

Expanded Safety Division Investigation of April 19, 2014

Electrical Contact and Fatality with a PSNH 3 Phase Distribution  
System in Keene, NH



*Additional and Expanded Investigation for DE 15-417*

*December 9, 2016*

Table of Contents

Purpose.....3

Executive Summary and Conclusions .....3

Compiled Staff Recommendations: .....3

Investigation Review. ....5

1. Additional Facts of the April 19, 2014 electrical accident.....6

2. The remedial steps taken by PSNH as a result of the April 19, 2014 accident.....9

3. PSNH’s knowledge of the condition of crossarms and other equipment attached to the top of poles in its system.....10

4. PSNH’s policies and procedures related to power line inspection and maintenance, education of the public as to downed power lines, the repair of poles, crossarms and related equipment and the process for prioritizing such repairs, and the schedule and procedure for inspecting poles, crossarms, and related equipment.....12

5. Any information in PSNH’s possession, indicating poles, crossarms or related equipment that requires repair or replacement.....16

6. The known current state of PSNH inventory of poles, crossarms, and related equipment.....19

7. The methods PSNH uses to manage risks associated with operating and maintaining its plant.....22

## **Purpose**

The Safety Division, as directed and authorized by the Commission in NHPUC Order No. 25,818, (September 25, 2015), hereby submits its review of the issues directed by the Commission in the second phase of an investigation stemming from an April 19, 2014 electrical accident.<sup>1</sup> The additional investigation primarily focuses on assessing whether other similar hazardous conditions exist within the Public Service Company of New Hampshire (“PSNH”, “Eversource/PSNH” or “the Company”) electrical distribution system. The evaluation considered whether policies, procedures, training or internal systems used by PSNH contributed to the unfortunate result (a fatality) and determining if any deficiencies exist associated with operations and maintenance procedures. The Safety Division further examined whether any associated inherent risk would be systemic in nature or limited to an isolated event.

## **Executive Summary and Conclusions**

Based on its investigation of the facts and the information provided in this Report, Staff believes the Company has adequate maintenance policies and procedures in place to be able to operate and maintain its New Hampshire electric system in a safe and reliable manner. The Company has also demonstrated that its employees are sufficiently trained to follow policies and procedures, and to perform their assigned duties at high levels of proficiency.

The unfortunate and tragic accident of April 19, 2014 was an extremely rare event for the Company. Although the Company’s electrical systems encompass more than 440,000 pole locations throughout the state, (with a similar estimate for attached crossarms), **broken crossarms are a rare occurrence for this system.** A broken crossarm or other electric system equipment failures that result in a fatality are extremely rare. With the review of materials provided, Staff does not believe there are any policy or procedural issues that are systemic in nature.

Staff has made seven recommendations to the Company in this report that are intended to refine existing policies and procedures.

## **Compiled Staff Recommendations:**

**Staff Recommendation 1:** The Company should take immediate actions to incorporate into training programs the recognitions and aftereffects of this accident, emphasizing with the clearest of instructions and importance of following the existing policies applicable for its line crews, supervisors, managers and subcontractors to recognize and consider broken crossarms to be a failure of critical equipment requiring an immediate call to the Eversource Customer Care number.<sup>2</sup> This is information that should

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<sup>1</sup> RSAs 365.5, 374.37 and 374.38 authorize the Commission to investigate accidents, performance, conduct, and omissions of a utility to determine if it is in compliance with laws, rules, and Commission Orders.

<sup>2</sup> Listed in procedure “ED-3032 Distribution ROW Line Patrols, Section VIII. C. Reports of Repairs Needed”.

be reported immediately, essentially alerting Customer Care of the potential, if not immediate safety risk, triggering the appropriate prioritization and scheduling of a prompt repair or replacement action. The risk of a line inspection report that documents important potential safety related risks of being misplaced, or otherwise forgotten before it is received by Customer Care, must be mitigated immediately.

**Staff Recommendation 2:** Appendix A should be more clearly identified with ED-3032 and include the Eversource name in the header or footer of the page (or appropriate operating company name, if not standardized), the “Effective Date”, “Revision Date”, and “Approved By” information, similar to what is provided on pages 1 through 5. Lastly, language should be inserted in the corrective action table to clearly classify a broken crossarm as an example of a P1 risk, requiring immediate repair or replacement

**Staff Recommendation 3:** Re. EMP 5.45.1 Table 1 ROW Maintenance. The time interval should be revised from the condition-based “*as required*” to the time-directed “*annual*”, to be consistent with ED-3032, Section VIII. A. Annual ROW Patrols.

**Staff Recommendation 4:** Eversource should provide the explicit details and language used in M8-MT-3001 into ED-3032 or alternatively clearly reference how and when M8-MT-3001 is applied to the sub transmission system inspections.

**Staff Recommendation 5:** Eversource should extend its public outreach efforts to include those facilities with campus-like settings including county complexes, educational facilities such as universities, community colleges, prep schools, and large institutions such as hospitals with auxiliary onsite medical office buildings and other health care facilities. Its Fires and Wires training which is traditionally provided to Fire Departments and Emergency Responders can be applied to these facilities where Security Departments, Facilities Departments and Buildings/Grounds Maintenance responsibilities are in place.

**Staff Recommendation 6:** The Company’s training and maintenance procedures should include a section that provides more detailed instructions for field inspectors to collect some level of measurable data related to the condition of wooden crossarms. The collected data should somehow scale, or classify the level of deterioration. This field inspection data should be entered into the Cascade data base when the inspection notes are turned in to E. The procedure should follow NESC guidelines that will allow the Company to efficiently perform analysis of the data to determine and compare the current structural strength of each crossarm to NESC requirements. A section should be added to the appropriate field inspection form(s) for the purpose of collecting this data on each crossarm. Results of the assessment of deterioration of crossarms and related structures, using NESC guidelines, should be efficiently collected, documented in Company inspection and maintenance reports and entered into the Cascade database.

**Staff Recommendation 7:** The Company shall review its procedures for adequacy related to *Line Maintenance Policy and Procedure M8-MT-3001, Section 4.1 Aerial Line Patrol and Subsections 4.1.3, specific to assigning an observer to conduct each aerial patrol, and 4.1.6, specific to broken crossarms and decayed/rotted pole tops*. Staff believes the procedures and training related to ED 3032 policy need to be closely examined and strengthened. One method is to incorporate M8-MT-3001 language of aerial patrols and other type of patrols.



## **Investigation Review.**

This Staff review consists of the following seven elements:

1. Additional investigation of the facts of the April 19, 2014 accident;
2. The remedial steps taken by Public Service Company of New Hampshire ("PSNH") as a result of the April 19, 2014 accident;
3. PSNH's knowledge of the condition of crossarms and other equipment attached to the top of poles in its system;
4. PSNH's policies and procedures related to power line inspection and maintenance, education of the public as to downed power lines, the repair of poles, crossarms and related equipment and the process for prioritizing such repairs, and the schedule and procedure for inspecting poles, crossarms, and related equipment;
5. Any information in PSNH's possession, indicating poles, crossarms or related equipment that requires repair or replacement;
6. The known current state of PSNH inventory of poles, crossarms, and related equipment;
7. The methods PSNH uses to manage risks associated with operating and maintaining its plant.

Within each of the elements, this report comprises information obtained from the Company, and additional comments from Staff.

On December 17, 2015, Public Service Company of New Hampshire submitted a comprehensive response to issues raised by the Commission in New Hampshire Public Utilities Commission Order No. 25,818. Staff reviewed the PSNH responses, conducted a conference call on March 16, 2016 and attended one technical session on August 2, 2016 with the Company to discuss the relevant issues and to ask additional questions related to information shared during the discussions. Eversource met with Staff, discussed various issues and answered follow up questions. For this phase of the investigation, Eversource assembled a group of management, engineering and operations professionals having applicable responsibilities that provided key details to their maintenance policies and procedures.

The facts of this case, although basically the same as previously described by Staff in its September 18, 2015 report, are supplemented with additional information provided by the Company in its December 17, 2015 submission, as well as through responses to Staff inquiries and follow up discussions with Staff.

## **1. Additional Facts of the April 19, 2014 electrical accident.**

The root cause of the incident was determined to be human error. Processes were in place that if followed would have likely repaired the broken crossarm by immediately scheduling a replacement and eliminating the safety hazard.

This phase of the investigation opened during the March 16, 2015 conference call, when Staff probed the Company to explain how the January 15, 2014 field inspection report that revealed the broken crossarm on Pole 185/24 was processed. Staff inquired how this particular inspection report and all inspection reports were prioritized and managed, identifying all applicable policies and procedures.

*In response, the Company explained that a subcontractor on foot patrol conducted a routine line inspection of W185, as part of the vegetation management activities portion of the Reliability Enhancement Program. It was during this patrol that the broken crossarm, attached to pole 185/24 was discovered. The subcontractor completed an inspection report form for pole 185/24 noting the broken crossarm, as well as other less serious issues. The inspector also took photos from a ground level position that documented the damaged crossarm, still attached to the pole top. At some point during the same day the PSNH field supervisor for this W185 inspection was made aware of the broken crossarm. The paper copy of the report and the photographs were sent to this supervisor.<sup>3</sup>*

The Company provided Staff with the results of its internal investigation of events that transpired after the January 15, 2014 field inspection report of pole 185/24 was delivered by the subcontractor to the PSNH Supervisor.

*The inspection report document was placed in the PSNH field supervisor's Company vehicle with no further immediate action taken. The field inspection report was then inadvertently misplaced while in the possession of the field supervisor. The critical information detailed in the document was not entered into the Cascade system<sup>4</sup> and prioritized for immediate repairs by a Company line crew. As a result, no follow up maintenance repairs were conducted. The misplaced inspection report was not located until after the April 19, 2014 incident.*

The Company explained to Staff how this information **would have been** prioritized in the Cascade System if procedures were properly followed.

*The broken crossarm on Pole 185/24, as described in the field inspection report, would normally have been categorized as a P4 "high priority"<sup>5</sup> repair item. Eversource/PSNH*

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<sup>3</sup> Re. Company Response #20, Attachment 20 (received on 5/19/14).

<sup>4</sup> PSNH uses the Cascade System as a work order management system.

<sup>5</sup> ED-3032 Appendix A - Work Prioritization Guide in effect in January 2014, describes a P4 as "Maintenance on critical components which is necessary to insure safe, reliable, and economical operation of the system. Work will be scheduled 0 to 4 weeks out and proceed until system component is returned to service." P5 was the highest or most urgent priority at the time of the incident, as PSNH was using a priority scale of P1, lowest priority to P5, highest priority.

*explained to Staff that repairs of broken crossarms are moved to the top of the work schedule of reported P4 issues, with repair orders generally being called in, scheduled and completed on the same day. P4 “high priority” can have time frames of repairs from 0 to 4 weeks but this type of inspection finding would have put it closer to the next scheduled work day. Of all the findings from the W185 ROW inspection that day, Pole 185/24 was the only one to have a broken crossarm, as well as the only damage that would have been prioritized as a P4 or greater issue found during the January 15, 2014 foot patrol inspection. All other issues reported as a result of the field inspection of the W185 line were considered lower priority items that would be corrected as part of the Company’s routine maintenance procedures.*

**PSNH Procedure ED-3032, Distribution ROW Line Patrols:**

Staff reviewed *PSNH Procedure ED-3032, Distribution ROW Line Patrols* that was in effect at the time of the January 15, 2014 right of way (ROW) inspection of W185.

In *Section VIII.C. Reports of Repairs Needed*, the first sentence reads:

*“Situations found within distribution Rights of Way that are an immediate safety hazard or may cause an immediate outage to the line should be reported to Customer Experience as a trouble ticket at 1-800-662-7764.”*

In this case the field supervisor did not call in a trouble ticket for the broken crossarm. At the time, the crossarm had not completely broken away from the pole top and the #1 phase line had not yet separated from the insulator attached to the broken crossarm. The conductor remained at or near its normal height above the ground.

The second sentence of *Section VIII.C.* reads:

*“All other situations and findings of damaged equipment should be reported to the Supervisor – Construction & Contract Project Services.”*

In this case, upon his return to the office at the end of the day, the PSNH field supervisor was expected to processor otherwise report information from the inspection report documents into the Cascade data base. The database is used for work maintenance prioritization, and scheduling for repair/replacement as needed and generating a tracking method for these tasks. Any record from the January 15, 2014 ROW inspection activity related to the discovery of the broken crossarm on pole 185/24 was not reported by the PSNH field supervisor. As a result, the information of the broken crossarm was not entered into the Cascade system and the Supervisor – Construction & Contract Project Services was not made aware of issue, and the PSNH procedure for the normal work maintenance prioritization process was not completed.

The remainder of *Section VIII.C.* reads:

*“Regardless of the method of communication, a follow-up e-mail to the Supervisor, with a copy the Division Field Engineering Manager will be made. The Supervisor – Construction & Contract Project Services will acknowledge the email and provide an estimated time frame to investigate and perform repairs if required.”*

The PSNH normal maintenance prioritization chain was broken when the information from the inspection report for pole 185/24 was not processed according to procedure.

**Staff Recommendation 1:** The Company should take immediate actions to incorporate into training programs the recognitions and aftereffects of this accident, emphasizing with the clearest of instructions and importance of following the existing policies applicable for its line crews, supervisors, managers and subcontractors to recognize and consider broken crossarms to be a failure of critical equipment, requiring an immediate call to the Eversource Customer Care number.<sup>6</sup> This is information that should be reported immediately, essentially alerting Customer Care of the potential, if not immediate safety risk, triggering the appropriate prioritization and scheduling of a prompt repair or replacement action. The risk of a line inspection report that documents important potential safety related risks of being misplaced, or otherwise forgotten before it is received by Customer Care, must be mitigated immediately.<sup>7</sup>

Using information that Staff has pulled from various documents, reports and data responses received from PSNH, a timeline of PSNH inspection and maintenance activities on the W185 ROW, structures (poles, crossarms) and attached equipment leading up to the accident is provided here:

- On October 8, 2008, the Company performed a Ground Line Inspect & Treat (GLT) on the W185 with an estimated 69 structures being treated.<sup>8</sup>
- In 2011, the Company performed a NESC inspection of the entire 16.4 miles of W185.<sup>9</sup>
- On October 14, 2013, the Company performed an aerial inspection of pole top structures on the W185. The aerial inspection of W185 reportedly “found nothing”.<sup>10</sup> This was approximately three months prior to the 1/15/14 foot patrol inspection that noted the broken crossarm.
- On January 15, 2014, approximately three months prior to the accident, the Company performed a foot patrol ROW inspection of the W185. The inspection reported the broken crossarm on pole 185/24.<sup>11</sup>
- The incident occurred on April 19, 2014, as a result of the crossarm failing. The #1 Phase line<sup>12</sup> of W185 broke away from the structure and dropped to a level just above the ground.

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<sup>6</sup> Listed in procedure “ED-3032 Distribution ROW Line Patrols, Section VIII. C. Reports of Repairs Needed”.

<sup>7</sup> During the technical session between Eversource and Staff at Company headquarters in Manchester on 8/02/16, Company representatives informed Staff of ED-3032 process flow changes to account for reporting. One new reporting requirement is that Eversource inspection contractors are now instructed to call in to Customer Care to report information related to any line inspection findings that are recognized as serious situations.

<sup>8</sup> Re. Company Response #16 (received on 5/19/14) and Eversource/PSNH response to Commission Order No. 25,818, (see 12/17/15 PSNH response in DE 15-417, Volume 1 of 3, Tab 3, 2008 GLT inspection table). The Company is scheduled to perform its next GLT inspection of W185 circuit in the year 2023 (15 year cycle, EMP 5.61.1).

<sup>9</sup> Re. 12/17/15 PSNH response to Issues Raised in Commission Order No. 25,818 in DE 15-417, Volume 1 of 3, Tab 2, page 10 of 13).

<sup>10</sup> Re. Company Response #16, (received on 5/19/14).

<sup>11</sup> Re. Company Response #16, (received on 5/19/14).

<sup>12</sup> Re. Company Response #8, (received on 5/19/14).

## **2. The remedial steps taken by PSNH as a result of the April 19, 2014 accident.**

The Company indicated the following remedial steps were taken as a result of the April 19, 2014 accident:

### Field:

1. *On 4/19/14, the Company replaced the crossarms and insulators on pole 185/24.*
2. *On 4/21/14, PSNH Line Workers assigned to the Keene AWC started a complete patrol and review of 66 structures in the ROW areas of the W185 circuits. The patrol was completed on 4/23/14.*
3. *Two poles were replaced on 4/29/14 as a result of the ROW inspection of W185 circuits.*
4. *The Company reported no other conditions on W185 that would present a danger.*

### Back Office:

5. *The PSNH procedure for Emergency ROW Patrols, ED-3032 Distribution ROW Line Patrols, was revised November 2, 2015 to ensure needed repairs are tracked in Cascade system.*
6. *ED-3032 Appendix A - Prioritizing Distribution Corrective action, formerly referred to as Work Prioritization Guide, has been revised on November 2, 2015 most notably to resequence the numeric order of significance for P1 through P5<sup>13</sup>.*
7. *PSNH is adding design of ROW lines to its STORMS Work Management System (previously a paper system)<sup>14</sup>.*

During the 3/16/16 conference call between Staff and the Eversource/PSNH team, Staff referenced Appendix A of the 11/02/15 revised procedure *ED-3032 Distribution Right of Way Line Patrols*. Specifically, Staff asked why the “*Prioritizing Distribution Corrective Action*” section did not address broken crossarms.

*In response, the Company informed Staff on 4/15/16 that the “Prioritizing Distribution Corrective Action” list has been revised to include broken crossarms as a Priority 1 corrective action, requiring immediate corrective action.*

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<sup>13</sup> In the old Work Prioritization Guide an issue ranking of P1 was for scheduling the least significant system maintenance items while a ranking of P5 was for scheduling the most significant system maintenance items. Under the revised Appendix A - Prioritizing Distribution Corrective action, a ranking of P1 has become the highest priority maintenance scheduling issue. Conversely, a P5 is now the ranking for lowest priority maintenance work scheduling.

<sup>14</sup> STORMS (Sewer/Trent Operations Resource Management System) is a work management system while CASCADE is a time and condition based maintenance system.

Staff believes the Company's decision to add broken crossarms to the list of examples that fall under the Priority 1 (P1) category in the latest revised Prioritizing Distribution Corrective Action table is an important clarification as to how these occurrences are to be addressed in the Eversource Maintenance Policies and Procedures. The most current version of Eversource procedure ED-3032 Appendix A available to Staff<sup>15</sup> did not include crossarms as an example of a P1 corrective action.

**Staff Recommendation 2:** Appendix A should be more clearly identified with ED-3032 and include the Eversource name in the header or footer of the page (or appropriate operating company name, if not standardized), the "Effective Date", "Revision Date", and "Approved By" information, similar to what is provided on pages 1 through 5. Lastly, language should be inserted in the corrective action table to clearly classify a broken crossarm as an example of a P1 risk, requiring immediate repair or replacement<sup>16</sup>.

**3. PSNH's knowledge of the condition of crossarms and other equipment attached to the top of poles in its system.**

The Company provided the following four inspection program cycles and circuit summary information:

- *NESC Inspection and Maintenance – roadside circuits inspected and maintenance completed list for the period of 2007 through 2012;*
- *Roadside ground line inspect and treat summary reports of poles for the most recent ten year cycle (2006-2015);*
- *ROW ground line inspect and treat summary reports of poles for the most recent ten years (2006-2015) of the fifteen year cycle;*
- *ROW foot patrol circuits inspected list for the period of 2011 through 2015 (funded by REP2).*

Between July 25, 2016 and August 5, 2016, as an electric service reliability initiative the Company informed Staff that it performed visual inspections of all three-phase lines in its NH system. This covered approximately 3,600 miles of lines, with more than 440,000 pole locations with crossarms attached also being checked. Only 23 crossarms were identified as needing repair. The work was completed on August 26, 2016. An additional 1,078 crossarms were recommended for replacement but did not require immediate attention. As a result of these inspections, 267 locations were identified where insulators were recommended for replacement. Vegetation management issues were reported at 1,415 locations. Other routine maintenance issues such as transformers without fuses, missing animal guards, hot line clamp and spacer cable issues were also identified. 99.4% of the locations of three phase circuits are in adequate condition.

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<sup>15</sup> Re. ED-3032 Revised Version 11/02/15, included in Volume 1, Tab 1, of the Company's December 17, 2015 submitted documents.

<sup>16</sup> The Company reported to Staff on 8/2/16 that the Prioritizing Distribution Corrective Action table has been updated to include broken crossarms as an example of a P1, highest priority corrective action.

Although not related to the April 19, 2014 incident, the Company informed Staff that it is now using new standards for poles and crossarms. Standard poles are now Class 2 and crossarms are now composed of composite materials. Staff views these changes as beneficial improvements for both safety and reliability.

Company procedure ED-3032 “Distribution ROW Line Patrols” is a policy of Eversource/PSNH “to improve reliability and safety”. This procedure supplements EMP 5.45 “Right of Way Inspection”, which provides a checklist of potential maintenance and repair issues, including top of pole structures and attached equipment, within distribution rights of way. The policy references five other Eversource Maintenance Programs and other Company guidelines, policies and procedures used in its inspections plus the Cascade distribution ROW line patrol and tracking system.

Based on what Staff has learned from this investigation, the Company’s specific knowledge of the condition of crossarms and other equipment attached to the top of poles is generally attained from its various inspections, inspection reports and defined policies and procedures for reporting of troubles during the normal course of operating and maintaining its system. The field inspection report used by the subcontractor to report the broken crossarm on pole 185/24 is one example of how information is collected and reported back to Electric Field Operations. ROW inspection reports (EMP-6.45) and Form OP1857, used for Foot Patrol inspections of line equipment and ROW conditions<sup>17</sup> are other examples. Occasionally the public will notify the Company of a condition that has changed over the course of a day.

The Company supplements its land based inspections with Aerial Line Patrols (M8-MT-3001, Section 4.1), using helicopters, to visually determine the condition of transmission lines and structures without actually climbing structures or using testing equipment. Aerial Line Patrols use an observer to inspect the transmission line and record any abnormalities on a tape recorder, hand held computer, or by written notes.

Staff’s assessment is that PSNH, while having data regarding when inspections were last conducted, lacks specific knowledge of the condition of the state of each component that makes up the Overhead Plant. There appears to be a gap of what is identified in the inspection form 6.33 and that which is retained in the Cascade database. PSNH’s knowledge of the poles alone is more robust, as that particular database has many fields. For example, the Test and Treat Report for poles has specific details such as type, year installed, class pole, height of pole, pole manufacturer, pole species, original treatment type, original circumference, inspection type, last inspection date, who treated the pole last. Unfortunately pole information is only one component of the Overhead Plant and retention of other components knowledge is not as detailed.

Cross arms and other equipment attached to the top of poles does not have an equivalent or corresponding level of detail of knowledge of components. PSNH is attempting to backfill gaps and is attempting to attain more component specifics requiring increased data collection efforts.

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<sup>17</sup> See M8-MT-3001, Section 4.2 - Includes: poles, structures, and adjacent areas; insulators; potential vegetation problems; and condition of section ahead.

PSNH's knowledge of the condition of the crossarms and other equipment is calculated by default. It estimates how many crossarms that are in their total system and can estimate quantities of other equipment but it cannot precisely say what the configuration or material list is at every location. PSNH has demonstrated that it knows how many cross arms required repair. Thus it believes the remaining crossarms are in an adequate condition to continue the desired function of each. They also have no reason to believe that the condition will deteriorate until the next scheduled inspection cycle.

**4. PSNH's policies and procedures related to power line inspection and maintenance, education of the public as to downed power lines, the repair of poles, crossarms and related equipment and the process for prioritizing such repairs, and the schedule and procedure for inspecting poles, crossarms, and related equipment.**

Eversource has standardized the maintenance policies and procedures of its operating companies to the maximum extent possible, related to inspection and maintenance. These policies and procedures cover inspections, repairs and replacements of poles, crossarms and related equipment, as well as the prioritization of these maintenance actions. It is Staff's view that the policies and procedures are adequate for the intended purpose with the minor exception of clarifications of a small number of these policies and procedures addressed specifically in the few recommendations noted.

**Distribution Maintenance Program:**

The objectives of the Company's Distribution Maintenance Program are to:

- *Assure the availability and operability of utility assets and components to "as designed" or "as authorized" standards (ratings, limits, etc.)*
- *Assure the identification and recording of utility assets and components requiring maintenance or inspection activities*
- *Assure maintenance and inspection activities are appropriate, repeatable and uniform for similar/same utility assets and components*
- *Assure such activities are performed in accordance with equipment manufacturer's recommendations, adopted utility best practices, regulations, laws, or other policies or established practices, and are recorded as maintenance instructions*
- *Assure corrective maintenance activities are uniformly prioritized to ensure the reliability of service and the highest levels of efficiency, while minimizing system operating and maintenance costs for our customers and for our shareholders*
- *Assure the historical measure of maintenance, inspection and repair for all identified utility assets and components is maintained including periodic, scheduled, corrective, or emergency actions*
- *Assure training, tools, equipment and services are known and available to carry out identified maintenance and inspection activities*
- *Assure continuous improvement methods are in place and update the program as needed*



**Eversource Maintenance Policy:**

The Eversource Maintenance Program, in conjunction with industry codes and standards and Eversource design standards, is intended to provide the highest levels of public safety. The requirements and instructions within the maintenance program are designed to meet or exceed all regulatory and statutory safety requirements. Eversource categorizes and schedules its maintenance operations as either “Time-Directed” or “Condition-Based” Maintenance.

**EMP 4.1 Time-Directed Maintenance** is summarized as follows:

*Time-Directed maintenance has been the Company’s traditional method of maintaining equipment and systems. This method uses predetermined time intervals to perform inspections and various other maintenance tasks. This method has advantages and disadvantages. On the plus side, this method provides for a predictable cost structure for budgeting its maintenance activities. Conversely, this method is not always the most cost effective and in some cases can negatively impact system reliability.*

**EMP 4.2 Condition-Based Maintenance** is summarized as follows:

*Condition-Based Maintenance is based on using real-time data to prioritize and optimize maintenance resources. Its goals are to 1.) improve customer service by preventing equipment breakdowns that could disrupt service; and 2.) reduce maintenance costs by preventing damage to systems due to component failure and to eliminate undue maintenance such as replacing components on a time-directed schedule instead of looking at their actual condition.*

Staff has reviewed the policies and procedures pertinent to this docket. Staff has also compared these policies and procedures to the standards provided in NESC Code 2012.

The following eight policies and procedures<sup>18</sup> are related to power line inspections, maintenance, repair/replace of poles, crossarms, and top of pole equipment:

- a. TD953 Revision 7 – Inspection, Treatment, Restoration and Replacement Guidelines for Distribution System Wooden Poles (re. Vol. 1, Tab 5);
- b. ED-3032 Distribution ROW Line Patrols (re. Vol. 1, Tab 5);
  1. Appendix A - Prioritizing Distribution Corrective Action guidelines
- c. EMP 5.45 ROW Inspection of Distribution Lines (re. Vol. 2, Tab 5.45);
- d. EMP 5.61 Wood Pole Inspection and Maintenance (re. Vol. 2, Tab 5.41);
- e. OP-0030 Emergency Patrols and Actions for Line Faults (re. Vol. 1, Tab 5);
- f. EMP 6.45 ROW Inspection of Transmission Lines (re. Vol. 3, Tab 6.45);
- g. M8-MT-3001 Transmission Line Inspection and Maintenance (re. Vol. 1, Tab 5);
- h. Intercompany Operating Procedure #7 (re. Vol. 1, Tab 5).

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<sup>18</sup> Copies of these policies and procedures are included in Volumes 1, 2 and 3 submitted by the Company on 12/19/17. The Company provided numerous other maintenance policies for other parts of the system

**ED-3032** is the policy for Distribution ROW inspections. This policy references several of the Company's maintenance procedures that provide the detailed descriptions necessary to carry out the policy requirements. ED-3032, Section VIII. Procedure calls for:

*A. Annual ROW Patrols.*

*The supervisory of the Project Management organization, or assigned designee, shall initiate annual patrols of all 34.5, 12.47, and 4 kV ROW lines.*

Staff observes that annual ROW patrols are time-directed maintenance activities with an expectation of patrols being scheduled with predetermined time intervals of 1 year. Staff noted that Annual ROW patrols for W185 were not conducted annually. Staff could not find inspection information for 2009, 2010 and 2013 as stated in Section 1 of this report (see pages 5, 6.)

Eversource Maintenance Program procedure **EMP 5.45 Right of Way Inspection**, revised 6/06/15, provides additional details on ROW inspections. Section 5.45.1, Table 1 –ROW Maintenance Intervals reveals that Inspection and Maintenance Activity Schedules for Routine Inspections are now listed as condition-based inspections with an unspecified periodic time interval of “as required”. The ROW Maintenance Schedule line item for Routine Inspections includes the following note:

*Note 1: Routine Inspections are subject to O&M budgetary limitations. When funding or other resources become available, every effort should be made to perform these inspections on an annual basis.*

Staff notes the provision for time-directed annual ROW patrols, as described in ED-3032, is contradicted by the condition-based, unspecified maintenance interval for routine inspections as spelled out in EMP 5.45.1, Table 1, and Note 1. Revision 3 made June 6, 2015 reverses a previous better practice. Limited budgets should be the exception and not the standard practice and may be counter to achieving the goal of maintaining the highest safety standards as listed on page 10 of this report.

**Staff Recommendation 3: Re. EMP 5.45.1 Table 1 ROW Maintenance. The time interval should be revised from the condition-based “as required” to the time-directed “annual”, to be consistent with ED-3032, Section VIII. A. Annual ROW Patrols.**

**ED-3032. Appendix A**, as presented by Eversource with the 11/02/15 revision to ED-3032<sup>19</sup>, provides guidelines for prioritizing and scheduling maintenance corrective actions of reported problems on the Eversource electric distribution systems. The prioritization corrective actions are scaled from 1 through 5, with priority level 1 issues requiring immediate corrective actions and priority level 5 issues being lowest priority work which is typically scheduled concurrent with other scheduled maintenance activity. Although this version of Appendix A does not specify which priority level broken crossarms are

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<sup>19</sup> Re. Vol.1, Tab 1 of the Company response to issues raised in NHPUC Order No. 25,818

categorized, the Company has stated that it prioritizes broken crossarms as priority level 2 issues, which has a corrective action requirement of 0 to 4 weeks. Additionally, the Company states that it then moves these broken crossarm maintenance corrective actions to the top of the priority level 2 issues, typically requiring same day repairs or replacement.

**M8-MT-3001** is a comprehensive administrative guideline that provides an inspection and maintenance procedure that details measures to ensure efficient and timely inspection and maintenance of Eversource system *transmission lines*, structures and vegetative conditions. M8-MT-3001, one of several references supporting ED-3032, is a series of process steps that include the following:

- 4.1 Aerial Line Patrol
- 4.2 Foot Patrol
- 4.3 Emergency Patrol
- 4.4 Special Patrol
- 4.5 Aerial Vegetation Patrol
- 4.6 Climbing Inspection
- 4.7 Infrared Inspection
- 4.8 Wood Pole Inspection
- 4.11 Routine Maintenance (including poles, crossarms, insulator replacements)

Staff observes that although M8-MT-3001 primarily pertains to transmission line inspection and maintenance, the Company's reference to this administrative guideline in ED-3032 Distribution ROW Line Patrols is appropriate. The W185 circuit like many 34.5kv, three - phase circuits makes up the *subtransmission* system or "backbone" of the New Hampshire electrical system. PSNH management and employees often use the term. It is unclear whether the distribution policies or the transmission policies are applicable. Many of the inspection processes of M8-MT-3001 apply to this investigation of the accident that occurred on W185. Specifically, sections *4.1 Aerial Line Patrols*, *4.2 Foot Patrol* and *4.8 Wood Pole Inspection* are relevant to the investigation. Staff observed that the language and details provided about the types of patrols are much more explicit than what is provided in the Distribution Maintenance Policy ED 3032.

**Staff Recommendation 4:** Eversource should provide the explicit details and language used in M8-MT-3001 into ED-3032 or alternatively clearly reference how and when M8-MT-3001 is applied to the sub transmission system inspections.

**Public Educational and Awareness Training Safety Programs:**

Eversource periodically offers various educational presentations and DVDs to municipalities, universities, hospitals and other entities upon request that are designed to promote safety and awareness of the public around power lines. The Company provided Staff with examples of four such training program materials.<sup>20</sup> Staff believes the training materials are important and should be shared with a wider base rather than "available upon request".

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<sup>20</sup> Re. Vol.1, Tab 6 of the Company response to issues raised in NHPUC Order No. 25,818.

**Staff Recommendation 5:** Eversource should extend its public outreach efforts to include those facilities with campus-like settings including county complexes, educational facilities such as universities, community colleges, prep schools, and large institutions such as hospitals with auxiliary onsite medical office buildings and other health care facilities. Its Fires and Wires training which is traditionally provided to Fire Departments and Emergency Responders can be applied to these facilities where Security Departments, Facilities Departments and Buildings/Grounds Maintenance responsibilities are in place.

**5. Any information in PSNH's possession, indicating poles, crossarms or related equipment that requires repair or replacement.**

**PSNH Roadside and ROW Ground Line Inspect and Treat (GLT) Reports<sup>21</sup>**

	Roadside Poles Inspected	Priority Rejects (Immediate Replacement) Poles	Priority Rejects (Immediate Replacement) Percent	Normal Rejects (<6 month Replacements) Poles	Normal Rejects (<6 month Replacements) Percent	Restoration Rejects (Partial Repair) Poles	Restoration Rejects (Partial Repair) Percent	ROW Poles Inspected
2010	24,302	140	0.6%	212	0.9%	141	0.6%	1,710
2011	24,220	100	0.4%	101	0.4%	73	0.3%	1,814
2012	25,695	94	0.4%	153	0.6%	72	0.3%	1,209
2013	24,876	103	0.4%	242	1.0%	225	0.9%	1,526
2014	24,114	119	0.5%	182	0.8%	138	0.6%	N/A
2015	15,681	105	0.7%	119	0.8%	108	0.7%	1,341
	123,207							7,600

The Company tracks specific maintenance requirements in its Cascade system for poles, crossarms and related equipment. As reflected in the Roadside and ROW Ground Line Pole Inspection and Treatment statistics summarized in the table above, information comes in from routine inspections reports related to poles, crossarms, other equipment, etc. that has been found to need some type of maintenance, repair or replacement. The information is entered into the Cascade system and the issues are prioritized per Company procedure ED-3032, Appendix A. Damaged poles, crossarms and related equipment that may have immediate reliability or safety issues are prioritized accordingly with repairs or replacements scheduled immediately.

*PSNH reports the following number of crossarms that have failed during the last five years:*

<u>2010</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>
5	9	7	5	12

*PSNH reports the following number of crossarms that have been issued from inventory during the last four years:*

<u>2013</u>	<u>2014</u>	<u>2015</u>	<u>2016</u>
3,720	3,081	2,490	954 *

\* The 2016 numbers are through 4/15/16.

<sup>21</sup> Re. Vol.1, Tab 3 of the Company response to issues raised in NHPUC Order No. 25,818

PSNH did not provide a breakdown of the reasons why crossarms were issued (i.e. storm related, inspections revealed repairs were necessary, circuit relocations or additions, etc.). As of 4/15/16 PSNH reported 10 locations where crossarms need to be replaced. These are all in ROW locations and the first two of the 10 locations (on the 3165 and the 3172 circuits) were to be replaced in 2016 as a part of a larger project to replace several structures. The remaining eight locations were on the Company schedule for replacement this year<sup>22</sup>. All locations have been and will continue to be checked frequently until they are replaced.

### **NESC C2-2012:**

In reviewing NESC C2-2012, Staff references to the following:

**Table 261-1 Strength factors for Structures, crossarms, braces, support hardware, guys, foundations, and anchors**, where NESC addresses deterioration of critical wooden structures.

*Table 261-1— Strength factors for structures (includes poles), crossarms, braces, support hardware, guys, foundations, and anchors*  
***[It is recognized that structures will experience some level of deterioration after installation, depending upon materials, maintenance, and service conditions. The table values specify strengths required at installation. Footnotes specify deterioration allowed, if any. When new or changed facilities add loads to existing structures (a) the strength of the structure when new shall have been great enough to support the additional loads and (b) the strength of the deteriorated structure shall exceed the strength required at replacement. If either (a) or (b) cannot be met, the structure must be replaced, augmented, or rehabilitated.]***

In this case, the NESC code recognizes that wooden structures such as crossarms, exposed to the elements, will deteriorate over time. Table 261-1 provides strength factor requirements for Grade B and Grade C structures located in areas where exposure to the effects of 1) combined ice and wind district loading, or 2) extreme wind and extreme ice with concurrent wind loadings. Footnote 2, applicable to strength factors at predetermined levels (NESC Table 253-1) of ice and wind loading while Footnote 3 is applicable to strength factors at an extreme levels (NESC Table 253-1) of wind loading and extreme ice with concurrent wind loadings. The pertinent parts of footnotes 2 and 3 read as follows:

1. *Wood and reinforced structures shall be replaced or rehabilitated when deterioration reduces the structure strength to 2/3 of that required when installed.*

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<sup>22</sup> A rotted crossarm was formerly a lower priority and ranked P2 it would now be a P4. A broken crossarm is a higher priority and formerly ranked as a P4 it would now be considered a P1 (high outage risk). This has been modified since the incident.

2. *Wood and reinforced structures shall be replaced or rehabilitated when deterioration reduces the structure strength to 3/4 of that required when installed.*

PSNH has demonstrated that it has inspected all of its roadside and ROW circuits within the past ten years with documents showing the results of its NESC inspections of the Company's roadside circuits. Although the NESC inspection results do not provide details specific to structure strength or deterioration of crossarms, the Company has provided copies of Maintenance Order Data Sheets that show some details related to the observed condition of crossarms are reported and entered into the Cascade system.

**Staff Recommendation 6:** The Company's training and maintenance procedures should include a section that provides more detailed instructions for field inspectors to collect some level of measurable data related to the condition of wooden crossarms. The collected data should somehow scale, or classify the level of deterioration. This field inspection data should be entered into the Cascade data base when the inspection notes are turned in to Electric Field Operations. The procedure should follow NESC guidelines that will allow the Company to efficiently perform analysis of the data to determine and compare the current structural strength of each crossarm to NESC requirements. A section should be added to the appropriate field inspection form(s) for the purpose of collecting this data on each crossarm. Results of the assessment of deterioration of crossarms and related structures, using NESC guidelines, should be efficiently collected, documented in Company inspection and maintenance reports and entered into the Cascade database.

**Aerial Line Patrols:**

As described in the section 1 above, on 10/14/13 the Company performed an aerial line inspection of pole top structures on the W185. The purpose of aerial line patrols, as described in the Company's Line Maintenance Policy and Procedure M8-MT-3001, Rev. 1, Aerial Line Patrol is as follows:

*The purpose of **aerial patrols** is to visually determine the condition of transmission lines and structures without actually climbing structures or using testing equipment.*

Additional Aerial Line Patrol specifics include the following:

- 4.1.3 *Assign an observer to conduct each aerial patrol; and*
- 4.1.6 *Inspect the transmission line and record any abnormalities on a tape recorder, hand held computer, or by written notes. Examples include, but are not limited to:*
  - *Broken Crossarms*
  - *Missing/broken shield wire*
  - *Decayed/rotted pole tops*

The Company's 10/14/13 aerial line inspection reportedly "found nothing".<sup>23</sup> Staff is concerned that this aerial inspection, with the specific purpose to determine the condition of lines and structures, including crossarms, revealed that it found nothing to report specific to the rotted condition of the crossarm attached to pole 185/24. Three months later (on 1/15/14), during a foot patrol field inspection of the same W185, pole 185/24 was reported to have the broken crossarm. An additional three months following the 1/15/14 foot patrol discovery, on 4/19/14, the tragic accident happened. On 4/20/14, Staff examined the broken crossarm at the AWC and observed quite evident decay, dry rot, and deterioration, particularly on the upward facing surface. This particular crossarm was installed in 1950.<sup>24</sup> Because the purpose of aerial patrols are to record any abnormalities such as broken crossarms or decayed/rotted pole tops, Staff asserts the level of decay on this crossarm should have been visible to the observer performing the aerial inspect of W185 that day. By not observing this level of deterioration during the aerial patrol, Staff questions the validity of those specific examples cited in the Aerial Line Patrol maintenance procedure.

**Staff Recommendation 7:** The Company shall review its procedures for adequacy related to *Line Maintenance Policy and Procedure M8-MT-3001, Section 4.1 Aerial Line Patrol and Subsections 4.1.3, specific to assigning an observer to conduct each aerial patrol, and 4.1.6, specific to broken crossarms and decayed/rotted pole tops*. Staff believes the procedures and training related to ED 3032 policy need to be closely examined and strengthened. One method is to incorporate M8-MT-3001 language of aerial patrols and other type of patrols.

**6. The known current state of PSNH inventory of poles, crossarms, and related equipment.**

**Inventory:**

PSNH estimates its distribution systems contain 442,644 pole locations. PSNH also estimates that approximately half of the approximate 442,644 pole locations are PSNH assets and half are telecommunication company assets<sup>25</sup>. For the pole assets that PSNH maintains, it performs inspections; the remaining poles are maintained by the respective telecommunication companies. PSNH does perform time-directed inspections of all circuits, which captures pole-attached equipment at all pole locations. These time-directed inspections are NESC inspections, which are conducted on 10-year cycles.

Although the Company has provided Staff with an estimate of how many crossarms are currently in use on its NH distribution system, it is not able to specify exactly how many are currently in use. PSNH stated the Company's accounting system previously did not account for crossarms as physical assets. Depending on the design, each pole may include one, or more than one crossarm on a single pole (large corner, heavy conductor loading, etc., may use multiple crossarms). It also acknowledged that many pole

<sup>23</sup> Re. Company Response #16 from the original investigation of this Keene incident, received on 5/19/14.

<sup>24</sup> Re. Company Response #9 from the original investigation of this Keene incident, received on 5/19/14.

<sup>25</sup> PSNH has Intercompany Operating Agreements in place with Fairpoint and with TDS for poles that are shared, or jointly owned.

locations don't have any cross arms. Consequently, the Company's best approximation assumed that for every pole that had multiple crossarms, there were an equal number of poles with none. Thus PSNH estimates there approximately 220,000 poles that they maintain that have crossarms.

PSNH's pole mounted equipment is considered Overhead Plant. Pole mounted equipment is typically considered the traditional equipment that performs the customary electrical function of providing power supply service to end use customers. The Company accomplishes this by installing, operating, and maintaining primary and secondary systems. Equipment also refers to auxiliary components used for identifying, supporting, and protecting various components required for the distribution system to operate in an integrated manner. A sample of overhead plant facilities and equipment includes:<sup>26</sup>:

- Armless Brackets
- Arresters
- Pins
- Cable TV
- Clearance
- Conductors
- Cutouts Shift/Remove Items
- Crossarms
- Emergency Trimming
- Grounds
- Guying
- Insulators
- Municipal
- Overhead Fault Indicators
- Poles
- Ridge Pins
- Service
- Squirrel Guards
- Streetlight Lamps/Brackets
- Tags
- Telephone
- Termination
- Transformers

**State of Inventory:**

**Poles:**

PSNH supplied information that from 2010 through 2014 they inspected approximately 123,200 poles that are located roadside. The Company inspects approximately 22,000 to 24,000 poles per year. Of these completed inspections, on average, each year

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<sup>26</sup> Overhead Plant is described more fully Eversource Maintenance Program Document 5.33 Rev 4 dated July 1 2015.



approximately 2% of the poles are considered needing some sort replacement. [0.5% need immediate attention, 0.75% require replacement within 6 months, and 0.75% require restoration services]. In 2015 this amounted to approximately 330 pole replacements/restorations.

**Crossarms:**

Until recently, company data was limited regarding age of installation for any given crossarm as well as other equipment that has been attached to a structure (pole). Today, the Company has begun cataloging more detailed crossarm information derived from inspections and maintenance activities. Summary information gets into its Cascade database. In the past this wasn't heavily emphasized, leaving a void of information regarding condition of auxiliary equipment in its vast asset inventory. The Company's inventory is and was kept in discrete disparate databases; historic records systems containing various activity and maintenance reports. Although a new Geographical Information System (GIS) has recently been implemented, an inventory of all the pole equipment is not readily or easily available. For this report, the Company made extensive efforts to gather, analyze and provide data, statistics and other pertinent information that attempted to reflect the Eversource New Hampshire system, but neither the Cascade database, the STORMS system nor the GIS have all the inventory and maintenance history of the overhead plant.

The Cascade system is able to collect inspection and maintenance activities for all the 171 substations<sup>27</sup> operated by PSNH but it does not collect all information associated with maintenance activities of overhead plant. The primary purpose of the Cascade System is to issue work orders so that inspection, maintenance and capital equipment purchases as well as labor can be tracked.

**How Overhead Plant inspection intervals are determined:**

Within Cascade's system are time period triggers defined by PSNH for each maintenance cycle defined within the Eversource Maintenance Manual. The time period triggers are different for different types of plant (substation switches, protective relays, pad mounted switchgear etc.). Overhead plant is just one of the categories within the Cascade System.

Inspection activities are classified into two general types:

- *Time Directed Maintenance* based on pre-determined intervals
- *Condition Based Maintenance* considers continuous monitoring equipment such as SCADA systems.

The vast majority of overhead plant uses *Time Directed Maintenance* Schedules for Intervals of Inspection. PSNH uses a 1 year interval for small segments of circuits that originate from the substation to the first protective electrical device. These are referred to as Backbone Inspections. The vast majority of the Overhead Plant is inspected on a time defined maintenance schedule of 10 years.

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<sup>27</sup> Re. FERC Form No. 1, PSNH Annual Report, End of 2014/Q4, Page 450.1, Number of Substations.

PSNH performs an NESC inspection in which includes the following for lines and equipment in service:

- compliance with safety rules when placed into service
- inspected at such intervals as experience has shown to be necessary
- shall be subjected to tests as necessary to determine required maintenance
- conditions or defects affecting compliance with NESC code revealed by inspection or tests, if not promptly corrected, shall be recorded; such records shall be maintained until the conditions or defects are corrected
- lines or equipment with recorded conditions or defects that would be expected to endanger life or property shall be promptly corrected, disconnected, or isolated
- Other conditions or defects shall be designated for correction

**Forward looking progress:**

As described earlier, 100% of the Company's new crossarms are made from composite materials, where applicable, that are not susceptible to rotting or insect damage. The new standard pole is a Class 2, which is a much stronger pole than the old Class 3 standard poles. Thus any new pole installation will be at a minimum, a Class 2 pole. New crossarms installations to poles will be made from composite materials. Any existing rotted, or broken crossarm that is scheduled for replacement, will be replaced with one made from the newer composite material. While this is an improvement it still leaves the large inventory of existing crossarms that must be periodically inspected and its impact in the short term will be minor compared to the inspection workload that PSNH performs.

**7. The methods PSNH uses to manage risks associated with operating and maintaining its plant.**

A Risk Management program is not a tool traditionally employed by PSNH or most electric utilities. The extremely rare event of electrical contact made by the public with PSNH's plant (poles and wires) even though located in open and unrestricted environments can lend itself to dismissing the probability as extremely low. Risk is defined as the probability or likelihood of an event times the consequence of such event. The other half of the risk equation is evaluating the potential consequences when assessing and ranking risks. Inspections are completed more on a company established frequency basis than on a risk basis. These frequencies are established for maintaining reliability of systems and keeping customer interruptions minimized. If a condition is found that requires repairs then it is prioritized and scheduled. The inspections themselves are not performed on a risk managed basis.

Staff has carefully reviewed the Company's applicable operations and maintenance policies and procedures. The Company's maintenance policies and manuals describe procedures specific to maintaining its electric distribution and transmission systems. Procedures are generally structured to provide the following information:

- Purpose
- Areas/Persons affected
- References to supporting documents, policies, procedures, management systems

- Definitions
- Safety and Health Handbook considerations
- Policy goals
- Overview
- Procedure specifics
- Appendix
- Revision History

There is very little mention of risk management when looking at the policies. The concept of risk management can be difficult to consider when the overhead plant of PSNH is found in nearly every community, street, and building throughout its extensive service territory. Staff believes emerging technologies will allow PSNH to include risk management concepts into future inspection processes.

The Company has also demonstrated that its workforce, including its subcontractors, supervisors and managers receive safety training and are generally aware of how these operations and maintenance responsibilities and tasks, are performed in accordance with its policies and procedures. To a large extent, this combination of instructions and training is an element of those traditionally found in risk management processes.