases in section 2.3 of this report. The 359 RMA meters do not exclude nor individually identify destructive failure events. See section 2.2 for further information on destructive meter incidents.

2.7 HOT SOCKET ISSUES

Hot socket issues have been flagged as a possible reason for some of the meter failures. The stabs on the back of the meter plug into connecting jaws in the meter socket. If the connecting jaws and stabs are loose and do not fit together with a tight fit, electrical heating can occur. Also, if the conductor terminations are not tight, electrical heating can occur. This heating is referred to as a “hot socket”. Generally, the amount of heat generated increases with the amount of current passing. For the first six fires, SaskPower tested the jaw tightness and found that all six sockets passed. At location six, cable terminations showed signs of heating that could result in a hot socket condition. The Sensus Smart Meter, Generation 3.3 has a temperature sensor that is typically set at 70 degrees Celsius. As the meter is communicating with the AMI network regularly, approximately every 30 minutes, a slow buildup of heat in the meter socket should result in a high temperature alarm. A high temperature alarm can also cause the meter to send a message more quickly outside of the regular communications interval. The temperature sensor is on the printed circuit board within the meter. As the heat source is the socket, the passage of time is required for the heat to build up temperature within the meter enclosure. The heat buildup is directly related to the amount of current passing through the

bad stab, jaw and cable termination. The more current, the more heat generated. This type of failure most often occurs over an extended period of time. As a result, a high temperature alarm should have occurred. SaskPower has indicated that many of the smart meter features including temperature alarms were not fully functional at the time of the fires. Meter readings were also being made manually. For a variety of reasons it appears that high temperature alarms were not being received and/or monitored consistently.

The maximum demand on the service at this time is reported by SaskPower to be approximately 25 amperes, which is between 12% and 25% of the service capacity, depending on whether the service is 200 amperes or 100 amperes. From June 21 to July 12, SaskPower reports the typical load to be approximately one half of the maximum demand. As the load was very light, we feel that a hot socket condition resulting in a destructive meter failure and fire are not likely.

2.8 METER COMMUNICATION LOSS

In several of the fire situations, there was a loss of communication with the meter. For example, with fire number 4 in Earl Grey, a loss of communication occurred 27 hours prior to the customer calling to advise of a power outage. In fire number 1, the loss was 5 hours and fire number 5, the loss was 3 hours. SaskPower advises that interruptions for up to a day can be expected. There are several reasons but many are related to communication bandwidth being insufficient.

This trend makes reporting of off-normal conditions on a timely basis somewhat unreliable.

2.9 OVER-VOLTAGE ISSUES

Sensus has claimed that some of the smart meter fires were caused by utility over-voltage. Most services are fed from a transformer that serves other customers. If an over-voltage situation occurred, then the other services and the meters fed from the same transformer would have been subject to the same potentially harmful over-voltage condition.

During their investigation, SaskPower, removed meters from adjacent customers. These meters were dismantled and checked for signs of arcing and other abnormal conditions. No arcing or failure of Metal Oxide Varistors (MOV) was found. The MOV's provide protection against surges and over-voltage conditions. However, there was some evidence of moisture and dust intrusion.

Over-voltage of 282 volts was found for fire number 2 at Pilot Butte and SaskPower did have a system disturbance at the time. Over-voltage of 288 volts was found for fire number 3 and SaskPower did have a system disturbance at the time. Over-voltage of 265 volts was found for fire number 4 at Earl Grey and SaskPower did not have a system disturbance at the time. The smart meters are rated for an over-voltage of 20% or 288 volts.

We have not found any evidence to support that a significant over-voltage occurred and resulted in a destructive meter failure.

SaskPower personnel and their report indicate that the MO's installed within the meters and those that were not destroyed by the fire, were tested and found to be intact. SaskPower indicates that system switching or operation, system over-voltage, or system protection mal-operation was not found to be a factor in these meter failures and fires. We have found no evidence that would be contrary to this finding.

3. RELATED STUDIES AND DOCUMENTS

3.1 UNDERWRITERS LABORATORY REPORT

Not yet received by SaskPower

3.2 KINETRICS REPORT

Not yet received by SaskPower

3.3 UL & ANSI STANDARDS

The Sensus Generation 3.3 meters had not been tested when selected by SaskPower for this meter upgrade program. UL has a new standard UL2735 that was published in May 2013. This standard does stipulate construction and performance requirements. Prior to the first issue of UL2735, standard UL 61010 had been considered by SaskPower to be the best UL standard that might be applicable to smart meters. The scope of UL 61010 encompasses both laboratory equipment covered in Healthcare applications and equipment covered under other industrial applications. This standard does not fully apply to utility metering equipment.

We have been unable to find any information that shows that the Sensus Smart Meter Generation 3.3 meets either UL61010 or UL2735. Due to the date that UL2735 was issued, it is

not unexpected that there was no SaskPower initiative to have UL2735 compliance on the Generation 3.3 meters. UL 61010 has been available for many years. As this standard largely focuses on other types of equipment such as those used in the Health Care industry, it is not unusual that a utility meter manufacturer would not certify their product to this standard. However, as more issues and problems have arisen with the Sensus meters, certification particularly to UL 2735 is very important.

SaskPower has suggested that the new Sensus Generation 4 meter will likely meet UL2735. We have not found any documentation that establishes certification with UL 2735. The upcoming UL report will provide a better insight to this possible certification.

Other manufacturers such as Landis + Gyr, who were considered by SaskPower for this meter upgrade, do not meet UL 2735.

Itron electronic meters have been used by SaskPower for many years and are the manufacturers of the meters being used to replace the Sensus smart meters. The Itron meters do not meet UL 2735.

ANSI is the American National Standards Institute and provides a certification program for a large variety of electrical equipment including utility metering equipment. Sensus Generation 3.3 meters meet the following ANSI standards.

- ANSI C12.1 - 2001
- ANSI C12.10 – 1997
- ANSI – C37.90.1 – 1989
- ANSI – C12.20 – 2002 (Class 0.2)

Landis + Gyr meet the following ANSI standards.

- ANSI C12.1
- ANSI C12.10
- ANSI C12.19
- ANSI C12.20

Itron meet the following ANSI standards.

- ANSI C12.1 - 2008
- ANSI C12.20 (Class 0.5) - 2010
- ANSI C12.18 - 2006
- ANSI C12.19 - 2008
- ANSI C12.21

4. CONCLUSION

We have reviewed the SaskPower reports and other documentation. We have interviewed SaskPower personnel and inspected two of the failed meters and several meters returned to SaskPower through their internal RMA process. We have inspected new meters, a meter from Landis & Gyr and a meter from Itron. Our opinion is based on this information. To date we have not seen any information or reports from Kinetrics or UL.

After reviewing the information available, we have found the following.

- No indication with the two failed meters of pitted or discolored stabs that might be indicative of a “hot socket” condition.
- Indication that one meter had increased levels of calcium, magnesium and aluminum suggesting the presence of dust within the meter.
- Indication that several meters, aside from the failed eight meters, had arcing and tracking between the two bus bars on the main board.
- Indication that some meters had indication of staining from dust and moisture in the bottom of the meter.
- No indication was found that would suggest that the meter installation caused any of the destructive failures.
- Indication of very significant precipitation preceding the meter fires.
- In 2014, the rate of SaskPower meter failures was not significantly greater than the historical average. However, Sensus meters were involved in a substantial portion of these failures.
- There is some danger with destructive meter failures and potential resulting fires.
- No evidence that over-voltage caused the meter to fail destructively

In view of the above, we are of the opinion that moisture and contaminants within the meter has been a major factor in the meter failures and ensuing fires.

5. RECOMMENDATIONS

Throughout the investigation process for this report, several areas have been identified where alternative methods could be considered. This section highlights a few areas of possible improvement that might be considered in a new smart meter program.

5.1 METER PHOTO RECORDS

There is currently a procedure for SaskPower meter installers to take pictures of the old and new meters when a new meter is installed. The pictures are generally close-ups of the meter faces, which provide little insight to site conditions when viewed later. A more detailed approach would be to take pictures of the meters before and after installation, the meter socket/jaw conditions, and also an area photo that is taken from further away showing the conduit stubs from the ground into the meter and general site conditions. This would provide a more complete picture of the install site and existing conditions of the meters and socket. This information would be helpful if problems develop in the future.

5.2 METER ANALYSIS

There has been evidence of electrical tracking on the power boards of a number of meters that have been returned for other reasons, as described in section 2.3. Without further information, it is difficult to determine if this problem is more significant and involves larger numbers of meters. Furthermore, some of the electrical tracking and its symptoms could go unnoticed, caused by the large timeline between physical meter reads. There is a possibility that there are a number of working meters that were not part of any previous RMA and may have signs of arcing between the bus bars.

We understand that during the removal of all 107,000 smart meters, SaskPower has not investigated any of the normal in service meters and has been disposing of these meters. A statistical sample could be taken of sufficient size to provide a reliable data set for analysis. This may show that there are additional meters showing signs of degradation or it may confirm that there were no significant further problems.

5.3 DESTRUCTIVE EVENT REPORTING

As described in section 2.2 SaskPower has produced four reports. These include the Preliminary Safety Report and the Preliminary Technical Report detailing the first six fires. The last two reports were created each detailing the seventh and eighth fire respectively. These last two reports should be combined with the first two, forming a single safety report and technical report. Lastly, these documents still marked as "Preliminary", and should be finalized. All meter incidents should be reported and an ongoing data base created to document the evidence of each incident as well as providing a means to monitor trends and problems with certain types of meters.

5.4 METER DEPLOYMENT

SaskPower's deployment plan included a limited and concentrated installation in the town of Hanley in order to test the meters before rolling the program out to the rest of the province. This test showed that there were issues that required attention. A full firmware upgrade was required to alleviate some of the nuisance alarm problems. The next step in deployment included Regina/Saskatoon and surrounding areas. This is a large step, from roughly 500 meters to over 100,000 meters installations.

It was discovered that even after the 100,000 installations were completed, the AMI network was not fully operational and that further work was required to allow remote reading of the meters. All smart meters were still being read manually by SaskPower personnel at each installation location for billing purposes. Measurement Canada requires a certain number of meters communicate successfully before the data can be remotely read and used for billing purposes.

Furthermore, there was no record of the reception of a high temperature alarms in any of the eight destructive events. There is no way to distinguish if the absence of the high temperature alarm was caused by the meter never sending the alarm or the AMI network was not able to receive or process it. These issues indicate that the system was not fully operational in both billing and smart meter event records.

In future smart meter implementation plans, it may be prudent to use a smaller rollout and get the entire system fully commissioned and operable before embarking on a province wide program. This would require that the AMI network, billing interface and meter alarms capabilities be fully functional. An example would be the installation of several thousand meters in Regina where trouble shooting and access to engineers and other specialists are easy. This would allow the development of standard practices, such as appropriate responses to

certain meter alarms such as hot socket/high temperature. While there may have been more factors such as cost concerns driving a large implementation, problems do surface which can affect the program and related issues.

5.5 SENSUS METER REPLACEMENT

As there is some danger with destructive meter failures and potential resulting fires, we recommend that the existing Sensus Generation 3.3 meters be replaced as soon as possible. As the existing meter fires have had a close relationship to precipitation levels, SaskPower might wish to consider replacement no later than the end of winter and before the spring thaw and spring rains begin.

6. AUTHENTICATION