STATE OF CONNECTICUT
PUBLIC UTILITIES REGULATORY AUTHORITY

DOCKET NO. 12-07-XX

APPLICATION OF
THE CONNECTICUT LIGHT AND POWER COMPANY
FOR APPROVAL OF ITS SYSTEM RESILIENCY PLAN

____________________________________

TESTIMONY OF

DANA L. LOUTH

ON BEHALF OF

THE CONNECTICUT LIGHT AND POWER COMPANY

____________________________________

JULY 9, 2012
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## APPENDICES

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I. INTRODUCTION

Q. Please state your name, position, and business address.

A. My name is Dana L. Louth. I am Vice President of Infrastructure Hardening and Interim Vice President of Energy Delivery Services for The Connecticut Light and Power Company ("CL&P" or the "Company"). My responsibilities include developing a system resiliency plan as well as directing employees in activities associated with distribution system planning and major distribution project construction. My business address is 107 Selden Street, Berlin, Connecticut.

Q. Please summarize your education and professional experience.

A. Please see Exhibit DLL-1.

Q. Mr. Louth, have you testified previously before the Public Utilities Regulatory Authority ("Authority"), or its predecessor agency, the Department of Public Utility Control ("Department")?

A. Yes, I have. I have testified before the Authority on several occasions since 1997 relative to transmission and distribution issues.
Q. In what dockets before the Authority have you previously testified?
A. Please see Exhibit DLL-2.

Q. What is the purpose of your pre-filed testimony?
A. The purpose of my testimony is to present CL&P’s $300 million multi-year system
resiliency plan ("System Resiliency Plan", or the "Plan") as required by Article 4.1 of the
Settlement Agreement\(^1\), approved by the Authority in its decision in Docket No. 12-01-07
dated April 2, 2012\(^2\).

Q. What does Article 4.1 of the Settlement Agreement specifically require of the
Company?
A. Article 4.1 of the Settlement Agreement requires that CL&P, “within 90 days of the closing
of the [merger] Transaction, submit to the Authority a multi-year plan and cost recovery
mechanism for $300 million of spending in additional distribution system resiliency".\(^3\) My
testimony will present CL&P’s System Resiliency Plan. Mr. Michael Mahoney’s pre-filed
testimony will present CL&P’s proposed cost recovery mechanism for the Plan.

Q. Can you provide a brief overview, or summary, of your testimony herein?
A. Yes. My testimony provides background to the Company’s System Resiliency Plan by
discussing (i) the characteristics of CL&P’s distribution system, (ii) the effects and
impacts of major storms on the CL&P distribution system, and (iii) the relationships
between storms of different types and distribution infrastructure damage. My testimony

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\(^1\) This “Settlement Agreement”, dated March 13, 2012, was entered into by and between Northeast Utilities and
NSTAR, George Jepsen, Attorney General of the State of Connecticut, and Elin Swanson Katz, Consumer Counsel,
on behalf of the State of Connecticut, Office of Consumer Counsel, in connection with the application of Northeast
Utilities and NSTAR, dated January 19, 2012, for approval of a holding company transaction pending before the
Public Utilities Regulatory Authority (“Authority”) in Docket No. 12-01-07.

\(^2\) See final decision of the Authority in Docket No. 12-01-07, “Application for Approval of Holding Company

\(^3\) Settlement Agreement, Page 5.
will discuss various considerations, goals, and the process used by the Company in
developing the System Resiliency Plan. These include things such as (i) the variety and
types of system resiliency initiatives available to the Company, (ii) the system resiliency
practices of other utility distribution companies, and (iii) the recommendations of various
Connecticut distribution utility infrastructure performance storm reviews, such as those
recently conducted by Witt Associates ("Witt"), Liberty Consulting ("Liberty"), and Davies
Consulting ("Davies"). My testimony will describe system resiliency improvement
activities already initiated by CL&P and then provide a comprehensive discussion of the
Company’s Plan including (i) its underlying philosophy or basis, (ii) details of the what,
why, where, and cost of each proposed element of the Plan, and (iii) the prioritization
process used by the Company in targeting each proposed element of the System
Resiliency Plan.

Q. Please discuss the relationship between this filing and testimony you presented to
the Governor’s Two Storm Panel in the fall of 2012.

A. The Governor’s Two Storm Panel asked CL&P (and the United Illuminating Company)
what each company could do over the long term to make their electric systems less
vulnerable to the effects of storms. The Company presented a series of options along
with some general cost estimates associated with those options. Since that time, the
Company has been refining its thinking. This filing is CL&P’s proposal of a plan,

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4 Connecticut Governor Dannel P. Malloy announced the formation of The State Team Organized for the Review of
Management ("STORM") of Tropical Storm Irene on September 13, 2011. The eight member Panel was charged
with the following mission, “a broad, objective evaluation reviewing how Irene was handled in the state both in
preparation and recovery, identify areas that can be improved upon and, most importantly, make recommendations
for future disaster preparedness and response.” Following the October Nor’ easter, on November 8, 2011, the
Governor expanded the work of the Panel, renamed it The Two Storm Panel, and updated its charge “to include the
recent October Nor’ easter in its expanded scope.” Throughout this document the eight member Panel will be referred
to as the “Governor’s Two Storm Panel”.

5 See CL&P’s presentation to the Governor’s Two Storm Panel dated November 15, 2011 and Mr. Dana Louth’s
presentation to the same Panel dated December 14, 2011.
consistent with the terms of the Settlement Agreement, along with funding aimed at
improving system resiliency due to the effects of storms. It is consistent with material
presented to the Governor’s Two Storm Panel in terms of resiliency techniques and
segments of the distribution system to be upgraded.

Q. Please discuss the Company’s long-term approach for improving system
resiliency due to the effects of storms.

A. The Company has developed a phased approach that it will employ to develop and
implement its storm resiliency plans. The short-term plan consists of two phases that will
cover the years 2013 and 2014 in Phase 1 and the years 2015 through 2017 in Phase 2.
The long-term program, planned for implementation after 2017, will be based upon
evaluations done during Phases 1 and 2 of the short-term plan.

Q. How will the Company’s System Resiliency Plan benefit customers?

A. Upon completion of the System Resiliency Plan as proposed herein it is likely that fewer
customers will be without service during both normal, day-to-day activities and especially
in the wake of major and catastrophic storms. Additionally, because there will be fewer
interruptions, those customers that are without service will be restored (in aggregate)
more quickly upon completion of the System Resiliency Plan.

II. BACKGROUND INFORMATION REGARDING CL&P AND ITS VULNERABILITY TO
STORMS

Q. Please describe CL&P’s electric distribution system.

A. The CL&P electric distribution system serves approximately 1.2 million customers, covers
approximately 4,400 square miles or 87 percent of the total area in Connecticut, and had
a 2011 peak load of 5,516 megawatts (“MW”). Situated within this service territory are
149 communities including urban centers such as Hartford, Stamford, and Waterbury, suburban settings surrounding these cities, and rural settings throughout the state. The service territory includes heavily-treed areas, shoreline areas, and hilly terrain. Weather conditions are often severe and include ice and snow storms, heavy winds, thunderstorms, and occasional hurricanes and tornadoes.

The CL&P electric transmission system consists of approximately 1,638 circuit miles of overhead transmission and 135 miles of underground transmission. CL&P has 19 transmission substations, 97 distribution substations supplied from its transmission system, and 103 substations supplied from its distribution system. CL&P’s distribution system consists of approximately 16,976 circuit miles of overhead primary construction, and 6,352 circuit miles of underground primary construction, including both direct-buried and underground duct and manhole primary construction. Primary distribution voltages range from 4.16kV to 34.5kV with the majority of circuits operated at 4.8kV, 13.2kV, 13.8kV and 23kV. CL&P uses over 260,000 distribution transformers to supply its customers.

Q. Please further describe the weather events and conditions that can affect the Company’s distribution system infrastructure.

A. The location and geography of Connecticut is unique in that several different types of weather events can occur, sometimes in different areas of the state and sometimes simultaneously. Often these weather events are severe and these storms can severely affect the Company’s distribution system infrastructure. Storms can (i) occur during the winter, such as snow and ice storms that are sometimes combined with wind, or (ii) occur during the spring, such as high wind storms, or (iii) occur during the summer, such as thunderstorms and tornadoes, or (iv) occur during the fall, such as hurricanes and tropical
storms (or the remnants thereof) or other high wind storms.

Heavy rains, sometimes steady over a period of several days, and/or coastal storm surges as the result of hurricanes and tropical storms (or the remnants thereof) can cause flooding at/near the Connecticut coastline as well as along inland waterways and at other locations.

Q. What are the effects, on the Company’s distribution system infrastructure, of these weather events and conditions?

A. Trees, limbs, and other wind-blown debris can contact utility distribution infrastructure and cause damage, sometimes severely and sometimes extensively. It has generally been the Company’s experience that wind-blown debris, such as trees or other vegetation, damages the Company’s distribution system infrastructure directly rather than wind impinging upon utility structures and equipment. In the absence of trees, the Company’s distribution system infrastructure itself is generally able to withstand wind up to approximately 70 miles per hour before extensive damage begins to occur.

Ice (or heavy, wet snow\(^6\)) can affect utility distribution infrastructure and cause damage in two ways. First, trees (or portions thereof) that are overhanging or are within the fall zone of utility distribution infrastructure can fall and damage the underlying distribution infrastructure. Second, the weight of the ice (or heavy, wet snow) itself on wires and utility equipment, even in the absence of trees, can cause damage to utility distribution infrastructure from the sheer weight of the ice or snow. The Company’s distribution system infrastructure, in the absence of trees, is generally able to withstand up to 3/4” of

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\(^6\) The effects of snow on the CL&P distribution system are highly dependent on whether the snow is dry or wet. Dry snow is usually lighter or less dense and generally less “sticky” on trees and limbs, whereas wet snow is usually heavier or denser and generally sticks more easily to trees and limbs. Heavy, wet “sticky” snow loads trees and limbs much more than dry snow.
radial ice before extensive damage begins to occur. Flooding can also affect utility distribution infrastructure, cause damage, and impede timely service restoration. Flood water can rise into ground or pad mounted equipment (such as substation switchgear) causing electrical failures and/or other damage to the equipment itself. Flooding can also impede the Company’s access to its equipment and cause service restoration delays. Additionally, prolonged periods of heavy rain can saturate the soil, weaken the anchoring effect of tree root systems, and cause trees to become more vulnerable to falling over due to wind.

Q. How often do severe weather events occur within Connecticut?

A. The following Table DLL-1 details the event frequency for severe weather events within Connecticut. This data is a combination of actual severe weather events recorded since the 1950’s that is used to forecast the return frequency of severe weather events (such as hurricanes) for the state of Connecticut. The data in this table indicate that the frequency of some of these severe weather events is increasing. Knowledge of the types and frequency of severe weather events is useful in developing a storm resiliency plan.

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7 The Company’s electric distribution system construction standards have been prepared in conformance with the requirements of the National Electrical Safety Code (“NESC”). The state of Connecticut is within the NESC Heavy Loading Zone as illustrated in NESC Figure 250-1. For this zone, NESC Rule 250B and NESC Table 250-1 require that distribution system construction withstand \( \frac{1}{2} \)” of radial ice and 4 lbs/ft\(^2\) of simultaneous horizontal pressure due to wind loading. 4 lbs/ft\(^2\) of pressure due to wind loading equates to a wind speed of approximately 40 mph.
Table DLL-1

Frequency of Severe Connecticut Weather Events

<table>
<thead>
<tr>
<th>Event</th>
<th>Actual/Forecast</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summer</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thunderstorm (days per year)</td>
<td>Actual/Forecast</td>
<td>5.7 thunderstorm days per year since 1950</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 thunderstorm days since 1990</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14.6 thunderstorm days since 2000</td>
</tr>
<tr>
<td>Wind &lt; Tropical Storm 40 – 60</td>
<td>Actual</td>
<td>2 in the last 4 years</td>
</tr>
<tr>
<td>Category 1 Hurricane</td>
<td>Forecast</td>
<td>Return 15 – 20 years</td>
</tr>
<tr>
<td>Category 2 Hurricane</td>
<td>Forecast</td>
<td>Return 30 – 40 years</td>
</tr>
<tr>
<td>Category 3 Hurricane</td>
<td>Forecast</td>
<td>Return 60 – 70 years</td>
</tr>
<tr>
<td>Tornado (days per year)</td>
<td>Actual/Forecast</td>
<td>72 tornado days since 1950 (1.2 per year)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25 tornado days since 1990 (1.2 per year)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 tornado days since 2000 (1.4 per year)</td>
</tr>
<tr>
<td><strong>Winter</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter storms</td>
<td>Actual/Forecast</td>
<td>4.9 times per year since 1990</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.4 times per year since 2000</td>
</tr>
<tr>
<td>Ice storms (portions of the state)</td>
<td>Actual</td>
<td>11 events since 1990</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 events since 2000</td>
</tr>
<tr>
<td>Ice thickness</td>
<td>Actual/Forecast</td>
<td>0.75 inches most of the state, 50 year return</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.25 inches in the north-central region, 50 year return</td>
</tr>
</tbody>
</table>

8 The data on this table are derived from information published by the United States Department of Commerce National Oceanic and Atmospheric Administration ("NOAA"), and the National Weather Service ("NWS") and National Hurricane Center ("NHC") within NOAA. The source for data in this table can be found at the following web addresses: http://www.nhc.noaa.gov/HAW2/english/basics/return_printer.shtml ftp://ftp.ncdc.noaa.gov/pub/data/techrpts/tr200201/tr2002-01.pdf http://www.ncdc.noaa.gov/stormevents/ftp.jsp
Q. Do you have additional maps or diagrams that illustrate the levels or amount of wind and ice that can affect Connecticut?

A. Yes. These maps and diagrams are in Appendices A through E. Appendix A illustrates the location of individual hurricane strikes to the continental United States from 1950 – 2008. Appendix B illustrates the return period in years for hurricanes of various categories. Appendix C illustrates various wind zones in the United States. Appendix D illustrates the extreme wind loading criteria for the northeastern United States. Appendix E illustrates ice thickness for a 50-year return period in the eastern United States.

Q. Can you provide a description from the National Weather Service, or National Hurricane Center, of the sustained wind speeds associated with hurricanes?

A. Yes. The following Table DLL-2, from the National Hurricane Center\(^9\), lists the sustained wind speeds associated with hurricanes of various categories according to the Saffir-Simpson Hurricane Wind Scale\(^10\).

<table>
<thead>
<tr>
<th>Hurricane Category</th>
<th>Minimum Wind Speed (mph)</th>
<th>Maximum Wind Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 1</td>
<td>74</td>
<td>95</td>
</tr>
<tr>
<td>Category 2</td>
<td>96</td>
<td>110</td>
</tr>
<tr>
<td>Category 3</td>
<td>111</td>
<td>129</td>
</tr>
<tr>
<td>Category 4</td>
<td>130</td>
<td>156</td>
</tr>
<tr>
<td>Category 5</td>
<td>157</td>
<td>Greater than 157</td>
</tr>
</tbody>
</table>

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\(^9\) See the National Hurricane Center’s website at: [http://www.nhc.noaa.gov/aboutshws.php](http://www.nhc.noaa.gov/aboutshws.php)

\(^10\) The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage.
Q. Can you describe the effects in the Company’s service territory of the ten most severe, or damaging, storms in CL&P’s history?

A. Yes. The following table lists, in order from most severe to least severe, the ten most damaging storms in the last 50 years of CL&P’s history, as of the date of this testimony, in terms of the peak number of customers without service as a result of these weather events. The list indicates the variability in type of weather events that can cause significant interruptions to customers of CL&P.

<table>
<thead>
<tr>
<th>Event</th>
<th>Event Type</th>
<th>Peak Outages</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>October Nor’easter</td>
<td>Snowstorm</td>
<td>807,000</td>
<td>10/29/2011</td>
</tr>
<tr>
<td>Tropical Storm Irene</td>
<td>Tropical Storm</td>
<td>671,000</td>
<td>08/27/2011</td>
</tr>
<tr>
<td>Hurricane Gloria</td>
<td>Hurricane</td>
<td>506,150</td>
<td>09/27/1985</td>
</tr>
<tr>
<td>Hurricane Bob</td>
<td>Hurricane</td>
<td>275,000</td>
<td>08/19/1991</td>
</tr>
<tr>
<td>Ice Storm Felix</td>
<td>Ice Storm</td>
<td>250,000</td>
<td>12/16/1973</td>
</tr>
<tr>
<td>Snowstorm</td>
<td>Snowstorm</td>
<td>209,658</td>
<td>11/19/1986</td>
</tr>
<tr>
<td>Thunderstorm</td>
<td>Thunderstorm</td>
<td>201,651</td>
<td>07/23/1991</td>
</tr>
<tr>
<td>Wind</td>
<td>Windstorm</td>
<td>194,728</td>
<td>11/16/1989</td>
</tr>
<tr>
<td>Tornado</td>
<td>Tornado</td>
<td>174,700</td>
<td>07/10/1989</td>
</tr>
<tr>
<td>Thunderstorm</td>
<td>Thunderstorm</td>
<td>164,337</td>
<td>11/20/1989</td>
</tr>
</tbody>
</table>

11 With the exception of the October Nor’easter, Tropical Storm Irene, and Ice Storm Felix, the total number of customers interrupted shown on this data table is a summary of the data as reported to the Authority in Appendix 7 of the Company’s annual Transmission and Distribution Reliability Performance (“TDRP”) reports. In some cases, there have been some modifications to the peak number of customers interrupted for some of these storms.

12 See the response to Q-LF-039 in Docket No. 11-09-09.

13 See the response to Q-LF-039 in Docket No. 11-09-09.

14 Hurricane Gloria made landfall in Connecticut as a Category 1 hurricane.

15 Hurricane Bob made landfall in Rhode Island as a Category 2 hurricane.

16 The Northeast Utilities 1973 annual report to shareholders, page 15, says, “The unprecedented ice storm, which began December 16 and caused the worst tree damage since the 1938 hurricane, left over 250,000 CL&P and HELCO customers out of service”. The Company has been unable to locate any additional data regarding the peak number of its customers in Connecticut interrupted by this event.
Q. How many separate weather events in the last ten years caused outages to more than 50,000 CL&P customers?

A. As noted within Table DLL-3, two such weather events occurred during 2011 and are also presently listed in the top ten most severe storms (measured by the number of customers affected) in the last 50 years of CL&P’s history. During the last ten years there were an additional 18 separate weather events that each caused outages to more than 50,000 CL&P customers, for a ten-year total of 20 such events or about two per year.

Q. For what length of time were CL&P customers without service as a result of these severe weather events?

A. The length of time CL&P customers were without service varies by storm. In some cases, as a result of these severe weather events, some CL&P customers were without service for up to eleven days.

Q. Were there any other, non-weather-related events in the last ten years that caused outages to more than 50,000 CL&P customers?

A. Yes. The northeast blackout event of August 14, 2003, although not weather-related, interrupted service to 232,251 CL&P customers.

Q. Can you summarize the effects of weather on the Company’s distribution system infrastructure?

A. Yes. The state of Connecticut and the Company’s distribution system infrastructure is vulnerable to several different types of weather events that can result in long duration power outages to large numbers of customers across wide areas of the state. Ice storms, heavy wet snow, tropical storms, hurricanes and other wind events such as those
associated with severe thunderstorm activity can all cause power interruptions lasting
more than several days. The single biggest threat to the Company’s infrastructure and
facilities during significant, or severe, weather events is the trees/limbs that damage
and/or contact electrical plant.

III. REVIEW OF THE GOALS AND CONSIDERATIONS OF THE COMPANY’S SYSTEM
RESILIENCY PLAN

Q. Why is the Company investing in storm resiliency at this time?
A. The Company has always planned its infrastructure investments with an eye on the
weather (among other things). However, the severity of the two largest 2011 storms
caus[...]
caused the Governor of the state to challenge all state entities to be prepared for more
significant storms in the future. CL&P’s System Resiliency Plan will undertake steps that
will significantly reduce the vulnerability of CL&P’s distribution system to storms.

Q. What are the Company’s key goals in the development of the System Resiliency
Plan?
A. The Company’s key goals in the development of the System Resiliency Plan include the
following:

i. Achieve significant, sustainable improvement in infrastructure performance during
weather events.

ii. Focus the System Resiliency Plan initially on the most impactful activities, with
special emphasis on the Company’s worst-performing circuits.

iii. Provide preference in the System Resiliency Plan to initiatives that also provide
important improvement in day-to-day operations and system reliability.

iv. Utilize infrastructure retrofit initiatives to achieve both near term and lasting impact.

v. Utilize infrastructure evolution initiatives to continuously improve infrastructure
resiliency gradually over the next 40 to 50 years mainly through revisions to
construction standards and material selection/usage.

vi. Ensure expected improvement results occur and are sustained.

Q. **Please describe the difference between retrofit initiatives and evolution initiatives.**

A. Retrofit initiatives are those targeted at achieving an immediate impact by directly
seeking out and changing out a portion of the distribution system infrastructure, such as
replacing bare wire with covered wire along a circuit. Evolution initiatives are those
targeted at achieving impact over a much longer period of time, such as modifying the
criteria for selection of pole size/class so that whenever a new pole is needed (for any
routine reason) a larger/stronger pole is selected for installation than would have
otherwise been selected for installation.

Q. **Did the Company have any other considerations in the development of the System
Resiliency Plan and, if so, what are they?**

A. The Company believes certain upgrades to the electric distribution system can make it
more resilient to extreme weather events resulting in fewer customers being impacted
and consequently shorter overall restoration times associated with those events. There
are a number of types of resiliency initiatives which the Company has identified that can
contribute to the distribution system being more resilient; the Company reviewed most of
these potential initiatives at a high level during the Governor’s Two Storm Panel
hearings\(^{17}\) and has subsequently prepared a more detailed evaluation and development
of these initiatives for inclusion within this System Resiliency Plan.

\(^{17}\) See CL&P’s presentation to the Governor’s Two Storm Panel dated November 15, 2011 and Mr. Dana Louth’s
presentation to the same Panel dated December 14, 2011.
Q. Please describe how CL&P determined the mix of initiatives contained within its System Resiliency Plan

A. The Company determined the mix of initiatives contained within its System Resiliency Plan by (i) considering and remaining focused on its stated System Resiliency Plan goals, (ii) reviewing demonstrated performance improvement for various reliability-related improvement techniques, (iii) utilizing the analysis performed by Quanta Technology LLC ("Quanta") of the ability of existing CL&P distribution infrastructure to withstand extreme weather conditions and, (iv) utilizing input from others, such as distribution companies that have already developed system resiliency programs.

IV. THE COMPANY HAS REVIEWED THE SYSTEM RESILIENCY PRACTICES OF OTHER COMPANIES

Q. Has CL&P reviewed the infrastructure hardening or system resiliency practices of other electric distribution companies in North America?

A. Yes. The Company conducted extensive research and spoke directly with several U.S. utilities and one Canadian utility that have developed system resiliency or storm hardening programs.

Q. What were the other electric distribution companies has the Company consulted?

A. The Company spoke with key representatives from Florida Power and Light ("FPL"), Hydro-Quebec ("HQ"), the Long Island Power Authority ("LIPA"), and Entergy. Additionally, the Company reviewed filings and public documents from multiple other utility companies including Oklahoma Gas and Electric ("OG&E"), Progress Energy, Gulf Power, Florida Public Utilities, Ameren, and ComEd. The Company also reviewed results from investigations produced by the Public Utility Commissions of Florida, Texas, North

18 Quanta Technology LLC is a utility infrastructure consulting company based in Raleigh, North Carolina. It is a wholly owned subsidiary of Quanta Services.
Carolina, Oklahoma and the District of Columbia.

Q. From which companies did CL&P glean important information and experience that is most relevant to the Company?
A. The Company gleaned important information and experience from programs at FPL, HQ, LIPA, and OGE.

Q. Why did the Company select these four companies as those with information and experience that is most relevant to the Company?
A. After reviewing the different responses by various companies from various locations, the Company determined that it gleaned the most important information and experience from four of them as they represented the most salient responses to weather events that could be faced by CL&P. The Company included FPL due to its response to hurricanes, included HQ due to its response to major catastrophic ice events, included OGE due to its response to major ice events (in the United States) and included LIPA due to its geographical proximity.

Q. How did the insights, information, and experience from these four programs inform the Company’s proposal?
A. It was clear to the Company that most hardening or resiliency programs have some elements in common including a significant focus on vegetation management and structural hardening. Other elements of the hardening programs are specific to the company’s specific situations such as wind, ice, or flooding. Please see Appendix F for more details of the aforementioned utilities’ system hardening plans.
V. SYSTEM RESILIENCY ACTIVITIES UNDERWAY AT CL&P

Q. Can you please define, or describe, what you mean by infrastructure hardening or system resiliency?

A. Yes. The phrase “infrastructure hardening” at CL&P refers to (i) the electrical distribution infrastructure such as poles and wires and (ii) hardening refers to making the system more resistant or resilient to weather events. Stated alternatively, system resiliency refers to the concept of an electrical distribution system infrastructure that is better able to withstand weather events without failing or interrupting service to customers. These two phrases are used interchangeably within my testimony.

Q. Does the NESC provide the basis for how an electrical distribution utility, like CL&P, should design, build, operate, and maintain its system?

A. The stated purpose of the NESC\(^\text{19}\) is the practical safeguarding of persons, utility facilities, and affected property during the installation, operation, and maintenance of electric supply and communication facilities, under specified conditions. NESC rules are founded upon the fundamental principles used for safety of utility facilities\(^\text{20}\). The NESC is not intended as a design specification or as an instruction manual\(^\text{21}\). The Company’s System Resiliency Plan goes beyond NESC criteria.

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\(^{19}\) See NESC Rule 010.

\(^{20}\) The NESC is adopted within the state of Connecticut by the Authority’s regulations. See Section 16-11-134, “The commission recognizes the provisions of the National Electrical Safety Code and the National Electrical Code in effect from time to time as minimum requirements and recommends the same as a guide to good practice for the installation, maintenance and operation of electrical facilities in all cases not governed by specific commission orders and the provisions of this code as contained herein.” Conformance with the NESC is also required by Connecticut law. See Connecticut General Statutes Section Sec. 16-244i, “...Each electric distribution company shall maintain the integrity of the distribution system in conformity with the National Electric[al] Safety Code and such other standards found applicable by the department that are practiced by the electric distribution industry, in a manner sufficient to provide safe and reliable service, regardless of whether or not its generation entity or affiliate is the electric supplier, to all customers connected to the system consistent with this title and regulations adopted thereunder....”

\(^{21}\) See NESC Rule 010(D)
Q. Could you briefly describe the components of the Company’s System Resiliency Plan?

A. Yes. The Company’s System Resiliency Plan includes three areas; vegetation management, structural hardening, and electrical hardening. I will discuss each one briefly below.

- **Vegetation Management:**

  Tree-related failures as a result of wind (tropical storm Irene) and heavy wet snow (October Nor’easter) caused the vast majority of the power interruptions and distribution system damage during these two storms\(^\text{22}\). Indeed, most interruptions that have occurred during major storms within the CL&P territory in recent years have been related to trees. CL&P believes enhanced tree trimming (“ETT”) (clearing a wider envelope around primary wires, removal of overhanging limbs as well as weak, diseased or leaning risk trees in proximity to wires) and trimming on a shorter cycle will have a positive effect both on day-to-day reliability performance and performance of the infrastructure during major storms. Specifically, the CL&P team charged with developing the infrastructure hardening program will determine the specifications, selection criteria for circuits/line segments, and methods of sustaining benefits of enhanced trimming that will significantly improve storm performance as well as day-to-day reliability.

- **Structural Hardening:**

  Structural hardening involves the poles and related appurtenances that support or “hold up” electric distribution conductors and transformers, as well as communications wires and other attachments. While the vast majority of distribution structure failures during tropical storm Irene and the October Nor’easter of 2011 were initiated by large

\(^{22}\) See the Two Storm Panel Report at page 13 and the Davies Report filed in Docket No. 11-09-09 at pages 1 and 90.
tree or tree limb failure, the question has arisen as to what type of weather conditions
(such as wind and/or ice) existing distribution support structures can tolerate without
failing. CL&P retained Quanta to assist in evaluating both legacy and recently built
distribution line structures relative to their ability to withstand ice, wind and shock
loading (due to airborne debris, falling trees, or falling tree branches) from a design
standpoint. This evaluation, combined with subsequent age/physical condition
assessment, will enable CL&P to decide if its current structure design and material
standards need to be upgraded, as well as which poles or pole tops in the field should
be upgraded. CL&P will determine how to potentially strengthen structures
incrementally over a long period of time through design standard and material
changes, as well as which field structures may need to be retrofit in the near term to
meet new design expectations.

- Electrical Hardening:

Electrical hardening focuses on making electrical distribution conductors more
resilient to failure during weather events and also utilizes protective device upgrades
on overhead circuits to minimize the number of customers impacted when
interruptions do occur. Specifically, CL&P is evaluating the costs, benefits and
prioritization of upgrading its older “bare wire” primary conductors with stronger, more
tree-resistant covered “tree wire”. The evaluation is focusing on the mechanical
strength of the older conductor relative to static or dynamic loadings associated with
major weather events, as well as the advantages of covered wire in terms of
preventing interruptions when tree or limb contact occurs; currently CL&P’s primary
conductors are about 50% covered wire and 50% bare wire, much of which is 50+
years old. Also, circuit segment sectionalizing will be examined to determine if
opportunities exist to minimize customers impacted by adding intermediate protective
devices and, if so, guidelines for those additions will be developed.
Q. Has the Company already initiated certain system resiliency-related activities?
A. Yes. In 2012, the Company has already initiated the following five major storm resiliency-related activities:
1. A team of subject matter experts has been assigned to evaluate distribution overhead system resiliency options for consideration in a long range resiliency plan.
2. The Company has dramatically increased its tree trimming and tree removal activities.
3. The Company is evaluating, with the University of Connecticut, selective hardening options for critical town center type loads.
4. The Company is evaluating the resiliency of substation facilities, particularly with regard to flooding.
5. The Company is evaluating the resiliency of its own internal communication infrastructure\(^{23}\) during major weather events.

Q. When will the Company complete these evaluations?
A. The Company plans to complete these evaluations by the end of 2012.

Q. What is selective hardening?
A. One of the lessons learned from the 2011 storms was that during catastrophic weather events resulting in prolonged power outages, it becomes important that some critical regional/community facilities (i.e., hospitals, fire/police, pumping/sewage treatment plants, shelters) as well as other services (i.e., grocery stores, gas stations) either remain powered up or can be powered up quickly. During an even more catastrophic event,

\(^{23}\) Internal communication infrastructure refers to the Company’s own internal communication network system. This generally consists of fiber optic, radio, and microwave hardware and includes items such as towers, radios, base stations, cabling, and associated electronic systems.
such as a category 3 hurricane, a very large portion of the CL&P system is likely to fail. The electric supply to critical facilities can be “selectively hardened” to provide much higher levels of power supply security so that they can meet important societal needs.

CL&P has identified the following general methods of “selectively hardening” electricity supplies to critical regional/town facilities:

1. Undergrounding distribution lines from the nearest bulk substation to critical facilities.
2. Supplying such facilities with reliable back-up generation that can provide alternative supply for extended periods of time.
3. Developing an electrical micro-grid (to these facilities) with local generation that can “island” and continue to supply the facilities during catastrophic weather events.

CL&P has engaged the Schools of Engineering and Business at the University of Connecticut to evaluate the relative cost/benefit of each alternative to better understand which options may be worth considering in different locales across the state. This effort is expected to conclude in the fall of 2012 and is not a part of the Company’s $300 million System Resiliency Plan.

Additionally, the Company will consider selectively tree trimming to enhanced specifications along the distribution infrastructure supplying critical regional/town facilities.

Q. Please describe the Company’s resiliency initiatives for substations and the Company’s internal communications systems.

A. The Company is evaluating the resiliency of its substation facilities relative to extreme

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24 An electrical island occurs if one or more distributed energy resources, or local generation in a micro-grid, continues to energize a (usually small) part of the locally-connected distribution system after connection to the rest of the system has been lost.
This evaluation predominately involves:

1. Identifying substations that may be in areas prone to flooding from either ocean or river initiated events.

2. Determining the extent of flooding that might be expected to occur and its potential impact on substation equipment.

3. Evaluating options for mitigating the impact of flooding on substation equipment.

This evaluation and any potential remediation will be factored into the Company's long-range resiliency plans. The evaluation should be complete by the fall of 2012.

In a similar fashion and time frame, the Company is evaluating the vulnerability and redundancy of its internal communication system during major storms. The results of this evaluation will also inform the Company's long range resiliency plans.

VI. THE SYSTEM RESILIENCY PLAN

Q. Please provide an overall description of System Resiliency Plan

A. The Company is proposing a five-year time frame for executing the System Resiliency Plan. Table DLL-4 provides an overview of the projected cash flow and the high-level make-up of the Plan from 2013 – 2017. The Company’s System Resiliency Plan presents a phased approach to develop and implement both short term and long term storm resiliency plans. Phase 1 of the $300 million Plan proposes to spend $32 million in 2013 and $53 million in 2014, mostly on ETT. Phase 2 of the Plan proposes to spend the remaining $215 million over the period from 2015 through 2017, mostly on ETT and structural and electrical hardening. The long term program, planned for implementation after 2017, will be based upon evaluations of work done in Phases 1 and 2 of the short term plan.
Q. Why has CL&P selected five years for executing the System Resiliency Plan?

A. The Company selected five years for executing the System Resiliency Plan for several reasons. First, the Company recognizes that in order to effectively and efficiently manage significant, new incremental infrastructure investment it must be well-planned and phased-in rather than suddenly increased. Second, it has been the Company’s customary practice to present five-year capital expenditure plans to the Authority in its past rate cases. And lastly, the Company believes it is desirable to complete the Plan expeditiously in order to realize improvement as soon as practical.

Q. Does CL&P only plan to harden, or increase the resiliency of its system, for just the next five years?

A. No. Although the Company’s System Resiliency Plan as discussed herein is presently limited to five years, I will discuss later in my testimony the Company’s longer-term intentions for institutionalizing many system resiliency initiatives, such as modifications to construction standards and materials.
### Table DLL-4

The CL&P System Resiliency Plan
Projected Spending by Year

<table>
<thead>
<tr>
<th>Program Area</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Total (By Program Area)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2013</td>
<td>2014</td>
<td>2015</td>
</tr>
<tr>
<td>Expense</td>
<td>-</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Structural &amp; Electrical Hardening</td>
<td>-</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>System Automation</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Scheduled Maintenance Trimming</td>
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<td>7</td>
</tr>
<tr>
<td>Enhanced Tree Trimming</td>
<td>25</td>
<td>30</td>
<td>33</td>
</tr>
<tr>
<td><strong>Total (By Year)</strong></td>
<td>32</td>
<td>53</td>
<td>61</td>
</tr>
</tbody>
</table>
Q. Why is the projected spending not uniform across the five years from 2013-2017?

A. The Settlement Agreement specified that revenue requirements for the Plan in 2013 and 2014 (combined) could not exceed $25 million each year\(^{25}\), so capital and maintenance expenses in those two years were limited to a level that would not result in revenue requirements greater than $25 million.

While the most significant spending in the initial two years, or first phase, of the Plan is for tree trimming, the Company will also be revising its construction standards as I describe later in this testimony, as well as selecting and engineering the specific circuits and projects necessary to structurally and electrically harden the system mostly during the second phase of the Plan.

Q. Please explain the tree trimming expenditures in this Plan.

A. Tree trimming is the largest single portion of the Plan, in terms of dollars invested, since it generally provides the highest potential for reliability improvement during storms per dollar spent. Tree trimming in the Plan consists largely of two general initiatives, (i) working towards achieving a four-year cycle trim rate and, (ii) working towards clearing the most critical circuitry to enhanced trimming specifications in order to reduce exposure of these lines to tree-related interruptions during major storms. Tree trimming provides customers the largest benefit per dollar spent.

Q. Please describe the four-year tree trimming cycle proposal.

A. The Company proposes to trim its overhead distribution circuitry at a rate of approximately 4,240 miles per year going forward which represents approximately \(\frac{1}{4}\) of

\(^{25}\) Settlement Agreement, Article 4.1, Page 5.
it's 16,960 miles of distribution circuitry. As a result of the Company's 2010 rate case in
Docket No. 09-12-05, CL&P was authorized to trim at approximately a five-year cycle rate
which involved approximately 3,392 miles per year. The System Resiliency Plan includes
expenditures to allow the Company to continue transitioning to a four-year tree trimming
cycle rate.

Q. Why is the Company proposing a four-year tree trimming cycle rate?

A. The Company has proposed a four-year tree trimming cycle rate in the past\textsuperscript{26} and, in the
hearings associated with Docket No. 11-09-09, noted that it prefers to move from a five-
year to a four-year tree trimming cycle rate\textsuperscript{27}. A four-year tree trimming cycle rate is
common in the industry, generally considered a good utility practice, and is compatible
with tree species' growth rates and the Company's maintenance specifications of 8'
(side), 10' (under) and 15' (top) clearance. It generally limits the amount of contact
between adjacent tree regrowth and primary distribution circuitry between cycles. Longer
cycle lengths permit more significant contact between regrowth of cut branches and
distribution circuitry. This vegetation contact can cause outages particularly during rainy
and windy conditions and can also lengthen outages in some cases as it limits visual
access and the ability to assess the condition of the distribution system during the
restoration process. Additionally, a four-year tree trimming cycle permits revisiting
vegetation alongside distribution lines at a quicker interval than longer cycles to clear
branches, limbs or trees that may have become diseased or died.

\textsuperscript{26} See Page 39 of the pre-filed testimony of Dana L. Louth in Docket No. 07-07-01, dated July 30, 2007 and the
\textsuperscript{27} See Docket No. 11-09-09 Tr., at 1204 and the Company's response to Q-AG-017 in Docket No. 11-09-09.
The Company also notes that a shorter trim cycle for CL&P was endorsed by Liberty, Davies, the consultants utilized by the Office of Consumer Counsel (“OCC”), and Witt Associates in their reviews of recent storms and as part of Docket No. 11-09-09.

Q. What are the Company’s plans for trimming to enhanced clearances?

A. The Company plans to clear lines that serve a larger number of customers to enhanced clearances when compared to normal trim specifications. That will generally involve removal of overhanging branches as well as removal of trees that because of their condition and/or orientation to distribution lines pose an elevated risk, particularly during major weather events. The Company has designated its backbone circuitry and laterals that supply a larger number of customers for enhanced clearances in the System Resiliency Plan. Backbone circuitry is defined as major, three-phase circuitry that is protected by a major, three-phase protective device such as a substation circuit breaker or a three-phase recloser. Backbone circuitry generally also carries heavy electrical load. Laterals may be three-phase or single-phase and are generally protected by fuses or single-phase reclosers. The Company proposes to clear to enhanced specifications approximately 1/10 of this circuitry per year during the five-year System Resiliency Plan. This will enable clearing approximately 50% of the total system backbones and large laterals during the five year period from 2013 – 2017. The 50% to be cleared in the period from 2013 – 2017 will be targeted to the worst performing circuits. Achievement of these enhanced clearances in the System Resiliency Plan will be sequenced to occur

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30 See, “Direct Testimony of John W. Goodfellow and Michael W. Townsley on Behalf of the Office of Consumer Counsel”, dated April 17, 2012 at Page 56, recommendation 7
when circuitry is normally scheduled for cycle maintenance for efficiency and to minimize total costs.

Q. **Why are enhanced clearances important?**

A. Enhanced clearances, or clearing a wider envelope around primary wires, removal of overhanging limbs as well as weak, diseased or leaning risk trees in proximity to wires, and trimming on a shorter cycle will have a positive effect on day-to-day reliability performance as well as performance of the infrastructure during major storms.

The Company has used ETT in the past and has determined that it significantly reduces tree-related outages both during normal weather and during major storms. Specifically, the Company expects a reduction of tree-related outages of at least 35% during major storms as a result of fewer interruptions on circuitry that is trimmed to enhanced specifications. At other times, tree-related interruptions should be reduced by about 50%.

The Company also notes that the basic concepts associated with ETT or removal of hazard trees were endorsed by Liberty$^{32}$, Davies$^{33}$, and Witt Associates$^{34}$ in their reviews of recent storms and as part of Docket No.11-09-09.

Q. **What is included in the Company’s Plan with regard to structural and electrical upgrades?**


A. Structural and electrical upgrades are planned for (i) certain critical line crossings and (ii) on circuits with a history of poor reliability performance.

Q. Can you provide more information regarding the Company’s planned structural and electrical upgrades for certain critical line crossings?

A. Yes. Distribution line crossings over major, limited-access highways and major railroads across the state will be inspected. The most critical of these facilities will be evaluated and structurally upgraded, if necessary, to withstand category 3 hurricane force winds.

Q. Please discuss the Company’s planned structural and electrical upgrades on circuits with a history of poor reliability performance.

A. In addition to specific upgrades for certain critical line crossings, which will occur across the state where needed, structural and electrical upgrades will be scheduled from 2014 – 2017 on circuits that have a history of poor reliability performance, particularly during storms. Circuits will be selected each year for structural and electrical retrofit upgrades based on reliability performance over the previous four years with the effects of major storms included. The Company anticipates this will result in major structural and electrical storm resiliency upgrades on various locations/segments, as indicated, of approximately 10 – 20 circuits per year in the years 2014 -- 2017. This should result in those customers who have recently experienced the poorest overall reliability performance seeing the most significant reliability improvement as a result of this resiliency initiative.

Q. Can you provide more detail about planned structural upgrades?

A. The Company’s distribution infrastructure is built to NESC specifications for the northeast United States which require it to withstand ½” of radial ice combined with 40 mile per
hour winds\(^{35}\). CL&P recently retained Quanta to analyze the ability of both CL&P’s current “new build” standard construction and the Company’s legacy construction to withstand weather conditions that might be experienced in Connecticut beyond, or in excess of, the levels imposed by the NESC. This analysis shows that, in general, current standards for newly-built construction can withstand category 1 hurricane force winds (with a return period of 15 – 20 years) or radial ice of 1.25 inches which can be expected to occur from time to time in Connecticut\(^{36}\). However, some legacy pole construction, depending on pole class, the number of attachments, and wire span length would exceed its strength limits for winds in excess of 70 miles per hour. Also, some older wooden cross arms may have lost enough strength over time due to weathering, water penetration and/or fungus/insect damage such that they might be vulnerable to failure during heavy ice loading.

Additionally, pole and cross arm failure during storms in recent history have been predominately due to impact from trees and limbs, rather than as a direct result of the weather on the infrastructure.

As a result of these findings, CL&P has incorporated both a structural design strength assessment and an inspection-based conditional assessment on backbone and major lateral structures on circuitry that will be scheduled for resiliency upgrades in the Plan.

Structures on line segments found either to have significant design strength or condition-based limitation in terms of weather condition withstand will be candidates for upgrade in the System Resiliency Plan. These upgrades should improve performance in direct

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\(^{35}\) NESC Rule 250B and NESC Table 250-1 require that distribution system construction withstand \(\frac{1}{2}\)” of radial ice and 4 lbs/ft\(^2\) of simultaneous horizontal pressure due to wind loading. 4 lbs/ft\(^2\) of pressure due to wind loading equates to a wind speed of approximately 40 mph.

\(^{36}\) See Appendix D.
response to extreme weather and should also improve strength and resiliency in smaller
storms and for tree impact conditions as well.

Q. Are there other elements to the Company’s structural hardening plan?
A. Yes. Structural hardening may also include a limited amount of work to enhance the
ability of ground-mounted equipment located within substations to withstand the effects of
flooding.

Q. Can you provide more detail about planned electrical upgrades?
A. Yes. Electrical hardening upgrades will be done at the same time, and on backbones
and major laterals of the same “worst performing circuits”, as the structural upgrades.
There will be three focus areas:

1. Segments of line on the worst performing circuits that are heavily treed and perform
substantially poorer than average segments in terms of failures per mile will be
considered for electrical rehabilitation or reconductoring (if bare) with either spacer
cable or 175 mil tree-resistant, covered wire to reduce the amount of tree-related
failures.

2. Segments of line where the bare conductor consists of aged very small gauge
copper, will be considered for reconductoring with spacer cable or 175 mil tree-
resistant, covered wire. Very small gauge copper wire is mechanically frail and has a
high propensity to break with relatively small limb contact or on longer span lengths
for ice accretion of ¾” or greater.

3. Circuitry will be evaluated for other upgrades including the addition of intermediate
protective devices to limit impact of line failure in terms of numbers of customers
impacted.
Given the relatively high cost of reconductoring bare wire, this activity will be very surgical in nature and be confined to line segments serving significant numbers of customers or critical load types.

Q. Can you provide more detail about how circuits will be selected for planned structural and electrical upgrades?

A. Yes. The circuits selected for planned structural and electrical upgrades each year will be drawn from those listed in the Company’s ranking of its 100 worst-performing circuits in Appendix 14 of the Company’s annual Transmission and Distribution Reliability Performance (“TDRP”) report.

Q. Can you summarize the circuit ranking process used by the Company in developing its list of the 100 worst-performing circuits shown in Appendix 14 of the Company’s annual TDRP report?

A. Yes. Each year, a ranking process is carried out to determine which circuits are the Company’s poorest performing. Generally speaking, the most recent four years of outage data, including storms, are collected for each of the Company’s electric distribution circuits. The Company calculates the circuit’s impact on CL&P’s overall SAIDI as well as the SAIDI and SAIFI for each individual circuit. The circuits are then categorized, scored, sorted, and ranked from worst-performing to best-performing. The 100 worst-performing circuits are listed in Appendix 14 of the annual TDRP report along

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37 The TDRP report is filed annually with the Authority in accord with the requirements of Order No. 12 in Docket No. 86-12-03. The most recent of these TDRP reports was filed on March 31, 2012.  
38 The System Average Interruption Duration Index (“SAIDI”) is the average interruption duration in minutes per customer served. It is determined by dividing the sum of all customer interruption durations during a year by the number of customers served. SAIDI is thus a measure of the average number of minutes a customer is interrupted over the course of a year. A customer interruption is considered to be one interruption to one customer.  
39 The System Average Interruption Frequency Index (“SAIFI”) is the average number of times that a system customer is interrupted during a year. It is computed by dividing the total number of customers interrupted in a year by the average number of customers served during the year.
with individual reliability corrective action plans for each circuit, as applicable.

Q. Is the Company planning to modify its overhead construction standards to make the system more resilient on an on-going basis?

A. As part of its engagement of Quanta, the Company is evaluating changes to standards that might increase the resiliency of its distribution system over time as existing facilities are modified or replaced with new facilities as a result of normal business activities. Modifying/increasing the strength of the standard pole class used for distribution construction, composite (as opposed to wooden) cross arms, and modification of pole top configuration are options that are being considered as potential changes to standards.

Q. Is the Company planning to modify its protocols regarding the attachment of communication cables and third-party facilities to its overhead plant?

A. Possibly. In addition to direct changes to standards, the Company may further evaluate attachments of communication system cables as well as protocols for third-party attachments since the number of communication system attachments on a pole were found by Quanta to have significant impact on the ability of poles to safely withstand high wind loading.

The Company recognizes that the federal Telecommunications Act of 1996\(^40\) addresses the ability of a utility to deny or restrict pole attachments\(^41\) when they create safety or

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\(^{41}\) "The term pole attachment means any attachment by a cable television system or provider of telecommunications service to a pole, duct, conduit, or right-of-way owned or controlled by a utility." 47 C.F.R. § 1.1402(b).
The Company also recognizes that the Authority has noted that “it intends to provide non-discriminatory, equitable access to the public rights of way without compromising the safety of the public and utility workers” and that “utilities retain the right to limit the use of certain techniques when necessary to ensure safety, reliability, and sound engineering.”

Q. **When will these changes to standards be made?**

A. There are several factors that will determine when changes to standards will be made. While the recommendations for consideration in changes to standards should be complete by the end of September, 2012 some proposed changes will potentially involve pilots to evaluate new materials or design and many may involve evaluation/approval by other companies within the Northeast Utilities system or CL&P’s joint pole owner partners. Consequently, I would not expect to see major modifications to standards in place before the first quarter of 2013, and some modifications involving the pilot evaluation of new materials may not occur until much later.

Q. **Can you provide more detail regarding the distribution automation portion of the Company’s System Resiliency Plan?**

A. Yes. The Company’s goal in this area is to implement cost-effective system automation techniques to improve system resiliency by focusing a limited system automation program on two or three elements. One of these elements is acceleration of the

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42 Under 47 C.F.R. § 1.1403(a), “[a] utility shall provide a cable television system or any telecommunications carrier with nondiscriminatory access to any pole, duct, conduit, or right-of-way owned or controlled by it. Notwithstanding this obligation, a utility may deny a cable television system or any telecommunications carrier access to its poles, ducts, conduits, or rights-of-way, on a non-discriminatory basis where there is insufficient capacity or for reasons of safety, reliability and generally applicable engineering purposes.”

43 See the Authority’s Decision in Docket No. 08-06-19 at Page 10.

44 Id.
deployment of substation breaker automation by up to 30 extra per year in the 2015-2017 timeframe in order to provide 100% automation at all CL&P high-voltage distribution substations by 2017. The second element of this limited system automation program is to pilot the deployment of remotely-indicating right-of-way Smart Grid Sensors\(^\text{45}\) that can directly provide remote load and fault indication to the Company's system operations center in order to eliminate the need to physically visit the Smart Grid Sensor in the field to determine its status. The Company is also considering the potential deployment of additional recloser batteries to ensure longer life during major storms.

Q. Has the Company developed any formal mechanism for identifying additional areas that may need hardening?

A. Yes. The Company has developed a post-storm forensic review procedure, and a team of Company engineers have been trained to perform forensic damage surveys of distribution facilities immediately following storm damage. These surveys will catalog damage to CL&P facilities as a function of asset characteristics, or configuration, so that trends can be identified and factored into future asset management decisions.

Q. Does the Company have a mechanism to track or evaluate the efficacy of these proposed hardening and system resiliency initiatives?

A. Yes. The Company has recently developed an asset and investment management system ("AIMS") in order to help evaluate the effectiveness of capital improvements made to the distribution system. The AIMS establishes a relationship between construction work orders and the circuits and assets that they impact. This relationship allows the Company to track the type of work performed, the costs associated with the

\(^{45}\) The “Smart Grid Sensor” is a new product manufactured by Grid Sentry, LLC., of Beavercreek, OH. The product is also called a “GS-200 Line Sentry” by the manufacturer.
work, and the reliability performance of the area both before and after construction. The functionality of the AIMS is presently being improved to provide even greater ability to track the effectiveness of specific reliability improvement projects. The improvement to this tracking system is presently scheduled for completion by year end 2012.

Q. Are the elements of this System Resiliency Plan in addition to, or incremental, to the Company’s other capital and O&M expenditures?

A. The Company is seeking the Authority’s approval of this System Resiliency Plan as separate from its other capital and O&M expenditures. If approved, the Company is prepared to report on the expenditures associated with this Plan separately from its other capital and O&M expenditures.

VII. CONCLUSION

Q. In conclusion, Mr. Louth, what are the consequences if CL&P does not move forward with this System Resiliency Plan?

A. If this System Resiliency Plan is not adopted, customers can expect no material improvement in system performance during major storms.

Q. What is needed for CL&P to move forward with the Plan you just outlined in your testimony?

A. This Plan is critically important to mitigate the impacts of future storms on the delivery of reliable electrical service. It requires in the near-term revenues to directly support the initiatives referenced in my testimony as well as a strong CL&P financial framework in order to support the provision of a resilient electrical delivery system that will meet customer needs. Without adequate revenues and recovery of the costs associated with these initiatives, it will not be possible for CL&P to carry out its Plan.
Q. What overall performance improvement do you expect upon completion of the System Resiliency Plan?

A. The most significant performance improvement I expect, upon completion of the System Resiliency Plan as proposed herein, will be a reduction in the number of trouble spots yielding a reduced number of customers without service during both normal, day-to-day activities and especially in the wake of major and catastrophic storms. This reduction in the number of trouble spots, in most instances, will lead to a reduction in the overall duration of restoration activity.

The most significant contributor to the reduction in the number of trouble spots will be the vegetation management elements of the Plan. As I noted earlier, ETT provides an improvement of 35% during major storms and 50% at other times. By the end of the five-year period of this Plan, CL&P anticipates having cleared 50% of backbones and large laterals along the worst performing circuits. Additionally, the structural and electrical hardening aspects of the Plan will reduce trouble spots during significant weather events in those parts of the system with the worse reliability performance, leading to a reduction in the number of customers with multiple outages and customers with long outage durations.

In summary, as a result of completion of this Plan, fewer customers should experience outages (and for a shorter duration) both during normal, day-to-day situations and also during major or catastrophic storms.

Q. Mr. Louth, does this conclude your testimony?

A. Yes, it does.
Appendix A - Hurricane Strikes since 1950

[Map of Hurricane Strikes since 1950]

- Carolina (1954)
- Donna (1960)
- Gloria (1985)
- Elena (1969)
- Edna (1954)
- Bob (1991)
- Belle (1970)
- Ingrid (2005)
- Fran (1963)
- Bob (1985)
- Edna (1965)
- Camille (1969)
- Hazel (1954)
- Charley (2004)
- Ike (2008)
- Ivan (2004)
- Katrina (2005)
- Frances (2004)
- Charley (2004)
- Rita (2005)
- Ivan (2004)
- Katrina (2005)
- Wilma (2005)
- Bret (1999)
- Andrew (1992)
- Bob (1992)
- Hugo (1989)
- Camille (1969)
- Juan (1985)
- Debbie (1967)
- Elda (1969)
- Dora (1996)
- Hilda (1964)
- Becky (1994)
- Charley (2004)
- Gustav (2008)
-40
-30
-20
-10
-0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140

Salifir-Simpson Hurricane Categories (at strike or landfall)
Sustained Winds (MPH)
- Category 1
- Category 2
- Category 3
- Category 4
- Category 5

Due to density of storms in some locations, actual storm locations are approximate.
Appendix B - Hurricane Return Periods

Return Period In Years
For Category 1 Hurricanes

Return Period In Years
For Category 2 Hurricanes

Return Period In Years
For Category 3 Hurricanes

Return Period In Years
For Category 4 Hurricanes

Category 1 (years)
- 4 - 6
- 6 - 10
- 10 - 15
- 15 - 24
- 24 - 35

Category 2 (years)
- 6 - 12
- 13 - 22
- 23 - 30
- 31 - 62
- 63 - 130

Category 3 (years)
- 9 - 22
- 24 - 32
- 33 - 44
- 46 - 74
- 79 - 370

Category 4 (years)
- 16 - 33
- 34 - 78
- 79 - 120
- 121 - 260
- 261 - 500
Appendix C: Wind Zones in the United States
Appendix D: Extreme Wind Loading Criteria – Northeast

Notes:
1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10 m) above ground for Exposure C category.
2. Linear interpolation between wind contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
Appendix E: Ice Thickness

Figure 1 (cont). Uniform radial ice thicknesses due to freezing rain with concurrent 3-s gust speeds, for a 50-year return period b) eastern United States
Appendix F: Summary of Experiences of Four Other Companies

The Company performed a telephonic survey of the storm response and storm hardening experiences of several utilities and, after reviewing the different responses by various companies from various locations, the Company determined that it gleaned the most important information and experience from four of them as they represented the most salient responses to weather events that could be faced by CL&P. In summarizing the experiences of four other companies the Company included (i) FPL due to its response to hurricanes, (ii) HQ due to its response to major catastrophic ice events, (iii) OGE due to its response to major ice events (in the United States) and, (iv) LIPA due to its geographical proximity.

The storm hardening program at FPL

FPL and Florida experienced an unprecedented level of hurricane activity in 2004 and 2005. The most impactful storm, Hurricane Wilma (category 2/3), affected 60% of FPL’s service territory, led to 3.2 million customer outages and it took 16 days for full restoration. After the storms, FPL decided that significant changes were required in the way that it designed, constructed and operated its electrical system. FPL began to implement a storm hardening plan to improve resiliency to storms, reduce restoration times, and ensure that a critical mass of providers of basic services, essential to the health and safety of the communities, would have electric service as promptly as possible after a storm or major event.

FPL’s storm hardening initiative has three key elements:
1) Application of extreme wind loading ("EWL") criteria\(^{46}\) to critical infrastructure facilities.

FPL implemented EWL into three wind regions corresponding to expected extreme winds speeds of 105, 130 and 145 miles per hour. FPL began applying EWL to the top critical infrastructure feeders and any associated laterals serving critical customers. Critical feeders include those that serve facilities such as hospitals, 911 Centers, Emergency Operation Centers ("EOCs"), water treatment plants, police and fire stations.

In addition, EWL is also being applied to poles included in FPL’s targeted critical pole program. This program focuses on poles that can impact restoration efforts and includes poles on key highway crossings.

2) Incremental hardening to certain feeders supplying critical community needs. The objective of the incremental hardening program has been to increase the overall wind profile of a feeder to a higher wind rating, up to and including EWL. Some of the options that FPL has been using include pole guying, relocation, adding intermediate poles, upgrading of poles. For each extreme wind region, an incremental hardening minimum wind rating was established.

Incremental hardening has targeted “community projects” which are associated with feeders that serve community needs such as grocery stores, gas stations and pharmacies. In addition, FPL has targeted poles that are critical to restoration efforts and have additional electric equipment such as automated feeder switches/reclosers,

\(^{46}\) See NESC Rule 250C. EWL within the CL&P service territory, as noted by NESC Figure 250-2(b), varies across the state of Connecticut from approximately 120 miles per hour along the coastline to approximately 90 miles per hour in the northwest corner of the state. Within limited exceptions, the EWL provisions within NESC Rule 250C are not required to be met if no portion of a structure or its supporting facilities exceeds 60 feet above ground or water level. Since CL&P’s electric distribution facilities and structures are usually less than 60 feet in height, they are not typically designed to withstand EWL. See also Appendix D of this testimony.
capacitor banks and multiple circuits.

3) Construction design guidelines that require EWL for the design and construction of all new overhead facilities, major planned work, relocation projects and daily work activities. The guidelines are primarily associated with changes in pole class, pole type and desired span lengths to be utilized. Depending on the scope of work for a particular project, the FPL goal is to harden either the entire circuit to the EWL design standard or to harden one or more poles (in the near term) so the circuit can be more easily brought into compliance with EWL criteria in the future. For example, prior to this initiative, FPL used class 3 wood poles in critical pole locations however their new design standards call for Class III-H concrete poles in these cases.

Other storm hardening initiatives at FPL and other Florida utilities

After the storms, all Florida utilities implemented ten storm hardening initiatives including:

1) Three-year vegetation management cycle for distribution circuits
2) An audit of joint-use attachment agreements
3) A six-year transmission structure inspection program
4) Hardening of existing transmission structures
5) A transmission and distribution geographic information system
6) Post-storm data collection and forensic analysis
7) Collection of detailed outage data
8) Increased utility coordination with local governments
9) Collaborative research on effects of hurricane winds and storm surge
10) A natural disaster preparedness and recovery program

Key characteristics of the storm hardening program at HQ
In 1998, HQ experienced a significant ice storm event that interrupted service to 1.4 million customers, damaged 16,000 distribution poles, and led to restoration efforts of close to 30 days. Some portions of the system experienced up to four inches of ice accumulation. After the storm, HQ implemented a storm hardening program that included the following:

1) Developed enhanced distribution network construction criteria. After the storm, HQ revised its standards and created two sets of standards they call “regular” and “robust”. The regular standard applies to most of the grid and aims to withstand 1.41 inches of ice (36 millimeters). The robust standard has the objective of ensuring that critical portions of the system can withstand 1.77 inches (45 millimeters) of ice.

2) Implemented a staged approach to harden the system to the new standards. HQ spent approximately $200 million between 1999 and 2006 to harden the critical portions of the system to the new robust standard criteria.

Characteristics of the storm hardening program at LIPA

LIPA started a storm hardening program in 2008 as a proactive response to the hurricane events in Florida. LIPA’s primary focus was the potential impact of hurricanes in coastal areas, with special emphasis on the impact of category 3 hurricanes. In addition to analyzing the wind impact, LIPA also analyzed the potential impact of storm surges.

In 2008, LIPA started a 20-year, $500 million ($25 million per year) program that had three focus areas:

1) Vegetation management. LIPA decided to spend approximately $5 million a year in
additional tree trimming focused on removing danger trees.

2) Substations. LIPA analyzed the substation elements potentially impacted both by storm surges and hurricane force winds. LIPA identified insulators, and structures holding insulators, as particularly susceptible to wind stress. Based on an analysis of the criticality of substations and the probability of an impact, LIPA launched a hardening program that included several activities:

a. Raised elevation of certain substations to decrease flooding risk
b. Developed a process to create a “substation on the fly”
c. Ensured that manufacturers of substation equipment provide to LIPA components that were able to withstand extreme wind (130 mph) for certain substations in the system
d. Changed specifications on the substation controls
e. Increased amount of additional spare equipment for substations.

3) Structural hardening. LIPA focused its structural hardening efforts on the key poles that would impact restoration efforts. LIPA has been hardening three types of poles: (i) riser poles, (ii) poles that have an automated switch/recloser and, (iii) poles that are on key highway or railroad crossings. For these poles, LIPA moved from a Class 2 pole to a Class H1 pole, ensured no more than two attachments per pole, and does not allow junction boxes on these poles.

LIPA is spending about $20 million in extra capital per year for 20 years on the substation and structural hardening programs.

**Characteristics of the storm hardening program at OGE**
OGE experienced a major catastrophic ice storm in December 2007 with significant effects throughout its service territory. The ice storm led to more than 300,000 outages and the restoration efforts took 10 days to restore service to those customers capable of receiving it.\(^\text{47}\) In 2009, Oklahoma’s Public Service Commission approved a three-year system hardening program for OGE ending June 30, 2012 to include the following:

1) Aggressive vegetation management. OGE concluded that managing vegetation around power lines is one of the most effective strategies for hardening a distribution system. OGE’s program consists of several elements:

   a. Removal of risk trees
   b. Using herbicide more aggressively in rural areas
   c. Removing all voluntary trees\(^\text{48}\) with diameters of eight inches or less within easements
   d. Establishing four additional feet of clearance over standard 8 feet or 12 feet
   e. Removal of overhangs
   f. Implementation of the “right tree, right place” program

2) Circuit hardening. OGE’s program has focused on upgrading circuits to current design standards, strengthening support structures, replacing certain wire conductors, upgrading the grade of construction for certain distribution facilities and targeting undergrounding of certain lateral sections of distribution lines.

**The effectiveness of these storm hardening activities at other utilities**

None of these other utilities studied has experienced similar weather events to those that

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\(^\text{48}\) A voluntary tree is one not planted by human hands that begins to grow on residential or commercial property. Unlike trees that are brought in and installed on property, volunteer trees usually spring up on their own from seeds placed onto the ground by natural causes or accidental transport by people.
led to the development of their storm hardening plans. The other utilities interviewed did
highlight that they have seen performance improvements in normal/day-to-day weather
events of up to 40%. Specifically, for example, LIPA indicated that the hardened portions
of the system had no failures during last year's Tropical Storm Irene.