Mitigation of Pole Top Fires
Best Practice

Version 1

March 2017

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2. LEGAL NOTICE

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3. Introduction

3.1 Executive Summary

The *"Mitigation of Pole Top Fires Best Practice"* responds to the number of incidents of fires during the winter months on Local Distribution Company (LDC) owned wood poles potentially creating a safety hazard to members of the public, property damage and service reliability impacts to LDC customers.

The breakdown mechanisms of insulators, insulator type, framing configurations and environmental contamination are contributing factors that can lead to pole fire incidents.

Design considerations can assist in the prevention of poles fires. Selecting insulators manufactured with a one piece housing molded entirely from silicone will provide the overall best long-term performance in preventing pole fires.

Pole framing configurations that allow for natural washing of the insulators are preferred. Some configurations such as 'Christmas tree' configurations (Image 5) performed the poorest in field testing and should be avoided whenever possible (CEA 265 D 748).

The selection of equipment such as the replacement of metal brackets with fibreglass brackets for fused cutout switches, arrestors and crossarms should be considered in an effort to further reduce the likelihood of a pole fire. Pole fire mitigation measures should be considered in areas where there is known high contamination, or where there have been historical problems.

Proposed practices can be applied towards new or rebuild type construction projects, as well as individual pole replacements. They also identify some mitigation opportunities to reduce the risks of pole fires on wood poles. It is left to the user's discretion to review and determine whether to incorporate these considerations into their own design process to reduce the possibility of wood pole fires.

Tracking, review and determining the cause of each pole fire will assist in gathering information on identifying trending so that appropriate mitigation strategies can be deployed to attempt to reduce or eliminate reoccurrences.

Adopting the contents of the document will provide the pole line designer and maintainer options to assist in the reduction of the number of pole top incidents. LDC's may consider implementing some or all of the recommended changes as outlined in this document.

3.2 Background

In March 2015, there were a number of LDC's in Ontario that experienced a large number of pole fires as reported through the media. The incidents occurred particularly along the high speed travelled highways. During this time, there was no or very little rain to naturally wash away and contaminants that may have accumulated on the insulators. ESA approached the Utility Advisory Council meeting in May 2015 to seek advice from the Council to solicit stakeholder input on determining the causal factors of pole fires and determine preventative measures. A Working Group was formed whose members are identified in the Appendix.

4. Scope

The scope of this Best Practice is to:

- Identify contributing factors around pole fires;
- Identify and combine effective design and maintenance methods from LDC's or others to reduce the number of occurrences.

5. Contributing Factors

When a pole top fire occurs, there typically are multiple contributing factors. The insulator's role in the electrical distribution system is to support the energized conductor and to provide a high resistive path to oppose the flow of current to ground. When there is a breakdown of the insulation value of the insulator, current will flow or leak along the surface of the insulator, to the poles surface. The current is concentrated at that point, generating heat and causes an ignition point on the pole that develops into an open flame which eventually starts a fire.

Breakdown of an insulator can be due to a temporary or permanent condition. A permanent condition is the failure of the insulator from a hairline crack in the material such as in porcelain or from age of the insulator which contributes to insulation breakdown. A temporary condition would be a leakage situation along the insulator surface due to foreign contamination from environmental conditions such as pollution, salt contamination or even bird droppings. Insulators on poles located in industrial areas with high contamination levels or along high speed travelled highways may have a higher susceptibility to increased leakage currents due to airborne contaminants.

Due to the high number of pole top fire incidents during the winter months of 2015, the working group felt there would be value added to include information of de-icing materials into the document.

5.1 De-Icing

De-icing salt is used by road maintenance agencies across Ontario and North America to maintain safe driving conditions during winter storm events. Each agency, be it the Ontario Ministry of Transportation for Provincial highways, or lower tier agencies for local roads, follows their own material specifications and rules of practices for material application rates and conditions. All agencies use rock salt and many agencies use chloride-based liquids of various types in addition to rock salt. These materials are used to prevent formation of frost, to melt light snow, and to enhance plowing of accumulated snow and slush.

Rock salt is a naturally occurring material that is effective over the range of temperatures commonly experienced in populated regions of the Province, is affordable, and is safe and easy to transport, store and apply. Following its application to a snow covered road rock salt dissolves to form brine or a solid-brine mixture. Refer to Appendix 9.2 for additional information on de-icing materials used in Ontario.

6. Design Considerations

The design considerations within this section have been prepared with the assumption that the mechanism of how pole fires are initiated through leakage current is understood and accepted as the primary cause.

Site specific considerations and other factors may affect the final design configuration chosen. Operational practices, such as whether an insulator washing programs currently exists, may also need to be taken into account in the design stage. In areas that are being rebuilt using existing wood poles, the condition of the pole should be evaluated before proceeding as aged poles are more susceptible to pole fires than new ones.

6.1 Insulator Selection

Insulator selection is important in the prevention of pole fires. An insulator must contain a number of important characteristics, such as adequate flashover distance, sufficient leakage distance and a hydrophobic material surface that does not allow moisture to “wet out” and develop a significant leakage current travel path over the threshold to initiate a pole fire.

6.1.1 Types of Insulators

Table 1 shows the different types of insulators and their relative performance levels in preventing pole fires. It has been noted that insulators manufactured with a one piece housing molded entirely from silicone have proven to be the overall best long-term performers in preventing pole fires. They achieve this by being able to disrupt a continuous water path and shedding contamination easier than other types of non-silicone type insulators.

Modular skirt style insulators initially exhibit the similar characteristics as one-piece silicone insulators. However, as they age, the insulator can break down and allow moisture penetration between the modular skirts resulting in tracking along the insulator’s core rod.

Porcelain insulators must not be contaminated or damaged through hairline cracks (material breakdown) to retain their insulation characteristics. However as they age, they are subject to both electrical and mechanical failures.

In addition to selecting the appropriate type of insulator, over-insulating, or selecting a higher voltage class of insulator can offer additional leakage distance and provides additional resistance to pole fires by increasing the insulator leakage distance. (CEA 265 D 748)

6.1.2 Distribution Equipment Other Than Insulators

Fused cutout switches (Image 1), arrestors (Image 2) and riser cable terminations (Image 3) are also possible locations where leakage current may occur and be the travel path to the pole. The same considerations for selection of other insulating components also apply and would include these items. Replacement of metal brackets with fibreglass brackets for the fused cutout switches, arrestors and crossarms should be considered in an effort to further disrupt the leakage current path. (CEA 265 D 748)

Crossarms are another potential location for pole fires. Wood crossarms supported by metal braces provide a leakage current concentration path and can be a source for fire ignition. Steel crossarms do not provide any insulation properties and will also concentrate any leakage current to the connection point on the pole. Replacement of wood or metal crossarms with fibreglass crossarms should also be considered in an effort to further disrupt the leakage current path. (CEA 265 D 748)

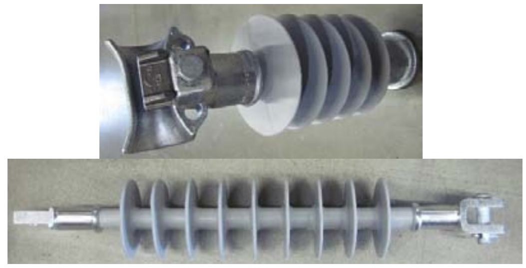
Rating	Description	Examples
Best	Silicone – Silicone insulators have proven to be the best material for prevention of tracking	
Better	EPDM - Ethylene Propylene Diene Monomer (EPDM) can initially provide good tracking prevention but can degrade over time.	
	Ceramic Post – Ceramic post insulators show significantly improved performance over porcelain pin insulators.	 
Worst	Porcelain Pin – Porcelain pin insulators have shown to offer the worst leakage current performance.	

Table 1: Types of Insulators

Image 1: Fused Cutout

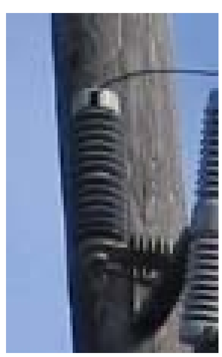


Image 2: Arrestor

Image 3: Riser Cable Terminations

6.2 Pole Framing

Pole framing configurations can also have an effect on the prevention of pole fires. Configurations that allow for natural washing of the insulators are preferred. The use of post type insulators on standoff brackets also known as armless construction (Image 4) have shown to perform best as line post insulators mounted horizontally have improved rain shedding characteristics (through higher natural wet tracking distance) than post insulators mounted vertically. ‘Christmas tree’ configurations (Image 5) performed the poorest in field testing and should be avoided whenever possible. (CEA 265 D 748)

Double crossarm construction should also be avoided whenever possible. This configuration requires more insulators and therefore provides additional leakage current paths (Image 6). (CEA 265 D 748)

Overloading a pole with hardware and other attachments provides more points for leakage currents to occur and will result in a higher leakage current flowing through the pole, thereby increasing the likelihood of a pole fire developing (Image 7). Pole fires occurring on poles with multiple circuits would require significant time and cost to replace and would have a significant effect on power restoration and reliability metrics. (CEA 265 D 748)

Image 4: Armless Configuration

Image 5: ‘Christmas Tree’ Configuration

Image 6: Double Crossarm Configuration

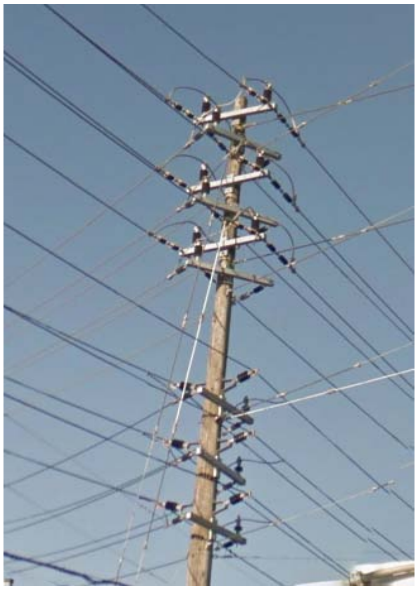


Image 7: Pole with various Attachments

6.3 Pole Grounding

Methods such as replacing wood poles with concrete poles and grounding the bases of insulators are not recommended as they may result in other negative consequences. The presence of wood insulation in series with porcelain or polymer insulation gives added lightning impulse strength. This electrical strength is discarded when the bases of insulators are bonded to ground to shunt leakage current from the pole. Studies report cases where bonded lines have outage rates that are roughly 60% higher than lines with unbonded construction. (CEA 265 D 748)

6.4 High Contamination or Historical Problem Areas

Pole fire mitigation measures should be considered in areas where there is known high contamination or where there have been historical problems. These typically include, but are not limited to, areas with industrial zones with high pollution emissions or areas that are in relative close proximity to major roadways. These areas may involve non-standard or custom designs for pole fire protection schemes which are a combination of the above considerations.

7. Pole Fire Tracking Process

When a pole top fire occurs an LDC may want to track pole fire incidents to understand the contributing factors to identify why the incident occurred. Typically there are multiple causal factors that affect an event's outcome. A major component of tracking is information gathering. An LDC may want to consider creating an internal process to gather all relevant information to confidentially determine cause of the pole fire.

Shown below is an example of a step by step process in which one of the LDC members of the working group has implemented in their internal process.

7.1 Process

Trouble Call Dispatch and Lines Crew Arrival on Location

- Lines crew is dispatched through the LDC's trouble call response process to respond to the trouble call.
- If it appears to be a trouble call that involves a pole fire, then the area is first made safe by lines crew and the fire department if necessary.
- Prior to starting any remedial work, it would be advantageous for the lines crew to take 'before' photos as visual evidence of the pole. The ignition point is defined as the location on the pole and the equipment involved that initiated the start of the pole fire. Gathering visual and physical evidence is critical as it allows the opportunity to try to confirm the ignition point. The greater the evidence collected, increases the likelihood that the ignition point will be identified with more certainty. Even though the ignition point may be obvious, the intent is to collect data on each pole fire to determine any trends, whether it be typical causes of pole fires, or LDC specific causes, and then determine mitigation methods. Image 8 and 9 are examples of 'before' photos.
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Image 8: 'Before' photo of pole fire

Image 9: Closer 'Before' photo of pole fire

- As part of the pole fire root cause analysis process, the lines crew makes their best assessment of what caused the pole fire based on the information available.
- E.g. Porcelain cutout switch tracked along 9”steel insulator bracket to pole, or porcelain cutout switch tracked along steel cutout switch bracket through bottom bolt to pole.

Restoration Effort

- The lines crew then follows the LDC’s power restoration process. The pole where the pole fire occurred could either be replaced completely as part of the trouble call response, or could be restored temporarily using a pole top extension until such time that the pole can be replaced completely.

- The selection of the pole and the equipment does materially have an impact on pole fires. Section 6 Design Considerations, provided information which should be considered as part of the LDC’s pole replacement philosophy.

Completion of Trouble Call

- The lines crew will document the trouble call as per the LDC’s trouble call response process. The content within this trouble report document will also contribute to the post trouble call analysis.

- It is would be advantageous that the equipment that was removed from the pole (evidence of the pole fire) is recovered and returned back to the LDC office by the lines crew. This evidence should be set aside and identified in such a manner that there is no confusion as to the evidence being mated directly with the pole fire location.

Post Trouble Call Analysis

- LDC staff assembles all the evidence, including possible statements from the lines crew members as to the exact cause of the fire, taking further pictures of the equipment if necessary, completing a pole reconstruction, and taking a copy of the trouble call document for the investigation. Image 10 and 11 are examples of a pole fire reconstruction.

Image 10: Pole fire reconstruction

Image 11: Closer view of pole fire reconstruction

- It is suggested that the completed analysis result in a document that collects all the evidence content in a single document / location. One example of this document is a “Pole Fire Profile” that records the pole fire as a specific case and identifies the ignition point. Figure 1 is an example of a Pole Fire Profile.

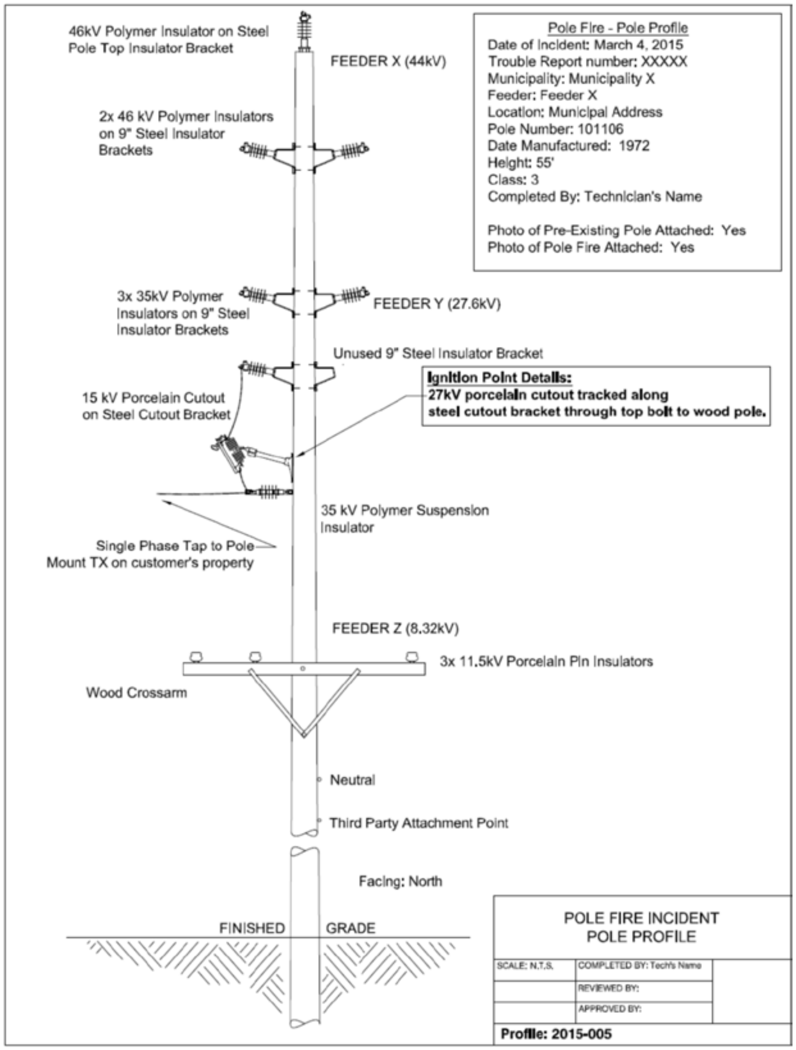

Figure 1: Example of a pole fire profile

- It is strongly suggested that all pole fire locations are mapped for tracking and trending purposes. Having all pole fires recorded on the same map allows an easier visual method to be able to identify problem areas within the LDC’s service area. Example, the location of a cluster of individual pole fires may identify a high speed high volume traffic route that is at higher risk for pole fires that other lower speed volume traffic routes.

- An overall annual report of the LDC’s pole fires should include analysis and recommendations that tie into the LDC’s feeder performance metrics as one way of trying to improving reliability by mitigating the factors that cause pole fires. Examples of possible annual programs that may be considered are porcelain insulator replacements and porcelain cutout switch replacement programs

8. POLE WASHING CONSIDERATIONS

Section 5 of this document notes that insulator contamination creates a path along the surface of the insulator which may allow current leakage to flow along the pole's surface and concentrate at the one point. Cleaning the contaminants from the insulators can be done naturally by rain water or through an insulator washing program.

Pole washing to combat insulation contamination can be a consideration if a utility has had previous experience with pole fires. Attention to geographical location, distribution voltages, cost, previous successful washing programs and insulation levels are necessary when deciding whether to develop a pole washing program or not. A survey of all Ontario LDCs indicated that those LDCs that do wash insulators have developed specific pole washing processes using IEEE Standard 957, Guide for Cleaning Insulators.

Insulator washing has been found to be effective in removing contamination and eliminating leakage current from ceramic equipment and should be considered as a pole fire mitigation measure in areas with this equipment material. Consultation with the manufacturer should be completed prior to washing of other materials as it may not be recommended or required.

8.1 Water Washing Considerations

Insulator flashover incidents can be considerably reduced by removing airborne contaminates that have landed on the insulators such as dirt, road salt, lime or gypsum dusts and other industrial pollutants. While the circuit is energized, water can be used to remove most contaminates and reduce future outages to the system.

It is recommended that Utilities develop a washing procedure that is safe, effective, and economical. The following excerpt from IEEE Standard 957-2005 highlights some of the key General Industry Practices used when water washing insulators.

General water washing industry practices (Process Considerations)

- The nozzle should be bonded to whatever the operator is standing on to ensure the gun and operator is at the same potential.
- The water must be brought to full-nozzle pressure before it is directed to the insulation.
- In general, warm water has a lower resistivity than cold water therefore; the initial stream should be directed away from the energized equipment until the warm water of lower resistivity is cleared from the hose line and pipes. The resistivity monitoring equipment should be used when available to determine safe operating levels.
- Either the cleaning equipment should be grounded or care should be taken to ensure that workers and public stay clear of the equipment.
- To reduce the risk of a circuit interruption, insulators, crossarms, and hardware should be inspected prior to the cleaning program.
- Damaged insulation should not be cleaned.
- The hose operator should consider protective equipment to prevent possible inhaling of dust or possible eye injury
- When cleaning any facilities, individual company grounding rules should apply.
- Results of efficient insulator cleaning can be judged by the following:
    - Visible surface condition—the surface condition of both the top and bottom of the insulator skirts should be visually clean and shiny after the water has dried.
    - Insulator vibration—Mechanical vibration (ringing) of insulator skirts under the impact of high-pressure washing and exhibiting evidence of efficient, swirling, cleaning action.
    - Absence of corona arcing or tracking—Leakage current discharges are not present.
    - Clarity of runoff— Clarity of the water runoff may also indicate the effectiveness of contamination removal. Clarity of water runoff may be difficult to observe due to distance, wearing of shaded safety glasses, etc.
- Flashovers during live-line washing can be minimized by the following:
    - Using high water pressure and a compact stream
    - Preventing polluted wash water from being sprayed over unwashed, dirty insulators
    - Avoiding partial wetting of unwashed insulators
- Tools and equipment shall be inspected prior to each use and any found with defects shall be taken out of service or repaired before being used.

8.2 LDC Pole Washing Survey (Program Considerations)

In addition to identifying IEEE Standard 957, Guide for Cleaning Insulators as the most widely used industry standard used to develop a pole washing program, the survey responses also provided useful information in other key areas. The following survey results summary can be considered when developing a pole washing program.

The survey was sent to 75 Ontario LDCs and 23 survey responses were received. Of the 23 respondents, 8 of 23 said they had a pole washing program and 15 of 23 said they did not have a pole washing program. The following three areas contributed to each utilities reasoning for either washing or not washing.

1. Geographical Location:
   - Utilities that experienced high levels of contamination from road salt were more likely to wash.
   - Utilities in locations that receive high amounts of rain, especially through the winter months, were less likely to wash.
   - Utilities that had no past experience with pole fires did not wash.

2. Distribution Voltage Level
   - 44kV was the predominate voltage targeted for washing, and there was some washing at the 27.6kV and 13.8kV levels.
   - Voltages less than 13.8kV were not washed, unless they were on the same pole as a 44kV circuit in which they would be included.
   - Utilities with lower distribution voltages such as 4kV, sighted this as reasoning for not having a pole washing program.

3. Insulation Level
   - Several utilities sighted over insulating as a method of combating contamination flashover. For example, 44 kV lines were re-insulated with 69 kV insulators and 27.6 kV lines were re-insulated with 44 kV insulators.
   - Some utilities that did not currently have a washing program stated that they had replaced poor performing insulators in the past with hydrophobic polymer insulators.
   - Utilities that washed were most often targeting porcelain insulators.

The original survey is available in Appendix 9.6 for review, and the complete survey results are listed in Appendix 9.7 for further reference.

9. Appendix

9.1 Working Group Members

Stephen Bell	K-Line Insulators Ltd.
David Burns	Powerstream
Tony Carreira	K-Line Insulators Ltd.
Joe Crozier	Powerstream
Darren Desrosiers	Hydro One Networks Inc.
Paul Kuner	Enersource
Rob McKeown	Toronto Hydro
Wilf Meston	Kitchener Wilmot Hydro
Max Perchanok	Ontario Ministry of Transportation
Peter Petriw	Veridian Connections
Robert Renshaw	Hydro Ottawa

9.2 Ministry of Transportation of Ontario Specifications

In recent years brines such as sodium chloride (NaCl), magnesium chloride ($MgCl_2$) and calcium chloride ($CaCl_2$) have been used in small quantities along with rock salt. Brines may be added to rock salt as it is applied to the road or may be applied directly to the road to prevent frost or in advance of snowfall. The judicious use of brines (also known as winter liquids) in association with rock salt reduces the overall quantity of salt that is needed (Fu et al, 2005).

Rock salt used in Ontario is mined from deep underground deposits. Brines may be sourced from underground deposits associated with oil or natural gas wells, from surface deposits such as Great Salt Lake or the Dead Sea, or from manufacturing processes. Sodium chloride brine is also obtained by dissolving rock salt in water.

Road agencies establish their own practices for using road salt and other aspects of winter maintenance. In 1989 road salt was placed on an Environment Canada study list to assess its effects on the natural environment. Subsequent studies resulted in the establishment of a national Code of Practice for the Environmental Management of Road Salts in 2004 (Environment Canada, 2016). The purpose of the Code is to encourage road agencies to use winter maintenance practices that will minimize the quantities of salt released to the roadside environment. The Code includes best practices for storage, application, and control of roadway drainage. All agencies in Canada that use more than 500 tonnes of road salt annually are required to develop a salt management plan, to report annually on quantities used, and on progress in meeting the Code (Environment Canada, 2016).

The Ontario Ministry of Transportation (MTO) is responsible for material standards and application practices for rock salt and winter liquids used on Provincial highways. Road maintenance on provincial highways is undertaken by 20 private companies (Area Maintenance Contractors) that operate independently on a day to day basis (MTO, 2016). They purchase and apply their own winter maintenance materials including rock salt and brine. The materials must meet MTO Material specifications (Appendix 9.3), and the application rate and timing must follow MTO approved guidelines (Appendix 9.4 and 9.5) to ensure road safety and prudent road salt management.

MTO is not responsible for the materials or practices used on roads other than Provincial Highways. The Ontario Good Roads Association is the appropriate contact for information about municipal road maintenance materials and practices. The Ontario Road Salt Management Group (ORSMG) is another source of contacts on salt use by lower tier government agencies in Ontario (ORSMG, 2015).

MTO material specifications govern the purity and gradation of rock salt (OPSS, 2010); the viscosity, eutectic (freezing temperature); and levels of contaminants controlled by the Ministry of Energy, Environment and Climate Change (Appendix 9.3). Some commercial brines that may be used by Area Maintenance Contractors may contain small quantities of additives such as sugar derived from various food industry byproducts like corn or sugar beets, or proprietary inorganic materials, to reduce freezing temperature, increase viscosity, balance pH or reduce corrosion potential (Nazari et al, 2016). All materials used as winter liquids on provincial highways must meet MTO's specifications to protect the roadside environment and to ensure effectiveness. MSDS sheets for all products that are known to be used on provincial highways recommend cleaning with water (MSDS, 2016).

Maintenance Contractors are expected to use the material that is most cost-effective at their particular location. Cost factors include: purchase, transportation from the source or bulk depot to the patrol yard, on-site storage, equipment for pumping from storage into the tank on the spreader truck, and pumps, plumbing and metering on the spreader trucks. Transportation from source is often the highest of the costs that determine cost-effectiveness. Depending on these factors, the type and total quantity of brine used in a given area may change from year to year.

The ice melting rate of various brines may impact cost-effectiveness. Laboratory tests show that the effectiveness (grams of ice or snow melted per gram of liquid) varies with temperature and that each liquid has its own characteristic curve, known as the eutectic curve. In practice the differences between chemicals are insignificant at higher temperatures (just below freezing) but may increase at lower temperatures (Koefod et al, 2014). Liquids are normally not used for anti-icing below -6 degrees C and for prewetting below -12 degrees C on Provincial highways. De-icing or anti-icing materials are not used below -18 degrees C on Provincial highways in Ontario.

The quantity applied (kilograms per 2-lane km) at a given time is adjusted within specified limits, according to the ambient intensity of snowfall, temperature, sunlight, traffic and other conditions. The frequency of application during a storm is governed generally by the highway classification which establishes the service interval (see attached) and the total quantity of application typically multiplies with the number of lanes of highway width. The total quantity applied in any storm for a given highway depends on the duration and intensity of the storm and in any year depends on the severity of the winter. The Ministry recently adopted a Winter Severity Index to rate and compares the severity of winter weather on a seasonal basis.

The quantity of materials used can vary by 30% or more from year to year or from place to place per unit length of highway as a function of weather conditions. The total quantity used on provincial highways in winter 2015-16 was 640,000 tonnes of rock salt and 10 million litres of brine. This equates to a provincial average of 37 tonnes of rock salt and 578 litres of brine per centerline kilometer of highway. 578 litres of brine equates to approximately 175 kg of dry salt.

The dispersal of salt to the roadside environment occurs principally through surface runoff into highway ditches, seepage into groundwater, and road spray aerosol. Scandinavian research findings indicate that the quantity of brine spray declines exponentially with distance from the roadside, with reduction by 90% within 8 metres, and returning to background levels within 200 metres of the roadside at ground elevation (Blomqvist and Goran, 2003).

9.3 Ministry of Transportation of Ontario Specification for Pre-Wetting/Anti-Icing Products

Description:
Products for pre-wetting/anti-icing are used for the purpose of de-icing/anti-icing the highways of Ontario by any or all of the following methods: direct application to the road surface or by adding the product to the aggregate being used to de-ice or provide traction to the road surface.

Materials: All materials shall meet the following requirements and specifications as listed herein.

1. No products shall contain constituents in excess of the following established total concentration limits as tested in accordance with the listed test methodology from this Appendix. Maximum concentrations are stated as parts per million (ppm). The specified limits may change to conform to current environmental policies and/or regulations.

Parameters	Units	Specification and Variance
Phosphorus	ppm	≤25.0 (+5%)
Total Cyanide	ppm	≤30.0 (0)
WAD Cyanide	ppm	≤0.20 (0)
Arsenic	ppm	≤5.0 (0)
Barium	ppm	≤10.0 (0)
Cadmium	ppm	≤0.20 (0)
Chromium	ppm	≤0.50 (0)
Copper	ppm	≤0.20 (0)
Lead	ppm	≤1.0 (0)
Selenium	ppm	≤5.0 (0)
Zinc	ppm	≤10.0 (0)
Mercury	ppm	≤0.05 (0)
Oil and Grease	ppm	≤20.0 (0)

2. The product shall not contain greater than 1.0% (V/V) Total Settleable Solids and shall have ninety-nine percent (99.0%) of the Solids Passing through a Number 10 sieve after being stored for 168 hours at -20 degrees C (+/- 1 degree C) **or** 10 degrees C above the stated eutectic temperature for that location (+/- 1 degree C), whichever is lower. The Percent total settleable solids and Percent solids passing on a No. 10 Sieve **must** yield a value greater than or equal to 99%.

3. The product shall not contain greater than 1.0% (V/V) Total Settleable Solids and shall have ninety-nine percent (99.0%) of the Solids Passing through a Number 50 sieve after being stored for 24 hours at the eutectic temperature of the area (+/- 1 degree C) and then stored an additional 24 hours at -20 degrees C (+/- 1 degree C). The Percent total settleable solids and Percent solids passing on a No. 50 Sieve **must** yield a value greater than or equal to 99%.

4. The pH level of liquid chemical products must be between 6.0 and 9.0.

5. The product must have a maximum viscosity of 500 centipiose at 10ºC above its eutectic temperature.

6. Natural / Multi-Chloride brines must meet MTO’s minimum friction requirements.

7. A graph and corresponding table documenting the viscosity of the product from 5 degrees C to the required eutectic temperature for the areas for which the product is to be used **must** accompany the bid and must meet the criteria for viscosity (at area eutectic value) and eutectic values for each given area, expressed in the following chart (Table 2).

Table 2

Area	Eutectic Temperature Degrees Celsius
Kenora	-35
Thunder Bay	-35
Cochrane	-35
New Liskeard	-35
Sault Ste. Marie	-30
North Bay	-30
Sudbury	-30
Ottawa	-30
Owen Sound	-30
Huntsville	-25
Bancroft	-25
Kingston	-20
London	-20

8. Submit a specific gravity chart with correlating weight percentage and freeze point information presented in 1% increments beginning with a five percent solution. The chart must contain information up to, including, and exceeding, ***by 5% (or the solubility limits of your product)*** the concentration being submitted for use by the Ministry.

9. Any anti-foaming agent that may be deemed necessary for unloading and/or circulation shall be present, at the correct proportions, in the samples submitted for testing with the bid.

10. Material Safety Data Sheet (MSDS) must accompany the most recent detailed product specification sheet, and all documents must be clearly legible.

    The MTO has the right to accept or reject products based on the materials used to produce the product. These materials will be assessed for the potential of causing a decrease in the public health and safety. The right to accept or reject a product based on composition rests solely with the MTO. The MTO assessment shall be final and in the best interest of the MTO.

9.4 Ministry of Transportation of Ontario Maintenance Best Practice

Ministry of Transportation

Ontario

MAINTENANCE BEST PRACTICE

Pre-Wetting - Road Salt

MBP-705

REFERENCE

- Maintenance Manual – Maintenance Quality Standard MQS's-701, 702 & 703
- Maintenance Manual – Maintenance Best Practices: MBP's -701, 702 & 703
- Maintenance Manual – Environmental Protection
- Maintenance Manual – Occupational Health and Safety Hazards

BEST PRACTICES

GENERAL

This Maintenance Best Practice describes the pre-wetting of road salt, which involves the use of liquid chemicals to enhance the performance of the road salt being applied to the road surface during winter operations.

When salt is pre-wet, more material is retained on the road surface, and as such, a reduction in salt application rates can achieve the same effectiveness as dry salt application at traditional rates. Pre-wetted salt begins to form a brine solution quicker than dry salt. It is the brine solution that prevents or breaks the bond between the road surface and the snow/ice.

The enhanced performance of the salt as well as the retention of salt on the road surface facilitates achieving a bare road more quickly and maintains bare pavement longer. A bare road surface provides better traction thereby increasing the safety of the highway for the motoring public.

The retention of the salt on the road surface not only enables a reduction in application rate it also reduces the amount of salt that is introduced into the environment from the road maintenance operation.

SPREADING

1. The methods for applying pre-wetted salt should follow MBP 702, with the exception of application rates.

2. Pre-wetted salt should be applied at rates in accordance with Table 705, Variable Application Rates for Onboard Pre-wet Road Salt.

3. When freezing rain is occurring or anticipated, pre-wetted salt may be applied. In such cases, it is recommended that the material be applied by spinner.

PRE-WETTING SALT APPLICATION RATES

The variable application rates for onboard pre-wet road salt should be used as suggested in Table 705. If the desired results are not achieved, then material can be re-applied.

The rates are based on a liquid chemical rate of 5% by weight added to the road salt as it is applied to the road. As with dry salt, results may vary depending on a variety of related conditions, such as road surface temperature, sun, cold wind, traffic volumes, high precipitation accumulation, high humidity or a combination of any number of these conditions.

TABLE 705

Variable Application Rates for Onboard Pre-wet Road Salt			
Precipitation	**Pavement Temperature Range**		
	0 to –5	**-5 to –10**	**-10 to -18**
Frost	50	70	70
Light Snow	70	100	130
Heavy Snow	130	130	170
Freezing Rain	130	170	170
Application rates are in kg/2lane km of pre-wetted salt			
Temperatures are in Celsius			

9.5 Ministry of Transportation of Ontario Direct Liquid Application Guideline

Direct Liquid Application (DLA) Guideline

February 9, 2007

The Ministry will continue the ban on Natural / Multi-Chloride Brine as a DLA liquid. Liquid suppliers may apply for an exemption to this ban on a specific product basis, based on MTO's minimum friction requirements.

DLA products may be used in accordance with Ministry DLA specifications, with the following additional guidance:

For all DLA liquids:

- DLA liquid should be applied to treat forecasted conditions at the rates outlined below:

Winter Event	Litres / Lane Km
Frost	60
Light snow	60 to 80
Moderate snow, Heavy Snow, Freezing Rain	80 to100

Sodium Chloride DLA liquids:

- DLA liquid should **not be** applied if the air and pavement temperatures are:
- Below –5°C at the time of application
- Forecast to be less than 10 C° above the eutectic temperature of the DLA liquid before the next winter event

Calcium, Magnesium and Natural / Multi-Chloride based DLA liquids:

- DLA liquid should **be** applied:
  - As close to the beginning of the Winter Event as possible
  - When the air and pavement temperatures are:
    - Below +5°C and forecast to remain below +5°C for the next 12 hours, and
    - A minimum of 10 C° above the eutectic temperature of the DLA liquid and forecast to remain a minimum of 10 C° above the eutectic temperature of the DLA liquid for the next 24 hours.
- DLA liquid should **not be** applied:
  - When both the relative humidity is below 60% and the air and pavement temperatures are between 0°C and +5°C
  - more than once in a three-day period unless a Winter Event (frost, snow or freezing rain) or rain, has removed the product from the pavement as DLA liquid can remain on the pavement up to several days after application

Issued By Highway Standards Branch: February 9, 2007

9.6 Utility Survey-Pole Washing Considerations

This survey is intended to gather information on considerations when designing a pole washing program.

1. Does your Utility perform Pole Washing? ☐ Yes ☐ No
   If no, please explain further in the comments section below.
2. When is washing performed? (Check all that apply)

   ☐ Spring ☐ Fall ☐ Winter ☐ Summer ☐ Other: ________________________

   ☐ Morning ☐ Afternoon ☐ Evening ☐ Other: _________________________

   Ambient temperature range (Deg C): _____________________

   Temperature constraints: _________________________

   Wind speed constraints: _________________________

3. Where is washing performed? (Check all that apply)

   Geographical Location (Road/area):

   ☐ Highway (400 Series) ☐ Major Rd ☐ Side/Residential Rd ☐ Farm

   ☐ Industrial ☐ Urban ☐ Rural ☐ Airport ☐ Other: ___________

   ☐ Sub-Station ☐ Distribution ☐ Other: ______________

   Do you use a strategy that targets roads within a specific proximity of Highways or Major Roads? ☐ Yes ☐ No If yes, what distance? (km): ______________

   Location on pole:

   ☐ Insulators ☐ Cut-out ☐ Equipment (Transformers, Switch, Etc.) ☐ Entire pole

   ☐ Other: ______________

4. What is washed? (Check all that apply)

   Insulator Material types:

   Polymer: (☐EPDM ☐Silicone ☐ EVA ☐ Polyethylene), Other:____________)

   ☐ Porcelain ☐ Glass ☐ Other:_____________

   Any type not washed? _________________ (if so why?): __________________

   Insulator type:

   ☐ Suspension ☐ Post type ☐ Pin type ☐ Other:___________________

   Any type not washed? _________________ (if so why?): __________________

   Framing Construction Types:

   ☐ Christmas tree ☐ Cross-arm ☐ Arm-less ☐ Other: ________________

   Any type not washed? _________________ (if so why?): __________________

   Circuit Types:

   ☐ Three Phase Circuits ☐ Single Phase Circuits

   Voltage levels washed? ____

   Any voltage not washed? _________________ (if so why?): __________________

5. Who does the washing: ☐ In-house crew ☐ Contractor

6. Industry Standards followed: ☐ IEEE Standard 957, Guide for Cleaning Insulators

☐ Other: _________________________

7. Effectiveness:

Is your pole washing program working? (i.e. reducing pole fire numbers in your service area?)

☐ Yes ☐ Needs Improvement ☐ Not Sure

Provide additional comments: ____

Is leakage current data collected? ☐ Yes ☐ No

If Yes, what is collected and what method is used? _________________________

8. Other Comments:

____
____
____
____
____
____
____
____

9.7 Utility Survey-Pole Washing Considerations (Results summary)

Answer to question1:

- 8 utilities responded YES, and the remainder of respondents said NO. Those who replied NO said they either did not have contamination or pole fire concerns, or they did have a pole washing program in the past but found it not to be effective or warranted.

Answer to question 2:

- The majority of responding utilities said they washed in both spring and fall. Some performed washing in Spring only, or December/January only.
- The majority of responding utilities said they washed morning and afternoon.
- Minimum washing temperatures were between -12 and -5 Deg C.
- Most did not wash in high wind speeds.

Answer to question 3:

- Geographical washing locations were determined mostly from each utilities past experience. These included 400 series highways, major roads, side/residential roads, sub-stations distribution centres, industrial areas, urban areas and rural areas.
- There were no specific distances used from target roads.
- 5 of 8 utilities with a washing program washed all insulation equipment on the pole, and 3 of 8 utilities with a washing program washed insulators only.

Answer to question 4:

- Responses to these questions varied between utilities however all INSULATOR MATERIAL TYPES, INSULATOR TYPES, FRAMING CONSTRUCTION TYPES and CIRCUIT TYPES were washed. Note: There was significantly less emphasis on washing voltage levels that were 13.8kV or below.

Answer to question 5:

- o The majority of respondents use a contractor to perform their pole washing.

Answer to question 6:

- o Most respondents follow the IEEE 957 guidelines however; some utilities supplement their procedures using additional internal standards.

Answer to question 7:

- Of the 8 utilities that have a pole washing program, 3 replied YES, 2 replied NEEDS IMPROVEMENT, 1 replied NOT SURE, and 2 did not enter a reply to this question.
- Zero respondents were collecting leakage current data.

Answer to comments section:

The following comments were provided by various utilities in the comments section of the survey: (comments are listed in no particular order)

- Poles containing 44kV CCT's are fully washed, which will also include any under build on them (including 13.8kV and 27.6kV if present). Poles with only 13.8kV or 27.6kV are not part of program.
- Our Utilities Pole washing program is working. We receive a high level of contamination from road salt around major highways and major roads that must be cleaned from insulators. For example, in March 2015 the weather had been cold for a long stretch of time and we were not able begin our spring pole washing activity as planned. When the weather sharply warmed up in mid-march, we experienced 52 pole fires. In contrast, in 2016 the contractor was able to start his activity at an appropriate time in late February and we only encountered one pole fire.
- Ever since we started the pole washing program in 2011, we have had no contaminant related equipment failure.
- We have not utilized pole washing in recent history. Our utility had some issues with insulator flashovers on poles adjacent to a freeway in the winter of 2015. Some of the problems were related to late 1980s/early 1990s vintage EPDM EPAC 27 kV class insulators. We have recently replaced the insulators adjacent to the freeway with the next highest insulator class in order to prevent this issue from occurring again. The 44 kV lines were re-insulated with 69 kV insulators and 27.6 kV lines were re-insulated with 44 kV insulators.
- Our Utility does not experience the same salt/ industrial contamination found at other LDC's. We have not experienced any pole fires because of contamination there for do not perform pole washing
- We do not pole/insulator wash. The locations of our poles are not susceptible to road salt.

- We have no pole fires so no need to wash
- Our Utility does not complete an Insulator Washing Program.
- We used to perform insulator washing in the fall, using our own crews. We did not have a history of having many pole fires and were not sure whether our insulator washing was contributing to this or the fact that we use 46kV insulators on our 27.6 kV system. We also replaced nearly all of our porcelain insulators with hydrophobic polymer insulators. We stopped washing about 8 years ago and have found that we continue to have low (almost no) incidents of pole fires. In our opinion, for our area and typical framing, pole/insulator washing is unnecessary.
- Our Utility does not perform Insulator washing we are situated in an area that does not require it. We do not have any history of pole fires from contamination,(not located near any major highway). We are surrounded by Hydro One infrastructure and they also do not perform this task in our area.
- To date we have not experienced any pole top fires that would be attributed to pole / insulator contamination. The service territory is considered urban in nature with a very limited amount (approx. 1%) in close proximity (100 to 300 meters) to a major highway corridor.
- Our Utility does not follow an insulator washing program. We have 4 KV as our primary distribution voltage and as such we have not had pole fire issues. We have infra-red and yearly pole testing to monitor any potential problems and would certainly use insulator washing if pole fires became a concern.
- We have no Pole washing program and have not performed pole washing in the past 6 years.
- Our Utility does not have a pole/equipment washing program. Over the past several years we have implemented an insulator and cut-out switch replacement program due to premature failures and tracking issues. The program has been successful in reducing associated outages and pole fires.
- We have very infrequent pole fires.
- Our rate of failures is much higher before seasonal wash. The pole wash program effectiveness is dependent on the responsiveness of crews during optimal washing weather conditions.
- We are washing porcelain insulators twice per year, installing higher class insulators at major highways and areas with higher contaminations.
- Our Utility is aware of ESA Distributor Bulletin DB-01-16 Mitigation of Pole Top Fires and believes this is not a major concern for our distribution system for the following reasons:
- There is no correlation between outages due to pole top fires and “dirty” insulators in our distribution system.
- Our Utility has no poles in close proximity (less than 50m) to 400 series Highways and is not aware of any significant air pollution generated by local commercial/industrial customers
- It rains frequently in this area, even in the winter, due to proximity to large water bodies; the insulators are effectively washed by the rain
- Distribution voltages are mainly 44kV and 4.16kV (we currently have less than 1km of 13.8kV). A typical pole contains up to one 44kV circuit at top of pole and up to two 4.16kV underbuild circuits (either cross-arm or arm-less framing). All new 4.16kV overhead circuits are framed using 15kV hardware in anticipation of future voltage conversion. For 44kV circuits, we suspect the mounting height makes these circuits less susceptible to airborne pollutants that are “kicked up” into the air at low level by vehicular traffic. For 4.16kV circuits which are mounted lower on the pole and may be exposed to more pollutants that are “kicked up” in the air at low level by vehicular traffic, we suspect the low operating voltage combined with the new 15kV hardware (increased creep distance) makes it less likely for a 4.16kV circuit to track and sustain a flash-over due to pollutants.

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