STATE OF NEW JERSEY
BOARD OF PUBLIC UTILITIES

I/M/O THE VERIFIED PETITION OF	**)**	**BPU Docket No. ER14030250**
ROCKLAND ELECTRIC COMPANY	**)**	
FOR ESTABLISHMENT OF A	**)**	
STORM HARDENING SURCHARGE	**)**	

DIRECT TESTIMONY OF STORM HARDENING PANEL ON BEHALF OF DIVISON OF RATE COUNSEL

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I. STATEMENT OF QUALIFICATIONS

Q. Would the members of the Storm Hardening Panel Review ("Panel") please state your names, positions, and business address.

A. My name is Charles Salamone, PE. I am Owner of Cape Power Systems Consulting, LLC a power systems consulting Company with an address of 23 Westerly Drive, Bourne, Massachusetts and I am subcontracting with Synapse Energy Economics, Inc. ("Synapse").

My name is Maximilian Chang. I am a Principal Associate with Synapse, an energy consulting company located at 485 Massachusetts Avenue, Cambridge, Massachusetts.

Q. On whose behalf are you submitting testimony in this proceeding?

A. We are submitting testimony on behalf of the Division of Rate Counsel.

Q. Mr. Salamone, please describe your education and professional background.

A. I hold a Bachelor of Science Degree in Electrical Engineering from Gannon University. I joined the Engineering Department of Commonwealth Electric Company in 1973. At that time, I became a Junior Planning Engineer where my primary responsibilities were to assist in the planning, analysis, and design of the transmission and distribution systems of Commonwealth Electric Company, later known as NSTAR. I generally followed the normal progression of positions with increasing levels of responsibility within the planning area until taking the position of Director of System Planning at NSTAR in 2000. I held that position until starting Cape Power Systems Consulting, LLC in 2005. During my career

with NSTAR, in addition to the responsibilities associated with overseeing System Planning, I served as Chair of the New England Power Pool (NEPOOL) Planning Policy Subcommittee (1997-1998), Chair of the NEPOOL Regional Transmission Planning Committee (1998-1999), and Vice Chair of the NEPOOL Reliability Committee (1999-2000). As a consultant, I have been providing consulting services to a number of power system industry clients since 2005. I am a Registered Professional Engineer with the Commonwealth of Massachusetts. I am also a member of the Power Engineering Society of the Institute of Electrical and Electronic Engineers. A copy of my resume is attached hereto as **Attachment SHPR-1**.

Q. Mr. Salamone, have you previously testified before utility regulatory agencies?

A. Yes. I have previously testified before the New Jersey Board of Public Utilities ("BPU" or "Board"), the Federal Energy Regulatory Commission ("FERC"), the Massachusetts Department of Public Utilities, and the Massachusetts Energy Facilities Siting Board on a number of technical matters relating to ratemaking and system planning.

Q. Mr. Chang, please describe your professional background at Synapse Energy Economics.

A. My experience is summarized in my resume, which is attached as **Attachment SHPR-2**. I am an environmental engineer and energy economics analyst who has analyzed energy industry issues for more than seven years. In my current position at Synapse Energy Economics, I focus on economic and technical analysis of

many aspects of the electric power industry, including: (1) utility reliability performance and distribution investments, (2) nuclear power, (3) wholesale and retail electricity markets, and (4) energy efficiency and demand response alternatives. I have been an author and project coordinator for the last two biennial New England Avoided Energy Supply Component reports used by energy efficiency program administrators in the six New England states to evaluate energy efficiency programs.

Q. Mr. Chang, please describe your experience in New Jersey energy matters.

A. In the last six years, I have worked on the following specific New Jersey Board of Public Utilities ("BPU" or the "Board") dockets: EO09010049 and EO09010054 (Infrastructure Investment Plan), ER09080664 (2009 ACE Base Rate Case), ER09060459 (Rockland Electric Smart Grid), EO11050306 (Stafford Properties Apartments), ER11080469 (2011 ACE Base Rate Case), EO11110780 (PSEG Base Rate Case), GO12050363 (South Jersey Gas Energy Efficiency), ER12121071 (2012 ACE Base Rate Case), EO13020155 (Public Service Electric Energy Strong), and EM140460581 (Exelon-PHI Merger).

Q. Mr. Chang, please describe your educational background.

A. I hold a Master of Science degree from the Harvard School of Public Health in Environmental Health and Engineering Studies, and a Bachelor of Science degree from Cornell University in Biology and Classical Civilizations.

Q. Mr. Chang, have you previously testified before utility regulatory agencies?

A. Yes. I have previously testified before the Massachusetts Department of Public Utilities and the Maine Public Utilities Commission. I have also filed testimony

before the District of Columbia Public Service Commission, Delaware Public Utilities Commission, Hawaii Public Utilities Commission, New Jersey Board of Public Utilities, and the United States District Court District of Maine.

II. PURPOSE AND SUMMARY

Q. What is the purpose of your testimony in this proceeding?

A. The purpose of our testimony is to review measures filed by Rockland Electric Company ("the Company" or "RECO") in its petition (the "Petition") for approval of its storm hardening and Smart Grid measures as proposed in its submissions, including the direct testimonies of the Company's Storm Hardening Panel ("Storm Hardening Panel") and Smart Grid Panel ("Smart Grid Panel"). Our testimony will review: (1) Substation Flood Mitigation, (2) Overhead Hardening Measures, (3) Selective Undergrounding, (4) Distribution Automation, and (5) Enhanced Vegetation Management. As filed, the Company's proposed storm-hardening measures amount to $31.7 million and smart grid measures amount to $29.3 million. .

Q. Please summarize your findings and recommendations.

A. Our findings and recommendations are summarized as:

1. With respect to Substation Flood Mitigation the Company has proposed a "Muscle Wall" containment system ($300,000 capital and $50,000 operations and maintenance expenses) for the Saddle River and Cresskill substations; the capital costs associated with the muscle wall appear reasonably storm related and incremental based on the information provided by the Company and should be

approved. However as recommended by Rate Counsel's witness Ms. Andrea Crane, the $50,000 in operations and maintenance expenses should not be recoverable through a deferral or surcharge.

2. With respect to the proposed overhead hardening measures (i.e., spacer cable systems, etc.), the Company did not sufficiently explain its selection prioritization. Thus, we are unable to determine how the Company prioritized its proposed overhead enhancement measures, which should be intended to address major storm related reinforcements of its distribution system.

3. Furthermore, we recommend that if the Company can demonstrate to the Board that its Overhead Enhancement Program is incremental to normal reliability spending, then the Board should only approve the capital amounts for the projects that are associated with critical facilities. The Company has identified four projects that are associated with "critical facilities": (1) Harrington Park-Harriot Ave ($830,000 capital and $207,700 operations and maintenance expenses), (2) Harings Corner ($731,800 capital and $183,000 in operations and maintenance expenses), (3) Old Tappan Road Reconductor ($331,600 capital and $82,900 operations and maintenance expenses), and (4) Old Tappan Road to Blanche Avenue ($750,100 capital and $187,700 operations and maintenance expenses). The total in capital expenses for the four projects, which encompass critical facilities such as hospitals, police stations, fire stations, and senior facilities, is $2,643,500. However as recommended by Rate Counsel's witness Ms. Andrea Crane, the $661,300 in operations and maintenance expenses should not be recoverable through a deferral or surcharge.

4. We recommend that the Board reject the Company's proposed Selective Undergrounding measures for the Ringwood and the West Milford substation projects, since both projects appear to address long-term reliability issues with these circuits based on reliability statistics that exclude Major Events. Instead, as part of its normal base rate capital expenditures to address historically poor-performing circuits, the Company should employ planning procedures that consider strengthening facilities for storm resiliency whenever major upgrades of the distribution system are to be undertaken.

5. We recommend that the Company's proposed Distribution Automation programs not receive special rate treatment. The Company has shown the Distribution Automation programs to be cost effective through greater capacity utilization and through improvement in reliability performance. Specifically, the Volt/Var program has been demonstrated as a cost effective program which pays for itself through reduced losses and reduced system demands, thereby saving the Company capital expenses through deferral of capital expenditures. However, these automation measures cannot be specifically identified as storm-related system improvements, in contrast to more general reliability improvements. Therefore, the proposed Distribution Automation measures should not be part of the storm hardening rate proposal.

6. We recommend that the Company's Enhanced Vegetation Management program not receive special rate treatment for what are routine operations and maintenance expenses. While the Company's proposed Enhanced Vegetation Management program would benefit the Company's storm response, these enhancements

should be incorporated as part of the Company's regular vegetation management procedures and schedules. Rate Counsel witness Andrea Crane's testimony details why operations and maintenance expenses should be excluded from the proposed storm hardening surcharge.

7. Reporting of Major Event performance metrics has been inconsistent and insufficient across New Jersey EDCs, as noted in the GE Energy Consulting's New Jersey Storm Hardening Recommendations Report.[1] As recommended in section 2.2.c of the GE Energy Consulting NJ Storm Report, the Company should develop and submit more detailed Major Event performance data and metrics for review by the Board as part of its storm hardening efforts.

8. Many of the programs proposed by the Company are unproven with respect to Major Event performance enhancements. As noted in the GE Energy Consulting NJ Storm Report section 3.2, programs such as undergrounding of facilities may or may not result in improved Major Event performance depending on the type of event. Therefore, we recommend that if the Board approves any programs sought in the Petition that they be considered "pilot" programs subject to future review of actual storm-related Major Event performance. Collection and reporting of more detailed information concerning storm performance would be an essential part of assessing the pilot program's costs and benefits and should be required.

[1] "Final Report for: NJ Storm Hardening Recommendations and Review/Comment on EDC Major Storm Response Filings", November 26, 2014, GE Energy Consulting ("GE Energy Consulting NJ Storm Report").

III. INTENT OF STORM HARDENING PROPOSAL

Q. What is your understanding of the Storm Hardening efforts within New Jersey?

A. It is our understanding that after the events of Hurricane Irene, the 2011 October snowstorm, and Superstorm Sandy the Board wanted to improve and ameliorate the ability of utilities to respond to storm-related Major Events. Following Hurricane Irene and the 2011 October snowstorm, the Board issued its Hurricane Irene Order that set forth 65 items requiring action by the electric distribution companies to address storm preparation and response.[2] In 2013, the Board issued an Order inviting EDCs to file proposals for "infrastructure upgrades designed to protect that State's utility infrastructure from future Major Storm Events."[3]

Q. Is it your understanding that other New Jersey electric distribution companies have filed petitions to address storm hardening and grid resiliency issues?

A. Yes. To our knowledge, one other electric distribution company has filed a petition to seek recovery for storm hardening and grid resiliency measures to address future Major Events.[4] In February 2013, Public Service Electric and Gas ("PSE&G") filed its five-year $1.7 billion Energy Strong petition for its electric

[2] I/M/O the Board's Review of Utilities' Response to Hurricane Irene, BPU Docket No. EO11090543 (Order, January 23, 2013) ("Hurricane Irene Order").

[3] I/M/O the Board's Establishment of a Generic Proceeding to Review Costs, Benefits and Reliability Impacts of Major Storm Event Mitigation Efforts, BPU Docket No. AX 13030197 (Order, March 20, 2013) ("Storm Proceeding Order"), p. 3.

[4] I/M/O the Board's Initiative to Revise Reporting Requirements and Improve Reliability Programs by the Electric Distribution Companies Operating in New Jersey, BPU Docket No. EO12070650 (Order, February 20, 2013).

distribution service system. Ultimately, the case settled in May 2014 to allow PSE&G to implement an $820 million electric distribution service system investment program.[5]

Q. Why is your focus on storm hardening measures important for this docket?

A. We focus on the intent of the program, because in our view the programs to address storm hardening should be viewed differently than programs to improve day-to-day reliability. Because these programs are designed to respond to Major Events, the traditional reliability statistics that generally exclude Major Events do not necessarily apply. Normal reliability issues should be addressed through the existing base rate procedures when performance improvements are needed based on traditional reliability metrics. We agree with the Board that storm hardening petitions should focus on Major Event data and performance improvements that address Major Event concerns. We note that the Board stated when ordering PSE&G to revise its Energy Strong Petition, that its initial Energy Strong petition was inadequate, in part, because it "…also fails to adequately distinguish storm hardening and mitigation efforts from normal operations and maintenance, reliability projects, and programs necessary to maintain safe, adequate and reliable service…."[6] This distinction is critical to this proceeding.

[5] See I/M/O PSE&G, BPU Docket Nos. EO13020155 and GO13020155 (Order, May 21, 2014).

[6] Storm Proceeding Order, p. 4.

Q. What are "Major Events" as defined by the Board?

A. It is our understanding that the Board has defined "Major Events" as interruptions affecting at least 10 percent of customers within an operating area.[7] This includes, but is not limited to: tornadoes, thunderstorms, snow storms, heat waves, ice storms; and extends to other service territories when providing mutual assistance to a territory.

Q. Should the Board's definition of Major Events be the only criterion that the Board should look to when evaluating these programs?

A. While this definition continues to be valid, we believe that the focus of the storm hardening proceeding should be solutions that address those events that the Board's has described in its Hurricane Irene Order:

> New Jersey experienced two unprecedented weather events in 2011. Though vastly different, both substantially affected New Jersey communities, residents and businesses, primarily due to prolonged power outages.[8]

As discussed in detail below, we have concerns that certain elements of the Company's proposal fail to provide solutions to address unprecedented weather events.

[7] N.J.A.C. 14:5-1.2.
[8] Hurricane Irene Order, p. 2.

IV. SUBSTATION MITIGATION ("MUSCLE WALL")

Q. Please summarize your recommendations about the Muscle Wall system.

A. We believe, based on the limited degree of exposure and the assessment of revised FEMA flood level data as it relates to substation elevations in the Company's service territory, that the Company's proposed "Muscle Wall" system designed to mitigate water intrusion at selected substations is a reasonable and appropriate measure for inclusion in the Company's storm hardening program. The Muscle Wall system is a series of temporary flood walls that can be stored and re-used.[9] We recommend that the Board approve the $300,000 capital costs associated with the "Muscle Wall" flood wall system as a pilot project, but exclude the recovery of operations and maintenance expense in this Storm Hardening proceeding.

Q. Did the Company experience any flooding at its substations during Major Events such as Hurricane Irene and Superstorm Sandy?

A. Only the Cresskill and Saddle River substations experienced minor flooding, which did not impact service performance.[10] Additionally, the Company has indicated that none of its other substations experienced flooding that resulted in outages during Major Events such as Hurricane Irene and Superstorm Sandy.[11] The Company has only identified the Cresskill and Saddle River substations as within or near FEMA flood zones based on recently revised FEMA flood level

[9] http://www.musclewall.com
[10] Direct testimony of the Storm Hardening Panel at 9:15-17.
[11] Direct testimony of the Storm Hardening Panel at 9:11-17.

elevations. Therefore, the Company has proposed to implement flood protection measures for those two stations.[12]

Q. Has the Company provided information for the selection of the Cresskill and Saddle River substations?

A. Yes. Since the two substations only suffered minor flooding, the Company determined that floodwall systems are sufficient to effectively keep flood water out of the substations.[13]

Q. Please describe the floodwall system proposed by the Company for the two substations.

A. The Company is proposing to install a Muscle Wall system for the two identified substations.[14] We understand that the Muscle Wall system is a series of temporary flood walls that can be pre-positioned before a flood, installed in anticipation of a flood, removed afterwards, and then stored for re-use.[15] The Company contends that the Muscle Wall flood wall system provides a low-cost and long-term solution to temporary and minor flooding issues at the two substations. [16, 17, 18] The Company anticipates that the capital costs associated with the Muscle Wall

[12] Id.
[13] Id. at 9:20-22.
[14] Id. at 10:1-2.
[15] http://www.musclewall.com
[16] Id. at 22:9-21.
[17] RCR-ENG-86.
[18] RCR-ENG-82.

system will be $300,000 and that the 2016 O&M expenses for the Muscle Wall system will be $50,000.[19]

Q. Do you have concerns regarding aspects of the Company's proposed Muscle Wall systems?

A. We do have concerns that the Company is proposing to include O&M expenses associated with the Muscle Wall system as part of the Storm Hardening proposal. Rate Counsel witness Andrea Crane describes why the recovery of operation and maintenance expenses should be through a normal rate case procedure.

V. OVERHEAD ENHANCEMENTS

Q. Please summarize your concerns about the Company's proposed overhead enhancement program.

A. The Company has not established specific selection criteria or a priority list of Major Event impacted circuits. As a result, it is unclear whether the proposed overhead enhancement program specifically targets circuits that are susceptible to damage during Major Events or, alternatively, service critical facilities. It appears that most of the proposed overhead projects generally address day-to-day reliability issues rather than Major Events. Based on the consideration concerning circuits that supply critical facilities, we recommend that if the Board were to approve this program, then the Board should only approve the capital costs associated with the following four pilot projects that the Company claims are related to critical infrastructure: (1) Harrington Park-Harriot Ave ($830,000), (2)

[19] Direct testimony of the Storm Hardening Panel at 26:14-15.

Harings Corner ($731,800), (3) Old Tappan Road Reconductor ($331,600), and (4) Old Tappan Road to Blanche Avenue ($750,100). In addition, the Board should require the Company to establish a reporting mechanism to assess how the circuits perform during Major Events.

Q. Please describe the Company's proposed overhead enhancement program.

A. The Company proposes to install spacer cable systems at select locations to enhance the storm resiliency of elements of its existing overhead distribution system.[20] In its Petition, the Company has proposed eight specific overhead spacer projects and an annual overhead blanket for the 2017-2020 period. These projects are detailed below:

[20] Direct testimony of the Storm Hardening Panel at 17:7-10.

SHPR 1 RECO Proposed Overhead Construction Projects.

Project	Circuit	Critical Facilities	Project Year	Capital Cost ($000's)
1. Harrington Park - Harriot Ave (Schraalenburgh To Bogert Mill)	Not Detailed	Yes	2018	$830
2.Harings Corner - White Ave (Orangeburg Rd To Clinton Ave)	30-1-13 30-7-13	Yes	2018	$732
3. Old Tappan - Old Tappan Rd Reconductor	30-4-13	Yes	2018	$332
4. Old Tappan - Leonard Drive (Old Tappan Rd To Blanche Ave)	Not Detailed	Yes	2019	$750
5.Closter - Cedar Lane (Tie to Schraalenburgh Road)-NJ	28-5-13 28-8-13	No	2019	$300
6. Oakland - Chuckanutt Drive tie - New Jersey	35-10-13 35-5-13	No	2017	$420
7. Wyckoff - Cresent Ave mainline - New Jersey	39-1-13	No	2016	$475
8. Wyckoff - Godwin Ave mainline -NJ	39-1-13	No	2016	$452
Annual Overhead Blanket post 2020		Unknown	2020	$1,000
Total				**$5,291**
Notes Storm Hardening Panel Direct Testimony Exhibit ARP-1, Schedule 3 Critical facilities as defined by Synapse				

Q. Did the Company provide selection criteria for these eight projects?

A. No, the Company did not provide selection criteria for determining how these eight specific projects were selected other than general service reliability concerns and improving overall storm resiliency.

Q. Did the Company explicitly define what a critical facility is?

A. No.

Q. Do you have a working definition for critical facilities?

A. Yes, the Federal Emergency Management Agency ("FEMA") has an appropriate definition. FEMA's definition is as follows: "… critical facilities include

hospitals, fire stations, police stations, storage of critical records, and similar facilities."[21]

Q. Why do you include critical facilities in your analysis of the proposed projects?

A. The Company has noted that its service territory experienced unprecedented damages during Hurricane Irene, the October Snowstorm, and Superstorm Sandy.[22] As a result, numerous customers experienced prolonged outages. During prolonged outages associated with major storm events, communities will require the continued operations of essential services such as police, fire, ambulance, and emergency shelter facilities. Thus, we believe that identifying and incorporating these critical facilities should be part of the Company's prioritization processes for storm hardening.

Q. Has the Company identified critical facilities associated with the proposed projects?

A. The Company has identified some critical facilities associated with its proposed work, but has not provided specifics. The Company has noted that four of the projects: (1) Harrington Park-Harriot Ave, (2) Harings Corner, (3) Old Tappan Road Reconductor, and (4) Old Tappan Road to Blanche Avenue contain what we have determined to be critical facilities such as schools, police stations, fire stations, and a medical rehabilitative complex. These projects are shown in SHPR 1.

[21] http://www.fema.gov/critical-facility
[22] Petition, pp. 5-7.

Q. Did the Company provide Major Event performance data for the eight projects?

A. Yes, in response to discovery requests, the Company provided the outage performance associated with the eight listed projects during Major Events and non-storm events for the last 10 years. The data included the number of faults during Major Events, the number of affected customers during Major Events, and the number of outage minutes during Major Events. The results are summarized below.

SHPR 2 Reliability Performance of Overhead Enhancement Projects During Major Events in the last Ten Years.

Project	Faults during Major Events	Affected Customers during Major Events	Outage Minutes during Major Events	Non-storm condition affected customers	Non-storm Outage Duration Minutes	Response	Critical Facility
1. Closter-Cedar	41	2,532	2,918	392	45,878	RCR-ENG-53	No
2. Harrington Park	38	2,935	1,308	560	58,780	RCR-ENG-50	**Yes**
3. Oakland-Chuckanutt	24	225	1,614	219	22,333	RCR-ENG-49	No
4. Old Tappan Reconductor	12	2,018	2,069	413	51,942	RCR-ENG-51	Yes
5. Old Tappan-Leonard Drive	12	2,018	2,069	413	51,942	RCR-ENG-54	Yes
6. Wyckoff-Cresent Ave.	10	2,792	4,425	328	38,722	RCR-ENG-48	**No**
7. Wyckoff- Godwin Ave.							
8. Harings Corner	6	2,407	1,595	130	14,652	RCR-ENG-52	Yes
Notes Critical facilities defined within testimony. Wyckoff-Cresent Ave. & Godwin Ave projects combined per RCR-ENG-48							

It is not clear how the Company incorporated this information in their determination of overhead enhancement projects relative to other circuits on their distribution system. The Company provided a list of worst performing circuits based on storm data in discovery, but did not identify where the eight proposed

projects ranked on the list.[23] Therefore, we were unable to rank how these circuits perform relative to the Company's other circuits during storm-related Major Events.

Q. Should the Company have developed selection criteria for this program?

A. Yes. We believe that the Company should have developed selection criteria for this program. To address storm resiliency the selection criteria should, at a minimum, incorporate the outage performance during Major Events, the number of affected customers, the number of faults, and the presence of critical facilities. The Company should determine the appropriate weighting of each criterion based on its experience and judgment, but the application should be consistent for this program. We believe that the establishment of objective selection criteria is important to rank and prioritize overhead enhancement work that is incremental to work that would be otherwise initiated to address general reliability issues. That prioritization should focus on circuits susceptible to damage during Major Events and circuits serving critical facilities.

Q. Please summarize your recommendations regarding the Company's proposed overhead enhancement program.

A. In the absence of data supporting each of the Company's proposed overhead enhancement projects, we recommend that only the following overhead enhancement pilot projects be approved: (1) Harrington Park ($830,000), (2) Harings Corner ($731,800), (3) Old Tappan Road Reconductor ($331,600), and

[23] RCR-ENG-43.

(4) Old Tappan Road to Blanche Avenue ($750,100). These projects are in proximity to critical facilities that would benefit from the implementation of the proposed overhead enhancements. We recommend that the Board reject the remaining overhead enhancement projects since it appears that the remaining projects might only help improve general reliability and do not appear to have critical facilities associated the proposed scope of work. They should be addressed by the Company in the normal course of business.

VI. SELECTIVE UNDERGROUNDING

Q. Please summarize your concerns about the Company's selective undergrounding program.

A. We have several concerns about the Company's proposed undergrounding of the Ringwood mainline and West Milford circuits. Our primary concern is that the circuits associated with the proposed undergrounding program are consistently on the Company's worst performing circuit list. Thus, it appears that the Company is using a program designed for extraordinary storm events to address general reliability efforts. We are also concerned that the Company did not adequately examine other alternatives to the proposed solution offered for Ringwood and West Milford.

Q. Please summarize the Company's proposed undergrounding projects.

A. The Company is proposing two specific undergrounding projects. The first project is a proposed 3.6 mile undergrounding, which will create a third circuit path to

address the current overhead double circuit path from the Ringwood substation.[24] The Company's anticipated cost for this project is $7.2 million for the undergrounding and $868,000 for associated circuit upgrades.[25, 26] The Company's second proposed project is undergrounding one existing circuit and adding a new underground circuit at the Company's West Milford substation. The Company's anticipated cost for this project is $5.1 million.[27] Both projects are summarized below.

SHPR 3 RECO Proposed Selective Undergrounding Projects

Project	Critical Facilities	Underground Length (miles)	Project Year	Capital Cost ($000's)
Underground Sections of Ringwood Mainline	Not Identified	3.6	2017	$7,240
New Circuit Position Ringwood	Not Identified		2016	$868
West Milford Underground Circuit 2 & Circuit 5	Not Identified	1.6	2016	$5,090
Total		5.2		$13,198
Notes Exhibit ARP-1, Schedule 3 Smart Grid Panel Direct Testimony				

Q. Has the Company identified critical facilities associated with the two proposed projects?

A. The Company has not indicated if there are any specific critical facilities located on the circuits that would benefit from the two proposed undergrounding projects.

[24] Direct testimony of the Storm Hardening Panel at 14:12-15.
[25] Id. at 14:22.
[26] Id. at 15:8.
[27] Id. at 16:17-18.

Q. Do the circuits associated with the two projects have reliability issues?

A. Yes. Many of the circuits associated with the Ringwood and West Milford substations have been on RECO's worst performing circuits list for a number of years based on the Company's Annual System Performance Reports ("Annual System Reports") filed with the Board. The following table shows the rank of the Ringwood and West Milford circuits for the Company's worst performing circuits from 2009 through 2014.

SHPR 4 Ringwood and West Milford Substations - Worst Performing Circuit Rankings 2009-2014

Number	Circuit	Substation	2009	2010	2011	2012	2013	2014
1	78-1-13	Ringwood	1	3	1	1	1	1
2	78-2-13		34	29	10	10	11	6
3	79-3-13	West Milford	4	7	20	4	7	2
4	79-4-13		42	64	40	53	10	5
5	79-5-13		2	9	12	5	2	3
n			76	83	77	84	78	8

Notes
Data from RECO Annual System Reports provided in response to RCR-ENG-30 and AMI-33
In 2014, RECO ranked circuits by Division

As shown in the table, Ringwood Circuit 78-1-13 is consistently ranked as one of the Company's worst performing circuits. The West Milford circuits 79-3-13 and 79-5-13 also consistently rank poorly among the Company's circuits.[28] In our review of the Company's assessment of the outages, we observed that the Company generally attributed outages for these circuits to tree damage, which is consistent with the hilly and forested terrain of the area. Improvements to these

[28] West Milford circuit 79-6-13 also appears on the Company's worst performing circuits list, but is not part of this Petition.

circuits should have been implemented some time ago based on performance measurements that expressly exclude major storms. For Ringwood Circuit 78-1-13, in its 2014 Annual System Report the Company has noted four major improvement projects planned for the next two years. These include: (1) installation of a mainline loop off the Mohawk Trail that will reduce the current 3.4 miles of double circuit by 0.6 miles; (2) connection with the new Blue Lake Station (Tuxedo, NY); (3) the proposed undergrounding described in this Petition; and (4) the addition of three field reclosers.[29] For West Milford Circuits 79-3-13 and 79-5-13, the Company's 2014 Annual System report describes the undergrounding of circuit 79-5-13 as described in the Petition, and also describes the addition of a new circuit 79-2-13 that is not sought in this Petition.[30]

Q. If these circuits have ranked poorly, what has the Company done in the past to address reliability concerns associated with the two substations?

A. In general, the Company has undertaken incremental actions to improve the reliability at these circuits even though three of the circuits are consistently identified as poor performing circuits. For Ringwood circuit 78-1-13, the Company (1) added a total of three reclosers in 2009 and 2010, (2) included the circuit as part of its Circuit Ownership Program in 2009, (3) trimmed the circuit in 2009 and 2012, (4) installed lightning and animal guards in 2010, and (5) in 2011 reconfigured the circuit and reduced it to serve only 2,031 New Jersey customers.. For the other circuits, the Company has also maintained its three-year trimming

[29] RCR-AMI-33, page 48 of 109.
[30] RCR-AMI-33, pp. 49-50.

cycle and periodically installed animal guards as needed. In the Company's last base rate case (BPU Docket No. ER13111135), the Company proposed a very similar undergrounding project for the Ringwood substation to address normal reliability concerns. We note that the Company's cost estimate for undergrounding at that time was $6 million, compared to $7.2 million now.[31]

Q. How much has the Company spent on tree trimming of these circuits in the two trimming cycles?

A. The Company has spent a total of approximately $737,000 to trim five of the six circuits in the last two trimming cycles or approximately an annual average of $368,000 for the five circuits.[32]

Q. Has the Company analyzed the impact of more accelerated tree trimming cycles for these circuits?

A. Prior to 2013, the Company did not contemplate increased vegetation management for the five Ringwood and West Milford circuits.[33] Following major storms in 2011 and 2012, the Company instituted new clearance standards in 2013.[34] However, based on the trimming cycle schedule, the Company does not plan to implement the new clearance standards on the Ringwood and West Milford circuits until 2016.[35]

[31] Direct testimony of Wayne Banker (BPU Docket No. ER13111135, dated November 27, 2013) at 8:18-19.
[32] RCR-ENG-87. Circuit 79-6-13 was not included in the request and therefore not included.
[33] RCR-ENG-88.
[34] Id.
[35] Id.

Q. What would be the cost impact if the Company accelerated trimming cycles for the six circuits at the two substations?

A. If we were to include an additional $110,000 to account for West Milford circuit 79-6-13 (based on the trimming costs associated with circuits 79-3-13 and 79-5-13) that would increase the annual trimming costs for the six circuits to $478,000. This illustrative analysis suggests that the proposed cost of undergrounding would be equivalent of trimming the six circuits each year for 27 years ($13,198,000 ÷ $478,000 = 27.6).

Q. Please explain if the worst performing circuits list includes major storms such as Hurricane Irene, the October Snowstorm, or Superstorm Sandy?

A. Earlier, we noted that Table SHPR 4 details the relative ranking of the six circuits in the Company's determination of worst performing circuits. The Company's worst performing circuit information focuses on day-to-day reliability and not on the storm-related Major Events that are the focus of this Board initiative. We note that the Company expressly excluded the impact of Hurricane Irene, the October snowstorm, and Superstorm Sandy in ranking its worst performing circuits.[36]

Q. Why are you concerned about the fact that these circuits are on the worst performing circuit list?

A. Circuits that are not only listed on, but also rank very high on, Board-required worst performing circuit lists should have their reliability performance addressed in the normal course of business. Such circuits can hardly be expected to perform

[36] RCR-ENG-30.

well under more severe major storm events. These circuits typically have higher exposure to tree-related events and are often more susceptible to outages under such conditions. As shown in the Company's Annual System Reports, tree contact is a predominate cause of interruptions on its distribution circuits. Such worst performing circuits should be corrected to address non-storm related reliability performance, which would in turn improve the circuit's performance during major storm events. However, these actions should be part of normal reliability spending. Further, in the future when considering major improvements to a circuit, the Company should review the circuit's Major Event performance characteristics to determine if a more effective storm hardened design should be used for the upgrade.

Q. Why do you find it problematic that Major Events such as Hurricane Irene, the October snowstorm, and Superstorm Sandy are not incorporated in the Company's determination for selective undergrounding?

A. We are concerned that the exclusion of outage data from the three Major Events that are the impetus for this filing undermines the Board's desire to improve grid resiliency and responsiveness to storm-related Major Events. Major Events are typically excluded from the Company's outage statistics. In response to RCR-ENG-24, the Company provided a list of circuits and associated number of faults for Hurricane Irene and Superstorm Sandy. We then compared the Company provided list in RCR-ENG-24 with the 13 circuits referenced in Storm Hardening Panel's Direct Testimony for both the Overhead Enhancement and Selective Undergrounding programs. Based on the number of faults, only two of the 13

circuits were on the poorest performing ten circuits based on the list of circuits for either Hurricane Irene or Superstorm Sandy. Circuit 78-1-13 made the poorest performing ten circuit list for Hurricane Irene and circuit 35-5-13 was one of the poorest performing ten circuits for Superstorm Sandy. We note that circuit 6-8-13 was one of the poorest performing ten circuits based on the number of faults for both Hurricane Irene and Superstorm Sandy, yet that circuit does not appear in the Company's Storm Hardening proposal. We find it problematic that the circuits targeted under the Company's Storm Hardening proposal are not necessarily the same circuits that experienced the poorest performance under two of the unprecedented storms that initiated this proceeding.

Q. Should the Company modify its current planning process?

A. The Company has suggested that on a going-forward basis, a storm hardened construction design would be used (e.g., selective undergrounding or spacer cable, etc.) where conditions call for it whenever new construction or major upgrades are to be built. The majority of upgrades included in the undergrounding program are associated with circuits that are on the worst performing circuit list (which excludes major storm effects) and are in need of upgrades as part of the Board's reliability maintenance programs. A circuit that needs to be corrected to address normal reliability performance concerns should be upgraded using the Company's suggested storm hardened design only if its storm performance warrants such a design. Therefore the Company does not need special rate treatment. This work should be done as a matter of standard practice to correct problem circuits based on normal reliability concerns.

Q. Please summarize your recommendations.

A. We recommend that the Board reject the Company's undergrounding proposal for the Ringwood and West Milford substations because the Company's proposal essentially addresses a long-standing reliability issue at these two substations, but does not appear to be based on fault or outage data specific to storm-related Major Events that are the objective of the Board's Storm Hardening initiative. The Company's endeavors to improve reliability of these circuits should be considered as part of the Company's base rate case, and not part of this Storm Hardening proceeding.

VII. SELECTIVE UNDERGROUNDING BLANKET

Q. Please describe the Company's proposed selective undergrounding blanket program.

A. The Company proposes to introduce a blanket for the 2017-2020 period for generic work that is not defined at this time.[37] This blanket would enable the Company to underground approximately two miles per year over what the Company envisions will be a 15 to 20-year period.[38] The Company proposes that the selection and prioritization process would be based on storm outage history, customer counts, cost, and critical customers.[39]

[37] Direct testimony of the Storm Hardening Panel at 13:3-4.
[38] Id. at 12:21-22.
[39] Id. at 17:3-4.

Q. What is the anticipated capital cost associated with this program?

A. The Company has proposed to spend a total of $13 million starting with $1 million in 2017 and then increasing to $4 million per year through 2020.[40] This single program represents approximately 35 percent of the capital spending proposed by the Company's Storm Hardening Panel. We understand that the Company proposes to continue this program over a 10 to 15-year time period and that at some time in the future, the Company would re-evaluate the extension of this program.[41] Significantly, the Company has not provided its selection criteria and ranking of circuits for this project.

Q. Has the Company provided the criteria associated with the selection of specific areas?

A. Beyond the specific projects for undergrounding portions of the Ringwood mainline and some of the West Milford circuits, the Company has not provided a detailed listing of locations or specific details of the selection process. In fact, the Company's internal committee reviewing selective undergrounding recommended that the Company conduct a detailed analysis of storm outage data.[42] The Company did not provide this analysis to support its proposal. The Company should have developed criteria that is expressly based on storm-related performance and concerns. This should have been followed by a review of the Company's distribution system under such a criteria which would serve as the

[40] Direct testimony of the Accounting and Rate Panel, Exhibit ARP-1, Schedule 3.
[41] Direct testimony of the Storm Hardening Panel at 13:3-5.
[42] RCR-ENG-71 Attachment 1, page 8 of 117.

basis for determining the specific projects and estimated costs to be considered as part of the storm hardening program. In fact, this is essentially the same recommendation provided to the Board by General Electric Energy Consulting in section 3.2.3 of its GE Energy Consulting NJ Storm Report.[43]

Q. Has the Company conducted selective undergrounding in the past two years?

A. Yes. In 2013 and 2014 the Company conducted undergrounding of 200 and 2,200 feet respectively.[44] Notably, the Company did not seek a special rate recovery mechanism to implement these projects.

Q. What was the Company's selection criteria for the 2,400 feet of undergrounding?

A. In response to discovery, the Company claims that it determined the selected areas based on (1) sound engineering, (2) past performance during storm conditions, and (3) known areas that needed to be addressed in order to harden the system.[45] While the Company provided these general guidelines, they did not provide the supporting evaluation criteria or a ranking of circuits.[46]

Q. Have there been recommendations for objective undergrounding criteria?

A. Yes. The GE Energy Consulting NJ Storm Report provides an illustrative methodology to select and prioritize selective undergrounding projects.[47] Given that GE Energy Consulting found that the conversion cost of overhead to

[43] GE Energy Consulting NJ Storm Report.
[44] RCR-ENG-84.
[45] RCR-ENG-94
[46] Id.
[47] GE Energy Consulting NJ Storm Report, p. 3-27.

underground distribution ranges from $158,000 to $2,420,000 per mile, we believe that RECO must follow an objective methodology to rank and justify any selective undergrounding project.[48]

Q. Why are objective selection criteria important?

A. Selection criteria are necessary in order to identify projects that could improve storm-related reliability and provide a benchmark to determine the efficacy of the Company's proposed undergrounding program. However, as we noted earlier, the Company has not provided the selection criteria for this program. .

Q. What are your recommendations to the Board regarding the annual undergrounding blanket?

A. We recommend that the Board exclude this program since the Company has not provided sufficient detail or justification to support the approval of a $13 million blanket program for selective undergrounding. The Company has provided neither the selection criteria nor a list of possible undergrounding locations based on Major Event outage data.

VIII. DISTRIBUTION AUTOMATION

Q. Please summarize your concerns about the Company's distribution automation program.

A. We have several concerns about the Company's proposed distribution automation program, specifically its voltage ("Volt") and volt-ampere reactive (VAR) control

[48] GE Energy Consulting NJ Storm Report, p. 3-22.

initiatives.[49] Our primary concern is that while the proposed Volt/VAR improvements will help improve voltage control and efficiency of the distribution system generally, they will not necessarily improve major outage response. Thus, we believe that the Company's proposed Volt/VAR program should not be included as part of this storm hardening filing.

Q. Please describe the Company's proposed Volt/VAR program.

A. The Company proposes to introduce Volt/VAR as part of a $1.6 million blanket for the 2016-2020 period.[50] This $1.6 million blanket would also enable the Company to implement distribution system modeling in the future. The Company envisions that it will take about 15 years to expand Distribution Automation throughout its entire service territory.[51] RECO's allocation of the Volt/VAR software and modeling costs at this stage is $159,000.[52]

Q. What are the software and modeling efforts?

A. Our understanding of the Integrated System Model ("ISM") and Distribution Engineering Workstation ("DEW") software is that they enable the Company to conduct a large volume of power flow calculations to obviate the need for simplifying assumptions that are typically used to optimize the RECO distribution

[49] Volt/VAR controls manage power flows through the distribution network by measuring and adjusting voltage (volt) regulation and reactive power (VAR).
[50] Direct testimony of the Storm Hardening Panel at 13:3-4.
[51] Direct testimony of the Smart Grid Panel at 8:2-3.
[52] RCR-ENG-13.

systems.[53] RECO would use the ISM system to integrate planning, design, economic evaluation, training, real-time analysis, and real-time control.[54]

Q. Are you concerned that the program has few storm hardening benefits?

A. Yes. We observed that the Company listed a number of benefits attributable to the Volt/VAR program that included phase balancing, improving/reducing delivery system losses, improving system capacity/utilization, and reducing customer usage and consumption.[55] The Company further notes specifically that the Volt/VAR program will allow the Company to operate more efficiently while providing cost savings and benefits.[56] We note that none of the purported benefits of the Volt/VAR program were linked to storm-related Major Events or the Company's response to outages. Further, the Company specifically focused on programs to show the highest cost-benefit potential.[57]

Q. Is the Volt/VAR program cost justified on its own?

We note that the Company identified automation technologies that show the highest cost-benefit potential. We further note that the Company engaged the Electric Power Research Institute ("EPRI") to conduct a cost-benefit analysis of elements of the Orange and Rockland Grid Modernization program.[58] Taking the EPRI results at face value, we note that the EPRI cost-benefit analysis showed that the Company's approach produced a net benefit of $3.8 million on a 10-year

[53] RCR-ENG-2 Attachment at 4-1.
[54] Id.
[55] Id. at 11:22-23.
[56] Id. at 12:1-2.
[57] Petition at p. 8.
[58] RCR-ENG-2 Attachment.

present value basis.[59] This indicates that the proposed program savings exceed the program cost[60] which suggests that the Company would benefit from its implementation.

Q. Did the EPRI analysis suggest any other distribution automation benefits?

A. The EPRI analysis included estimates of system-wide savings based on reductions in Crew Switching times as a result of distribution automation investments. At face value, the EPRI analysis showed that the analyzed distribution automation investments related to outage performance improvements provided a 10-year present value benefit of $7.6 million.[61] Additionally, the EPRI report indicated that the program would also have a benefit associated with asset deferral. This benefit was associated with the reliability improvement brought about by distribution automation and was estimated at $7.0 million based on a 10-year present value calculation.[62]

Q. Please summarize your recommendations.

A. Notwithstanding the positive benefit-cost ratio, we recommend that the Board reject the proposed voltage and VAR pilot and distribution automation program because it appears that the majority of the benefits attributable to this program would occur during normal operations and lead to an economic savings to the Company. Although, it appears that the EPRI analysis shows that the proposed program would provide net benefits in excess of the program costs, the Company

[59] RCR-ENG-2Attachment at 6-1.
[60] RCR-ENG-2 Attachment at 6-1.
[61] RCR-ENG-2 Attachment at 5-12.
[62] RCR-ENG-2 Attachment at 6-1.

should incorporate the program in base rates rather than through this storm hardening surcharge. While the EPRI analysis does show some benefits for storm response, the report also noted that the program provides the Company with improvements in capital project deferral, normal reliability, and blue sky reliability performance.[63]

IX. ENHANCED VEGETATION MANAGEMENT

Q. Please describe your concerns about the enhanced vegetation management program proposed by the Company.

A. We believe that the Company's proposed enhanced vegetation management program is merely an expansion of the Company's current vegetation management O&M expenses and does not deserve special rate treatment. The Company proposes to increase O&M expenses by $1.146 million over five years to implement this program. We agree that vegetation management will provide benefits from reducing tree limb contacts for Major Events such as hurricanes, but it will also provide benefits during the course of normal, less severe events.

Q. What is your recommendation regarding enhanced vegetation management?

A. While we believe that enhancing the Company's vegetation management programs maybe a reasonable and more cost effective alternative to a number of the elements in the Company's Storm Hardening program, we do not believe that the O&M expense should be incorporated into the storm hardening surcharge petition as described in detail in witness Andrea Crane's testimony.

[63] RCR-ENG-2 Attachment at 7-1.

X. SUMMARY

Q. Does this conclude your testimony?

A. Yes. However, we reserve the right to supplement our testimony subject to further updates to discovery and information provided by the Company.

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PROFESSIONAL EXPERIENCE

Synapse Energy Economics Inc., Cambridge, MA. *Principal Associate*, 2013 – present, *Associate*, 2008 – 2013.

Consults and provides analysis of technologies and policies, electric policy modeling, evaluation of air emissions of electricity generation, and other topics including energy efficiency, consumer advocacy, environmental compliance, and technology strategy within the energy industry. Conducts analysis in utility rate-cases focusing on reliability metrics and infrastructure issues and analyzes the benefits and costs of electric and natural gas energy efficiency measures and programs.

Environmental Health and Engineering, Newton, MA. *Senior Scientist*, 2001 – 2008.

Managed complex EPA-mandated abatement projects involving polychlorinated biphenyls (PCBs) in building-related materials. Provided green building assessment services for new and existing construction projects. Communicated and interpreted environmental data for clients and building occupants. Initiated and implemented web-based health and safety awareness training system used by laboratories and property management companies.

The Penobscot Group, Inc., Boston, MA. *Analyst*, 1994 – 2000.

Authored investment reports on Real Estate Investment Trusts (REITs) for buy-side research boutique. Advised institutional clients on REIT investment strategies and real estate asset exchanges for public equity transactions. Wrote and edited monthly publications of statistical and graphical comparison of coverage universe.

Harvard University Extension School, Cambridge, MA. *Teaching Assistant*, 1995 – 2002.

Teaching Assistant for Environmental Management I and Ocean Environments.

Brigham and Women's Hospital, Boston, MA. *Cancer Laboratory Technician*, 1992 – 1994.

Studied the biological mechanism of tumor eradication in mouse and human models. Organized and performed immunotherapy experiments for experimental cancer therapy. Analyzed and authored results in peer-reviewed scientific journals.

EDUCATION

Harvard University, Cambridge, MA
Master of Science in Environmental Science and Engineering, 2000

Cornell University, Ithaca, NY
Bachelor of Arts in Biology and Classics, 1992

REPORTS

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Resume dated September 2015

Charles P. Salamone P.E.

Profession: Power systems analysis and assessment, with a special emphasis on transmission planning, performance and design

Nationality: U.S. Citizen

Years of Experience: 40 years

Education B.S.E.E, Power System Engineering, 1973
Gannon University, Erie, PA

Position: Owner/Manager, Cape Power Systems Consulting

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Summary: Mr. Salamone provides professional services based on 40 years of electric utility industry experience in the areas of Transmission Planning, Substation Planning, Distribution Planning, ISO-New England Planning Procedures, New England Power Pool Procedures, Congestion Management, Generator Interconnections, Planning/Capital Budget Management, Meter Engineering, and State (Mass DPU and New Jersey Rate Council) and Federal (FERC) Regulatory Agency Filing Development and Expert Witness Testimony

Experience:

2005- Pres. **Cape Power Systems Consulting**
Established a power system design, analysis, planning and assessment consulting company to work directly with diverse power system stakeholders.

- Worked with a number of clients for the development of analysis, reports and presentations in support of regulatory and technical review/approval process for transmission and distribution projects
- Provided technical assistance for transmission planning activities for an Independent System Operator including support for major transmission system expansion programs and development of a 10 year transmission plan
- Worked with a large Massachusetts Utility as an expert witness in support of State regulatory reviews for the siting of a major transmission system upgrade plan

- Worked with state regulatory agencies in support of electric utility rate case proceedings including expert witness testimony and assessment of electric utility performance
- Worked with multiple state regulatory agencies in support of review of electric utility smart grid initiatives including review of the technical performance, system benefits and viability of proposed electric utility programs
- Developed and conducted a comprehensive training program for implementation of an Energy Management System (EMS) based transmission system security assessment application for a large Massachusetts utility
- Worked with clients to conduct load flow assessment of transmission system performance for feasibility and reliability performance studies across New England and New York

1979-2005 NSTAR (Previously Boston Edison and Commonwealth Electric)

2000-2005 ***Director System Planning***

NSTAR (Previously Boston Edison and Commonwealth Electric) Boston, MA

- Responsible for long term planning of Company transmission, substation and distribution systems
- Successfully managed the studies, design, internal and external review and regulatory approval for a $250M 345 kV underground transmission expansion project serving the greater Boston area
- Managed numerous generator interconnection studies, design and approvals
- Successfully managed studies, design and approval for congestion mitigation plans and expansion project
- Oversaw transmission and distribution planning efforts to establish a comprehensive 10 year $300 million system expansion plan
- Served as Company representative on NEPOOL Reliability Committee and the New England Transmission Expansion Advisory Committee
- Served as Company expert witness for system planning related regulatory proceedings at both the state and federal levels.
- Supervised a staff of 10 senior engineers

1989-1999 ***Manager, System Planning and Meter Services***

Commonwealth Electric Company, Wareham, MA

- Develop risk based prioritized $10 million construction budget procedures
- Supervise a staff of 6 professional engineers and 4 analysts
- Served as chair of the NEPOOL Regional Transmission Planning Committee (currently the NEPOOL Reliability Committee)
- Process billing determinant and interval data for all major system customers
- Lead implementation of first MV90 meter data processing system
- Develop annual performance analysis reports for all transmission and major distribution systems

- Manage multiple FERC tariff based transmission customer and generation developer system impact studies
- Served as expert Company witness in State and FERC regulatory proceedings
- Implemented a risk index for prioritization of all transmission and major distribution construction projects
- Implemented automated electronic processing of major customer billing data, which significantly reduced time needed to generate bills
- Served as lead member on information technology company merger team
- Implemented process and equipment to perform all tie line, generator and wholesale customer meter testing
- Served as chair of the NEPOOL Planning Process Subcommittee, which established numerous NEPOOL policies for transmission/generator owners
- Served as Vice-Chair of the NEPOOL Reliability Committee

1984-1989 ***Meter Engineer***

Commonwealth Electric Company, Plymouth, MA

- Designed and supervised installation of 15 generator meter data recorders
- Developed customer load plotting and analysis software
- Developed meter equipment order data processing system for four remote offices
- Implemented PC control of meter test boards, which significantly reduced processing and record keeping time
- Managed programming of all electronic meter registers to insure accurate data registration

1979-1984 ***Computer Application Engineer***

Commonwealth Electric Company, Wareham, MA

- Implemented numerous technical and analytical software applications for engineering analysis
- Served as member of decision team for implementation of a new SCADA system

1978-1979 **San Diego Gas & Electric, *Planning Engineer***

San Diego Gas & Electric Company, San Diego, CA

- Performed extensive stability analysis for a new 230 kV transmission interconnection with Mexico
- Performed transmission design and performance analysis for a new 250 mile 500 kV line from San Diego to Arizona

1973-1978 **New England Gas & Electric Association, *Planning Engineer***

New England Gas & Electric Association, Cambridge, MA

- Performed extensive stability analysis for a new 560 MW generating plant on Cape Cod
- Developed transmission plan for a new 345 kV transmission line on Cape Cod
- Developed plans for design and sighting of new 115 / 23 kV substations on Cape Cod