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November 20, 2007

VIA HAND DELIVERY

Hon. Jaclyn Brilling
Secretary
State of New York Public
Service Commission
Three Empire State Plaza
Albany, New York 12223-1350

Re: Case 06-M-1078 – Proceeding on Motion of the Commission to Audit the Performance of Consolidated Edison Company of New York, Inc. in Response to Outage Emergencies

Dear Secretary Brilling:

Pursuant to the Commission's Notice Inviting Comments issued in the above referenced proceeding on October 25, 2007, please find enclosed an original and five copies of the Initial Comments of the City of New York. A copy of the City's Initial Comments has also been served on the active parties in Case 06-E-0894 in the Commission's investigation of power outages in Con Edison's Long Island City network.

Please have the extra copy of these Initial Comments time-stamped and returned to our messenger. Please call me if you have any questions.

Very truly yours,

COUCH WHITE, LLP

/s/ Moshe H. Bonder

Moshe H. Bonder

MHB/dp
Enclosures
cc: Active Parties in Case 06-E-0894 (via e-mail).
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Case 06-E-0894
Investigation of Electric Power Outages in Con Edison's Long Island City Network

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November 15, 2007

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STATE OF NEW YORK
PUBLIC SERVICE COMMISSION

Proceeding on Motion of the Commission to Audit the Performance of Consolidated Edison Company of New York, Inc. in Response to Outage Emergencies	**Case 06-M-1078**

INITIAL COMMENTS OF THE CITY OF NEW YORK ON THE AUDIT REPORT

Dated: November 20, 2007

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PRELIMINARY STATEMENT

The City of New York ("City") hereby submits to the State of New York Public Service Commission ("Commission"), pursuant to the Notice Inviting Comments issued October 25, 2007,[1] its Initial Comments ("Initial Comments") on the *Final Report – Independent Audit of Consolidated Edison Company Electric Emergency Outage Response Program for the New York State Department of Public Service* in Case 06-M-1078, Proceeding on Motion of the Commission to Audit the Performance of Consolidated Edison Company of New York, Inc. in Response to Outages Emergencies ("Audit Report"). The City commends the Commission for initiating this proceeding and for having an independent audit performed to address Consolidated Edison Company of New York, Inc.'s ("Con Edison" or "Company") preparedness, performance and response to electric outages.

This proceeding was initiated by the Commission on September 8, 2006, in response to four different major power outage events that occurred on the Company's system during 2006. Three of these events, those occurring during January, July and September, 2006, involved the Company's overhead electric distribution system and generally did not affect New York City. The fourth event, beginning on July 17, 2006, involved power outages in the Company's underground network distribution system and, more specifically,

[1] Case 06-M-1078, Proceeding on Motion of the Commission to Audit the Performance of Consolidated Edison Company of New York, Inc. in Response to Outage Emergencies, "Notice Inviting Comments" (issued October 25, 2007).

in the Company's Long Island City ("LIC") network.[2] The comments contained herein, and the City's analysis of the Audit Report, are focused exclusively on the Company's preparedness, response and recommendations from the July 17, 2006 Long Island City network event.

STATEMENT OF FACTS

Starting on July 17, 2006, large portions of Con Edison's power distribution system began to fail when multiple primary feeders supplying its LIC network de-energized ("LIC Outage"). The primary feeder outages started on Monday, July 17, 2006 and ended on Friday, July 21, 2006, when all network feeders were restored to service. It is estimated that the LIC Outage left between 25,000 and 65,000 customers without service or with degraded service (i.e., low voltage) for some time during this period.[3] All customers were restored to service, either by restoration of the network or by alternative means, on Tuesday, July 25, 2006.

On July 26, 2006, the Commission instituted Case 06-E-0894 and directed the Department of Public Service Staff ("Staff") to conduct a "comprehensive examination of the circumstances surrounding the failure of the [LIC] feeders and the outages, the events that led to the failures and outages, Con Edison's response, communication and restoration efforts, the need for changes to Con Edison's practices and procedures to avoid similar

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[2] Con Edison's Long Island City network is comprised of the neighborhoods of Astoria, Sunnyside, Woodside and Hunters Point.

[3] See, Staff Report, p. 23; Company's October 12th Report, p. 1-9.

failures and outages in the future, and the costs incurred by Con Edison related to the failures and outages."[4] In response, Staff and other parties, including the City, conducted voluminous discovery and attended several technical conferences. On February 9, 2007, Staff filed its report on the LIC Outage.[5] Pursuant to a Notice of Comment Schedule and a Notice Extending Reply Comment Schedule, the City submitted Initial Comments on the Staff Report on March 2, 2007, and Reply Comments on March 31, 2007.[6] As part of its Initial Comments on the Staff Report, the City included as an appendix its comprehensive report on the Long Island City event titled *Investigation by the City of New York into the Northwest Queens July 2006 Power Outages* ("City Report").[7]

Con Edison also conducted its own investigation of the LIC Outage. The Company issued a report titled *Comprehensive Report on the Power Outages in Northwest Queens in July 2006*, issued October 12, 2006 ("October 12th Report") and commissioned a

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[4] Case 06-E-0894, Proceeding on Motion of the Commission to Investigate the Electric Power Outages in Consolidated Edison Company of New York, Inc's Long Island City Electric Network, "Order Instituting a Proceeding and Directing Staff Investigation" (issued July 26, 2006), pp. 1-2.

[5] *Department of Public Service Staff Report on its Investigation of the July 2006 Equipment Failures and Power Outages in Con Edison's Long Island City Network in Queens County, New York* (issued: February 9, 2007) ("Staff Report").

[6] Case 06-E-0894, supra, Notice of Comment Schedule (issued: February 13, 2007) and Notice Extending Reply Comment Schedule (issued March 14, 2007).

[7] The City Report was prepared with the assistance of nine experts in utility operations, underground system design, transformers, cable failures and information systems. The City Report was 250 pages long and contained 53 specific recommendations, many with subparts, to improve Con Edison's emergency preparedness and response. The City's Initial Comments, City Report and Reply Comments are attached hereto as Attachments A, B and C, respectively.

second report titled *Long Island City Network July 17-25, 2006, Incident Investigation Committee*, issued February 12, 2007 ("Committee Report"). In addition, the New York State Assembly Queens Power Outages Task Force issued its report on the power outages on January 30, 2007, titled *Concerning the July 2006 Power Outage in Consolidated Edison's Service Territory* ("Assembly Report").

On September 8, 2006, the Commission instituted an audit proceeding to examine the "Company's system-wide operations, practices, and procedures as they relate to emergency planning, response to outages, and restoration of service."[8] As part of the Audit Proceeding, the Commission recognized that the Commission's proceeding investigating the LIC Outage (Case 06-E-0894) includes a "review of the circumstances leading to loss of primary feeders and need for improvement to the Company's plans, practices, procedures, and operations to avoid similar outages."[9] The Commission's Order initiating the Audit Proceeding also stated that "[i]t is anticipated that the audit instituted herein will take into consideration the information, findings, and recommendations resulting from the Long Island City Electric Network investigation."[10]

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[8] Case 06-M-1078, Proceeding on Motion of the Commission to Audit the Performance of Consolidated Edison Company of New York, Inc. in response to Outage Emergencies, "Order Instituting Proceeding and Directing Audit" (issued September 8, 2006) ("Audit Proceeding").

[9] Id., p. 2, fn. 1

[10] Id.

POINT I

THE AUDIT REPORT MAKES NUMEROUS RECOMMENDATIONS AND FINDINGS THAT SUPPORT THE CITY REPORT AND ITS RECOMMENDATIONS

A. Voltage Reduction

The issue of when and under what circumstances the Company should use voltage reduction is one of several areas of the City recommendations that the Company has failed to implement. As discussed in detail in the City Report, Con Edison should perform studies and conduct empirical analysis to determine the conditions under which voltage reduction would be effective, and to determine the effects of voltage reduction on actual voltage and current in the network under multiple contingencies.[11] After collecting this data, the City's recommendations provide that the Company should develop a set of specific operating procedures and specifications to provide clear guidance for when and under what circumstances voltage reduction should be used in response to distribution system contingencies. The Audit Report supports the City's voltage reduction recommendation.

Significantly, the Audit Report is the second report that supports the City's technical evaluation and recommendations regarding the possible negative impacts of voltage reduction when a network is under multiple contingences and/or no longer intact.[12] The City's position regarding voltage reduction is supported by the recent study commissioned by

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[11] City Report, pp. 79-82.

[12] Audit Report, p. 104.

Con Edison from the Polytechnic University entitled *Effects of Voltage Reduction on Electrical Equipment Using Electronic Control*, dated March 29, 2007. The March 29, 2007 report supplements the previous two-part report from Polytechnic University entitled *Effects of Prolonged Voltage Reduction on Motors Used in Residential/Commercial Sealed Compressor Units*, dated August 31, 2005. The March 29, 2007, Polytechnic University report concludes, based upon their laboratory study, that reduction in voltage levels can result in increases in current levels being drawn from the electrical network.[13]

The Audit Report's finding V-F36 states "[t]he application of the Voltage Reduction Program could exacerbate the network loading situation."[14] Moreover, Exhibit V-9 further discusses the Voltage Reduction Program within the last box utilizing an example of electric water heaters that, while accurate, has limited applicability to the Con Edison service territory.[15] The induction motor contribution is much more relevant and significant in this region of the country, particularly during the summer with air conditioning in residential areas.

In addition, it is noteworthy that the last sentence of Exhibit V-9 of the Audit Report repeats Con Edison's estimate of a 5.2% reduction in short-term load for an 8%

[13] See, Con Edison's September 15, 2007 response to the parties' recommendations numbered 82, 83 and 84.

[14] Audit Report, p. 104.

[15] Audit Report, p. 108.

reduction in voltage.[16] While this statement is accurate, it only applies when the network is intact and operating under normal conditions, such as when load reduction is required to respond to a transmission outage event. The City's position on the use of voltage reduction has consistently been that it can be an effective tool to reduce load when the network is operating under normal conditions.[17] The City's concern with the use of voltage reduction, both to the customers impacted and the network, is when conditions in the network are not normal (e.g., operating under multiple contingencies).

For these reasons, the City recommends that detailed instructions be provided to the Con Edison operators so that they can utilize voltage reduction effectively and appropriately. The Contingency Operations Specification, EO-4095, still needs to be revised regarding the use of voltage reduction to include specific guidance applicable to the conditions effects of voltage reduction to damaged networks or networks operating under multiple contingencies.

B. Monitoring of the Secondary Network

The Audit Report's finding V-F39 supports the City's critical recommendation for the establishment of secondary monitoring points remote from the network transformers so that Con Edison operators can be knowledgeable about the conditions within the

[16] Audit Report, p. 108.

[17] See, City Report, p. 79-82.

secondary networks under stress.[18] Specifically, the Audit Report states that "[p]resently utilized computer simulation and modeling programs do not provide reliable results relative to the network secondary main load flows."[19] This finding is directly supported by the City Report's analysis and recommendations on Network Monitoring and Information Technology Systems.[20]

It is unclear where the Audit Report finds its support for finding V-F40, wherein it states that "[t]he LIC network connectivity model has been shown to be unreliable. No reason exists to believe that the accuracy of other network's connectivity models are better."[21] Contrary to finding V-F40, it is our understanding that the Brooklyn / Queens region had the least accurate models due to their use of two different model maintenance systems, whereas the other operating regions with network systems utilize a single system.

C. Transformers Out of Service

The Audit Report's findings V-F49 and V-F50 are directly supported by information contained within the City Report and Committee Report.[22] Both of these

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[18] Audit Report, p. 117; City Report, p. 62.

[19] Audit Report, p. 117.

[20] City Report, pp. 57-63.

[21] Audit Report, p. 117.

[22] Audit Report, p. 125; City Report pp. 107, 108; Committee Report, p. 46.

findings address the replacement of failed transformers before the 2006 summer load period and ensuring that other equipment is operating as it was designed.[23] Clearly, had the large number of banks-off the system been addressed as part of the Brooklyn / Queens regional summer preparedness program, there is a high probability that the entire LIC Outage could have been limited or even mitigated.[24] Moreover, the Audit Report's finding V-F51 states that "[m]any of the occurrences contributory to the cascading nature of the LIC network event could have been avoided if Con Edison was more proactive regarding systems, engineering, operations, and maintenance."[25] Many of the cited examples of occurrences that contributed to the LIC Outage in the Audit Report are directly supported by the City Report.[26]

Moreover, the resulting recommendation, V-R16, that Con Edison "place a higher priority on replacement of failed or nonfunctioning network systems components including transformers, network protectors, and RMS transmitters immediately prior to and during the summer months" is strongly supported and similarly recommended by the City Report.[27]

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[23] Audit Report, p. 125.

[24] See, City Report, pp. 107, 108.

[25] Audit Report, p. 128.

[26] City Report, pp. 54-63, 65, 67, 107 and 108.

[27] See, City Report, pp. 107 and 108.

D. Proof Testing of Network Feeders

The Audit Report states that "[a] higher rate of failures appears for those feeders not subjected to testing, and highest failure rates occur for feeders tested and ultimately returned to service prior to completion of the testing protocol."[28] This statement is in direct agreement with the conclusions contained within the City Report.[29] Specifically, it is better not to test a feeder than to stress it during one or more high potential proof tests without bringing the feeder to a satisfactory pass-test condition.[30] The uncompleted stress failure of the incipient faults will leave the partially tested feeder with a higher propensity to failure than where it started.[31]

The Audit Report's recommendation V-R19 for the continuation of the DC hipot program and the appropriate transition to the VLF testing program also is in agreement with the observations and recommendations included within the City Report.[32]

E. Preventive Maintenance

The Audit Report's three findings on maintenance (V-F55, V-F56, and V-F57) and one recommendation (V-R20) on Con Edison's maintenance practices are all supported

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[28] Audit Report, p. 131.

[29] City Report, p. 24-26, 71 and 72.

[30] Id.

[31] Id.

[32] Id.

by findings and conclusions contained within the City Report.[33] Specifically, the Audit Report properly concludes that poor contractor oversight, improper documentation of substation work, poor past work testing and acceptance practices, too many banks-off and open-mains, too low of an RMS reporting rate, and incomplete hipot testing program, to name a few, all contributed to and accelerated the problems experienced by Con Edison during the LIC Outage.[34]

F. Communications

Generally, the Audit Report's findings and recommendations addressing communications are in agreement with the conclusions and recommendations of the City Report.[35] However, even if the Company implements the recommendations contained within the Audit Report and City Report, it is only during an event similar to the LIC Outage that it will be determined how effective these recommendations are in improving the Company's communications with its customers and other interested parties.

The Audit Report's communications section supports the City Report's recommendation to install a customer service and voltage monitoring system. Specifically, the Audit Report states that "[o]ne of the most misunderstood aspects of utility storm

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[33] Audit Report, pp. 132, 133; City Report, pp. 65-69, 107 and 108.

[34] Audit Report, pp. 132, 133.

[35] Audit Report, pp. 148-163; City Report, pp. 43-48.

restoration is that the utility somehow is aware of all customers who are without power."[36] The City Report's recommendation that the Company "should install voltage sensors, with the capability to be read remotely, in a homogeneous distribution throughout each network such as in secondary manholes and service boxes" would allow the Company to know which customers were without service or with degraded service to a greater degree than is currently available.[37]

The Audit Report's recommendation VI-R3 states that the Company should "[d]evelop a methodology based on previous outage experiences to provide customers a global [Estimated Time of Restoration] ETR on a more timely basis than the current commitment."[38] However, the usefulness of global restoration commitments are of very limited value, even when updated correctly and on a periodic basis because customers are traditionally only interested in when their electricity will be restored and not when the area problem will be resolved (e.g., global restoration).

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[36] Audit Report, p. 151.

[37] City Report, p. 62.

[38] Audit Report, p. 154.

POINT II

THE CITY SUPPORTS THE AUDIT REPORT'S RECOMMENDATION THAT CON EDISON DEVELOP A BETTER METHOD OF IMPLEMENTING PARTIES' RECOMMENDATIONS

Throughout the investigation of the LIC Outage and the other power outages many parties submitted recommendations for actions that Con Edison should take to improve its preparedness and response to power outages. As demonstrated in the Audit Report, there have been at least 344 recommendations made by Con Edison and other interested parties in response to the Company's 2006 power outages.[39] Of these 344 recommendations, 62 were related to the overhead outages and 282 were for the LIC Outage.[40]

The Audit Report highlights deficiencies in how the Company's evaluation and implementation of recommendations that it has received.[41] Specifically, the Audit Report recommends that the Company do a better job of grouping recommendations so that priorities can be established and "root causes" identified and addressed.[42] The Audit Report concludes that unless the Company's approach to responding to the parties' recommendations is modified, many worthwhile recommendations will not be fully considered or, more importantly, implemented.

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[39] Audit Report, p. 49; Appendix 4, p. 267.

[40] Id.

[41] Audit Report, pp. 47-51.

[42] Id., p. 49.

The Audit Report proposes a bucketing system whereby recommendations of similar subjects would be accumulated together and that these groupings would then be analyzed together to determine if they have a similar root cause.[43] In addition to addressing root causes of similar recommendations, rather than individual recommendations, this methodology has the further advantage of grouping corrective actions that may provide the potential for more efficient, collective solutions. The City supports this "grouping" methodology as it will provide the Company with an effective and comprehensive way of reviewing and implementing a large number of recommendations.

Appendix 4 of the Audit Report classifies all recommendations found within the various outage reports (both underground and overhead) from the major outages of 2006, into similar categories (i.e., buckets) for ease of review, implementation and reporting.[44] This approach is somewhat similar to that used in Appendices A through D of the Commission's July 20, 2007 Order Implementing Outage Recommendations.[45] The purpose of Appendix 4 is to combine similar recommendations and related actions to promote a more efficient determination of common root causes.

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[43] Id.

[44] Audit Report, Appendix 4, p. 267.

[45] Case 06-E-0894, supra, "Order Implementing Outage Recommendations" (issued: July 20, 2007), Appendices A-D.

The City supports this effort to promote root cause analysis of common LIC recommendations.[46] However, while the grouping of recommendations (with proper identification as to the source) is valid, and should be supported, it is imperative that the Company develop one classification system that meets its needs.[47] The Company should then place each of the recommendations into the category (only one per recommendation and/or any sub-recommendations) that can best assist the Company in managing its responses and implementation.

Because it would be beneficial to have one set of recommendations to work from, thereby improving the Company's ability to analyze and implement the parties' recommendations, the City supports the grouping of similar recommendations for review and implementation. In addition, the Company should then use the classification system to report to the Commission and the parties on the implementation status of all recommendations.

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[46] The Audit Report introduces a classification system that is different, although more detailed, than that used in the Commission's July 20th Order. Indeed, the Commission's July 20th Order uses one grouping system for Appendices A through C (Staff recommendations) and another for Appendix D (other parties).

[47] It is important that the listing include the source of the recommendation. The reference should be to the original report number in the appropriate report. If the original report does not contain recommendation numbers, then the Company should assign an appropriate number.

POINT III

SEVERAL RECOMMENDATIONS IN THE AUDIT REPORT WARRANT FURTHER EXAMINATION

A. The Audit Report Includes A Non-Viable Recommendation for Minimizing the Impact to Critical Customers in the Event a Network is De-Energized

The Audit Report's finding V-F52 repeats the Company's after-the-fact position that a concern for the operation of the public transportation system was one of the main reasons they continued to maintain the LIC network in service.[48] The impact that a de-energized network could have on critical customers such as the MTA and LIRR was discussed in the City Report, including what measures could be taken to alleviate this concern in the future.[49] Specifically, the City Report recommended that the Long Island City and Sunnyside networks be designed so that in the event a network is shut-down or experiences power outages in portions of the network, critical customers, such as MTA and the LIRR, can continue to operate.

The Audit Report's finding V-R17 incorrectly identifies the means to alleviate the impact of a power outage on the public transportation systems, specifically the MTA and

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[48] Audit Report, p. 129; October 12th Report, p. 4-22. Without again addressing the decision itself, the City shares the Audit Report's concerns regarding the Company's decision-making process regarding the network shutdown decision (Audit Report, p. 124) and made a number of recommendations to rectify those concerns (City Report, pp. 87-90).

[49] City Report, pp. 100-102.

LIRR.[50] The Audit Report's finding V-R17 states that Con Edison should "[c]onsider secondary feeders to high profile customers such as the MTA and Long Island Railroad when reconfiguring or modifying future networks."[51] Providing secondary feeders will not alleviate the problems associated with de-energizing a network inasmuch as secondary feeders are responsible for powering the lighting and signals systems, whereas the primary distribution system is responsible for powering the high tension (i.e., traction) services required for rail movement on the mass transit system.[52] Thus, the Audit Report solution is not viable.

B. The Size of a Network Should Not Be the Sole Determinant of Whether a Network Should Be Divided

The Audit Report's finding V-F53 states that "[t]he size of the LIC and other networks may be too large and inflexible to meet the established goals of reliability. Smaller networks with shorter feeders and fewer connected loads are inherently more stable."[53] While it is true that smaller networks are more reliable, the size of a network alone should not be used to determine whether networks should be split. As an initial matter, there are more reliable and predicative tools to determine which networks should be reinforced, or

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[50] Audit Report, p. 129.

[51] Id.

[52] See, City Report, pp. 100, 101.

[53] Audit Report, p. 129.

even split, than simply the size – or connected load – of a network. For example, Con Edison's jeopardy model creates a ranking of the Company's 57 networks based upon a probabilistic estimate of their relative probability of failure.[54] Additionally, a network split may be required if a station loading capability is predicted to be exceeded in the near future.

Moreover, the Audit Report's finding that large networks should be examined for reduction in size needs to be construed very narrowly to ensure that size alone does not become the litmus test for whether a network should be divided. For example, the City's recommendation to split the LIC network was based primarily on the severe stress that the network experienced during the 2006 event. While the City supports the splitting of large networks, such as Long Island City, where factual and engineering analyses support such a course of action, it does not follow automatically that all large networks would benefit from splitting. Accordingly, size alone should not be the determining factor for whether a network should be divided. Instead, the final decision must include a number of factual and technical considerations wherein the size of the network is an important, but not the only, factor considered.

C. The Audit Report Recommendation that Network Feeders Should Have Peak Loads that are Less Than 70% of Normal Ratings is Without Support

The Audit Report states that it was recommended that network feeders should be designed so that "peak loads are less than 70% of normal ratings for avoidance of higher

[54] City Report, p. 97.

failure rates during first and second contingencies."[55] There is no support for the change in the design of the loading of primary feeders so that they are less than 70% of normal ratings. Network feeders predominately fail because of environmental conditions, physical damage and failures in appurtenant equipment.[56]

Furthermore, cable ratings are normally determined by the thermal limits of the emergency loadings. The higher the normal loading (i.e., base thermal condition of the cable), the lower the emergency load limit will result (shorter thermal loading distance to the thermal limit of the cable). The result of lowering the normal loading would be to provide additional capability in the network feeders under contingency conditions. Accordingly, lowering the normal ratings of feeders will not decrease their failure rates during first and second contingencies.

[55] Audit Report, p. 129.

[56] See, City Report, Appendix A.

CONCLUSION

For all of the reasons contained throughout these Initial Comments, the Commission should review the Audit Report consistent with these Initial Comments and the City Report and order Con Edison to implement the City recommendations set forth in the City Report to help ensure that an event similar to the LIC Outage either does not occur again or, if it occurs, is responded to more effectively and promptly.

Dated: November 20, 2007
Albany, New York

Respectfully submitted,

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STATE OF NEW YORK
PUBLIC SERVICE COMMISSION

Proceeding on Motion of the Commission to Investigate the Electric Power Outages in Consolidated Edison Company of New York, Inc.'s Long Island City Electric Network	**Case 06-E-0894**

INITIAL COMMENTS OF THE CITY OF NEW YORK ON STAFF'S REPORT

Dated: March 2, 2007

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PRELIMINARY STATEMENT

The City of New York (the "City") hereby submits to the State of New York Public Service Commission ("Commission") and Administrative Law Judge Eleanor Stein its Initial Comments ("Initial Comments") in response to the report that the Department of Public Service Staff ("Staff") filed with the Commission on February 9, 2007, in Case 06-E-0894, Proceeding on Motion of the Commission to Investigate the Electric Power Outages in Consolidated Edison Company of New York, Inc.'s Long Island City Electric Network ("Staff Report").[1] The City commends the Commission for opening this investigation of the outages and has participated in this proceeding since it was instituted. The City also has conducted its own independent investigation into the events that caused the outages, as well as Con Edison Company of New York Inc's ("Con Edison" or "Company") response to the outages and, as part of these Comments, provides recommendations for the Company to perform in order to prevent or greatly reduce a similar event from occurring again.

STATEMENT OF FACTS

In late July, 2006, large portions of Con Edison's power distribution system began to fail when multiple primary feeders supplying its Long Island City ("LIC") network

[1] *Department of Public Service Staff Report on its Investigation of the July 2006 Equipment Failures and Power Outages in Con Edison's Long Island City Network in Queens County, New York* (Issued: February 9, 2007).

de-energized ("LIC Outage").[2] The primary feeder outages started on Monday, July 17, 2006 and ended on Friday, July 21, 2006 when all network feeders were restored to service. All customers were restored to service, either by restoration of the network or by alternative means, on Tuesday, July 25, 2006. It is estimated that the LIC Outage left between 25,000 and 65,000 customers without service or with degraded service (low voltage) for some time during this period.[3]

On July 26, 2006, the Commission instituted this proceeding directing Staff to conduct a "comprehensive examination of the circumstances surrounding the failure of the feeders and the outages, the events that led to the failures and outages, Con Edison's response, communication and restoration efforts, the need for changes to Con Edison's practices and procedures to avoid similar failures and outages in the future, and the costs incurred by Con Edison related to the failures and outages."[4] In response, Staff and other parties, including the City, have conducted voluminous discovery and attended several technical conferences, culminating with the filing of the Staff Report.

Con Edison also conducted its own investigations of the LIC Outage. The Company already has issued a report titled *Comprehensive Report on the Power Outages in*

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[2] Con Edison's Long Island City network is comprised of the neighborhoods of Astoria, Sunnyside, Woodside and Hunters Point.

[3] See, Staff Report, p. 23; Company's October 12th Report, p. 1-9.

[4] Case 06-E-0894, Proceeding on Motion of the Commission to Investigate the Electric Power Outages in Consolidated Edison Company of New York, Inc's Long Island City Electric Network, "Order Instituting a Proceeding and Directing Staff Investigation" (Issued: July 26, 2006), pp. 1-2.

Northwest Queens in July 2006, issued October 12, 2006 ("October 12th Report") and commissioned a second report titled *Long Island City Network July 17-25, 2006, Incident Investigation Committee*, issued February 12, 2007 ("Committee Report"). In addition, the New York State Assembly Queens Power Outages Task Force issued its report on the power outages on January 30, 2007, titled *Concerning the July 2006 Power Outage in Consolidated Edison's Service Territory* ("Assembly Report").

<u>**THE CITY REPORT**</u>

The LIC Outage created many hardships for people in the affected areas. From the onset, the City was heavily involved in maintaining public safety, providing human resource services to affected residents, and assisting Con Edison in its recovery efforts. Once power was restored, the City began investigating the causes of the outages, with a strong focus on identifying improvements to Con Edison's system and its operating procedures to reduce the likelihood of such an event happening again.

The City's team of experts participated in Con Edison's testing of failed primary cables, joints, terminations, transformers and network protectors. The City's experts and counsel also interviewed Company employees, served the Company with hundreds of discovery requests, reviewed other parties' discovery, reviewed Company reports prepared in response to this event and Company manuals, procedures, and reports that were issued after prior power outages, participated in the Company's technical conference and attended depositions conducted by Staff of Con Edison employees.[5]

The City's exhaustive investigation of the LIC Outage has resulted in a report entitled *Investigation by the City of New York into the Northwest Queens July 2006 Power Outages* ("City Report"), attached hereto as Appendix A. The City Report is intended to be an independent and technical analysis of Con Edison's electric distribution system, the events preceding the outages, including the Company's operating and maintenance practices, as well as the Company's response to the outages. The City Report includes 53 comprehensive recommendations (including numerous sub-parts) that the Company should consider adopting to correct or improve its operations and thereby assist in preventing similar events. The City Report is offered also to assist the Commission in its deliberations of the actions necessary to ensure safe and reliable operation of the Con Edison system.

The City applauds the excellent effort that Staff has put forth, culminating in a comprehensive Staff Report. In many instances, the recommendations set forth in the City Report are similar to those offered by Staff. However, in other instances, the City Report addresses issues that the Staff Report does not, or offers conclusions and recommendations that differ from Staff's. These Initial Comments will highlight these similarities and

[5] A detailed timeline of key events of the Long Island City event can be found in the City Report.

differences in the context of providing comments on how to improve Con Edison's operations.[6]

POINT I

THE CITY GENERALLY AGREES WITH STAFF'S CONCLUSION THAT BETTER PREPARATION AND RESPONSIVENESS BY CON EDISON COULD HAVE REDUCED THE LIKELIHOOD OF THE LONG ISLAND CITY OUTAGE AND DECREASED ITS IMPACT ON RESIDENTS AND THE COMMUNITY

Con Edison categorizes the factors that initiated the Long Island City power outages as being "precipitated by three unrelated events that combined to create an unprecedented set of circumstances and strain on the network system."[7] The Company identifies these three unrelated events as being: (i) a low-voltage cable that caused a fire in an underground conduit, causing two primary feeders to fail; (ii) a substation breaker failed when a third feeder de-energized, causing three additional feeders (two network and one non-network) to be isolated from the system; and (iii) when operators attempted to restore feeders to service, they experienced a phenomenon known as inrush[8] current that prevented feeders from being restored to service.[9] The Staff Report concludes otherwise:

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[6] The full scope of the City's analysis, conclusions and recommendations is set forth in the City Report.

[7] October 12th Report, p. 1-2.

[8] Inrush is defined as additional current many times a primary feeder's normal maximum load that occurs when a de-energized feeder supplying transformers is placed back in service.

> After reviewing the many factors involved, Staff concludes that, while those were contributing elements, the overriding cause of the Long Island City Network event, and the extensive and lengthy impacts for consumers, was the Company's failure to confront and resolve a multitude of issues associated with its operation, maintenance, and oversight of the network and to recognize and take effective action to limit the extent of the cascading system damage and the resulting consumer impacts.[10]

The City agrees that the scope and duration of the LIC Outage could have been reduced by better preparation and responsiveness by Con Edison. For example, in 1999, the Company experienced a severe power outage that was followed by an extensive analysis of Con Edison's operations and a series of recommendations to prevent a similar event from occurring again. As set forth in more detail in the City Report, many of the Washington Heights recommendations had not been fully implemented before the LIC Outages, almost seven years later.[11] If these recommendations had been implemented, the LIC Outages might have been less severe, and Con Edison's response would have been better.

In addition, the City agrees with Staff's overall conclusion that Con Edison's response to the LIC Outages was lacking in many respects. Con Edison's inability to accurately count or quantify, in a timely manner, the number of customers affected by the outages was wholly unacceptable and adversely affected Con Edison's response and the deployment of critical resources to City residents. Even if the Company could not have completely avoided these power outages, it should have better understood the damage that

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[9] October 12th Report, pp. 1-2, 1-3.

[10] Staff Report, p. 6.

[11] City Report, p. 116.

was occurring to the secondary system, correctly estimated the number of customers without service or experiencing low voltage and more appropriately responded to events as they occurred.

Although the City generally concurs with Staff's overall finding that Con Edison could have reduced the likelihood of the Outage and decreased its impact, the following sub-points highlight areas where the City's analysis and recommendations differ from those of Staff.

A. Implementation of Staff Recommendations From the 1999 Washington Heights Power Outages

Following the 1999 Washington Heights power outages, Staff issued a report that contained 44 recommendations to address weaknesses and concerns in Con Edison's network distribution system and operations. The Staff Report mentions the 1999 Washington Heights incident and its recommendations, but does not sufficiently address the impact that the Company's failure to fully implement the Washington Heights recommendations had on the scope and duration of the LIC Outages.

While somewhat different in origin and extent, there are compelling similarities between the Washington Heights incident and the LIC Outage. Both events occurred during periods of hot and humid weather, both involved primary feeders supplying networks that were subject to high loading and both networks experienced numerous equipment failures. Both events imposed disruptive and economically damaging harm on customers, residents and businesses. Unfortunately, many of the recommendations from the Washington Heights event were not followed through or were not fully implemented. While it is impossible to definitively state what the impact would have been if all of the recommendations had been implemented, it is reasonable to conclude that some of the damage, the scope and/or the duration of the LIC Outage would have been reduced had they been implemented. To the extent that the Company failed to implement the full range of recommended actions, the Public Service Commission, in its supervisory role over the Company in the years since the Washington Heights event, also must bear some share of responsibility.

As an example, Washington Heights Recommendation II-2 directed Con Edison to evaluate reasonable actions that the Company can take to improve monitoring of its secondary system because the absence of information on the secondary system can result in the Company being unaware that secondary cable sections were being excessively overloaded.[12] If the Company had complied with this recommendation, the Remote Monitoring System ("RMS") would have been reporting at a better rate than the 79.5 % rate that it was reporting at when the LIC Outage began.[13] Furthermore, had the Company deployed Secondary Underground Network Distribution Automation System ("SUNDAS") prior to the outage, it would have been provided with a "picture" of the secondary system, including valuable information with regard to voltage levels and overloaded secondary mains. These two improvements may have helped to prevent the LIC outages and certainly would have provided tools to manage it better.

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[12] City Report, p. 118.

[13] The RMS is designated by Con Edison for a reporting rate of 95%.

Similarly, Washington Heights Recommendation II-15 directed Con Edison to monitor the loading of high-tension customers' transformers as part of its system modeling programs.[14] This was not done beyond a minimal pilot program. As a result, during the LIC Outages Con Edison had no real time information regarding the loading at the major customer locations (e.g., La Guardia Airport, MTA traction Substations, Rikers Island, etc.). If the Company had this information, it may have made different decisions.

In addition, Washington Heights Recommendation IV-1 directed Con Edison to evaluate the further acceleration of its paper/lead cable removal program.[15] Had Con Edison further accelerated this program and its associated targeted stop joint removal program, this equipment would have been removed and would not have contributed to primary feeder failures during the LIC Outage.

Washington Heights Recommendation V-3 directed Con Edison to implement a rigorous training program to ensure that all its employees are adequately trained in emergency procedures.[16] During the LIC Outages, there were several instances where operators made decisions that prolonged the event. For example, the application of three

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[14] City Report, p. 127.

[15] City Report, p. 122.

[16] City Report Section 7.0, Recommendation 36. *See also*, Washington Heights Recommendation V-1 on Appendix 12 to the City Report. Although these recommendations are contained in the Communications section of the Washington Heights report, unlike other recommendations in that section they are not limited to communications.

phase grounds to clear backfeeds while there were severe low voltage conditions in the network was a common error.

Con Edison must be more proactive in identifying and removing the most failure prone components on its system. This is particularly true at the primary feeder level, where both the Washington Heights and Long Island City network events were centered. Con Edison also must have better monitoring systems in place so that it fully understands what is occurring on its electric distribution system at all levels. Finally, Con Edison must have appropriate systems deployed to better enable its operators to respond in a more effective and timely manner.

B. Supervision of Substation Contractor

On Monday, July 17, 2006, three primary network feeders and one non-network feeder were taken out of service resulting in the event escalating from a 2nd to a 5th contingency. The cause of these three feeders de-energizing was the result of a malfunctioning circuit breaker at the North Queens substation.[17] The breaker malfunctioned due to a misalignment of the control circuit contacts on the breaker cubicle and on the removable breaker element.[18] The circuit breaker's misalignment was not detected because of the faulty installation by a Con Edison contractor.

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[17] The North Queens substation supplies the Long Island City network through twenty-two 27kV feeders.

[18] October 12th Report, p. 3-15.

The Staff Report mentions contractor oversight briefly but the City Report addresses it in more detail, as contractor error was a contributing factor to the LIC Outage. Had the breaker malfunction not occurred, the Long Island City network would only have escalated to a third contingency instead of a fifth contingency, and this reduced level of stress might have avoided the cascading feeder failures.

The two breakers with inoperable trip circuits should have been revealed to the substation operators through a visual indicating light located within the North Queens substation control room. However, during the breaker retrofit process, this monitoring circuit was incorrectly wired so that no visible indication of the loss of this trip circuit to either of these circuit breakers was provided to the substation operators. Had a proper indication been provided to operators, it is believed that these malfunctions would have been corrected well in advance of the LIC Outages. While Con Edison's October 12th Report attributes this condition to the misalignment of the breaker-tripping control circuit contacts, the misalignment arose out of deficient oversight of the circuit breaker upgrade program.[19] The Company should review its contractor work inspection process.

[19] *See*, October 12th Report, p. 4-27.

C. 2006 Summer Substation Preparations

The City Report concludes that the Company could have been better prepared for the 2006 peak summer load period.[20] First, prior to the 2006 peak summer load period 15 of the 22 feeder circuit breakers at the North Queens substation were retrofitted with rack-out breakers as part of a system-wide breaker replacement program. With the installation of these new breakers, new Ground and Test ("G&T") devices would permit the simultaneous processing of multiple faulted feeders within a bus section. In order to enhance and expedite the feeder restoration process utilizing the new G&T devices, all that was required was to DC high potential ("Hi-pot") test these units and perform current injection and trip tests in conjunction with a scheduled bus section outage.[21] However, at the start of the 2006 peak summer load period, these new G&T devices were not yet operational at the North Queens substation.[22]

In addition, the PQNode at the North Queens substation was only made operational on July 17, 2006, the day the event started.[23] It should have been made operational well in advance of the 2006 peak summer load period. Having the system installed at this late date provided no opportunity to make the Reactance-to-Fault ("RTF")

[20] City Report, p. 67.

[21] DC Hi-pot testing works by applying high voltage to the primary feeder for a short period of time to determine if any incipient faults exist on the cable.

[22] City Report, p. 68.

[23] Company Response to Staff Interrogatory 253 (dated: October 23, 2006).

application operational for this network. The RTF functionality provides an estimate of the distance to a fault on a faulted feeder and this information would have expedited the restoration effort.

The Staff Report mentions the lack of the availability of the G&T devices but it does not recognize that if these units were operational during the event it could have significantly aided in restoring multiple faulted feeders to service simultaneously.[24] Additionally, the Staff Report does not mention the lack of functionality of the PQNodes and the RTF application. Had both of these systems been operational prior to the 2006 peak summer load period, as they were designed, the Company could have shortened the time it took to identify, process and restore feeders to service.

D. The Company's Use of Voltage Reduction

Con Edison initiated an 8% voltage reduction on Monday, July 17, 2006, when the Long Island City network was operating in a fifth contingency. The Company maintained voltage reduction on the system until Sunday, July 23rd, two days beyond when the network was restored to a zero contingency. Historically, utilities have used voltage reduction for peak load reduction in times of generation shortages or system emergencies. It is widely believed that in implementing voltage reduction to reduce power and reactive power, it will also result in reducing current. This is not always true. When voltage is

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[24] *See*, Staff Report, p. 103.

reduced, the current flowing through the load-feeding circuits may either decrease or increase. This depends on several factors including:

- the real-load-to-voltage and reactive-load-to-voltage sensitivities;
- the load power factors; and
- the level to which the voltage is reduced

(City Report, pp. 79-80.)

At some load points during the LIC Outages, where the voltage was already below normal levels due to several primary feeders being out of service, additional voltage reduction resulted in an increase in reactive loads and equipment motors stalling because of low voltage.[25] Measurements of the primary feeder currents after initiation of voltage reduction during the LIC Outage showed that in 10 feeders the current increased and in 7 feeders the current was reduced.[26]

The Company's use of voltage reduction did not always reduce the currents going through the secondary system and/or the currents flowing through the distribution transformers. Additionally, with each loss of an additional primary feeder, the loading of the secondary circuits increased, causing the voltage to be decreased even more. While it is not possible to conclude that all low voltage problems were caused by the implementation of voltage reduction, it does suggest that the Company did not fully understand the impact the use of voltage reduction would have on its system and on its customers.

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[25] *See*, City Report, p. 81.

[26] Company Response to City Interrogatory 133 (dated: October 24, 2006).

Even assuming there are demonstrable benefits from reducing voltage, it took an inordinate amount of time to fully implement the 8% voltage reduction. The Staff Report adopts the Company's position that it took 55 minutes to institute an 8% voltage reduction.[27] However, data collected by the City shows that it took approximately 55 minutes to obtain an approximately 5.7% voltage reduction but several hours to reach 8%.[28] Such a delay in fully implementing the 8% voltage reduction must be corrected.

The timing of the removal of the voltage reduction and its impact on customers was not addressed in the Staff Report. As stated earlier, the Company removed the 8% voltage reduction on Sunday, July 23rd, two full days after the system was restored to a zero contingency. The continuation of voltage reduction after the network was returned to a zero contingency could have contributed to the continuing problems experienced by the network customers after the primary feeders were restored. Furthermore, once the Company decided to remove voltage reduction, it took approximately four hours to successfully do so. The delay in successfully implementing and disengaging voltage reduction must be addressed by the Company.

E. Operation and Maintenance of Equipment Prior to the Long Island City Network Event

A significant portion of the investigation that followed the Long Island City event involved examination of damaged and failed equipment. The equipment investigation

[27] Staff Report, p. 117.

[28] City Report, Appendix 10.

focused on cables, joints, terminations, transformers and network protectors. While the Staff Report discusses some observations and conclusions stemming from the inspection of failed and damaged equipment, the City Report uses the test results to broaden its recommendations to aid in better operation of the Company's equipment.

1. Cables, Joints and Terminations

While the Staff Report discusses some observations from examination of the cable and joint autopsies, the recommendations resulting from these autopsies were limited. For example, the Staff Report recommends that "the Company [should] continue to replace paper-insulated lead-covered cable at its current rate under each of the programs that replace such cable. Staff further recommends that paper-insulated lead cable in the Long Island City Network should be replaced by the end of 2012."[29] It has been well documented for years that the paper-insulated lead-covered cables have a higher failure rate than other cable types.[30] The high failure rate of these cables was even recognized following the 1999 Washington Heights event, where it also was recommended that these cables (along with specifically identified and targeted stop-joints) be replaced. It is for these reasons that the City recommends that the Company's programs to replace these cables should be accelerated.[31]

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[29] Staff Report, p. 80.

[30] Company Response to Staff Interrogatory 73 (dated: August 23, 2006).

[31] City Report, Section 7.0, Recommendation 2.

Con Edison has stated that one of the primary factors that caused the Long Island City event was a short-circuited low-voltage cable that resulted in a fire in an underground structure. While this and other secondary cable failures and resulting fires played a significant role in this event, the Staff Report does not provide any recommendations to aid in rectifying the situation. To address this problem, the City recommends the Company reconsider the incorporation of flame resistant construction concepts for insulation and jackets into secondary cables employed for future use in underground structures.[32]

2. Transformers

The Staff Report does not discuss that several of the failed transformers involved tank ruptures, and in one case stress corrosion, or the causes of these conditions. The City Report considers failures from these causes to be significant enough to warrant additional examination.[33] Accordingly, the City Report recommends that studies be performed on these failures to determine if transformers of a similar design and vintage are more prone to failure from these causes.[34]

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[32] City Report, Section 7.0, Recommendation 3.

[33] City Report, Section 7.0, Recommendations 10 and 11.

[34] *Id*.

The Staff Report does not address the difficulty, during the discovery process of this investigation, of obtaining accurate and complete transformer maintenance records. Maintaining accurate records is critical to effective maintenance and replacement of the Company's equipment. Therefore, the City recommends that the Company's equipment records should be subjected to random audits to ensure they are being properly completed and stored.[35]

3. Network Protectors

The Staff Report addressing network protectors focused on the operating voltage of the relays and the Remote Monitoring System ("RMS") reporting rate. In the Staff Report, it is recommended that a feasibility and cost study be performed on the replacement of the 13,000 non-microprocessor relays.[36] However, while this study is underway, the City recommends that the focus should be on assuring that operating personnel are informed of the existing operational limitations and instructed as to the actions to be taken for the various types of relays. Personnel also should have ready access to the equipment database so that they can easily determine the type of relay used at a particular location.[37]

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[35] City Report, Section 7.0, Recommendation 23.

[36] Staff Report, pp. 101-102.

[37] City Report, Section 7.0, Recommendation 25d.

Additionally, although the Staff Report makes no reference to it, the City Report reveals that Con Edison has specified that the microprocessor relays do not permit the network protectors to close if the network voltage is between 60 and 13 volts.[38] The City Report advocates that this limitation should be reviewed and that operating personnel should be informed of it.[39] This issue will become increasingly important as the number of microprocessor network protector relays increases.

Throughout the course of the LIC Outages, several of the network protector microprocessor relays showed evidence of damage due to transients during the event. While the Staff Report recommends that studies be performed to assess the potential replacement of non-microprocessor network protector relays, they make no mention of this potential problem or recommendations for the Company to correct the situation.[40] The City Report addresses this topic and recommends that the Company have additional transient studies performed to assist in determining if relay design changes are required.[41]

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[38] City Report, Section 7.0, Recommendation 25.

[39] *Id.*, at Recommendation 29.

[40] *See*, Staff Report, p. 102**.**

[41] City Report, Section 7.0, Recommendation 22.

F. Equipment for Network Visualization

The Staff Report correctly concludes that Con Edison needs to do a better job of assessing damage to the secondary system[42] and estimating the number of affected customers.[43] Con Edison's ability to visualize the network was hampered by the fact that the primary tool to assess the condition of the network, the RMS, was only operating at 79.5%.[44] There is no disagreement that the RMS reporting rate needs to be improved system-wide to its designated reporting rate of 95%.

In addition to improving the RMS reporting rate, Staff recommends examining the feasibility of replacing all RMS transmitters to third generation transmitters by 2010.[45] The City does not oppose this recommendation; however, the City believes that installing voltage sensors throughout the network to create a voltage profile should be given a higher priority.[46] The voltage at the transformers (i.e., RMS) is not the best indication of the condition of the network. Rather, installing voltage sensors throughout the network would

[42] Staff Report, p. 14.

[43] *Id.*

[44] October 12th Report, p. 6-3.

[45] Staff Report, p. 102.

[46] City Report, p. 62, Section 7.0, Recommendation 32a.

better equip operators to visualize and obtain the "full picture" on the condition of the network.[47]

While the Staff Report discusses the Company's deficiencies with regard to obtaining accurate information on the status and condition of the underground network distribution system, it does not describe what operational tools are needed to correct this condition. The City Report specifically recommends that Con Edison should expand the use of visualization tools at its Brooklyn/Queens control center, as it has already been done in the Manhattan control center. In addition, the City Report recommends that the Company combine multiple information reporting systems at its Brooklyn/Queens control center and improve the way that critical operating information is presented to the control center operators, especially with regard to secondary network events and customer service problems (e.g., outages, side out, and low voltage).[48]

G. Alternative Means of Testing Primary Feeders

After a primary feeder's circuit breaker opens, and before it can be restored to service, it must be tested to determine whether there are any additional faults on the feeder. Con Edison traditionally has utilized DC Hi-pot testing to determine if any such faults exist on a feeder. Additionally, the Company uses DC Hi-pot testing on a regular basis to determine whether to remove weakened cable sections and joints prior to each summer. The

[47] City Report, p. 62.

[48] City Report, Section 7.0, Recommendation 43.

selected feeders are tested annually prior to each summer in an attempt to discover incipient faults before failure and to mitigate primary feeder outages. As noted in the Staff Report, DC Hi-pot testing remains controversial.[49]

Concerns associated with the use of DC Hi-pot testing include that it may not always identify the weakened section of cable and that the test itself may induce problems in un-failed cables that accelerate their future demise Examination of primary feeders within the Long Island City network using DC Hi-pot testing in the years leading to the 2006 power outages (i.e., 2004 and 2005) did not provide any guidance or advance warning of the feeders that failed during the event. This lack of predictive testing from the primary tool to determine feeder reliability indicates that alternative methods should be examined.

To address the limitations in DC Hi-pot testing, the electric distribution industry and Con Edison have been examining an alternative method known as Very Low Frequency AC high potential ("VLF") testing. The VLF testing is not believed to have a damaging effect on feeders as it operates on alternating current. The use of a non-DC based test is particularly important because it is believed that using a DC source for testing grades the electrical stress by a resistive (not capacitive) process that does not equate to in-service grading. This is especially significant for joints and terminations and is considered to be one of the reasons that DC testing does not detect certain deficiencies in joints and terminations. While VLF testing may not have detected all faults on feeders within the Long Island City network, its earlier adoption or use within this network may have alerted the Company to

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[49] Staff Report, pp. 84, 85.

faults on feeders that ultimately failed and contributed to the severity of this event. Thus, the City joins Staff in recommending the introduction of VLF testing and differs only in the time frame for adoption.[50]

H. Training of Company Management and District and System Operators For Emergency Conditions

The Staff Report identifies the need for additional training of call center and customer service staff but fails to identify the critical need for additional operational training for Company managers and district and control center operators.[51] During the LIC Outage, there were errors by managers and operators that could have been avoided had they been better prepared to address the situation confronting them.[52] As an example, due to a district operator error a bus section was re-energized without clearing the faulted feeder, which significantly delayed feeder restoration.[53] Similarly, the Company used rapid restoration in attempts to quickly restore feeders to service; however, this caused several cut in open autos with faults being found at a later time**.** Proper training of operators could have prevented

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[50] City Report, p. 25; Staff Report, p. 85 (the City recommends applying VLF testing to 5% of the Company's second tier of worst performing system feeders where Staff recommends applying VLF testing system-wide by the summer of 2007).

[51] Staff Report, p. 61.

[52] City Report, pp. 66-69; 72-73.

[53] October 12th Report, p. 3-20.

these actions.[54] These and other examples highlight the need for additional training to ensure managers and district and system operators are properly prepared to operate the system during emergency and stressful conditions. Specific areas where the Company should focus additional training include, but are not limited to, transformer cooling, application of three-phase grounds, use of voltage reduction during network multiple contingencies, rapid restoration, modified Hi-pot testing and VLF testing.

<u>POINT II</u>

STAFF'S POSITION THAT THE LONG ISLAND CITY NETWORK SHOULD HAVE BEEN SHUT DOWN IS UNSUBSTANTIATED

In its Report, Staff concludes that the Company did not make the right decision and acted incorrectly and unreasonably in maintaining the Long Island City network in service given the information it had available at the time of the incident.[55] Specifically, the Staff Report states that "[t]he sheer magnitude of manhole and service box events (manhole events) spoke volumes about the damage that was occurring to Long Island City Network's secondary system during the event,"[56] and that "[a]ny competent network operator would know the facts demonstrate that the Long Island City Network experienced severe damage in the secondary grid during the incident."[57]

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[54] City Report, Section 7.0, Recommendation 27d.

[55] Staff Report, p. 75.

[56] Staff Report, p. 68.

Con Edison has stated that it balanced five factors in deciding whether to de-energize the network: (i) number of primary feeders overloaded; (ii) number of primary feeders returning to service; (iii) number of transformers overloaded; (iv) electricity demand; and (v) damage to the secondary network.[58] Con Edison also maintains procedures in EO-4095 that specify the criteria for determining when to maintain or shutdown a network operating during a multiple contingency event.[59] The factors included in this procedure focus on operational and engineering parameters, and it is these parameters that Staff concludes the Company did not properly consider in making the decision to shutdown the network.[60] Staff specifically excluded the Company's assertion that "societal implications" supported the decision not to shut down.[61]

The City Report concludes that Staff's position that the Long Island City network should have been shutdown is not fully supported. As explained in greater detail in the City Report, the network shutdown decision was a complex one and even today, with the benefit of hindsight, it is not possible to say with certitude that the Company's decision was wrong. It does appear that the Company's determination not to take the network down was made without access to sufficient information. Specifically, the lack of an effective control

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[57] *Id.*, p. 69.

[58] Con Edison Technical Conference, October 26 and 27, 2006, pp. 830 – 831.

[59] Company Response to City Interrogatory 22 (dated: August 21, 2006).

[60] Staff Report, p. 75.

[61] *Id.*; *see also*, Con Edison Technical Conference, October 26 and 27, 2006, pp. 830-831.

center visualization tool that was capable of combining multiple information sources from currently available information on the secondary system, as well as the trouble ticket (ECS) system, resulted in management not having all the information it required to make a more informed decision.

In order to justify the conclusion that Con Edison was wrong, it is incumbent upon Staff to demonstrate that a different network shutdown decision would have yielded better results. Staff's conclusion assumes, but does not demonstrate, better results. For example, it is unclear when exactly a decision to shut down "should" have been made, or whether an affirmative decision at that time would have avoided the damage to the secondary system (i.e., had it already occurred?). Unless this question can be answered positively, and with reasonable certainty, upon restoration of the network, this damage still would have remained, with the consequences unchanged (except that more customers would have been affected).

Moreover, the Staff Report does not demonstrate that a network shutdown decision would have reduced the cumulative damage that occurred to the Long Island City network, the total duration of the outages, the impact on the system and equipment when the network was returned to service and the resources that would be required to reenergize the network. In sum, there is no analysis to support the conclusion that a total network shutdown would have resulted in a more rapid restoration of the initial outage area, or otherwise resulted in a "net benefit" compared to what actually occurred. Finally, Staff's investigation did not evaluate whether "societal implications" justified keeping the network up, as Con

Edison alleged.[62] In making a network shutdown decision, the utility should consider the net potential costs and benefits, including the impact of expanding the outage area and the number of persons affected.[63] It is difficult to understand how Staff could reach its conclusion regarding the shutdown decision without assessing the broader societal impacts. Thus, while the City Report agrees with Staff that Con Edison did not have all of the information it needed at the time that it decided not to shutdown the network, it does not believe that Staff has fully supported its conclusion that the decision not to shut down the entire network was wrong.[64]

The Staff Report also recommends that the Commission initiate a proceeding "to examine the prudence of the Company's actions or inactions that led to unnecessary expenditures of funds provided by ratepayers."[65] Similarly, the Assembly Report states that the Commission "should institute a formal proceeding on the question of Con Edison's prudence and gross negligence."[66] A prudence proceeding is authorized under the Public Service Law to allow the Commission to investigate the propriety of costs incurred by a utility.[67]

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[62] Staff Report, p. 75.

[63] City Report, p. 87.

[64] City Report, p. 89**.**

[65] Staff Report, p. 4.

[66] Assembly Report, pp. 10; 55.

[67] *See*, N.Y. Pub. Ser. L. §§ 66(12) and 72.

Due to steps taken by the Commission when instituting this proceeding, Con Edison already is isolating costs attributable to the LIC Outage. The Staff Report states that: "[t]o date, the Company has tracked costs totaling $91 million for activities related to the event."[68] The Company has already agreed to absorb all operations and maintenance expenses and claim payments attributable to the outages (currently, approximately $58 million).[69] Importantly, the Staff Report confirms that incident-related O&M expenses and all claims payments, whatever they end up being, will not be recovered from customers in electric delivery rates.[70]

With all expenses and claims payments isolated for the Company to absorb, there is less reason to recommend an immediate prudence proceeding. Staff justifies its recommendation for a prudence proceeding to ensure that: (i) incident-related expenses do not affect the shared earnings provisions of the existing settlement agreement governing Con Edison's rates; and (ii) incident-related capital additions to the Long Island City network remain subject to review and potential disallowance.[71] While the City shares Staff's concerns, it is equally concerned that the institution of a prudence proceeding at this time

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[68] Staff Report, p. 10.

[69] *Id.*

[70] Additionally, in accordance with the Company's last electric rate plan, the Company will be subject to a negative revenue adjustment of at least $9.3 million as a result of the metered customer outages (Staff Report, p. 8).

[71] Staff Report, pp. 140-142.

could distract Con Edison from completing the numerous, critical improvements that the City, Staff and others have recommended for immediate action prior to this summer.[72] In order to ensure that the Company is focused on its preparations for this summer, but also to preserve these important issues for further review, the City urges Con Edison to stipulate that the shared excess earnings calculations will be unaffected by LIC Outage expenses and that incident-related capital costs will not be subject to the tracking mechanism established in the last rate case.[73] Such a stipulation would permit the incident-related capital costs to be subject to a fair examination in the upcoming electric rate case without the burden of instituting a prudence proceeding now.

[72] As noted earlier, Con Edison already has issued two comprehensive studies of the LIC Outage, the October 12th Report and the Committee Report. In addition to the Staff investigation culminating in the Staff Report, the Commission also instituted a separate proceeding to audit the Company's performance in response to outage emergencies Case 06-M-1078 – Proceeding on Motion of the Commission to Audit the Performance of Consolidated Edison Company of New York, Inc. in Response to Outage Emergencies, (Instituted: September 8, 2006), and that audit is ongoing. Finally, a comprehensive electric rate case filing by Con Edison is expected prior to May 1, 2007.

[73] Approximately $32 million of capital costs has been incurred by the Company to date, and Con Edison is proposing to recover those capital costs from customers over the useful lives of the equipment (Staff Report, p. 10). The Company could offer such a stipulation in its Reply Comments to the Staff Report.

POINT III

THE CITY AGREES WITH STAFF'S CONCLUSION THAT THE COMPANY MUST IMPROVE ITS PROCESS FOR RECOVERING SAMPLES FROM DAMAGED AND DESTROYED EQUIPMENT

An essential function following any major power outage is the ability to analyze and examine the equipment that failed. As with any outage, following the Long Island City event the Company initiated extensive autopsies and teardowns from failed and damaged equipment. Both the Staff Report and the City Report address the Company's failure to collect and track sufficient component failure samples for dissection and analysis to identify root causes for the in-service failures.[74] Although there is no disagreement between the City and Staff on this issue, the Company's failings in this regard are significant enough to highlight here.

The Staff Report discusses being unable to complete 25% of the planned autopsies due to the Company's failure to collect the actual failed sections of equipment.[75] When Con Edison is unable to collect actual samples from where equipment failed, it often collects nearby samples for analysis. The collection of "nearby" samples does not allow for sufficient analysis to be performed as the equipment did not fail. Staff considers the Company's sample recovery failure rate "unacceptable and far exceeds the historic level for

[74] City Report, p. 20; Staff Report, p. 79.

[75] Staff Report, p. 80.

such an event."[76] The City Report also recognizes that conclusions from the equipment failures for the Long Island City network event were very difficult to reach because of the very small number of actual failure specimens that were provided by Con Edison for examination and analysis.[77] Less than 50% of the possible cable, joint, and termination failures (11 of 25) were actually made available and some of them contained insufficient components to determine the cause of the failure.

As a consequence of the LIC Outage, the City joins Staff in recommending that the Company develop better procedures to effectively and efficiently collect and save failed component samples following major power outages. The lack of such samples greatly inhibits the Company's ability to determine the root causes of equipment failure or to identify necessary equipment changes or O&M modifications. The Company's sample recovery procedures should be revised immediately.

POINT IV

STAFF'S REPORT INCLUDES SEVERAL FACTUAL AND TECHNICAL ERRORS THAT SHOULD BE CORRECTED

The Staff Report includes several inaccuracies and technical errors that should be highlighted to aid the Commission in its deliberations. The City highlights these errors not with the intention of being critical of the Staff Report or the diligent efforts that Staff has

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[76] *Id*.

[77] City Report, p. 20.

put forth, but rather to highlight the need to have input from the Company and other interested parties before Staff's findings, conclusions and recommendations are adopted by the Commission.

In its Report, Staff discusses the situation where seven primary feeder cables were over their normal operating rating but below their emergency ratings and still failed.[78] Staff states that: "[s]uch [cable] failures draw into question the validity of the primary cable calculations and ratings derived by the Company."[79] This statement is not correct because loading histories of the cables also have a direct impact on and affect the calculation of a cable's loss of life. Thus, ratings are only part of the assessment of how long a cable can operate, and Staff's statement does not take account of how the loss of the ability to withstand voltage stress can contribute to failures.

Also, addressing normal and emergency loading, Staff states Con Edison should ". . . adjust its normal and emergency ratings for all of its transformers and factor those ratings into its planning to improve network predictability and reliability."[80] There is insufficient support for this statement. While transformers were overloaded and some failed, there were many more that also were overloaded but did not fail. Decreasing the ratings of transformers so that they will not fail is not supported by the data or the record. Additionally, many component failures, including transformers, occur below normal ratings.

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[78] Staff Report, p. 81.

[79] *Id*.

[80] *Id.*, p. 96.

The Staff Report also states that "Con Edison relies on the World-class Operations Load Flow ("WOLF") program as a real-time monitoring tool during contingency events."[81] The WOLF program does not provide real time monitoring. Rather, WOLF looks at the next worst case scenario. The RMS system, which is an input to WOLF, provides near real-time monitoring. This correction should be noted regarding one of the Company's primary tools for responding to multiple contingency events.

Staff's Report examines issues with current limiters and other protective devices and attempts to identify a potential flaw in their coordination. Specifically, Staff states that "[a]s in the case of the Long Island City Network event, under multiple contingency events, current limiters do not coordinate well with other protective devices and, thus, fail to adequately protect the secondary network system."[82] The only protective devices in the network other than current limiters are the network protector fuses. There is no evidence that current limiters and network protector fuses do not coordinate very well together.

Finally, the Staff Report also makes an error when describing the Company's relay settings. Specifically, Staff states that "[i]t is possible that equipment will operate beyond acceptable limits and thus would not be taken out-of-service in a timely manner."[83]

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[81] Staff Report, p. 88.

[82] *Id.*, p. 92.

[83] *Id.*, p. 106.

The relay settings do not protect for equipment overloads. Rather, they remove the feeder from service for a primary fault. Staff continues that "[r]aising the relay limits could cause equipment damage. Raising the settings to prevent one feeder failure, in and of itself, is not warranted."[84] However, raising the relay settings will ***not*** cause equipment damage. The settings were not raised to prevent a failure, but rather to avoid a cut in open auto problem (i.e., a situation that arises when a faulted feeder is returned to service and opens immediately upon re-energization).

[84] *Id.*, p. 106.

CONCLUSION

For all of the reasons contained throughout these Initial Comments and in the City Report, the Commission should review Con Edison's operating practices and procedures thoroughly and adopt the conclusions and recommendations set forth in the City Report to help to ensure that an event similar to the LIC Outage either does not occur again or, if it occurs, is responded to more effectively and promptly.

Dated: March 2, 2007
Albany, New York

Respectfully submitted,

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INVESTIGATION BY THE CITY OF NEW YORK INTO THE NORTHWEST QUEENS JULY 2006 POWER OUTAGES

March 2, 2007

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1.0 Executive Summary

A. Overview

The City of New York ("City" or "NYC") commissioned this Report to examine the July 2006 power outages of Consolidated Edison Company of New York, Inc.'s ("Con Edison" or the "Company") Long Island City network. The primary feeder outages started on Monday, July 17, 2006 and ended on Friday, July 21, 2006 when all network feeders were restored to service. All customers were restored to service, either from the network or by alternative means by Tuesday, July 25, 2006. The power outages that occurred in the Long Island City network had a devastating impact on those that live, work and commute in the area. While initially estimated to have affected a few thousand customers, Con Edison later estimated that over 25,000 customers lost service as a result of the outages.[1]

On July 26, 2006, the New York State Public Service Commission ("Commission") instituted a proceeding and directed the Department of Public Service Staff ("Staff") to investigate the outages and report its findings and conclusions to the Commission. The City was an active party to the proceeding and has participated in all aspects of Staff's investigation. The City also has conducted its own investigation into the technical causes of the power outages and presents recommendations in this Report to minimize the possibility of similar events in the future.

To assist in its independent investigation, the City retained recognized experts in the fields of underground network design and operations, network operations and electric distribution equipment. The City also retained the law firm of Couch White, LLP to act as its outside legal counsel in Staff's investigation and to lead the City's independent examination. The City's experts and counsel have participated in the teardown, inspection and failure analysis of equipment removed from the Long Island City network, interviewed Con Edison employees, served the Company with hundreds of discovery requests, reviewed other parties' discovery requests, reviewed Company reports prepared in response to this event and Company manuals, procedures and reports that were issued after prior power outages, participated in the Company's technical conference, attended depositions conducted by Staff of Con Edison employees, reviewed the report the Company had prepared by an independent committee and reviewed the Staff final report issued on February 9, 2007.

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[1] On February 9, 2007, the Department of Public Service Staff issued its final report on the Long Island City power outages ("Staff Report") wherein they estimated the metered customer outages or customers with low voltage to be approximately 65,000 customers. (Staff Report, p. 23).

B. Objectives of this Report

This report is intended to be an independent and technical analysis of the Company's operations, the electric distribution system, the events preceding the outages, the equipment that failed during the outages and the Company's response throughout the outages. To accomplish this objective, large amounts of data were analyzed and conclusions were reached based on this analysis. From these conclusions, recommendations have been included for the Company to consider adopting to correct or improve its procedures and operations to assist in preventing similar events. Additionally, this Report is being provided to the Public Service Commission to assist in its determination of the causes of the outages and in its oversight of the Company's operations.

C. Recommendations to be Implemented Prior to Summer 2007 Peak Load Period

Given the severity of the Long Island City power outages, the City presents here its recommendations for immediate work that the Company should perform before the beginning of the summer 2007 load period. These actions are designed to reduce the likelihood of a similar event this summer. A more detailed and comprehensive list of recommendations, both short term and long term, is included throughout the remainder of the Report.

- Con Edison should develop a better method to measure the number of customers without service or with low voltage. This should include utilization of the voltage readings obtained from the Remote Monitoring System and from customer service points; developing an appropriate system algorithm to identify lost customer load as an indicator of customers out of service; taking account of the condition of the secondary system, including manhole events, and considering the level of voltage being supplied to customers. In addition, the Company should expedite discussions with cable television providers to transmit a loss of power message to the Company and should incorporate information obtained from third parties into the Company's customer count.

- The Company should apply Very Low Frequency testing technology to 50% of the Long Island City network feeders prior to the 2007 summer load period. The feeders that are selected for Very Low Frequency testing should not have DC Hipot testing applied to those tested feeders for a minimum of three years after Very Low Frequency testing is performed. The remaining feeders within the Long Island City network should receive a DC Hipot prior to the 2007 summer load period. In addition, Con Edison should implement, prior to the 2007 summer load period, an inspection and test program for all network transformers in the Long Island City network that were overloaded during the event.

- Prior to the 2007 summer load period, the Company should complete a testing program for each feeder within the Long Island City network that will exercise all network protector relays (including all other electrical and mechanical components) and identify non-responsive units for correction and re-test if necessary to insure improvement in the performance of these network feeders. These feeders should not stay Alive on Back Feed when removed from service due to a fault or by operator action.

- Prior to the 2007 summer load period, the Company should complete an appropriate inspection and maintenance program to improve the reporting rate of its Remote Monitoring System up to, at a minimum, its designated 95% reporting level. In addition, the Company should accelerate the planned installation of a remote monitoring capability for all of its high-tension customer installations system-wide.

- Prior to the 2007 summer load period, the Company should examine its training and testing program for Substation Operators and District Operators to insure that operators are properly instructed, with particular emphasis on actions to be undertaken during stressful emergency conditions.

- Prior to the 2007 summer load period, the Company should install substation PQNodes on a system-wide basis and complete testing and tuning of the PQNodes to insure that the Reactance-to-Fault application is functional for all of the networks. Con Edison should also complete the required testing of the G&T devices at the North Queens substation to insure that they will be available to expedite the feeder processing effort before the summer of 2007.

- Con Edison should expand the use of visualization tools to its Brooklyn/Queens Control Center, as it has already done in its Manhattan Control Center, to combine multiple information reporting systems and improve the way that critical operating information is presented to the control center operators, especially with regard to secondary network events and customer service problems (e.g., outages, side out, low voltage, etc.).

- The Company should improve its formal plans for operating networks under multiple contingency conditions including criteria for evaluating the secondary network cable system, manhole events, customer outages, and the level of secondary voltage supply to their customers. Improved guidance clearly needs to be provided to determining when a network load area should be de-energized. Specifically, this should also include guidance on the application of three phase grounds to clear backfeeding network protectors, and guidance on the cooling of network transformers.

- Con Edison should review the design settings for all relay protection schemes on its distribution feeders to insure that they have been kept up-to-date and reflect the increased load growth (transformers) being supplied. Any identified corrective actions should be completed prior to the start of the 2007 summer load period. In addition, Con Edison should utilize the three existing vacant feeder positions at the North Queens substation to create three additional 27 kV feeders providing supply to the Long Island City network in order to increase the overall reliability of service.

- The Company should develop a specific operating procedure that provides clear rules for the use of voltage reduction in response to distribution system contingencies. Specifically, the Company's development of the procedure should take into account the potentially damaging effect of voltage reduction on all system components as well as on customers who may already be experiencing sub-standard voltage due to the multiple contingency.

D. Major Findings and Recommendations

The sections of the Report are organized to provide a thorough background of the topic supported by data gathered during this investigation, followed by conclusions and recommendations supported by the facts and data. The Report, in some instances, discusses the same or a similar topic in more than one place. This is done so that the same topic can be examined from different perspectives, and its full system implications can be explored. These individual recommendations are retained to emphasize the impact one recommendation can have on multiple aspects of the Company's operations. In addition to the above recommendations for the 2007 summer load period, an overview of some of the Report's other main findings and recommendations is set forth below.

1. Customer Outage Information and System Visualization

Finding: The reliance on customer interruption reports via customer phone calls caused the Company to overlook other useful sources of data and ultimately hindered its ability to make informed decisions about keeping the network in service, resources and manpower needed, public communications strategies and the restoration process.

Con Edison failed to obtain an accurate count of the number of customers without service or that were experiencing low voltage during the Long Island City event. Relying on customer reports of no service, the Company estimated that fewer than 2,000 customers were without electricity during the peak of the outages all the way until Thursday, July 20th. It was later determined that over 25,000 customers did not have power, and Staff believes the actual number, including customers experiencing low voltage, was as high as 65,000 customers.

During the power outage, other sources of data could have been utilized to better inform the Company of the magnitude of the outages. One such source was manhole events such as fires, smoking, etc., which the Company was tracking. The increase in manhole events throughout the course of the outages should have provided an indication that the secondary network was suffering damage and that the number of customers without power was much higher than what was being reported. In addition, the inability of Company operators to visualize the condition of the secondary network most likely contributed to the Company's underestimates of the number of customers without service and impaired the Company's ability to deploy resources in a coordinated effort. Finally, the Company either failed to obtain, or failed to process, outage information from responsible parties in the field, including its own employees and thus grossly underestimated customer interruptions days into the event.

Additional Recommendations:

- Con Edison should modify its emergency procedures to establish a clearly defined protocol to incorporate observations made by responsible outsiders, as well as its own employees, regarding conditions in the field.

- Con Edison should develop and implement appropriate technology and/or systems to identify network distribution customers that are out of service (one or more phases) or are being provided inadequate voltage on a real-time basis. Additionally, the Company should expand the number of network transformers equipped with voltage reporting capability so that an improved voltage picture is available to the control center operators.

- Con Edison should begin the deployment of the Secondary Underground Network Distribution Automation System (SUNDAS) in a uniform manner with sufficient representation of these units throughout all of the networks so that sensors will provide data on the condition of the secondary network, including three-phase voltage information.

2. Equipment Failures

Finding: A portion of the equipment installed within the Long Island City network either failed or did not perform as it was designed during the event.

Prior to the outages, the Company was not as pro-active in addressing vulnerable or failure prone equipment and operating systems as it should have been. Replacement of targeted stop joints and PILC primary cables, which are known to have a higher failure rate than other joint and cable types, should have been completed more quickly than was scheduled under the Company's plan. Additionally, the Company's records for equipment maintenance were often inconsistent or incomplete. It is also troubling that the Company's main tool to assess the condition of its Long Island City network, the Remote Monitoring System ("RMS"), was only operating at 79.5% efficiency, rather than the designated 95%, when the event started. Had the RMS been operating up to Con Edison's own standard, it is possible the Company could have taken additional, and potentially significant, action sooner to respond to events as they unfolded.

The Company also has lagged behind when it comes to examining and implementing new technologies into its operations. New forms of cable testing, predictive diagnostic tools, upgrades to the RMS, installation of voltage sensors and automatic meter reading at select customer locations are all areas Con Edison could have more actively pursued to improve its aging system.

Additional Recommendations:

- All Alive on Backfeed events should be reviewed to determine the amount of backfeed and the duration of that backfeed and the transformer's condition should be noted with respect to any accelerated loss of life. It is recommended that gas in oil analysis also be performed for those units that have experienced significant accelerated loss of life or have reached a significant accumulated loss of life.

- The Company has indicated that its policy is to impulse test (BIL test) reconditioned transformers before returning them to service. As an added aspect of this test, it is recommended that Con Edison consider conducting dielectric testing while the transformer is at elevated temperatures.

- It is recommended that the Company evaluate the use of condition-based maintenance, where the service life and service conditions of transformers are used in a more prominent role in the determination as to when maintenance is required.

3. Voltage Reduction

Finding: Voltage reductions imposed by the Company during the Long Island City event contributed to the damage on the secondary network and adversely impacted customers for longer than was necessary.

Voltage reduction is primarily used during times of system emergencies or generation shortages to reduce load. The effect of reducing load does not always mean that the currents flowing through the secondary system and through the distribution transformers are reduced. During the Long Island City network event, it appears that the Company's use of voltage reduction contributed to the damage to the secondary network by increasing the current and placing additional stress on the system. This situation was worsened when the Company continued to impose voltage reductions after all of the primary feeders were restored to service.

The Company's decision to maintain voltage reduction for two additional days after the network was restored negatively impacted customers that were experiencing low voltage service conditions because of damage to the secondary network. Moreover, even when Con Edison made the decision to disengage the voltage reduction system, it took the Company approximately four hours to successfully do so.

Additional Recommendations:

- If Con Edison plans to continue using voltage reduction for unloading distribution circuits, which should mean reduction of current, the Company should perform studies to determine the conditions under which the voltage reduction would be effective for this specific objective, if at all.

- Con Edison should perform a thorough field and empirical analysis to determine the effects of voltage reduction on actual voltage and current in the network under severe contingencies. The Company should also establish along with the Department of Public Service Staff a value of service voltage that would be considered inadequate and therefore would be equivalent to a service outage.

4. Training of Con Edison Managers and Substation and District Operators

Finding: It was revealed during the investigation that actions taken prior to the outages and during restoration by Con Edison management, Substation Operators and District Operators contributed to or prolonged the Long Island City outages.

Multiple feeder trip outs during the event might have been avoided by better project management of the circuit breaker upgrade program. The wire checks associated with Con Edison's inspection and acceptance testing of the contractor work should have revealed the failure of the trip circuit monitoring light to operate properly. The fact that Con Edison has stated that it cannot determine whether the contractor either designed the circuit incorrectly or installed it improperly is a further indication of its failure to properly monitor and control this retrofit project. Moreover, this failure should cause the Company to review its contractor work inspection process.

Additional Recommendations:

- Con Edison should examine and strengthen their contractor oversight processes from initial design, to on-site inspection, and through acceptance testing, to ensure that proper controls are being exercised over contractor work within its substations.

- Con Edison should modify its procedures for operating the distribution system under contingencies to provide guidance for operator actions under severe contingency levels with potential low voltage conditions within the network of concern.

- Con Edison should reevaluate the requirement that network protector relays prevent the network protector from closing if the network voltage is between 60 volts and 13 volts. They should also modify their procedures for operating the distribution system under contingencies to ensure that operating personnel are aware of this requirement.

- The Company should consider the creation of a dedicated engineering team directed towards the evaluation of the secondary network cable system during multiple feeder contingencies to ensure that appropriate attention, evaluation, and planning is applied to this area while immediate efforts are directed towards the restoration of the primary feeders.

5. Temperature Variable

Finding: The Con Edison system is designed under the assumption that it is subjected to extreme heat events once every three years. In fact, extreme heat events occurred more frequently on the Con Edison distribution system. The frequency of these events places stress on the system that is not being accounted or planned for and has made the system more vulnerable to failure.

The Company's electric distribution system is designed under the assumption that it is subjected to extreme heat events once every three years. An extreme heat event is defined as when the Company's temperature variable design criterion of 86 degrees Fahrenheit is exceeded.[2]

An examination of the past 11 years indicates that there have been fifteen days in which the 86 degree temperature variable was exceeded. This is an average of approximately 1.4 times a year that the distribution system is pushed beyond its design limitation, rather than once every three years. The number of times that the Company exceeds its temperature variable is an indication of the amount of stress being placed on the system. When a system is designed to be exceeded one year out of every three and in actuality is being exceeded 1.4 times annually, there is significantly more stress being placed on the system then it was designed to accommodate. While the temperature variable during the Long Island City event was 83.6 degrees, the system may have been more vulnerable due to this cumulative and continuing source of stress.

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[2] The Company's temperature variable design criterion is based upon a weighted average of the wet-bulb and dry-bulb temperatures during the three hottest consecutive hours of the present day and the two previous days.

Additional Recommendations:

- Con Edison should review its method for calculating its design temperature variable. A statistical analysis of weather conditions that has existed over an extended period of time (e.g., 50 – 100 years) should be performed. The analysis should consider the weather conditions of all days, and not just the maximum annual temperature variable, to gain a true measure of the expected frequency that weather conditions will exceed the system's design conditions.

6. Washington Heights Recommendations

Finding: A number of recommendations made by Staff following the Washington Heights blackout were not fully implemented by the Company.

Following the 1999 Washington Heights incident, Staff issued a report with 44 recommendations aimed at reducing the likelihood that a similar event would occur again. A number of the recommendations made by Staff, had they been fully implemented, would have directly improved the Company's response to the Long Island City network event or reduced the potential for a failure of the magnitude of the Long Island City event.

Additional Recommendations:

- Con Edison should be required to fully implement all of the Washington Heights recommendations or explain why it cannot do so. In addition, Con Edison should evaluate its emergency procedures in light of lessons learned from the July 2006 outages and modify these procedures as necessary.

2.0 Introduction

2.1 Overview of the Long Island City Electric System

During the period of July 17 through July 25, 2006, the electric supply to the customers of Con Edison in the Northwest portion of Queens, New York suffered severe disruption. Con Edison refers to this area as the Long Island City network.

The Long Island City network includes the neighborhoods of Long Island City, Astoria, Sunnyside, Woodside and Hunters Point as well as Rikers Island and La Guardia Airport. The area is bounded by the East River on the west and north, the Brooklyn-Queens Expressway on the east, and Newtown Creek on the South[3] Figure 2.1-1 below, reproduced from the Company's October 12th Report, outlines the boundaries of the Long Island City network.

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[3] Company's October 12th Report, p. 2-6.

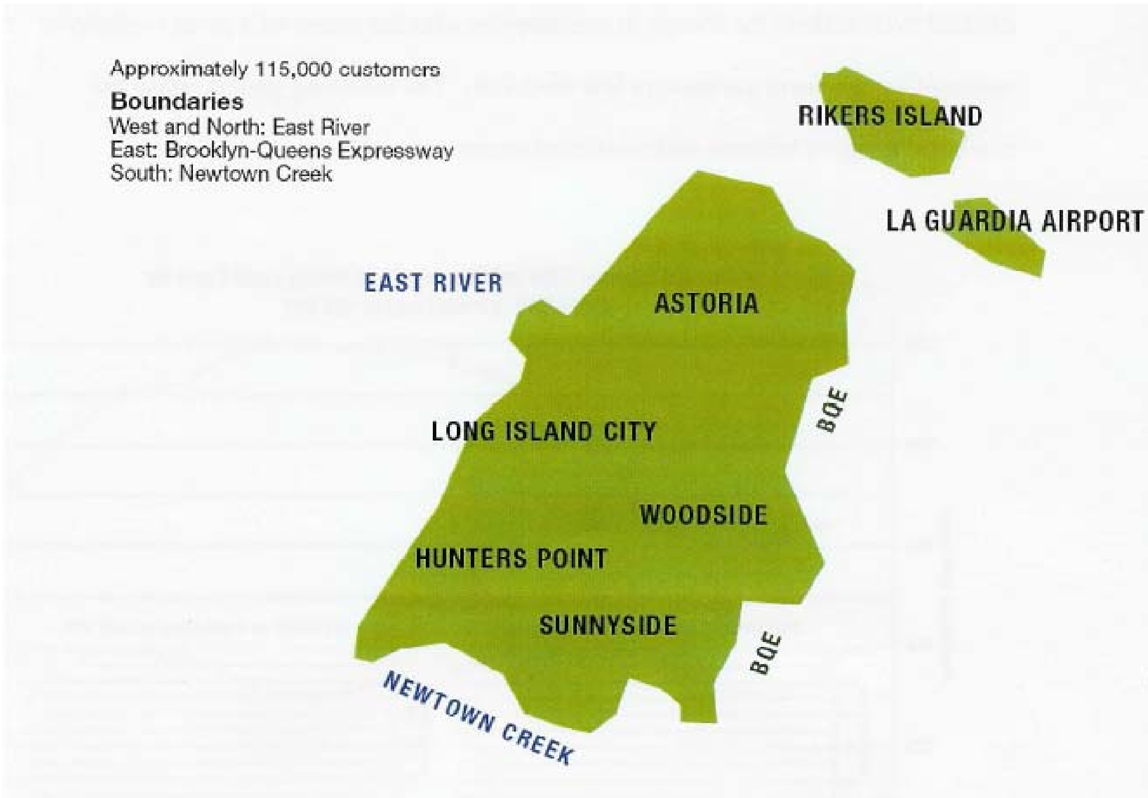

Figure 2.1-1 - Map of Con Edison's Long Island City Network Boundaries[4]

The Long Island City Network serves both commercial and residential customers. Together these two classes of customers total approximately 115,000. While it is difficult to translate a customer into numbers of persons served it is estimated that over 600,000 people live in the area supplied by the Long Island City network.

The 2006 forecasted peak demand for the Long Island City network was 395 MW. At the peak time, which occurs between 14:00 and 18:00 hours on a weekday (*see*, Figure 2.1-2 below) the ratio of commercial load to residential load, is approximately 3:1 (i.e., 300 MW commercial and 100 MW residential). However, these two types of load do not peak coincidentally. By 18:00 hours the large commercial loads would decrease from their peak while the residential loads would increase. This can be seen by reviewing the Saturday and Sunday peak loads (there are very little large commercial loads on these days), which were forecasted to be 296 MW (68% of weekday) and 261 MW (66% of weekday) respectively.

[4] Reproduced from the Company's October 12th Report, Figure 2- 4, p. 2-7.

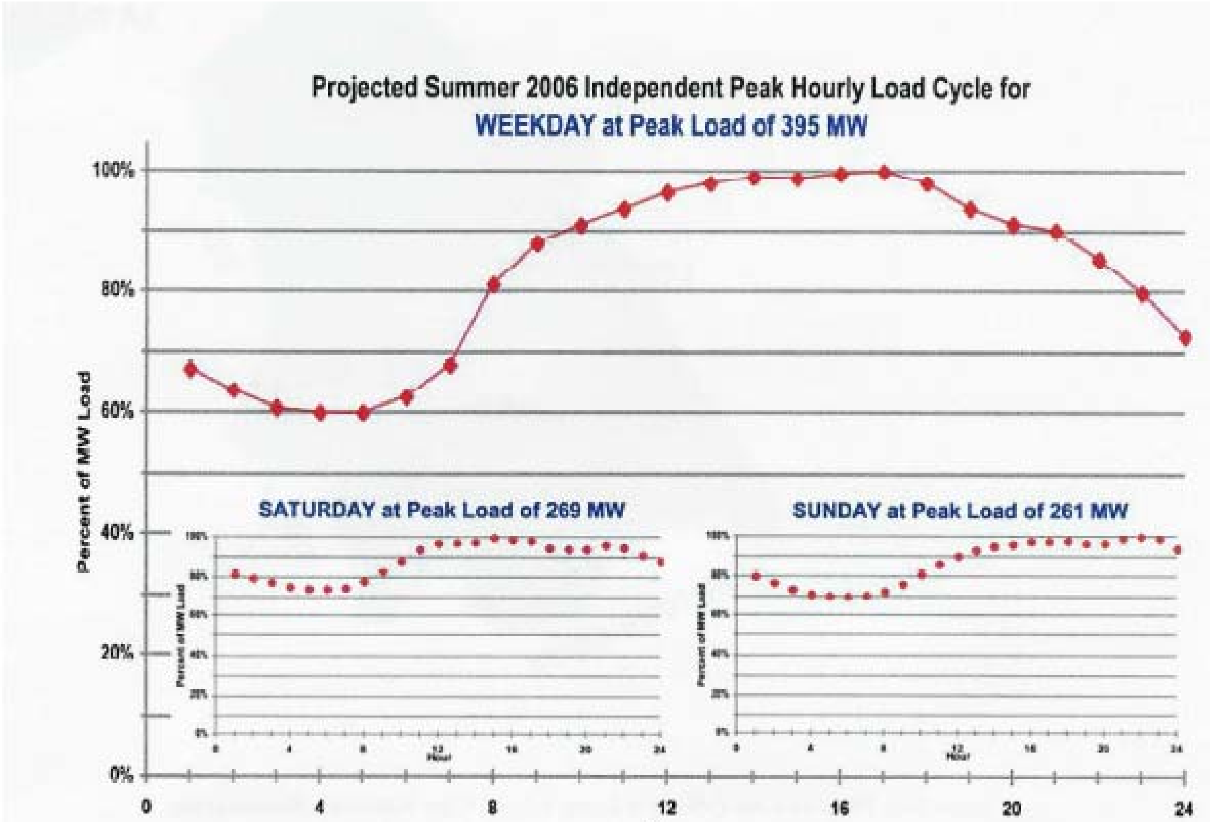

Figure 2.1-2 Long Island City Network Hourly Demand Cycle[5]

The Long Island City network is a low voltage distributed network. In this design, primary feeders (consisting of cables and joints), operating at 27,000 volts (27 kV) and originating at an area substation, supply network transformers that transform the voltage from 27 kV to 216Y/120 volts or 470Y/277 volt. The network transformers cannot be disconnected from the primary feeders without sending crews to perform work on the primary cables. This work requires that the cables be disconnected from the area substation. The transformers in turn supply network protectors (an air break interrupting device). These network protectors (one per transformer) connect the transformers to the low voltage secondary cables. A network protector can be opened to disconnect the transformer from the secondary cables. Many low voltage secondary cables are interconnected to form a grid (the low voltage secondary). The customers are supplied by the low voltage grid through their service cables and disconnect switch. Figure 2.1-3 below provides an overview for how this system is designed. In order to disconnect the customers from the grid either the cables must be opened (i.e., cut or burned out) or the customer's service switch must be opened.

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[5] Reproduced from the Company's October 12th Report, Figure 2-5, p. 2-8.

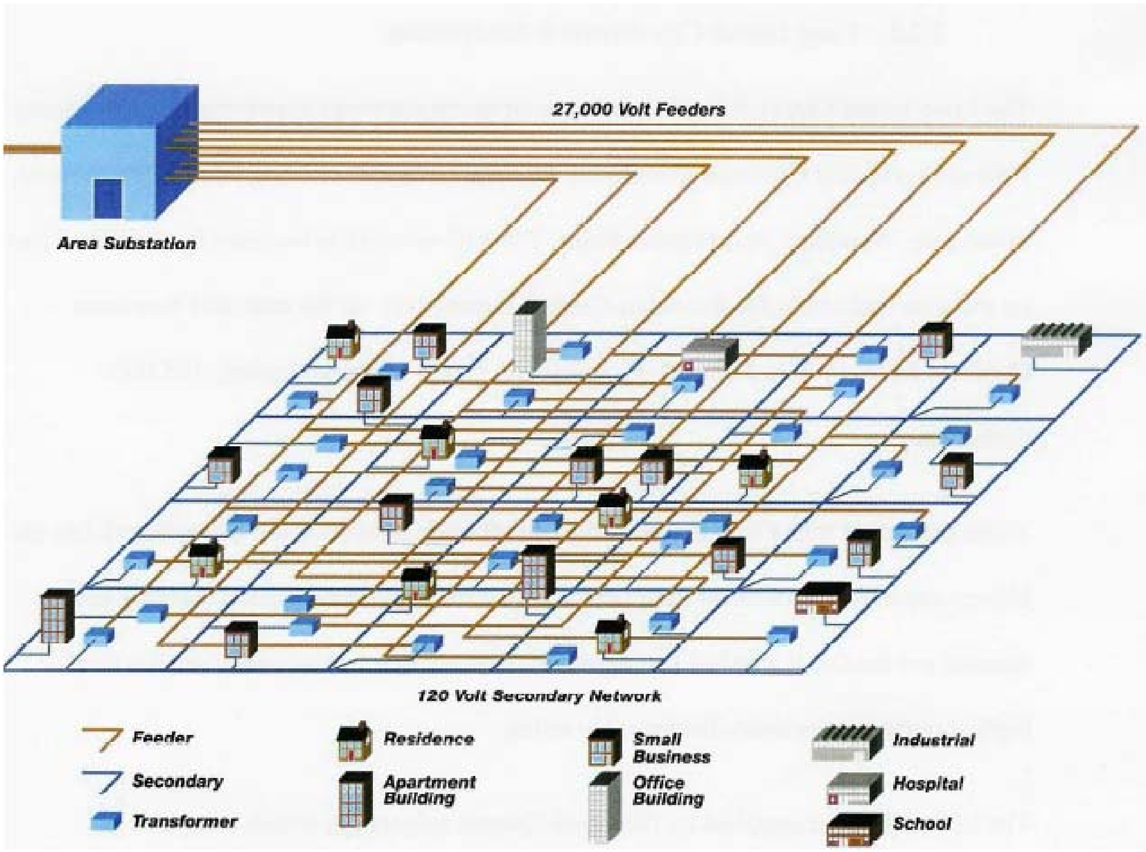

Figure 2.1-3 Illustration of Con Edison's Primary and Secondary Network System[6]

In July 2006, the North Queens area substation, located on the Con Edison Astoria property in the northwest corner of the trouble area supplied the Long Island City network utilizing 22 primary feeders. These 22 primary feeders consist of approximately 290 circuit miles of cable (3 cables per circuit). The feeders consist of many cable sections, which are coupled together by joints (connectors). There are approximately 1,200 network transformer/protector combinations that supply the low voltage grid. In addition, Con Edison has 4,400 manholes/vaults, 11,000 service boxes and 3,000 utility poles in the Long Island City network. The low voltage grid is comprised of 1,700 miles of secondary cable.[7] The cables, primary and secondary, are routed through an extensive conduit system that interconnects the cables, transformers, protectors and customers. For the most part this equipment is installed underground (outside of the area substation) and is sometimes referred to as an underground secondary network.

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[6] Reproduced from the Company's October 12th Report, Figure 2-3, p. 2-5.

[7] Con Edison's Initial Report on the Power Outages in Northwest Queens in July 2006 (dated: August 2, 2006) ("Con Edison Initial Report"), p. 2-1.

The use of the network design allows power to flow over many paths to the customer from multiple primary feeders and many secondary cables. The Long Island City network (as all of the Con Edison networks) is designed to operate without customers experiencing low voltage with any two of the primary feeders and their associated transformers out of service, either for regularly scheduled work or as a result of failure on a peak load day. A peak load day is defined as a weekday where the design temperature is equal to 86^{o} temperature variable.[8]

This design is inherently reliable when operated within its design limits. In fact, in 2005 customers in the Long Island City network experienced less than three interruptions per thousand customers served per year. This is in the top quartile of the Con Edison networks and is over 400 times better than the average customer experience in New York State.[9] However, when operated beyond design limits underground secondary networks have proven to pose significant operating challenges. This is complicated by the fact that the equipment is located underground and cannot be easily inspected. The underground system requires special techniques to monitor conditions and locate problems. These systems must be coupled with highly trained and qualified personnel to repair the problem and restore equipment to service. Repairs of underground equipment typically take longer than those on comparable overhead equipment.

3.0 Long Island City Network Event of July 2006

3.1 Summary of Key Events

Appendix 1A provides the sequence of primary feeder failures the Company faced as the event unfolded in its Long Island City network in July, 2006. In addition to outlining the sequence of primary feeder failures, this section also includes the status of the secondary system as it was reported to the operators by the Company's monitoring systems and field personnel.

The information contained in Appendix 1 is presented in chronological order and was collected from the Company's October 12, 2006 *Comprehensive Report on the Power Outages in Northwest Queens in July 2006* (the "October 12th Report"), from interrogatory responses collected throughout this investigation and from interviews with Company personnel. Case numbers used to identify each of the events are

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[8] Temperature Variable uses the average wet bulb and dry bulb temperatures (AWD) in the following formula: Temperature Variable (TV)= 0.7*(maximum 3-hour AWD of the current day)+0.2*(maximum 3-hour AWD of the previous day)+0.1*(maximum 3-hour AWD of two days prior). The TV provides a measure of discomfort associated with high temperature and humidity.

[9] Con Edison Initial Report, p. 1-10.

identical to those used in the Company's October 12th Report. The Case numbers used in Appendix 1A will be referenced in discussions throughout this Report.

Con Edison utilizes a nomenclature system that uniquely identifies its distribution feeders. In this system feeders in the Long Island City network are designated by their prefix "1," which identifies the network, and "Q," which identifies the borough. The two digit number following the borough designation distinguishes the specific feeder. For example, feeder 1Q01 designates the first feeder in the Long Island City network in Queens

A. Sequence of Events - Primary Feeder Outages

The Long Island City network event was caused by outages to 27 kV primary feeders supplying portions of Northwest Queens. The event started at 1550 hours on Monday, July 17 when the first feeder was automatically removed from service (Case 1) and ended at 0801 hours on Friday, July 21 when the network was in a zero contingency state (Case 42). The event lasted for over 88 hours. While additional primary feeder outages occurred beyond this time period, they did not result in the network being in a greater than 2nd contingency. A detailed recounting of the problems with the primary feeders is set forth in Appendix 1A.

After the event ended on July 21st the Company still faced significant challenges to restore all customers to service and to make permanent repairs to the network and the secondary system. All customers were restored to service by midnight on Tuesday, July 25, 2006. Permanent repairs are ongoing as of the date of this report.

Figure 3.1.1 below provides a graphical representation of what was occurring on the primary system during the period covered by this chronology. This figure references the case numbers, times, and contingency levels. It provides a listing of all of the primary feeders out at the particular time; the time the feeder was restored to service and shows graphically the contingency level. Lastly the table indicates the length of time that the feeders were out of service and provides a running count of the number of feeders restored.

Case Summary																
Case No.	**Date / Time Out**	**Contingency**	**Feeders Out**	**Feeder Restored**	**Time Out**	**Time Out**	**Time Out**	**Time Out**	**Time Out**	**Time Out**	**Time Out**	**Time Out**	**Time Out**	**Time Out**	**Duration hrs:min:sec**	**Restore Count**
0	7/17/06 12:00 AM	0	----													0
1	7/17/06 3:50 PM	1	17			1Q17										0
2	7/17/06 4:22 PM	2	17,16				1Q16									0
3	7/17/06 6:48 PM	5	17,16,07,15,21		1Q15			1Q07	1Q21							0
4	7/17/06 7:10 PM	4	17,16,07,21	1Q15											0:22:00	1
5	7/17/06 7:48 PM	5	17,16,07,21,02		1Q02											1
6	7/17/06 8:08 PM	4	17,16,07,21	1Q02											0:20:00	2
7	7/17/06 9:43 PM	5	17,16,07,21,20							1Q20						2
8	7/17/06 9:49 PM	6	17,16,07,21,20,01		1Q01											2
9	7/17/06 11:21 PM	5	16,07,21,20,01	1Q17											7:31:00	3
	7/17/06 11:37 PM		no change - 1Q16 CIOA				-------									4
	7/18/06 2:49 AM		no change - 1Q21 CIOA						-------							5
	7/18/06 5:53 AM		no change - 1Q20 CIOA							-------						6
10	7/18/06 8:23 AM	6	16,07,21,20,01,02								1Q02					6
11	7/18/06 9:33 AM	5	07,21,20,01,02	1Q16											17:11:00	7
12	7/18/06 11:37 AM	4	21,20,01,02	1Q07											16:49:00	8
13	7/18/06 11:55 AM	5	21,20,01,02,17									1Q17				8
14	7/18/06 3:14 PM	6	21,20,01,02,17,18				1Q18									8
	7/18/06 5:11 PM		no change - 1Q21 CIOA						-------							9
	7/18/06 6:56 PM		no change - 1Q02 CIOA								-------					10
15	7/18/06 8:05 PM	7	01,20,17,18,21,02,13			1Q13										10
16	7/18/06 8:33 PM	8	01,20,17,18,21,02,13,12					1Q12								10
17	7/18/06 8:33 PM	9	01,20,17,18,21,02,13,12,15										1Q15			10
18	7/18/06 8:38 PM	10	01,20,17,18,21,02,13,12,15,1											1Q16		10
19	7/18/06 8:53 PM	9	20,17,18,21,02,13,12,15,16	1Q01											23:04:00	11
20	7/18/06 9:26 PM	8	20,18,21,02,12,15,16,17	1Q13											1:21:00	12
21	7/18/06 9:46 PM	7	20,21,02,12,15,16,17	1Q18											6:32:00	13
22	7/18/06 9:51 PM	8	20,21,02,12,15,16,17,18			1Q18										13
23	7/18/06 10:25 PM	9	20,21,02,12,15,16,17,18,19		1Q19											13
24	7/19/06 12:00 AM	8	20,21,02,12,15,16,17,18	1Q19											1:35:00	14
25	7/19/06 12:06 AM	9	20,21,02,12,15,16,17,18,19				1Q19									14
26	7/19/06 6:19 AM	8	20,02,12,15,16,17,18,19	1Q21											35:31:00	15
	7/19/06 8:50 AM		no change - 1Q17 CIOA									-------				16
27	7/19/06 8:51 AM	9	20,02,12,15,16,17,18,19,14		1Q14											16
28	7/19/06 11:33 AM	10	20,02,12,15,16,17,18,19,14,0						1Q01							16
29	7/19/06 1:10 PM	9	02,12,15,16,17,18,19,14,01	1Q20											39:27:00	17
30	7/19/06 1:37 PM	8	02,15,16,17,18,19,14,01	1Q12											17:04:00	18
	7/19/06 4:05 PM		no change - 1Q15 FOT										-------			19
31	7/19/06 7:05 PM	7	15,16,17,18,19,14,01	1Q02											34:42:00	20
	7/19/06 7:43 PM		no change - 1Q16 AM CL											-------		21
32	7/19/06 8:41 PM	6	15,16,18,19,14,01	1Q17											32:46:00	22
33	7/19/06 9:29 PM	7	15,16,18,19,14,01,17					1Q17								22
34	7/20/06 12:46 AM	6	15,16,19,14,01,17	1Q18											26:55:00	23
35	7/20/06 4:33 AM	5	15,16,14,01,17	1Q19											30:08:00	24
36	7/20/06 6:36 AM	4	15,16,01,17	1Q14											21:45:00	25
37	7/20/06 12:38 PM	3	15,16,01	1Q17											15:09:00	26
38	7/20/06 1:37 PM	4	15,16,01,07		1Q07											26
39	7/20/06 1:48 PM	3	16,01,07	1Q15											41:15:00	27
	7/20/06 8:22 PM		no change - 1Q01 FOT						-------							28
	7/20/06 9:03 PM		no change - 1Q07 FOT		-------											29
40	7/21/06 6:37 AM	2	16,01	1Q07											17:00:00	30
41	7/21/06 7:49 AM	1	01	1Q16											59:11:00	31
42	7/21/06 8:01 AM	0	----	1Q01											44:28:00	32
				22										**Total time =**	**490:06:00**	
														Average time =	**15:18:56**	

Figure 3.1.1 Sequence of Primary Feeder Events and Feeder Restoration Time

B. Sequence of Events – Secondary System

While the Company was responding to primary feeder outages, information systems within the control center were also providing operators with information on the status of the secondary system. The chronology of events occurring on the secondary system is set forth in Appendix 1B. The same Case numbers used to identify the Primary Feeder Outages in Appendix 1A are used to identify the events affecting the secondary network.

As in Appendix 1A, the sequence of events affecting the secondary system is only discussed through Case 42 when there were no primary feeders out of service. Total numbers presented in Appendix 1B are <u>cumulative</u> from the start of the event on Monday, July 17, 2006.

3.2 <u>Analysis of Equipment Failures</u>

3.2.1 <u>Failures of Primary Cables, Joints, and Terminations</u>

A. Introduction

This section of the report will discuss the various primary cable, joint, and termination failures during the Long Island City network event. Secondary cables were not examined as part of this Report, but they will also be discussed. Based upon an examination of the failed components, an analysis is provided and, where feasible, appropriate conclusions and recommendations for improvements are presented.

The sequence of events for the Long Island City network power outage can be found in Appendix 1A and 1B of this Report. In those appendices, each of the failures reported by Con Edison are identified by a Case number and a date and time. To establish a clear line of reference the case numbers in Appendix 1A and 1B will be utilized to identify the observations made during the failure autopsies discussed in this Section. It should be noted that not all failure samples were provided by Con Edison for examination.[10] Only those primary cables and joint samples provided and subject to examination are discussed in this Report and accompanying appendices. While the sequence of events in Appendix 1A and 1B ends with Case 42 (when the network returned to a zero contingency level), additional samples resulting from failures after that time were examined and are presented in this Report and the accompanying appendices as they contribute to the conclusions and recommendations.

In order to foster a better comprehension of the discussion presented within this Section, a number of definitions are presented to insure a common understanding of terms:

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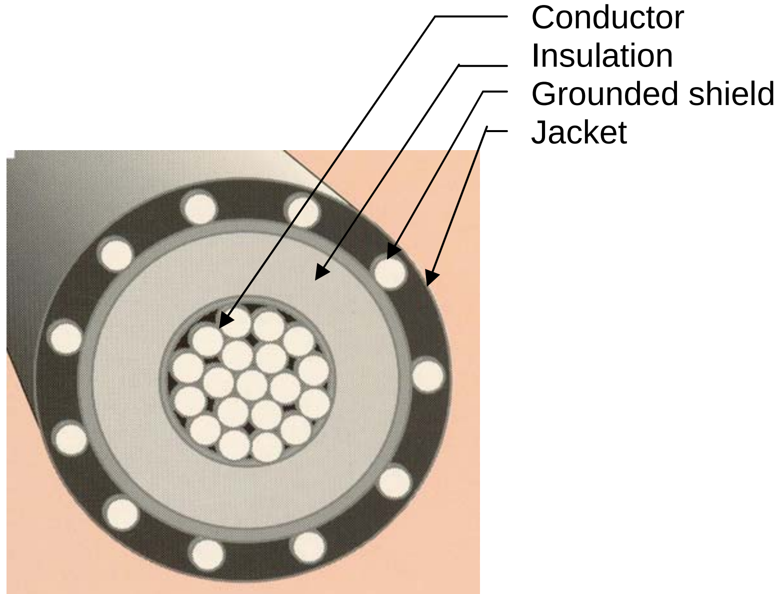
[10] Apparently a number of the samples were lost and unaccounted for.

1. Cables

On the Con Edison system, a primary cable is an insulated conductor designed to carry electrical power at voltages above 4,000 volts (4 kV) up to about 33,000 volts. The cable consists of the following components: a metallic conductor or conductors, a layer of insulation such as paper (PILC), cross-linked polyethylene (a plastic material identified as XLPE), or ethylene propylene rubber (EPR), semiconducting layers (consisting of a carbon-black filled polymeric material) between both the conductor and the insulation, and the insulation and the jacket, and a grounded concentric layer of metallic shielding over this insulation; sometimes, an overall non-metallic layer known as a jacket covers the complete construction. A typical primary cable is shown in Figure 3.2.1-1 below.

Figure 3.2.1-1 – Primary Cable[11]



A secondary cable is an insulated conductor designed to carry electrical power at lower distribution voltages below 600 volts. A secondary cable may have either a single or two layer construction over the conductor with no semi-conducting shield.

Both primary feeders and secondary cables are used within the Long Island City network. The primary cables operate at 27,000 volts (27 kV) and the secondary cables, which supply the customers directly, operate at either 216/125 volts or 470/277 volts (for large customers).

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[11] Photo courtesy of National Rural Electric Cooperative Association.

2. Joints

A primary joint, which is also known as a splice, is a connection between two (or more) lengths of cable. Joints are usually constructed within underground structures called manholes. Joints have all of the components of the cable and are designed to combine sections of cables in the field. There are several types of joints as indicated below:

- Hand Taped: This type of joint is insulated by hand in the field with wrapped tapes.

- Pre-molded Joints: These joints include parts that are completely made within the factory and are placed over the cable ends in the field.

- Heat Shrink: The majority of the work on this joint is done at the manufacturing plant and heat is utilized in the field to shrink the parts together.

- Cold Shrink: The majority of the work on this joint is done at the manufacturing plant and the parts are shrunk together when a retaining form is removed and the sleeve shrinks back down to its normal size; no heat is required.

- Stop Joints: This type of joint is comprised of the types of joints previously described but in addition they join a paper insulated cable to a solid dielectric cable (either cross-linked polyethylene or ethylene propylene insulated cable), these joints are sometimes called a transition joint.

A secondary connection or joint is generally made with a simple compression fitting that joins the conductor portions and is covered by insulation. At points within a network system where multiple cable directions are all interconnected pre-manufactured connection crabs or trees may be installed. Internal or external in-line cable fuses, also known as limiters, are often utilized in conjunction with these cable crabs.

3. Terminations

A termination is the electrical seal for the end of a cable. It is used where the cable connects to a different type of equipment such as a transformer, switch or a live end cap where equipment has been temporarily removed from service.

B. Examination of Failed Cables, Joints, and Terminations Through Case 42

The sequence of events referenced in Appendix 1A lists a total of 33 equipment failures that removed feeders from service between 1550 hours on July 17, 2006 (Case 1) through 0801 hours on July 21, 2006 (Case 42), when the Long Island City network was restored to a zero contingency level. Of these identified feeder failures, the following were the identified failure components: 7 were cable failures, 13 were joint failures, 2 were termination failures, and 11 were transformer failures. The Company's October 12th Report lists an additional five equipment failures (3 joints and 2 transformers) that between 0801 hours on July 17th and 2208 hours on July 23rd. The cable, joint and termination failures will be discussed in this section. Additional details can be found in Appendix 2. The thirteen transformer failures will be discussed in section 3.2.2 and Appendix 8.

During the course of this investigation, 11 cable, joint and termination failures were made available by Con Edison for inspection. Included in these 11 samples was what was later identified as 4 cable and 7 joint samples. One of the samples identified as a cable failure (Case 30 feeder 1Q15) was identified as the failure of a termination applied to a cable so that it could be energized. This type of termination is called a Live End Cap. The summaries provided below represent the City's conclusions from these inspections and autopsies.

On July 26, 2006, an examination and analyses of failed joints removed by Con Edison was performed. On August 14, 2006, an examination and analysis of sample sections of failed primary extruded cables (XLPE and EPR) was performed. Both of these examinations were completed at Con Edison's Van Nest facility and were performed by Cable Technology Laboratories ("CTL"), a cable testing company employed by Con Edison to assist in their analysis. The joints and cables were dissected, cut open, and portions of the cable jackets were removed, when present, so that cable insulation, shields and conductors could be examined visually. Additional laboratory tests on the extruded cables were subsequently performed in September, 2006 at CTL's facility in New Brunswick, New Jersey. This latter testing of the extruded cables focused on cable properties such as volume resistivity,[12] dielectric strength, water treeing examination, and other common tests normally performed on failed extruded cable insulation. For the discussion that follows, in many cases there was more than one cable specimen examined; either more than one segment was supplied, or the cable section supplied was cut prior to examination. The individual segments themselves may have had different appearances (for example, degradation was severe, little or none), and the discussion below encompasses examination and

[12] Resistivity is a property of a material which determines its resistance to the flow of electricity.

discussion of all available segments.[13] A detailed review of these cable failures is included in Appendix 2.

C. Examination of Failed Cables, Joints and Terminations that Occurred after Case 42

A detailed review of these failures is included as Appendix 3.

Summary of Cable Examinations

Conclusions for the Long Island City network event were very difficult to reach because of the relatively small number of failure cases obtained from the event. This situation was further exacerbated by the very small number of actual failure specimens that were provided by Con Edison for examination and analysis. Less than 50% of the possible cable, joint, and termination failures (11 of 25) were actually made available and some of them contained insufficient components to determine the cause of the failure. What can be noted relative to the primary cable and joint failure specimens actually examined is as follows: None of the samples analyzed failed from conventional thermal overload. The overheating that was observed during examinations was a result of external heat from a fire or fires, and aging was not a factor in the failure of the extruded cables. It is also concluded that what is required is an improved Company wide process for identifying, collecting, and tracking failure specimens to insure that they are received by their cable lab for examination and analysis.

It was observed that none of the cable samples analyzed during this investigation showed any indication that they failed as a result of thermal overload. Cable aging did not appear to be a factor in the failure of any of the extruded (cross-linked polyethylene, XLPE, and ethylene propylene rubber, EPR) cables. One of the XLPE cables exhibited some indication that partial discharge had occurred, but there was no evidence that this contributed to the failure. Due to the very small number of cables that were available for examination broader conclusions cannot be made. However, the mere fact that thermal overload was not the primary cause of failure means that the Company should redouble its efforts to analyze the state of its cables, joints, terminations and associated equipment.

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[13] The Case numbers associated with cable failures or failed restoration efforts are provided below for reference and the full description of the Case can be found in Appendix 1A.

Recommendation:

CJ-1 For network contingencies where greater than two feeders are out of service during a heat storm, Con Edison should institute an improved process for the collection of failed cable, joint, and termination components for examination and analysis, including a detailed chain of custody. This should include both primary and secondary samples.

D. Discussion of Joint Issues

Joint technology is significantly more complex than cable technology in that joint design varies among different manufacturers: hand tapes, pre-molded joints, heat shrink, and cold shrink. Different types of joints are utilized to join various types of cable (i.e., paper to paper, and paper to solid dielectric). In addition to 'simple' joints, there are trifurcating or "Wye" joints that are more complex as they join three directions together. After a period of use, many reliability problems have been encountered by the users, resulting in individual manufacturers changing their designs over time to respond to these concerns as they arose. The reliability of the joints is influenced by both the design and the installation (i.e., workmanship) and it often takes many years for these issues to be reflected in the failure rates. Many varied and older designs remain installed at Con Edison (and at other utilities as well) so that aging is not the only factor influencing their reliability.

Stop joints, specifically paper to solid dielectric, have proven over the years to be the most difficult joints to be properly designed and installed in the field. The failure rates for these joints are influenced by both water intrusion and degradation of the paper insulation.

Dielectrophoresis, or water intrusion, is a process where moisture is drawn through most non-metallic materials in the direction of the higher electrical stress. In a typical cable, the highest electrical stress is found at the conductor or at an imperfection. In a joint, the highest electrical stress is usually found near the connector or an area created by poor workmanship. Once water enters the paper portion of the stop joint construction it induces harmful effects which result in early failure of the joint. Because of the significance of this topic, a more detailed description of dielectrophoresis is included in Appendix 4. It has been observed that the stop joints almost always fail on the paper side of the joint, due to the combined effects of water intrusion and subsequent degradation of the paper insulation.

The joints that failed during the Long Island City network event are of older designs. Manufacturers have moved away from these older designs and Con Edison has a planned program to replace the older less reliable stop joints. The major issue of concern is whether there is a better way to prioritize the replacement process, which because of the magnitude of the effort, already has taken many years and is planned to continue for many years in the future.

As a consequence of the targeted stop joint and paper cable replacement program, Con Edison obtains many samples in the course of a year. Con Edison may benefit by creating a database in which the Company performs and logs the results of paper degradation tests. Analysis of the resulting data many provide valuable insight for prioritizing the replacement of stop joints. A suggested approach for Con Edison to consider this approach can be found in Appendix 5.

It was observed that none of the failed joints analyzed during this investigation showed any indication that they failed as a result of thermal overload. Aging was not a factor in the failure of the stop joints. Degraded paper insulation was observed during the physical examination of the stop joints but there was no evidence that the degraded paper insulation within the stop joints was the cause of the failures. Stop joints that failed were of older designs, and are part of a targeted replacement program. Some of these joints were very difficult to install making workmanship a factor along with design itself. For those stop joints that failed, the failure always occurred on the paper side of the joint (not the extruded cable side). Because only a very small number of joints that failed were available for examination broader conclusions cannot be made.

Recommendations:

CJ-2 Con Edison should accelerate its programs to eliminate the PILC primary cables and the associated targeted stop joints from the electric distribution system as rapidly as reasonably practicable given cost and other factors.

CJ-3 Through the autopsy and examination of removed primary cables, joints, and terminations, the Company should immediately improve the prioritization methodology to insure that the most failure sensitive components are being removed first.

E. Secondary Cable Discussion

Although Con Edison did provide some secondary cables for examination in late November, 2006, they provided no information on the samples, and it is not known if these cables relate to any specific failures. In the absence of controlled and identified failure samples, it is impossible to comment on the possible root causes of the large number of secondary cable failures.

It should be noted that secondary cables played a significant role in the event. The first two primary cable failures were caused by a fire caused by the failure of a secondary cable that was loaded beyond its emergency rating. In fact, secondary cable failures were the cause of 16% of the primary cable system failures during this extended outage. This contribution rate is significantly higher than the normal percentage of primary failures caused by secondary failures on the Con Edison system. Importantly, the number of secondary cable failures experienced during this event exceeded normal levels by a magnitude of three. Some background on secondary cables is provided in Appendix 6.

Secondary cable fires were a major contributing factor in the escalating contingency level during the Long Island City network event. However, as of the writing of this report (January 2007) there were no secondary cables made available by Con Edison for examination. As a result, no conclusions can be drawn as to the cause of secondary cable failures and fires.

Recommendations:

CJ-4 Con Edison should reconsider incorporation of flame resistant construction concepts for insulation and jackets into secondary cables employed for future use in ducts. Because a higher temperature insulation is required for secondary cables used with present-day limiters, older materials currently in the field are not necessarily designed for such high temperatures and may not suffice. Tests might be required to qualify any new flame resistant insulations for secondary cables employed in Con Edison's ducts.

CJ-5 Con Edison should consider use of more modern secondary cable constructions on their system for new constructions; i.e., self-sealing cables. Although the latter were developed primarily for direct buried, aluminum conductor cables, Con Edison should discuss with their supplier(s) the possibility of incorporating flame-resistant additives into the flowable component of the self-sealing cable construction (while maintaining the same, presently used cable and jacket materials).

F. Discussion of Feeder Testing Methods

1. Testing at High Temperature

Testing at high temperatures has been suggested as an area for consideration to enhance reliability. While there is support that testing in the field should be done at elevated temperatures, there are several reasons why this is neither practical nor feasible:

- The primary feeders are monitored for the amount of current they carry as they exit the substation. The initial current produces a temperature approaching 90^0C in the vicinity of the substation, but the load decreases as the various transformers tap off load along the length of the feeder. The result is that the temperature is much lower as distance from the substation increases.
- The test window is generally limited to times of the year when loads are lower than peak.

- Many safety precautions are built into such a test program. Time is required to accomplish these necessary safety provisions. The time between taking a feeder out of service and the start of the voltage application is sufficient for the feeder to cool down even in those first portions of the circuit.
- The concern regarding the knowledge that cables tended to fail during the summer and fall periods led the Cable Engineering Section of the Association of Edison Illuminating Companies to evaluate high temperature testing of new cables in the 1970s. Tests were conducted by United States cable manufacturers "for engineering information only" in laboratory tests. A short sample was raised to the prescribed temperature of 90^0C by circulating current. The sample was then immediately taken to the impulse generator for the breakdown test. The results showed that the breakdown strength was a few percent higher than that of a companion sample that was tested at factory ambient temperature (i.e., 20^0C to 25^0C). These results convinced the industry to stop examining the use of high temperature tests in a laboratory setting.
- In summary, high temperature tests in the field are almost impossible to accomplish by DC or any other off-line assessment method and offer minimal, if any, practical value if conducted.

2. DC High Potential Proof Testing

Con Edison employs a DC High Potential Proof ("DC Hipot") test on a regular basis to determine whether to remove weakened cable sections and joints prior to each summer. The cables tested include PILC, XLPE or EPR and the joints are from various manufacturers. Selected primary feeders are tested annually in an attempt to discover incipient faults before failure and mitigate primary feeder outages prior to the summer. Feeders are selected for testing based on past performance history, composition in terms of component type, and relative support (i.e., importance) the feeder provides to the network. Based on these characteristics, a composite index of the likelihood of poor feeder performance and potential adverse network effects due to that performance is derived. Using this index, network feeders are prioritized.

The DC Hipot test has been and remains controversial with regard to both its true value and ultimate impact to the cable system. The concerns of this test are that it does not always identify the weakened link, and that the test itself may induce problems in un-failed cables that accelerate their future demise. These criticisms have some validity, but also must be viewed from the perspective of the Con Edison primary cable system, which has employed lead covered distribution cables.

It is notable that examination of the prior failure history for the Long Island City network feeders (2004 and 2005) did not provide guidance regarding the other feeders that eventually failed in July, 2006. This suggests that a better overall predictive method of estimating future performance of all feeders is desired.

DC Hipot testing is not a complete answer for improving reliability of a feeder system. For this reason, substitute tests are being examined by the industry as well as by Con Edison. The limitations involved in applying DC Hipot testing are further described in Appendix 7.

For the reasons noted, accelerating the present approach by applying additional DC Hipot testing is not a complete answer to improving reliability. It would be necessary to test every feeder every year, and that approach would not assure complete success either. Nevertheless, until a proven replacement test (or tests) is available, application of DC Hipot testing in a judicious manner, while incorporating awareness of the limitations in interpreting the results, is recommended.

3. Very Low Frequency Testing

The industry wide concern over the use of DC Hipot testing has spawned a cluster of new diagnostic tools that are being examined. The common test that is intended to serve as a replacement for the DC Hipot test is the Very Low Frequency AC high potential, or Hipot ("VLF") test.

One of the advantages of VLF testing is that the wave-form is alternating current. Even though one cycle requires 10 seconds to complete, there is a 'cleansing effect' in the reversal of polarity that tends to eliminate the probability of high energy electrons caught in the insulating wall (resulting in trapped charges). These trapped charges are considered to be a major factor in the additional deterioration of XLPE insulation. Another important reason to use an alternating current wave is that the cables, joints, and terminations are designed to operate in that mode: in what is known as a capacitive grading of electrical stress. Using a DC source grades the electrical stress by a resistive (not capacitive) process that does not equate to in-service grading. This is especially significant for joints and terminations and is considered to be one of the reasons that DC does not detect certain deficiencies in joints and terminations.

Application of VLF testing has been examined in recent years and remains under study by the IEEE Insulated Conductors Committee and other utilities.[14] At the present time there is no conclusive evidence that VLF testing has been successful in eliminating the latent failure problem inherent in DC testing but studies are ongoing.

As the Con Edison system has been moving towards a system with less PILC cable and associated joints, the Company has been examining the benefits of this new testing technology. Pending the results of this test program, Con Edison anticipates moving towards VLF testing in place of DC testing for feeders that predominately consist of solid dielectric cable.

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[14] Issues that are being examined relate to the level and duration of voltage stress to be applied. These subjects are all well understood and resolved for DC Hipot testing.

Recommendations:

CJ-6 Con Edison should continue to examine the use of VLF testing and its associated procedures, and develop results and conclusions.

CJ-7 VLF testing technology should be applied to 50% of the Long Island City network feeders prior to the 2007 summer load period. The feeders that are selected for VLF testing should not have DC Hipot testing applied to those tested feeders for a minimum of three years after VLF testing is performed. The remaining feeders within the Long Island City network should receive a DC Hipot prior to the 2007 summer load period. Additionally, Con Edison should plan to Hipot test the 3 worst performing Long Island City feeders each year until the Long Island City network is split into two networks.

CJ-8 Con Edison should apply VLF testing to 5% of the second tier of worst performing system feeders (those between the worst 5% and 10% of the worst performing feeders) on their system and not apply DC Hipot testing to those tested feeders for a minimum of 3 years after VLF testing is performed.

4. Predictive Testing

Another approach being pursued by the industry is the evaluation of predictive test methodologies that are designed to estimate future performance of the tested primary cable systems. (DC Hipot and VLF tests are not predictive.) Predictive tests are relatively new to the utility industry and developments are ongoing.

Predictive tests are performed either on-line or off-line. DC Hipot and VLF are off-line tests. The obvious advantage to on-line testing is that the system may remain energized and in operation while testing is performed. The off-line tests measure partial discharge signals, changes in losses (e.g., low frequency dissipation factor), or measure losses over a wide range of frequencies (dielectric spectroscopy). On-line testing measures partial discharge signals but also other signals not necessarily due to partial discharge. Other tests are in the research or development stage. Con Edison is currently examining predictive test methodologies.

It is also recognized that after Washington Heights (*See*, Section 6.0) it was recommended to Con Edison that substitutes for DC Hipot tests be studied. Con Edison apparently did so, but without success. However, since 2000, advances in technology and application have taken place, and newer technologies have also been developed. Therefore, it is recommended below that Con Edison re-examine predictive diagnostic testing.

Application of these newer technologies will require the institution of strict test controls as well as detailed monitoring of the system to validate the technology being examined. Regardless of the technology involved, a strong argument can be made that DC Hipot testing should not be utilized after a predictive test protocol is employed. The commercially available new tests should be applied in a planned manner.

Recommendation:

CJ-9 Con Edison should initiate an aggressive plan to evaluate commercially available predictive diagnostic tools to analyze the current state of installed cables, joints, terminations and associated equipment.

3.2.2 Network Transformers

A. Background

A transformer is a static device that, by electromagnetic induction, transforms electric energy from one electric circuit to another. Typically, this involves changing the voltage and current from one set of values to another set of values. In the case of the Long Island City network, this transformation is from 27 kV to 216 volts. The transformer consists of a core, which is used to contain the magnetic flux, and coils through which the power will be transformed from primary to secondary windings by magnetic induction.

There are three fundamental aspects of transformers that need to be considered in their design, application and use: mechanical, dielectric and thermal. The mechanical aspect relates to the ability of the transformer to withstand repeated situations of above normal levels of current during its useful life. A transformer experiences internal forces on the windings whenever current is flowing in the transformer. Those forces are directly proportional to the square of the current. The core-coil design and manufacture must provide for a core-coil assembly that will remain tight and be able to withstand the forces generated by short circuit currents or other high levels of current, such as magnetizing inrush current to the primary winding upon energization.

The dielectric aspect of transformers relates to the ability of the transformer to withstand the steady state and transient voltages to which it can and will be exposed during the course of its operational life. The insulation system that is used to contain these stresses is typically comprised of cellulosic based paper and board, oil and enamel or epoxy resins. These materials have been used effectively for decades and continue to be used today. The oil acts both as part of the insulation system and as the agent that absorbs heat generated as a result of the losses in the core and coils and carries it to the cooling elements on the transformer tank. Moisture, air and elevated temperatures, individually or collectively, tend to degrade the dielectric capability of the oil and the insulation system of the transformer.

The thermal aspect relates to the ability of the transformer to operate within the design parameters without exceeding temperature levels described in ANSI/IEEE standards or defined by customers, if different from these standards. This limitation is intended to provide for a normal life span of the transformer. The great majority of the insulation components in the transformer are from organic materials. They are subject to accelerated deterioration from exposure to elevated temperatures for extended durations. In the case of insulating components of paper or board, aging will result in loosened coils due to material shrinkage and reduced dielectric capability, both of which can result in shortened equipment life.

Due to the nature of the materials used in their insulation systems, transformers age as a result of normal use. The rate at which they age or use up a part of their normal service life is a function of the temperature to which the insulation system is exposed during operation and the time duration of that exposure. Thus, higher temperatures and longer durations of exposure to higher temperatures result in greater loss of life than do lower temperatures for shorter durations. The accumulated loss of life for a typical transformer is based on the sum of each of the elements of temperature and coincident duration of exposure at that temperature. This provides a relative value as to the degradation that the insulation system has accumulated over its service life.

As noted, loss of life is a function of both time and temperature. A transformer is designed to provide a normal life when it is operated at a hottest spot temperature of 110^0C. The transformers life is shortened when it is operated at hottest spot temperatures above 110^0C and lengthened when it is operated at hottest spot temperatures below 110^0C. An increase in hottest spot temperature of only 6-8^0C on a continuous basis will reduce the life of the transformer's insulation system by half. As an example, a unit operating at a hottest spot temperature of 150^0C for 4.4 hours will experience a loss of life equivalent to that of a unit operating at a hottest spot temperature of 160^0C for 1.96 hours. If these events were repeated, the loss of life would be additive. In these discussions and all others related to loss of life considerations of transformer insulation systems, hottest spot temperature, not loading or percent loading of the transformer, and the duration of that temperature is the key determinant as to loss of life. Analysis by top oil temperature alone is generally inappropriate and not recommended. This is because the time constant of the winding is sufficiently shorter than the time constant of the fluid such that the winding will reach its steady state hottest spot gradient over top oil rise well before the oil reaches its ultimate temperature. It is recognized that utilities sometimes intentionally exceed the temperature design specification, acknowledging that it may impact the unit's life.

B. Transformer Analysis

During the course of the Long Island City network event, thirteen transformers were reported to have failed. All of these transformers were examined at Con Edison's Astoria facility. After viewing the teardown of these units and examination of other data relating to the history and service of these units up until the time of their failure, it was apparent that the major cause of the transformer failures was overheating. This overheating was the result of a combination of high loadings beyond normal levels and high ambient temperatures that resulted in high hottest spot and top oil operating temperatures.

The City's independent investigation supports Con Edison and its consultant's findings on the failure of 8 of the 13 units. As described in the Company's October 12th Report, these units failed for the following reasons:

Serial Number	Cause of Failure
F525458 F529863 M174722 F531695 H260569 M174194	Overloads carried by these six transformers resulted in overheating and deterioration of an already aged insulation system. This overheating and deterioration of the insulation system eventually resulted in unit mechanical or dielectric failure or possibly in gas evolution and bubble formation that precipitated dielectric failure. There is one aspect of the failure of F529863 that is not addressed in the October 12th Report. That is the possibility of low operating oil level that would have exacerbated the overheating and insulation system deterioration stemming from the overloading.
Q115445	HV bushing external failure – core/coil assembly tested and found acceptable.
D514708	Tank corrosion resulted in an oil leak that resulted in: 1.) elevated temperatures due to a lack of cooling fluid circulation in the cooler; and 2.) probable dielectric failure when live parts were exposed by the dropping oil level.

Based on data collected during the Long Island City investigation and in the individual failure reports for each of these units, it is likely that the first six units identified above were subjected to overloading and failed due to the cumulative effect of thermal and mechanical stresses over their lifetime and the relatively high short-term loading to which they were exposed during the outage event. This relatively high level of short term loading would result in further weakening of the dielectric and mechanical capabilities of these units. It is also apparent that the failure mode of the other two units cited above has been properly identified.

The failure of the other remaining five transformers is included in Appendix 8. Recommendations drawn from these five transformers are listed below.

Recommendation:

TR-1 It is recommended that Con Edison conduct a study to determine the internal static pressure that would be developed under the loading conditions to which some transformers (S/N F124281 and S/N F124624) were subjected. If the results of this study demonstrate that pressures exceed the design limits of these transformers, steps should be taken to restrict loading on transformers of similar design or to modify the design to tolerate the expected level of internally developed pressure without tank weld rupture.

The recommended study would be an extension of that already performed by Con Edison's consultants addressing 3 specific areas: (i) gas space based on manufacturers standard or oil level as indicated by the last CINDE report; (ii) average oil temperature and not top oil temperature; and (iii) gas absorption into the oil as a mitigating factor in reducing the pressure in the gas space. It could also be further validated by shop testing of similar units if this were deemed appropriate.

Recommendation:

TR-2 One transformer (S/N M105273) reportedly failed due to a weld leak resulting from stress corrosion. The presumed source of the stress corrosion was exposure to a high concentration of chlorides. It is recommended that a study be made to determine the likelihood of this problem occurring on other units of similar design. This determination should then be used to modify Con Edison specifications of its inspections and maintenance of network type distribution equipment to ensure that this possible failure mechanism is being examined and addressed during equipment inspections. Additionally, discussions may need to be held with transformer manufacturers to address design criteria that might preclude this situation from arising on new designs.

Other Transformer Recommendations:

TR-3 During the course of the Long Island City network event, many network transformers were exposed to high ambient temperatures and loadings well in excess of nameplate ratings for significant time intervals. Con Edison should implement, prior to the 2007 summer load period, an inspection and test program for all network transformers in the Long Island City network that were overloaded during the event. Priority should be given to those units that experienced the most severe loss of life as determined by the methodology presented in IEEE standard C57.12.91-1995, IEEE Guide for Loading Mineral-Oil-Immersed Transformers. Inspection should be performed in accordance with Con Edison's specifications and these units should be subjected to a dissolved gas-in-oil analysis. In order to ascertain the extent of loss of life sustained by the transformer, it is appropriate to also consider testing each transformer that experienced significant overloads for furanic compounds.

TR-4 Con Edison has indicated that its policy is to impulse test (BIL test) reconditioned transformers before returning them to service. As an added aspect of this test, it is recommended that Con Edison consider conducting dielectric testing while the transformer is at elevated temperatures. This elevated temperature can be achieved within the transformer through simple over excitation of the unit or by subjecting the unit to a modified temperature test. This will elevate the transformer temperature and provide a test environment closer to the field environment in which it will be operating. If over excitation is the method used to heat up the transformer, it might be beneficial to include dissolved gas in oil analysis testing after the over excitation analysis is complete.

A review of multiple Con Edison specifications indicates that the maintenance program the Company uses is primarily driven by events affecting the transformers, as opposed to any condition-based appraisal or evaluation of the transformer's operating condition. By event-based maintenance, it is meant that time, exceeding a set limit or results of inspections, determines what action is to be taken on the unit. By condition-based maintenance, it is meant that a transformer's current status is different from that expected based on ambient and loading and also that accumulated service plays a key role in the determination of what maintenance actions are to be taken.

Recommendation:

TR-5 It is recommended that Con Edison evaluate the use of condition-based maintenance, particularly where the service life and service conditions of transformers are given a more prominent role in the determination as to when maintenance is required. If transformer tank pressure, top oil temperature, oil level and load are parameters that are included in the RMS system, the Company could then use algorithms to determine if the oil temperature is consistent with the load, if the tank pressure is consistent with the top oil temperature, if the oil level is consistent with the oil temperature, or if excessive loss of life is being experienced. The Company could also determine the accumulation of loss of life data for each transformer, which would provide a relative comparison between units and assist in identifying units that should be subjected to testing. For example, a determination could be made that dissolved gas-in-oil testing will be conducted whenever loss of life in a single incident exceeds a certain percentage, or whenever the accumulated loss of life reaches a predefined percentage.

It should also be noted that all of the analysis set forth in TR-5 could be accomplished without an on site inspection. Although this would not eliminate the need for on site inspections, but it could seemingly reduce the frequency of them. In addition, using this analysis immediate notification of an unfavorable condition is made known.

Recommendation:

TR-6 A review of several Con Edison Specifications reveals that there is a relatively complex method of characterizing the capability of a transformer under various operating conditions. In spite of this relatively complex system, there is no apparent consideration given to loss of life per event or cumulative aging of the transformer insulation. The major determinant of transformer life expectancy is the combined effect of the hottest spot temperature in the transformer insulation system and the duration of that exposure. Loss of life is cumulative and non-reversible. Thus, it is recommended that Con Edison determine the cumulative loss of life as a result of normal or emergency operation.

Con Edison has the potential capability through its RMS system to capture the necessary data and to calculate the loss of life for periods in the life of the transformer. Only load and certain transformer design parameters are necessary in order to calculate the hottest spot gradient over top oil temperature. The top oil temperature would then be measured and reported through the RMS system. This could be done routinely in time elements appropriate to the loading curve. This would then form another reference point that could be used to determine inspection and testing routines and transformer changeout procedures. An alternative to measurement of the top oil temperature would be to measure the ambient temperature in the vault and calculate the top oil temperature based on ambient, loading and transformer design parameters. The ambient temperature could then be used to help assess thermal stress on cables and other equipment in the structure.

Recommendations:

TR-7 Transformer manufacturers today have the computer design capability to maximize KVA of transformation while respecting physical limitations on unit size. Thus, one could possibly design a 550 or 600 KVA unit that could physically fit into the vault that is currently occupied by a 500 KVA rated transformer. It is recommended that this issue be reviewed with manufacturers to determine whether or not and to what degree this could be accomplished.

TR-8 Con Edison's specifications state that the top oil temperature is the criteria that is to be used in determining whether supplemental cooling of the unit is required. The use of top oil temperature to solely determine whether or not to use supplemental cooling is not recommended. The time constant for the transformer oil is much greater than the time constant of the winding. Therefore, the winding hottest spot temperature could be at severely elevated levels while the oil has yet to reach its ultimate value as a result of step increases in load. Step increases would typically be seen as a result of loss of feeders.[15] Thus, it is recommended that Con Edison consider using the transformer's hottest spot temperature to determine if supplemental transformer cooling is required.

The October 12th Report indicated that there were situations during the Long Island City network event where there was insufficient backfeed current to operate the network protector fuses. Two of these the seven alive on backfeed (ABF) situations that were identified resulted in backfeed currents that exceeded the nominal rating of the transformer by 234% and 20%, respectively. The former case, if sustained for any significant period of time, would clearly result in accelerated loss of life. Thus, ABF situations can also result in accelerated aging of transformer insulation systems and shortened transformer lifetimes.

Recommendation:

TR-9 It is recommended that all ABF events be reviewed to determine the amount of backfeed and the duration of that backfeed and that, based on that review, each affected transformer's condition be noted with respect to any accelerated loss of life.

The October 12th Report has identified an operational issue related to transformer inrush magnetizing current and its effect on the relaying of the feeder breakers.[16] The proposed solution is, on an interim basis, to desensitize the relays controlling the operation of the feeder breakers. The longer-term solution is to utilize microprocessor based relays that have the capability to discriminate between magnetizing and fault currents.

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[15] This issue is addressed in detail in IEEE C57.12.91-1995, p 22.

[16] October 12th Report, p. 6-2, Finding 2.

Although this may be a reasonable approach to address the undesirable situation caused by the false tripping of feeder breakers, it needs to be recognized that this may result in a greater percentage of transformer tank failures than have been experienced to date. Desensitizing the relay setting will result in more energy being released inside the transformer tank during an internal fault and will likely result in a higher percentage of tank ruptures and their associated fires than has been seen to date. Thus, it is recommended that every effort be made to minimize the operational, safety and environmental risks by desensitizing the relays only where a compelling need has been identified and rapidly providing the new relays where it is deemed necessary.

Additionally, the fact that over half of these transformers suffered loss of tank integrity suggests mechanisms to reduce the likelihood of tank mechanical failure and associated collateral damage from fires as a result of internal electrical failures should be identified and evaluated.

Recommendation:

TR-10 It is recommended that an analysis of the relay targets associated with these transformer failures be made to determine if relay setting changes would have the potential of reducing the likelihood of tank rupture by reducing the I^2t energy released in the transformer tank during an internal fault.

In reviewing inspection reports (CINDE records) on the 13 transformers that failed, it was found that transformer reporting was inconsistent and sometimes incomplete. As an example, the following data was obtained during discovery.[17]

S/N F525458

M/Y	Reason	Vault Condition	Corrosion Present	Fluid Level – Found/Left	Fluid Sample Type/Reason	Pres. Test Found/Left	Oil Temp: Max/Present
3/03	B ticket – grating repair			25/25 Gauge OK			40/80 Gauge OK (max and present reversed?)
5/02	Open NWP LVT			25/25 Gauge OK		Yes, 1/1	65/40 Gauge OK
7/00	Open NWP			25/25 Gauge OK			130/40 Gauge OK (1)

Note (1): With a max temp of 130^0C, an oil sample should have been taken for a dissolved gas-in-oil analysis and possible unit changeout. It appears that an oil sample was not taken for this unit.

[17] *See*, Company Responses to City Interrogatories 48 and 59 (dated: September 21 and 18, 2006, respectively).

S/N D514708

M/Y	Reason	Vault Condition	Corrosion Present	Fluid Level – Found/Left	Fluid Sample Type/Reason	Pres. Test Found/Left	Oil Temp: Max/Present
10/02	RMS	OK	Y – top, moderate	Below min – Gauge defective	Y Dielectric, PCB - Routine	Y 2/2	90/45 Gauge OK
10/02	> 30 Yr	Defective – Flush Reqd	Y – top, heavy	51/51 Gauge OK	Y Dielectric, PCB - Routine	Y 1/1	80/40 Gauge OK

Note that this unit failed as a result of low oil level resulting from a tank leak caused by corrosion. No inspection was conducted on this unit since 2002.

S/N H260569:

M/Y	Reason	Vault Condition	Corrosion Present	Fluid Level – Found/Left	Fluid Sample Type/Reason	Pres. Test Found/Left	Oil Temp: Max/Present
3/04	Open NWP, Follow up			25/25 Gauge OK	Y Dielectric, PCB - Routine		50/25 Gauge OK
8/00	> 30 Yr	OK	N	50/50 Gauge OK	Y Dielectric - Routine	Y 3/3	65/50 Gauge OK
8/00	/D.O./#9			50/50 Gauge OK			70/45 Gauge OK
3/00	RMS, Make Auto			50/50 Gauge OK			80/45 Gauge OK

Recommendations:

TR-11 The historic database of transformers is an important tracking tool and additional emphasis should be placed on full completion of the inspection report. Thus, it is recommended that completed transformer reports should be subjected to a random sample audit to ensure that the database is relatively complete and up to date.

TR-12 It is recommended that prior to flooding vaults or spraying transformers as a means or reducing their oil temperatures, the units should be verified as leak free. This could be done via the new RMS capability, which would include tank pressure. Lacking that, one should consider checking the tank pressure to verify tank integrity prior to any such action. Failure to identify such a leak could result in loss of additional transformers and associated feeders.

TR-13 When testing or maintenance observations reveals that any transformer that has experienced significant accelerated loss of life or has reached a significant accumulated loss of life, it is recommended that gas in oil analysis also be performed on any such transformer.

Table 3.2.2-1
Transformer P Proba ble Cause Analysis

Ser #	Fdr #	Unit Age (Comp Rpt)	Annual Peak Load % of rated (PSC21f)	2nd contingency rating - % of rated (PSC21g)	Event Actual % of rated load (PSC168)	RMS data scan Hot Spot/Top Oil temp (City61)	Event % of rated load (City33)	Top Oil Gauge Maximum Reading (City14)	Con Ed % of unit load (Comp. Rpt) (1)	Con Ed Hot Spot (Comp Rpt) (1)	Con Ed Top Oil (Comp Rpt) (1)	Gas Analysis (City11)	Failure Mechanism per Con Ed Comprehensive Report (Comp Rpt)	Tank Rupture
F525458	1Q01	42	177	150	162-182	ND	ND	> 160	173	164	141	Hi CO/CO2	Overheating	No
F529863	1Q20	41	190	130	156	149/129	177	144	170	160	140	open tank	Overheating	No
M174194	1Q18	18	160	170	ND	114/108	160	damaged	155	150	128	open tank	Overheating	Yes
M174722	1Q18	18	212	149	174-189	159/132	210	155	200	200	175	Hi CO/CO2	Overheating	No
M133783	1Q12	21	ND	170	185	ND	ND	damaged	ND	ND	ND	open tank	Overheating	Yes/Fire
F124281	1Q15	43	143	140	158	99/99	ND	140	137	122	112	open tank	Weld failure - Oil loss due to overpressurization	Yes
F124624	1Q16	42	ND	151	ND	ND	ND	damaged	ND	ND	ND	high water - analysis not possible	Weld failure - Oil loss due to overpressurization	Yes
Q115445	1Q16	13	50	170	ND	ND	ND	damaged	ND	ND	ND	open tank	HV bushing failure	No
D514708	1Q17	45	ND	140	ND	ND	ND	103	ND	ND	ND	open tank	Corrosion - oil loss	No
H309368	1Q17	34	162	169	172	ND	175	missing	152?	ND	ND	open tank	Overheating	Yes
F531695	1Q17	41	ND	141	ND	216/197	ND	> 160	185	160	137	no data	Overheating	Yes/Fire
H260569	1Q19	37	235	140	223	184/154	235	62	199	214	184	open tank	Overheating	Yes
M105273	1Q19	29	217	162	157-192	49/49	ND	115	164	155	135	open tank	Corrosion - oil loss - leak	Yes

(1) - Data is extracted from RT3 graphs except for H309368 which is taken from the text.

3.2.3 <u>Network Protectors</u>

A. Introduction

The development of the automatic network protector was instrumental in the use and growth of the low voltage distributed network, or what is commonly known as the secondary network. The network protector is an air circuit breaker, similar to the breakers in residential homes except that they are much larger. Where a residential circuit breaker will generally have a rating of 15 to 20 Amperes, network protector ratings are in the range of 2250 to 4500 Amperes. Residential circuit breakers typically have an interrupting rating (under which they can open automatically) of 10,000 Amperes. The interrupting ratings of network protectors range from 30,000 to 60,000 Amperes. Network protectors are applied at voltages of 216Y/125 and 470Y/277 volts. The network protector contains an operating mechanism (mechanical), control wiring, and relays (electrical sensors) specifically designed for network applications.

On the Con Edison system, network protectors are installed within buildings or underground (within sidewalk vaults and transformer manholes) and are frequently housed inside of watertight and submersible enclosures. The underground environment in which these units are housed is very harsh. In general, the network protector is installed in the same underground structure as the network transformer. For the 470Y/277 volt applications, separate structures located inside of buildings are used. In the electrical system, the network protector forms the bridge between the network transformer and the low voltage secondary cables. When the network protector is closed, the power system can supply energy from the transformer into the secondary network and subsequently to the customers.

Network protectors are designed to allow a feeder to be out of service and to have other feeders supply the network. Opening the circuit breaker at the substation will cause all of the network protectors on a feeder to automatically open due to a reversal of power through the network protector. This allows work on primary feeders to proceed while power is supplied to the network's secondary system through other primary feeders. This automatic operation eliminates the need to visit each location on the feeder to open the network protectors and disconnect the power supply from the primary feeders (through the transformers) to the secondary network.

When the primary feeder is reenergized (by closing the circuit breaker at the substation) after repair or other planned work, and conditions are such that power will flow from the transformer to the network (as sensed by the network protector relays), all the network protectors on the subject feeder will automatically close. For short circuits (faults) on the primary feeders (the cables that supply the network transformer) the opening of the circuit breaker at the substation will similarly cause all of the network protectors supplied by that feeder (through the transformer) to automatically open due to a reversal of power through the network protector. Fuses that are installed in series with the network protectors (in the same enclosure) provide backup protection in the event that the network protector fails to operate either electrically or mechanically. The ratings of these fuses are generally larger than the network protector or network transformer so that they will not operate for short-term overloads.

B. Inspections of Network Protectors

During the events of July, 2006, within the Long Island City network, thirteen network transformers failed electrically. Each of the network protectors associated with the failed transformers were inspected to determine if they had any defects that could have contributed to the event. Inspections of the thirteen network protectors and one additional network protector requested by Staff were witnessed by an expert retained by the City on September 5th and 6th, 2006.

Independent analysis by the City of the removed network protectors indicated that none of these units contributed to or significantly prolonged the Long Island City network event. However, several conditions observed during the inspections raised concerns and resulted in recommendations that, if implemented, should improve the operation of the Long Island City network and the Con Edison system as a whole.

During the inspections several of the network protectors were found to have operating problems. Most of these problems appear to have been caused by the event and/or the associated transformer failure. However, some of the defects in the network protectors are significant enough to warrant further investigation and review of the operation and maintenance practices presently employed by Con Edison.

Specifically, one network protector did not operate at all, either electrically or mechanically, and based upon inspection this condition must have existed prior to the event. This defect would most likely have prevented the network protector from opening, thus causing its associated feeder to remain energized from the secondary side when the feeder came out of service. This condition is referred to as Alive on Backfeed (“ABF”). This would have caused a delay in processing the feeder in order to begin the repair. Another network protector had a misadjusted motor control relay and loose or missing motor bolts. These problems also prevented that network protector from closing.

One network protector had a slightly sticking operating mechanism. It is believed that this defect was caused during storage of the unit after the event as slight lubrication corrected the problem. If this condition existed in the field the network protector would not have opened and would have caused an ABF condition on the feeder. Five network protectors had damaged relays, two of them were electromechanical relays and three were microprocessor relays. These relays control the operation of the network protector. The relays were replaced during the inspections and the network protectors operated properly. Internal inspection of these relays indicated that one electromechanical relay had severely pitted contacts and the network protector would not open and the second electromechanical relay had a damaged operating coil and the protector would not close. The three microprocessor relays all had damaged power supplies which prevented them from operating. Transients generated as a result of faults during the Long Island City event most likely caused these defects. The network protectors may have operated correctly before their relays failed. It is impossible to know from the analysis conducted on these network protectors whether or not they operated properly before the start of the Long Island City event.

Since the relays were non-operational during the inspections no conclusion can be drawn as to whether or not the network protectors may have operated correctly before their relays failed and before the event started. One network protector stopped working in the middle of an inspection mid test due to a mechanical binding of the operating mechanism. A mounting nut from the nameplate was found lodged in the mechanism. Had this occurred while the network protector was in service it would have caused the network protector to remain closed.

Given observations made during the network protector inspections, the following recommendations are made:

Recommendations:

NWP-1 Con Edison should complete a testing program for each feeder within the Long Island City network prior to the 2007 summer load period that will exercise all network protector relays (including all other electrical and mechanical components) and identify non-responsive units for correction and re-test to insure improvement in the performance of these network feeders with regard to them staying improperly Alive on Back Feed when removed from service due to a fault or by operator action. In addition, Con Edison should implement a system-wide testing program to insure the operation of each feeder at least once biannually to exercise all network protector relays as well as other electrical and mechanical components and identify non- responsive units for correction and re-test.

NWP-2 During the analysis of the Long Island City power outages, Con Edison hired a consultant to perform an Electro Magnetic Transient Pulse ("EMTP") analysis to measure transients for the Long Island City event. Because it is suspected that several network protector microprocessor relays failed during the event as a result of transients, Con Edison should ensure that this study includes transients on the secondary system and share the results of the EMTP study with the network protector microprocessor relay manufacturers. Con Edison should work with the microprocessor relay manufacturers to conduct a design review of the relay and implement any design changes that may be required as a result of the study's findings.

NWP-3 Several times during the interrogatory process, requests were made for maintenance records pertaining to network protectors. Many of the records could not be obtained and those that were provided often lacked essential information.

Con Edison should develop a more detailed reporting form for their network protector and transformer inspections. The form that is completed by the field personnel should be entered into a field computer and then downloaded into a database that has the ability to be accessed to produce individual equipment reports and summary reports. From this data base, equipment failure trends could be discerned or developed.

In addition, Con Edison does not presently record the position of the network protector on failed transformers. This lack of information could lead to difficulty in performing analysis and trending of network protector malfunctions. Con Edison should modify its protocol to include the "as found" position on all network protectors associated with failed transformers.

NWP-4 Several times during the investigation of the Long Island City event, requests were made to provide loading history of network protectors and transformers. This data was in many cases unavailable due to problems with the Remote Monitoring System, which supplies the data from the field to the software system (the RMS had a 79.5% reporting rate at the beginning of the event, well below the designated level). The unavailability of this data makes analysis difficult after the incident, it also deprives operators of a valuable analysis tool to be used during the event. Accordingly:

1. Con Edison should complete an appropriate inspection and maintenance program to improve the reporting rate of its Remote Monitoring System within the Long Island City network up to, at a minimum, its designated 95% reporting level before the beginning of the 2007 summer load period.

2. Con Edison should engage in a program to improve the reporting rate of its Remote Monitoring System, systemwide, up to, at a minimum, its designated 95% reporting level within a reasonable amount of time.

    a. Additionally, the Company should expand the number of network transmitters equipped with voltage reporting capability so that an improved voltage picture is available to the control center operators. Moreover, the Company should examine accelerating the planned installation of a remote monitoring capability for high-tension customer installations.

C. Compromised Operation of Network Protectors During the Event

During the Long Island City network event, secondary cables were damaged in conjunction with extremely high primary feeder contingency levels well beyond what the network was designed to sustain. These two conditions created operating conditions that may have compromised the proper operation of network protectors throughout the network.

The occurrence of low voltage on the network may have seriously compromised the ability of these devices to operate properly. Network protector relays require sufficient voltage to operate and command the network protector to open and clear backfeed to an out of service primary feeder. As reported by Con Edison, there are three types of network protector relays currently in service on the Con Edison system.[18] The first is microprocessor relays, the most modern, which require a minimum of 13 volts on any one phase to operate. The second is solid-state relays which require at least 50 volts on B-phase and the third is the older electro-mechanical relays which require at least 60 volts on all three phases to operate. During the investigation of this event, Con Edison stated that the RMS telemetry showed a voltage reading as low as 26 volts. Voltages this low would have prevented solid-state and electro-mechanical relays from properly carrying out their functions. This would cause primary feeders to remain ABF and delay the processing and repair work until the backfeed condition could be cleared. Not all RMS transmitters presently have the ability to provide voltage readings. The present design of RMS does not include voltage readings on backfeeding network protectors. However, it is sometimes possible to get this information from readings on an adjacent feeder.

Con Edison's specification requires voltage between 60 volts and 13 volts in a live network before the microprocessor network protector relays would issue a signal for the network protector to close. Voltage in this range was reported in the Long Island City network and may have compromised operation of the microprocessor relays. If the voltage were not sufficient, Con Edison would either have to send crews to network protector locations supplied by live feeders to manually close them or use some other means to increase the network voltage to allow the network protectors to close automatically. This additional requirement to close network protectors would have delayed restoration of normal voltage in the low voltage areas of the Long Island City network.

The occurrence of insufficient backfeed current on the network presented significant obstacles to the proper operation of the system. In several instances Con Edison applied 3-phase grounds at the substation in an attempt to clear a backfeed condition by blowing the network protector fuses on the closed network protector(s). This is a common practice and works well during normal operations when the secondary grid is intact. However, the secondary system must be capable of providing sufficient current to blow the fuses and be properly designed to coordinate these fuses with down stream protection. With high primary

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[18] October 12th Report, p. 5-46.

feeder contingencies and damage to the secondary network, for some backfeeding network protectors, there would have been insufficient backfeed current available to blow the network protector fuses. With the ground applied there would be high levels of backfeed current present, however, because of the high level of primary contingencies and damage to the secondary network it could be insufficient to blow the network protector fuses. While this current is lower than the current required to blow the network protector fuses, it could be sufficient to overload the backfeeding network protector and transformer. This situation could have caused additional damage to the network at a time when it could least be tolerated.

Con Edison discussed these considerations in their post-event analysis of the event in their October 12th Report, but either did not recognize or chose not to act upon the information during the event. This certainly resulted in delays in processing, repairing and restoring some feeders to service.

Recommendations:

NWP-5 The Company should continue to improve the RMS system with increased consideration to the following:

- Aggressively pursue technology enhancements that will allow for an increased success rate of network protector information being available for stuck network protectors.

- Ensure that all new RMS transmitters have the capability to provide voltage readings (*see*, NWP 4). This becomes increasingly valuable as a tool to clear ABF conditions as information regarding stuck network protectors becomes more available.

- Con Edison should provide a link from NetRMS to the network protector relay information contained within the equipment database so that operators can have a quick way to determine what type of relay is installed at any location of interest.

NWP-6 In order to provide voltage information to further assess backfeeding network protectors, the Company should consider a system to obtain voltage readings in the network at points other than the transformers (at service boxes, lamp posts, customer premises, etc.). An automatic system with data being fed to a visualization tool would be best. However, in the interim, a program to obtain manual readings during events would provide information on the potential for network protectors to remain closed and thus become a source of backfeed. Such a system would also provide valuable information on the status of the network and further insight on the impact of the event to customers.

NWP-7 Con Edison should modify its procedures for operating the distribution system under contingencies to provide guidance for operator actions under severe contingency levels with potential low voltage conditions within the network of concern. This should include guidance on the application of three phase grounds to clear backfeeding network protectors.

NWP-8 Con Edison should reevaluate the requirement that network protector relays prevent the network protector from closing if the network voltage is between 60 volts and 13 volts. They should also modify their procedures for operating the distribution system under contingencies to ensure that operating personnel are aware of this requirement.

3.3 Response to Network Events

3.3.1 Con Edison Communications and Outreach Efforts

A. Introduction

The Company has developed a complex organizational structure to communicate with regulators, government offices, elected officials, the media, customers and the public. This Section evaluates how the Company performed during the Long Island City network event. The evaluation is based on reviews of Con Edison's various reports on the Long Island City network event, on the Company's responses to interrogatories and statements its employees made at depositions and interviews, on media reports, and on testimony and statements made by government and elected officials and customers at public hearings.

As an initial matter, until the morning of July 21, 2006, Con Edison was grossly underestimating the extent of customer outages in the Long Island City network. Until that point, the Company provided inaccurate information to all those impacted by the power outages, as well as affected regulators and responding agencies. Con Edison's failure to use its communications organization as a two way street contributed, in part, to the Company's underestimation of the customer count. Communication failures that contributed to the underestimation of the outage, as well as recommended remedies, are discussed in this Section. Other causes of the underestimation are discussed in the next Section, 3.3.2.

B. Con Edison's Communications Organizations

Con Edison's Public Affairs organization comprises several different departments: Media Relations; Government Relations; Local Public Affairs; Employee Communications; Creative Services; Strategic Partnerships; and Economic Development. Other permanent organizations involved in communications include: the Central Information Group; Marketing and Sales; Energy Services; Environment, Health and Safety; Customer Operations including Call Centers; Customer Outreach and Emergency Management.

In addition, the Company has created command structures to coordinate the Company's efforts, including those of the communication organizations listed above, when dealing with system emergencies. The underlying command structure for emergencies is the Incident Command System ("ICS"). The ICS is a scalable structure designed to respond to system emergencies. The ICS has been used by Con Edison since the early 1990's. The roles and responsibilities within the ICS are governed by procedures developed in advance of emergencies. There are regular drills of the ICS that include liaisons with governmental bodies, such as the New York City Office of Emergency Management, the NYPD and the FDNY.

For the Long Island City network event, the Company activated its Incident Command System on Sunday, July 16, 2006, within the Distribution Engineering Command Post ("DECP"), and later, on Thursday, July 20, 2006, as the magnitude of the situation was finally recognized, within its Corporate Emergency Response Center ("CERC").

C. Communications Assessment

A communications chronology, sorted by the organization responsible for that communication, that took place between Monday, July 17, 2006 and Wednesday, July 26, 2006 is provided in Appendix A of the Company's October 12th Report.

As the communication chronology illustrates, each part of the communication organization had specific roles to perform. Large customers were called directly by Marketing and Sales, the Media was issued regular updates by Media Relations, Energy Services contacted customers enrolled in the various Demand Side Management programs, customers on Life Support Equipment or registered as having a medical hardship were either contacted directly, or if that failed, the customers' information was provided to the NYPD. Additionally, there was frequent communication to the New York State Department of Public Service, NYCOEM, NYPD and the FDNY and these governmental entities sent representatives to Con Edison's command centers during much of the event. Call centers were updating the automated messages on their phone systems to reflect current information and Public Affairs updated elected officials.

D. Con Edison's Communications Recommendations

Con Edison's October 12th Report contains a number of recommendations for improvements in its communications. These recommendations are restated below and are endorsed here:

<u>Recommendations From the Con Edison Report:</u>

- Contact information for customers who participated in the EDRP and DLRP should be kept up-to-date.

- NYCOEM and Con Edison should review the numerous information paths used and consider ways to mitigate duplicative communications. NYCOEM should be better informed on why feeder restoration times are subject to change and how preemptive voltage reduction can be utilized as a load management tool.

- CERC activities can be improved with several changes.

  "CERCdocs," the documentation system for full-scale incidents, was an effective tool for managing data from the event and was used by the large majority of participants. However, more training on the use of this application is needed to produce uniform documents from one ICS position to another.

  Company departments thought not to be required were in fact needed during the incident as these organizations provided other types of support outside of their normal function. The Long Island City network event raised awareness about the need to establish other positions within the Company to address specific needs associated with this type of an event. For example, ice distribution, claims processing, and customer counts.

  Mutual-aid support required substantial effort and should be included as a unit under the Planning Section. As the incident entered its second week, support staff was brought in that may not have had ICS training. This should be corrected in anticipation of the need to bring in additional resources during future events.

  An Incident Management Assist Team should be in place to aid CERC staff in the use of their ICS-based position guides. Better incident situation tools (i.e., white boards, projection screens, computer screen messages, etc.) would facilitate dissemination of pertinent information to all full-scale incident staff.

- The customer call process should be revised to make it easier to report outages, especially during significant events, while improving the quality of the information reported. As an example, using voice recognition technology; modifying messages and customer service representative scripts to simplify the reporting process while asking more targeted questions; adding of phone lines to increase telephone capacity, and expanding the capacity of the self-service option for reporting emergencies all should be examined. Outreach should increase efforts to educate customers on the importance of reporting emergencies and service problems.

E. Additional City Recommendations For Con Edison Communications

Table 3.3.1-1 below compares, for the period July 17-21, 2006, the after-the-fact Company estimates of inferred customer outages, as taken from the Company's October 12th Report,[19] with the number of outages that Con Edison actually reported to the media prior to the evening news each day, as taken from Appendix A of the Company's October 12th Report.

[19] October 12th Report, p.4-56, Figure 4-10.

Date	After-the-Fact Estimates	Contemporaneously Released Data
July 17, 2006	4,400	500
July 18, 2006	8,300	1,700
July 19, 2006	23,000	1,800
July 20, 2006	21,600	1,920
July 21, 2006	22,600	25,000

Table 3.3.1-1 – Con Edison's After-the-Fact and Contemporaneous Customer Outage Estimates from July 17-21, 2006

Con Edison could have used its formidable communications network to better collect information from available sources (e.g., Company employees, third parties, City agencies), in order to correctly estimate the number of customers without service. Improving the customer call process as described in the Con Edison recommendations would significantly address one part of the problem. Nevertheless, there is compelling evidence that during this event, Con Edison missed multiple other opportunities to investigate or revise the customer outage estimate.

For example, the NYPD representative at DECP at 2110 hours on July 19, 2006, and the NYCOEM at its emergency operations center, reported to Con Edison that there were large areas without power in the Long Island City network and provided Con Edison with a list showing the areas affected. The Company responded to this information with an e-mail at 2312 hours on July 19th saying that the Company was working on the customer outage count. Regardless of this information, the customer survey that ultimately yielded realistic outage results was not begun for more than 24 hours.

Moreover, the Company had workers in the field could, and perhaps should, have been asked to report on the conditions they observed throughout the network. These employee observations and opinions were not sought, and, based on a review of the Company's depositions, when given, at least once they were not followed up.

There are several ways of remedying the situation, for example, one of Con Edison's Public Affairs staff could be designated as being responsible for receiving and responding to observations from responsible outsiders as well as from Con Edison employees. However, there may be other approaches as well. Thus, the following recommendation allows the Company the flexibility to address this problem as it considers most appropriate.

Recommendation:

C-1 Con Edison should modify its emergency procedures to establish a clearly defined protocol to incorporate observations made by responsible outsiders, as well as its own employees, regarding conditions in the field.

Another weakness in the Company's communication activities was its estimation of restoration times that were made available to the public. Clearly, for the first few days, when the Company was underestimating the extent of the outages, and still struggling to restore the primary feeders, any information it would have been releasing on estimated service restoration times would have proven highly optimistic.

Further, even when the extent of the outage is known, it is far more problematic to predict service restoration in a network than in an overhead radial system. In a network, finding the location of the failure is just the first of many challenges facing the Company. In an overhead radial system, the location of the failure is usually apparent and service restoration would be a minor task.

Nevertheless, customers should be provided information on when the Company expects their service to be restored. By Wednesday, July 18, 2006, Con Edison had established priorities for restoring service to its network customers that were location-specific. While it is understandable that these priorities can shift during widespread events, the most current information applicable to specific locations should be made available to customers who contact the call centers.

Recommendation:

C-2 Con Edison should incorporate available outage duration information for specific locations into its call center messaging system so that customers are given the best and most recent information on their specific situation.

F. Summary

While there are recommendations in this Report to improve communications, the Company does have in place appropriate communication organizations and did keep the pubic informed during the LIC Outage. The major factors that contributed to this success were: Con Edison's own communication organizations had well defined roles; the on-site presence of critical agencies facilitated communication; its ICS structure centralized control of information to the incident commander and, finally, the regular drills helped the participants understand their roles and the process.

The Company has made several recommendations to improve its communications process based on lessons learned during this event. The Company's recommendations should be implemented as soon as practicable. Additionally, as set forth above, there are two additional recommendations that the Company should take in future events to prevent similar breakdowns in its communications process. First, the Company should incorporate information from outside sources as well as its own employees. Its failure to do so during this event prolonged the time it took for Con Edison to discover the true magnitude of the outages. Second, the Company should develop a system to inform callers who are reporting electric outages know, to the extent it is available, what the duration of the outage is for their specific location.

3.3.2 Con Edison's Customer Interruption Reporting System

On a secondary network system like Long Island City, equipment damage and de-energization of particular equipment does not necessarily result in customer interruptions. The typical mechanism for Con Edison to learn that a customer does not have service is through a customer telephone call to one of its call centers. Other organizations, such as public safety offices, also report customer interruptions and other service-related problems to the Company's call centers, and in some cases directly to the Company's control center.

A representative at the call center records the customer's problem and creates a service request, sometimes known as a trouble ticket, or "B" ticket. The service request is then managed in Con Edison's Emergency Control System ("ECS").

Con Edison's Outage Manager application is a Web-based system that is used to manage data that is entered in the ECS system. Outage Manager accumulates the number of reported outages from the ECS and provides summaries of the number of customers interrupted. Company employees can view the reported number of customers without service by area within the company.

A. Number of Customer Interruptions Reported

Figure 3.3.2-1 below shows the cumulative number of reported customer interruptions for the Long Island City network during the week of July 17-21, 2006. The numbers shown are based upon the data that Con Edison had available in real-time during the event.[20]

In response to observations that the number of customers interrupted might be larger than the quantities shown in Figure 3.3.2-1, Con Edison conducted a survey on the evening of July 20th. Based on the survey, Con Edison estimated that 25,000 customers were without power on Friday, July 21st.

[20] Based on Con Edison response to Staff Interrogatory 36 (dated: August 21, 2006).

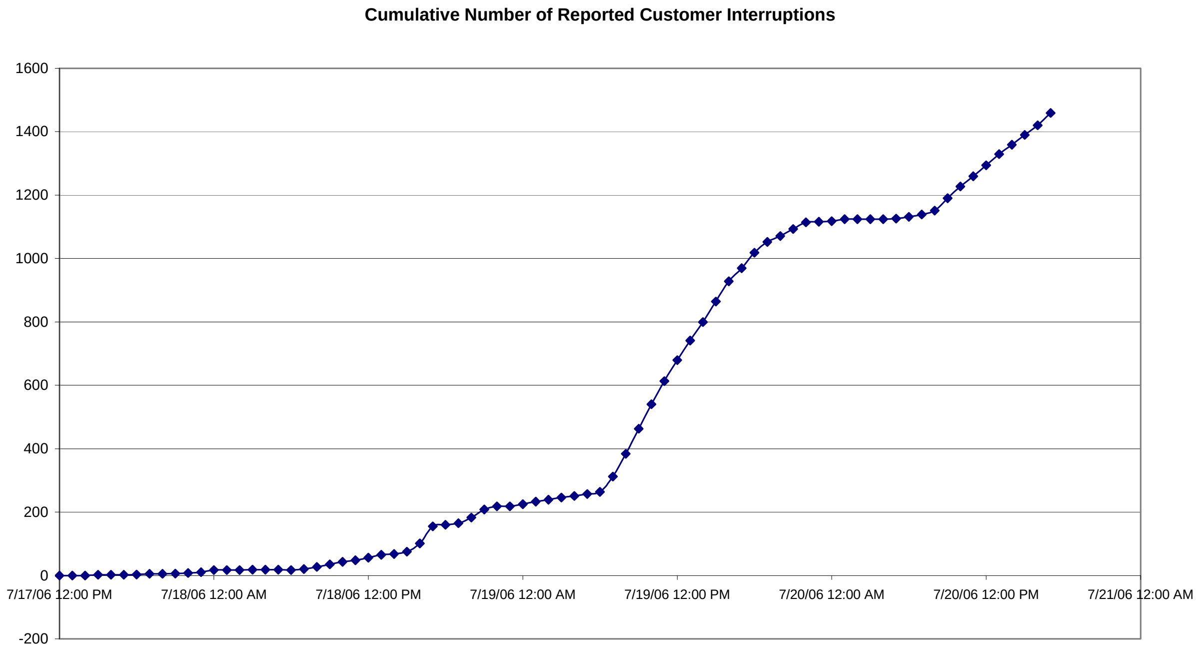

Figure 3.3.2-1 – Cumulative Number of Reported Customer Interruptions on Long Island City Network From July 17-21, 2006

B. Analysis of Customer Interruption Reporting

Customers on secondary network systems rarely experience service interruptions. Historically, and during this event, Con Edison's process for learning of customer interruptions was based primarily upon customer reports of no service. For the reasons noted below, that process proved to be woefully inadequate for understanding the number of customer interruptions during the Long Island City network event. As a result, for much of the week from July 17-21, there were many more Long Island City network customers without service than Con Edison realized.

Some Long Island City network customers with interruptions did not call Con Edison. It is likely that most of these customers fell into one of three categories:

- Customers who were unaware that they should call Con Edison to report a service interruption;
- Customers who did not know the phone number to call, or were unable to locate it; or
- Customers who did not make the effort to call, assuming that Con Edison would know about their service interruption, through other customers' calling, or through other reports.

It is also possible that customers with cordless telephones may not have been able to report service interruptions using their phones. Most cordless phones require electric power to operate, while the older-technology phones, in which the handset is connected to the phone through a cord, do not require electric power to operate. Customers with cordless telephones would have needed another means, such as a cell phone or some other telephone in operation, to call Con Edison to report an interruption.

Customers' ability to contact Con Edison through the telephone was also compromised at one point during the event. On the morning of Wednesday, July 19th, there was a time in which customers were reportedly getting busy signals. In response, Con Edison has since increased the number of phone lines from 450 to 600. Post-event data from Sprint (Con Edison's phone carrier) shows that there were approximately 6,000 busy signals. Of the busy signals, calls were subsequently received from 85% of those numbers. Subsequent calls were not received from the other 900 numbers, although it is possible that some of those customers called back from a different phone number.[21] While the additional phone lines that have been added would have helped Con Edison understand the magnitude of customer interruptions better, it would have had only a limited impact.

Customers who were able to reach Con Edison, but ended their phone call before reporting their service interruption, likely had a significant impact on Con Edison's underestimation of the extent of interruptions. Con Edison reported that 25,000 callers listened to the status message and ended their call without reporting an outage. Post-event analysis performed by Con Edison linked approximately 50% of those calls with specific accounts. Subsequent analysis showed that about 15% of those accounts, or 1,875 callers, were from Long Island City.[22]

Recommendation:

CI-1 Based upon the difficulties in communications between Con Edison and its customers during the Long Island City network event, improvements to the customer call process need to be implemented. In addition, a post-event survey should be conducted to understand the root causes of the problems in the customer interruption reporting process. Finally, the Company clearly needs to develop another way to either replace or augment the customers' interruption reporting process as a means of more accurately estimating the number of customers without service.

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[21] Con Edison Technical Conference, pgs. 84-85 (October 26, 2006).

[22] *Id*.

C. Other Indications of Customer Interruptions During the Event

Secondary system events where significant secondary network damage and customer interruptions occur are rare. The normal call process by which Con Edison receives and processes customer interruption information has had almost no real-world testing under such events. As noted above, the normal call process did not provide accurate customer interruption information during the Long Island City event.

Other mechanisms exist that can indirectly indicate significant secondary damage and potentially customer interruptions. Manhole events are reported to the control center, and the number is tracked. Figure 3.3.2-2 below shows the number of Long Island City network manhole events that were reported to Con Edison during the week of July 17, 2006. Figure 3.3.2-2 also shows the number of reported customer interruptions to Con Edison during that period.[23] There is a correlation between the number of manhole events and the number of reported customer interruptions.

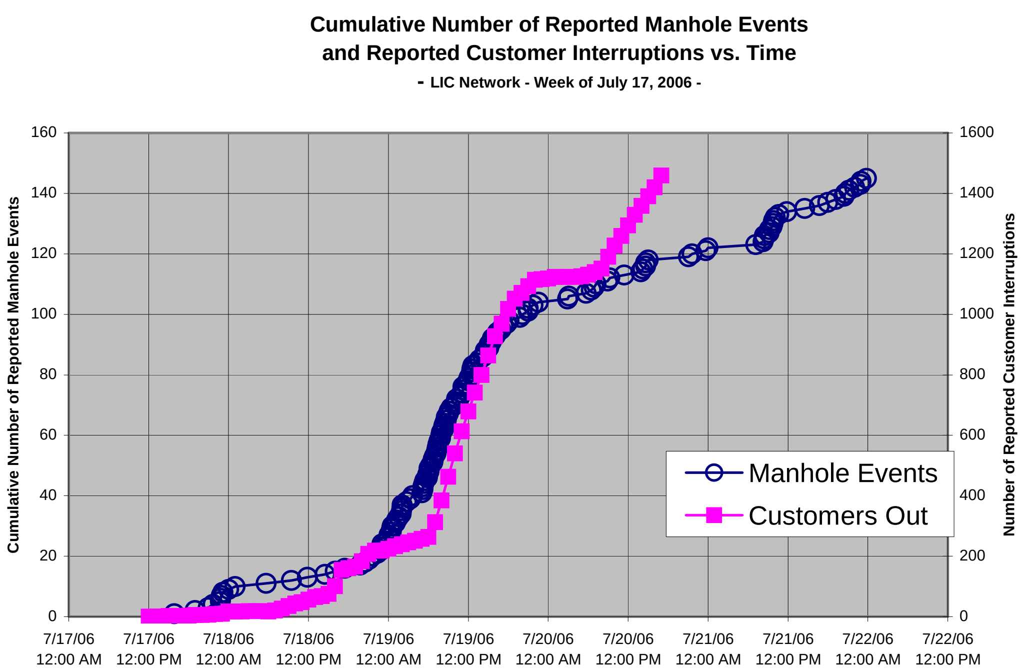

Figure 3.3.2-2 – Cumulative Number of Reported Manhole Events and Customer Interruptions vs. Time

Figure 3.3.2-3 below shows the number of manhole events that occurred per day for the Long Island City network event and selected reference points. The right side of Figure 3.3.2-3 shows the reported manhole events per day for the Long Island City event, July 17 through

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[23] The quantity shown is the number reported during that period, based on actual calls, and not based on the estimated total number of interruptions that was made on July 21, 2006.

July 21. The left side of the figure shows the reported manhole events per day for selected reference points, including a network average for summer days, days when the design temperature is exceeded, the per-day average for the Washington Heights event during July 1999, and the per-day average for the Long Island City network during the same period in July 1999.

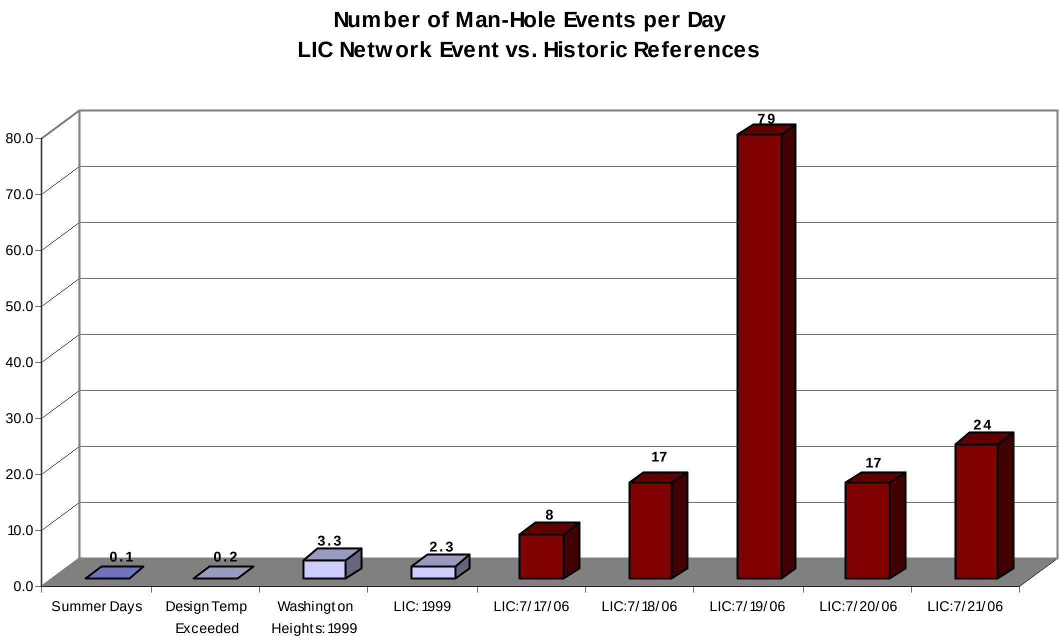

Figure 3.3.2-3 – Number of Manhole Events Per Day, for the Long Island City Network and Selected Reference Points

Table 3.3.2-1 below provides a more detailed description of the reference points used in Figure 3.3.2-3.

Table 3.3.2-1 – Description of Reference Points Used in Figure 3.3.2-3

Summer Days	The average number of man-hole events per day per network on the Con Edison system, June – August, for 1999 – 2006 (2002 was excluded since no dates were present in raw data). (Information provided by Con Edison in response to Staff Interrogatory 169 (dated: September 26, 2006)).
Design Temp Exceeded	The number of man-hole events per day per network on the Con Edison system on days when the Design Temperature Variable was Exceeded. (Information provided by Con Edison in response to Staff Interrogatory 169 (dated: September 26, 2006)).
Washington Heights: 1999	Average number of man-hole events per day on Washington Heights network, 7/5/99 – 7/7/99: 3; 7/5/99: 2; 7/6/99: 5; 7/7/99: 3. (Information provided by Con Edison in response to Staff Interrogatory 201 (dated: September 26, 2006)).
Long Island City: 1999	Average number of man-hole events per day on Long Island City network, 7/5/99 – 7/7/99: 2, 3;. 7/5/99: 1; 7/6/99: 4; 7/7/99: 2. (Information provided by Con Edison in response to Staff Interrogatory 4 (dated: August 28, 2006)).
Long Island City: 7/17/06 – 7/21/06	Number of man-hole events per on Long Island City. The values that would have been seen without duplicates that were removed. With duplicates removed after the event, the values were 8, 14, 75, 16, and 23 for the 5 days. (Information provided by Con Edison in response to Staff Interrogatory 201 (dated: September 26, 2006)).

By examining data such as that above, Con Edison should have realized sooner that there were significantly more customers without service than they were estimating during the event.

3.3.3 Network Monitoring and Information Technology Systems

A. Company Systems

Con Edison has a number of network monitoring and information technology systems that it utilizes when system operations are disrupted to assess the condition of the system and to assist in its restoration. Below is a brief overview of these systems as identified by Con Edison.

1. Distribution Information System

The Distribution Information System ("DIS") is an Intranet-based system that provides an overview status, or "health," of the electric distribution system. The DIS provides a view of the network loading for each geographic area, the status of the networks, and the status of feeders within each network. The primary data source for DIS is a PI historian that captures status information extracted from the System Operation Computer Control System Expansion ("SOCCSX") supervisory control and data acquisition ("SCADA") system.

The DIS also provides the following information:

- An Intranet-based view of SOCCSX area substation one-line diagrams;
- Links to more detailed information about feeders and networks including load curves, gauges, and ratings; and
- Alarms for the opening and closing of feeder breakers.

2. SOCCSX

The SOCCSX is a SCADA system that collects and displays a real-time view of electric distribution area substation information. SOCCSX also allows district operators to issue control commands to certain equipment, such as the opening or closing of a feeder circuit breaker in a particular area substation.

3. Feeder Board

The Feeder Board is an Intranet-based system that displays the status of all distribution feeders that are currently out of service. The information on the Feeder Board is retrieved from the Feeder Management System ("FMS"), which is used by district operators who control the feeder restoration process and by distribution control center operators who provide additional updated information.

4. FMS OnLine

FMS OnLine is an Intranet-based system that provides an on-line view of the Feeder Management System including active feeder outage summaries, individual feeder outages, and various management reports on feeder restoration performance.

5. Remote Monitoring System

The Remote Monitoring System ("RMS") collects real-time network transformer and network protector status information transmitted from underground vaults through power line carriers (i.e., along feeders) to receivers at area substations. Another system known as Vax Data Acquisition Management System ("VDAMS") continuously polls the receivers and processes this data, which it then makes available to other engineering analysis and operations systems, such as the Auto World-class Operations Load Flow ("Auto WOLF") system and the Network Remote Monitoring System ("NetRMS") (an Intranet-based version of RMS).

6. Network Remote Monitoring System

The Network Remote Monitoring System ("NetRMS") displays network transformer status, network protector status, and related details for all network vaults in the RMS. In addition to current status information, NetRMS provides various reporting and graphical tools that allow users to view and generate reports and queries against historical network transformer status and loading information, as well as that for their electrical "nearbys."

7. Rapid Restore

Rapid Restore is a system that allows information to be shared electronically between organizations involved in the feeder restoration process. It also permits the creation and electronic transmittal of operating orders from the district operators to operating personnel (e.g., substation operators, field operators, etc.).

8. Poly Voltage Load flow

The Poly Voltage Load Flow ("Win_PVL") is a balanced, 3-phase load flow application for secondary networks. Win_PVL utilizes models of distribution system components extracted from mapping systems to simulate the actual network (including substations, feeders, secondary mains, transformers, switches, etc.). Win_PVL is the core planning and design tool used by the Company's regional and customer engineering sections to forecast system deficiencies and develop reinforcement designs.

9. WOLF, Auto-WOLF, and Visual Auto-WOLF

WOLF is a subset of PVL used in real-time, load-flow analysis environments. WOLF was developed in order to analyze entire networks in short periods of time, often in a matter of seconds, including results for the current base case situation of the network and all subsequent scenarios for cases when feeders de-energize. WOLF operates manually by the user, while Auto-WOLF runs automatically for every network feeder event (i.e., loss or restoration of each feeder). A visualization of load-flow output reports was created, termed Visual Auto-WOLF, as an aid to operators in assimilating the results of Auto-WOLF's calculations.

10. Alarm Monitor

Alarm Monitor is a system that provides visual and audible alarms to the distribution control center operators on designated status changes in the electric distribution system.

11. Unit Substation Automation

The Unit Substation Automation ("USA") system provides supervisory control and data acquisition for the 4kV unit substations throughout the Company's electric distribution system.

12. Distribution Overhead System

The Distribution Overhead System ("DOS") is an Intranet-based system that displays the status of overhead vacuum recloser switches on circuits called auto-loops.

13. WeatherBank

WeatherBank is a completely integrated, full-service, meteorological consulting service that offers weather data and products, including custom programming solutions for businesses, government agencies, and the general public. Con Edison incorporates data from WeatherBank into all aspects of its system planning and operations.

14. Emergency Control System

The Emergency Control System ("ECS") tracks active trouble tickets by trouble type, records chronological actions and data input, permits referral for long-term repairs following completion of the initial response, and archives tickets for future reference. ECS also provides input to the Outage Manager system.

Among these systems, three are particularly important in assisting operators during network contingency events similar to the Long Island City incident. These systems are:

- RMS
- WOLF programs
- Emergency Control System

These three computer-based monitoring tools, collectively, are designed to provide valuable information on the status of the electric distribution system. Nevertheless, although valuable, these systems provide only limited visibility into the real-time status of the secondary network. With this limited visibility, operators cannot be sure of the condition of the network cable system, including any damage that may have occurred to the cable system. Operators are also limited in their ability to determine what action has to be performed on the system and are unable to know if an outage will occur or how long it may last.

B. Brief Description of the Remote Monitoring System

The Long Island City network includes approximately 1,200 network transformers installed and distributed throughout the network as required by the load distribution. Each network transformer is equipped with a monitoring apparatus known as the Remote Monitoring System ("RMS"). This system is based on a power line carrier communications technique that directly couples to one phase of the low voltage power line and transmits a high frequency signal nominally in the order of 50 kHz.

The system is designed to provide a one way communications path from the secondary network side of the network transformer, through the transformer and onto the primary (27 kV) feeders where it is transmitted to a receiver at the area substation via pick-up coils located within the pothead cubicles for each of the feeder circuit breakers. Every network transformer has an RMS transmitter associated with it, all of which eventually are connected to the 22 North Queens feeders. On average, there are approximately 54 RMS transmitters per feeder.

The RMS transmitter is directly coupled on one phase of the 120/208 volt secondary and referenced to ground (neutral). The 50 kHz signal propagates through the transformer to the delta winding side where the signal becomes a current, riding on top of the 60 Hz power waves. The delta winding requires the RMS signal to flow to the substation on one phase and return on a second phase through the substation circuit breakers and power transformer windings. A disadvantage of this configuration is that when the substation breaker is opened the RMS signal continuity is broken and communications and data are lost. An advantage of the RMS power line communications media is that it is owned and under the control of the utility and has a nominal data transfer cost.

Because the RMS signals are transmitted randomly every three minutes, statistically there will be signal collisions along the 27 kV feeders by the time the receiver at the North Queens substation magnetically detects the data stream. Therefore, the RMS, which is now more than twenty years old, was designed for approximately 95 percent of the operational RMS transmitter signals to be successfully read by the receiver in a 15 minute period.[24] The remaining 5 percent is intended to be read during the next 15 minute interval.

The structure of the first-generation RMS data stream, which is transmitted from the vault transmitter to the substation receiver, is a very critical part of the RMS and is directly related to the accuracy of the analog measurements that the system captures. The system uses a very limited protocol to deliver the data. For example, the current and voltage (if equipped) are provided as a 7 bit number instead of the usual 8 bit number for a system of this vintage.[25]

The Con Edison RMS is unique when compared to other utility supervisory control and data acquisition systems. And, while it is beneficial to have 25,000 network transformers monitored, the Con Edison RMS is of an older design and many improvements have been made to SCADA systems since the initial introduction of the RMS system. While Con Edison has availed itself of some of these improvements, the RMS system can still benefit from further refinements.[26]

New generation RMS equipment, which includes advances in SCADA systems over the last 20 years, is being installed by the Company throughout its system. Con Edison has reported that since January of 2006, 3 percent of the older RMS transmitters have been replaced by the new generation transmitters. At this rate of upgrade, it is estimated to take more then 17 years to replace the existing system, not including failures. Clearly, a more aggressive program is necessary to modernize the system, provide additional data and improve the reporting rate. These upgrades will provide an enhanced degree of monitoring that could help prevent another network wide event as experienced in the Long Island City network.

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[24] First-generation RMS systems were deployed in Con Edison's electric system beginning in 1982.

[25] The significance of this means that the system is very limited on accuracy since there are only 128 digital levels as compared to the normal 256 digital levels that can be converted to a decimal number. This is further complicated by the fact that the RMS is an average responding measurement tool and relies on the assumption that the waveform is sinusoidal and symmetrical. Any distortions of the waveform as would be the case during back feed conditions (conditions present in the Long Island City network) will give an inaccurate reading of the voltage and currents.

[26] The system as presently deployed is a quasi-real time system which can communicate in one direction only, with no read-on-demand or read by exception capability. Additionally, data security can be improved by employing modern data formats.

C. Analysis of Remote Monitoring System Operations During the Long Island City Event

The Long Island City network has approximately 1,200 distribution transformers, more than any other network in Con Edison's system. The RMS receiver's design specification states that each receiver will handle a maximum of 1,028 transmitters. Con Edison overcomes this limitation by using two receivers in North Queens and splitting up the transmitters between them.

Con Edison has stated that the RMS's reporting rate just prior to the Long Island City event was 79.5%.[27] During the course of the investigation into the power outages it was stated that the approximate relevance of this rate could be simply compared to receiving data from 8 out of 10 transformers.[28] Further analysis reveals that this reporting rate equates to approximately 250 transformers for the Long Island City network not reporting. This number of transformers not reporting is significant when one considers that these transformers could be concentrated in one geographic area of the Long Island City network where there were multiple contingencies and overheated transformers.

Coverage of the network must be maintained in order to have adequate RMS monitoring. In addition, a reduction of 20 percent of the available RMS data inputs would affect the accuracy of a WOLF load flow calculation especially when the network was in a fourth or fifth contingency. As Con Edison has stated in their October 12th Report, data from the RMS supplies the NetRMS program and this program in turn feeds WOLF and DIS.[29] It is unclear to what degree these systems were affected by a 20 percent reduction in data under varying circumstances.

Throughout the Company's October 12th Report, many of the overload analyses were made using the temperature calculation method known as Real Time Transformer Temperature or RT3. RT3 calculates the hot spot temperature of the transformer based on the RMS current (I) data. The calculation also uses data that is stored in the transformer database which includes the size of the transformer and other nameplate statistics. If any of these data statistics are incorrect or were not updated in the last transformer site upgrade, then the RT3 calculation may be incorrect. Other factors also can affect the calculation such as excessive debris in the transformer vault obscuring the air flow around the cooling fins of the transformer, or other sources of heat which can also affect the accuracy of the calculations. There should be a periodic check of the calibration constants used by the software to correctly scale the temperature values.

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[27] October 12th Report, p. 6-1.

[28] Con Edison Technical Conference, p. 853 (October 26, 2006).

[29] October 12th Report, Appendix B-4.

Because the RMS system is transmitting data in a random format there must be a well defined method of calculating and measuring the data flow rate with some repeatability. For example, a start time could be established and then the sample of transmitters recorded for a given network over a defined period of time. If this same cycle is repeated throughout an 8 hour period and all transmitters report then the 100 percent rate can be established. Those that do not report during these daily 8 hour load periods should establish the reporting rate.

The RMS returns are currently captured using the NetRMS database and at a selected hour during the day they are averaged over a short period and displayed as a percentage. Monitoring systems that employ power line carrier technology tend to have higher reporting rates during low load periods because the signal noise on the line is lower and therefore fewer collisions occur. It would seem advantageous to take actual reporting counts during the daily 8 hour peak load period to get a more accurate report rate. This is important since it would translate into the maintenance requirements to keep the RMS reporting at a usable rate. The non-reporting units need to be clearly identified since their inspection cycle needs to be reset to the more frequent non-RMS cycle.

The RMS is one of the systems that Con Edison relies upon to provide both primary and secondary information to the regional control centers so that their operators can make correct and timely decisions about how to respond to network events such as the Long Island City incident. Throughout the investigation of this incident, it can be concluded that there was insufficient coverage of the secondary system in the Long Island City network to address these considerations. Coverage would be defined as secondary metrics that are in the form of voltage or current near or at the customers' load points.

There was discussion in the Company's October 12th Report concerning the voltage monitoring throughout the Long Island City network as it relates to the network protector relay supply.[30] The RMS is physically at the same locations as the network protector relays and if more of the RMS transmitters had been equipped with a voltage measuring element, then this could have been a way of identifying and documenting areas with insufficient backfeed current to blow network protector fuses.

Voltage measurement at the transformer vault location is not the most advantageous location to take this metric since, with the primary feeder in service, this is the stiffest point in the network for voltage because it is directly at the source. Therefore, measurements at these locations would not provide an accurate picture of the voltage fluctuations that exist during high load periods. Moreover, it will not show the voltage at the fringe areas of the network where many of the customers reside.

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[30] October 12th Report, p. 5-46.

D. Secondary Load Flow Program

The secondary network is not being directly monitored in real-time by SCADA or similar systems. Instead, the network operating condition is estimated through the use of mathematical models. The Company uses the Poly Voltage Load Flow ("PVL") application to monitor the condition of the secondary network. The PVL is a collection of distribution systems analysis, data management, and report generating programs available under a single user interface, used to conduct load flow analysis for a comprehensive set of data.[31] The results from such iterative load flow analyses are used to guide the annual reinforcement work necessary in a given network.

The primary load flow program is a power flow analysis tool for simulating electric distribution systems. The data model can include single or multiple voltage levels, from transmission levels of 345 kV down to secondary levels of 208 Volts. The distribution system is assumed to be a balanced three-phase system. Individual single-phase systems cannot be modeled or simulated with PVL. The primary load flow simulates distribution systems that have radial primary feeders supplying secondary network systems including isolated network installations. Base, or normal, case models are developed for PVL analysis for the design criteria of normal first, and, where applicable, second contingency conditions.

According to Con Edison, the secondary system may also be analyzed using PVL. The flows for all sections of primary and secondary are calculated for the normal case, where no feeders are simulated out of service. Then, the flows for single and multiple contingency conditions, as specified in the parameters sections, are calculated separately and the results are reported by contingency condition.

The WOLF program is a real-time version of the PVL. It takes real-time inputs from the RMS and indirectly from the SOCCSX.

There are known inadequacies in the WOLF program. The program may not converge whenever the network is in a contingency level higher than 2. Because it is Con Edison's established practice to continue network operation beyond the second contingency, all critical tools such as the WOLF program must remain operational beyond the second contingency. This means that the RMS reporting rate must be improved to at least the minimal 95% reporting rate and the RMS system coverage must be expanded to include all High-Tension ("HT") customer metering points.

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[31] Con Edison response to New York City Interrogatory 31 (dated: September 11, 2006).

F. Emergency Control System

The ECS supports the customer trouble call management functions. Having an accurate scope of an outage in a timely manner is critical to the Company, its customers, the public and the City and local agencies that work with the Company during these situations. It is recognized that underground network systems provide reliable service. However, the same secondary network design that makes the system so reliable also makes most of the currently available trouble call management functions ineffective.

Recommendations:

NM-1 Con Edison should install voltage sensors, with the capability to be read remotely, in a homogeneous distribution throughout each network such as in secondary manholes and service boxes. These sensors should be used to develop a voltage profile of the network. Any problems relating to blown limiters, burned out cables, and faults would be displayed in an entire network voltage profile.

NM-2 Con Edison should study a means to utilize automatic meter reading ("AMR") to all or selected locations at customer premises to know when there are disruptions in service. Analysis of the Long Island City network event concludes that one of the most important items would be an outage detection system that is capable of alerting the Company that there is an outage and also specific information about the outage such as the date and time it occurred, the time service was restored, the voltage level, and the location. This type of system provides necessary secondary system information right from the customer's premise.

NM-3 Alive on Back feeds ("ABFs") are one of the causes for feeder restoration delays and are often caused by a network protector that does not operate properly. An approach that would make it easier to locate the malfunctioning network protector is use of a local remote secure radio control device built directly into the network protector relays. Field operators could use these devices to cruise the feeder with the ABF and locally monitor the protector status and locate the malfunctioning network protector.

NM-4 Con Edison should actively participate in the Department of Energy's Grid 2030, an "Advanced Metering Infrastructure" project ("AMI"). This project could assist the Company in deciding how it will collect and analyze data in the future. AMI is designed to allow utilities to optimize their distribution planning in real-time for both asset deployment and asset management. They will also be able to monitor and control capabilities of every distribution device on the system. This will help utilities move from pure outage management to real-time grid analysis which will enable them to predict and eliminate future outages.

NM-5 A valuable solution to multi-contingency problems in complex secondary networks is timely load shedding in the right locations. Studies should be conducted on how to collect real-time information supporting the real-time decision making on rapid directed load control. A combination of monitoring systems and deterministic and knowledge-based modeling methodologies should be considered. These studies should include an evaluation of which load controlling and shedding technologies are best suited for the unique operating conditions of Con Edison's system.

3.3.4 Feeder Restoration and Transformer Cooling

A. Feeder Restoration

1. Introduction

The underground network electric distribution system provided by Con Edison supplies approximately 86% of their total electric load. The underground network has been designed to provide a highly reliable electrical supply to their customers and, in general, has been recognized as meeting this goal in a consistent manner. The secondary network that connects customers to the Company's system provides redundant paths that have limited the interruption rate. The primary feeder system has a similar redundancy plan that is intended to provide full uninterrupted service to all customers within a network area under a peak summer load period when any two of the primary feeders supplying that network are out of service.

This redundant design allows feeders to be removed from service for scheduled work (new equipment, maintenance, reinforcement, etc.) while retaining the capability to have a second feeder fail and come out of service on an unscheduled basis without having any impact on reliability or customer service. This design criteria for the Company's network system is designated as n-2, indicating that regardless of the number of feeders on a network, the system is designed to operate normally when any two primary feeders are not in service. Because scheduled work is not normally performed during peak load periods, there is a further margin of safety and reliability built into the operation of the network system.

This section of the Report will focus on the feeder restoration processes followed by Con Edison in response to the feeder outages as they occurred, and evaluate some of the choices that were made by their operators. Not every feeder outage will be examined; rather select representative samples or groupings of similar feeder outages will be examined so that an analysis of the Company's response strategy and the effectiveness of its efforts to restore the faulted feeders to service within the Long Island City network can be made.

2. Initial Failures

The first Long Island City network feeder, 1Q17, opened automatically by automatic protective relay operation of the associated circuit breaker at the North Queens substation on July 17th at 1550 hours. Thirty-two minutes later, at 1622 hours, a second feeder, 1Q16, was similarly removed from service in response to a fault. In response to a report from the New York City Fire Department ("FDNY") of a manhole explosion, the faults were located in a parallel underground duct run. The initiating event is reported to have been a secondary cable failure within a wooden duct run which caused the ductwork to ignite and resulted in collateral damage to the two feeders located immediately below the secondary cable failure. These two outages created a second contingency within the Long Island City network with two directly conflicting feeders out of service.[32]

The second contingency created by the outage of feeders 1Q16 and 1Q17, in and of itself, should not have presented a problem but it was further exacerbated by the high number of transformers within the Long Island City network that were out of service and were not supporting the system thereby creating more significant local contingency conditions.[33] Con Edison has reported that as of 1200 hours on July 17, 2006, there were 86 transformers within the Long Island City network that were not supporting the network – this represents more that 7% of the roughly 1,200 transformers in the Long Island City network.[34] This resulted in higher secondary cable loadings and higher transformer loadings within localized areas where the transformers were not connected, as well as a shift in the anticipated feeder loading pattern for the nearby in-service feeders.

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[32] Not all feeder contingencies are equal in severity and do not have the same cumulative effect. The n-2 criterion used by the Company is based upon the worst case of two directly conflicting feeders being out of service. As another example, substation bus sections may be taken out of service for planned work with three or four network feeders being taken out of service at the same time since they are electrically spread across the entire network so that only an equivalent first contingency exists at multiple locations. It is not just the numerical number of the contingency but also the geographical location of the out of service feeders within the topography of the specific network that determines the impact of the outages.

[33] A local contingency is when a single transformer is out of service (either disconnected from the feeder or due to the network protector being open or having blown fuses) in a local area of the network. With one transformer out of service and a conflicting feeder removed from service it would create a local second contingency.

[34] Twenty-seven transformers were listed as being banks-off the system (i.e.: units dropped off of their respective feeders), sixteen transformers had blown fuses in their network protectors, and forty-three transformers had their associated network protectors open.

The initiating secondary failure within the older wooden duct also raises a number of concerns. The wooden duct run was 79 years old and not in accordance with current design standards. Its composition can be anticipated to ignite and to transmit heat to the surrounding area. Con Edison has indicated that as part of their Secondary Rebuild Program they are replacing some wooden duct sections in conjunction with secondary cable replacements. This initiative will be an extensive and very costly process as approximately 15% of all ducts are comprised of wood.

Feeders 1Q17 and 1Q16 were rapidly processed because the fire location was known and minimal time was spent locating the fault. The feeders were repaired and prepared for restoration to service in under eight hours. Unfortunately, by the time these two feeders were restored to service, the network was under a sixth contingency and in significant stress.

3. Substation Bus Section Outage

At 1848 hours on July 17th feeder, 1Q21's automatic protective relaying operated and attempted to remove the feeder from service as the result of a fault on the feeder. Due to a defective control circuit, the associated circuit breaker at the North Queens substation failed to operate and clear the fault. The back-up protective relay scheme operated (after an established time delay) to remove the entire bus section (3S) from service and tripping all of the associated circuit breakers. This removed two additional Long Island City network feeders from service (1Q07 and 1Q15) as well as one non-network feeder (1Q81) from service.

Subsequent investigation by Con Edison revealed that the circuit breaker (position 34W) failed to operate due to a misalignment of the control circuit contacts on the breaker cubicle (stationary) and on the removable breaker element (rack-out type). There were no initiating relay targets to indicate the source of the fault and the breaker in position 34E (1Q81) also failed to open when directed to trip via the back-up relay protection scheme. Both breaker positions 34W and 34E were retrofitted rack-out breakers (Merlin Gerin). It was also determined that the circuit breaker (position 34E) failed to operate due to a similar misalignment of the control circuit contacts on the breaker cubicle (stationary) and the removable breaker element (rack-out type). Both of these inoperable trip circuits should have been revealed to the substation operators through a visual indicating light located within the North Queens substation control room. However, during the breaker retrofit process this monitoring circuit was incorrectly wired so that no visible indication of the loss of this trip circuit to either of these circuit breakers was provided to the substation operators. Had a proper indication been provided to operators, it is believed that these conditions would have been corrected well in advance of this event.

While Con Edison's October 12th Report attributes this condition to be "due to the misalignment of the breaker-tripping control circuit contacts"[35] the true root cause of the

[35] October 12th Report, p. 3-15.

multiple feeder trip-out was questionable oversight of the circuit breaker upgrade program in this network.

The breaker retrofit effort at this substation had been underway since 1997 (excluding the one capacitor bank position that was completed prior to 1995). Eleven of the twenty-two active network feeder positions, four of the six non-network feeder positions, and the three spare feeder positions have been completed to date. In addition, one of the three capacitor bank positions was completed as well as nine of the fourteen transformer and bus-tie positions. In summary, twenty-eight of the forty-eight total positions (58%) were completed at this substation over the nine year period with one position being completed in 2005. The two positions that failed to operate were both completed in March, 2002.

It is Con Edison's responsibility to inspect and accept the contractor's work for the circuit breaker upgrade program. The wire checks associated with this inspection and acceptance testing should have revealed the failure of the trip circuit monitoring light to operate properly. The fact that Con Edison has stated that it cannot determine whether the contractor either designed the circuit incorrectly or installed it improperly is a further indication of problems with the monitoring and control of this retrofit project. Moreover, this failure should cause the Company to review its contractor work inspection process.

Recommendation:

FR-1 Con Edison should examine and strengthen their contractor oversight processes from initial design, to on-site inspection, and through acceptance testing, to ensure that proper controls are being exercised over contractor work within its substations.

The failure of the breaker to operate for feeder 1Q21 resulted in the Long Island City network moving to a fifth contingency. Because the three feeders on bus section 3S are, by design, spread across the entire network, the condition was represented by a series of local third contingencies. The condition was further exacerbated by the number of other transformers that were not closed in and supporting the network. Had 1Q21 cleared properly, the network would have been in a third contingency rather than a fifth contingency.

4. Bus Section Restoration

Bus section 3S and feeder 1Q21 remained alive on backfeed from the Astoria gas turbine site through feeder 1Q81 due to the breakers at positions 34W and 34E remaining closed until the generator breaker tripped via its own local loss of field relay protection. At 1902 hours on July 17^{th} bus section 3S was re-energized by closing a bus tie circuit breaker (MBSB-302) without first isolating the two still closed feeder breakers. This action re-established electrical supply to the fault on 1Q21 and the bus section was again de-energized by the operation of the back-up relay protection scheme. This attempt to re-energize bus section 3S should not have been attempted until the closed feeder circuit breakers had been opened. Realizing the error, the two breakers were finally opened at 1903 hours. At 1904 hours a second attempt to re-energize bus section 3S was attempted by closing the bus tie circuit breaker MBSB-302. The breaker did not close because the lockout relay had not been reset.

Recommendation:

FR-2 Con Edison should examine its training and testing program for Substation Operators and District Operators to ensure that operators are properly instructed, with particular emphasis on actions during stressful emergency conditions.

The bus section was restored to service at 1909 hours by closing bus tie breakers MBSB-302 and BT-330. Feeder 1Q15 was restored to service at 1910 hours.

5. Substation Feeder Processing

Feeder 1Q07 was closed at 1909 hours on July 17th in an attempt to restore it to service and immediately opened with a B-phase Instantaneous Over Current (IOC) relay operation. This is the first of several times that, according to Con Edison in its October 12th Report, "high transformer magnetizing inrush upon feeder energization may have caused the relays to operate."[36] Considering that the feeder was subjected to an extended fault transient during the delayed de-energization of the bus section, it is also possible that the damaged joint may have faulted then. Moreover, it is also possible that it was damaged during the fault locating process. The Company's explanation of magnetizing inrush on feeder restoration will be discussed later in this section.

Two other issues were brought to light with regards to opportunities to improve the feeder processing times that were lost by Con Edison due to a lack of preparedness for the summer 2006 peak load period.

First, with fifteen of the active twenty-eight feeder positions in the North Queens substation retrofitted to rack-out type circuit breaker elements, Con Edison did not have any Ground and Test (G&T) devices tested and ready for use in advance of the summer load period. These devices would have enabled multiple feeders to be processed without the inherent sequential use of the old style test bus arrangement that was part of the original design of this approximately fifty year old substation. These devices would have provided for a safer and more effective process then the use of ground leads within the pothead cubicles that was undoubtedly used to bypass the cumbersome nature of the test bus arrangement. In order to enhance, simplify, and expedite the feeder restoration process all that was needed was to Hipot these new G&T devices and perform current injection and trip tests in conjunction with a scheduled bus section outage. Prudent preparation for the 2006 summer peak load period would include the completion of this work.

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[36] October 12th Report, p. 3-21.

Second, the PQNode at the North Queens substation was only made operational on July 17, 2006, instead of having been made operational well in advance of the summer 2006 load period. Apparently the only reason the North Queens PQNode was connected on July 8, 2006, at all was because the work was added onto a scheduled outage on bus section #1 to investigate the PT's associated with transformer #1 as the result of a failed voltage reduction test conducted on March 7, 2006. Having the system installed at such a late date did not allow for the Reactance-to-Fault ("RTF") application to be operational because there was insufficient time to tune the system between its installation and when the network was in a multiple contingency. This was another preparation failure that could have further reduced fault locating times on the network and thereby potentially restored feeders more quickly throughout the event.

Recommendations:

FR-3 Con Edison should complete the required testing of the G&T devices at the North Queens substation to insure that they will be available to expedite the feeder processing effort before summer 2007.

FR-4 Con Edison should expedite the installation of substation PQNodes on a system-wide basis to insure that all of their substations are completed prior to next summer. Additionally, testing and tuning of the PQNode should be completed to insure that the Reactance-to-Fault application is functional for all of their networks prior to summer 2007.

6. General Case Comments

The relay target associated with the open auto of feeder 1Q02 at 1948 hours on July 17th (Case 5) was A-phase IOC, which was in contradiction to the subsequent information from the PQNode that clearly indicated a fault only on C-phase. The fault was determined to be a damaged joint and primary cable section on C-phase. Con Edison has verified that the relay labeling is correct and believes that the report of an A-phase relay target was incorrect. It is unexplained how the substation operator could have reported an incorrect target.

The relay targets associated with the open auto of feeder 1Q01 at 2149 hours on July 17th (Case 8) were determined to be A-phase and C-phase IOC. Yet no relay targets were reported during the event. During the investigation of the event, Con Edison was unable to explain why no relay targets were reported.

Recommendation:

FR-5 Based upon the number of process failures enumerated above, Con Edison should examine its training and testing program for Substation Operators and District Operators with particular emphasis on actions during stressful emergency conditions (see Recommendation FR-2, supra). Improvements need to be made to these processes to insure that operator errors do not impact the overall feeder restoration process by decisions being made on incomplete or incorrect data.

7. Rapid Restoration

Beginning with the automatic opening of feeder 1Q02 due to a fault at 1948 hours on July 17, 2006 Con Edison began attempting to restore feeders to service without the usual examination and process. This was the second time that the network had reached a fifth contingency that evening and, even though a C-phase IOC relay target was indicated, the Con Edison operators attempted to restore the feeder to service approximately 20 minutes later (at 2008 hours). Con Edison has provided no rationale for this deviation from standard process. Indeed, the PQNode recorded a single-phase fault current of 10,432 amperes. This attempt was successful for 12 hours and 15 minutes after which it opened automatically on July 18th at 0823 hours.

Feeder 1Q20 opened automatically due to a fault at 2143 hours on July 17th, and again the Company attempted immediate restoration. This was the third time that the network had reached a fifth contingency that evening and, even though an A-phase IOC relay target was reported, the Con Edison operators attempted to restore the feeder to service approximately 13 minutes later. The PQNode recorded a three-phase fault of 8,996 amperes which would indicate a high impedance fault, usually a transformer. The attempted restoration to service failed with the feeder protection scheme indicating multiple relay targets: A-phase IOC and ground time over-current. The PQNode recorded a matching fault on A-phase of 6,912 amperes. While no field report of a fault (manhole event, transformer fire, etc.) was reported following the trip of this feeder there was no rational reason to attempt immediate or rapid restoration of this feeder to service.

Feeder 1Q01 opened automatically due to a fault on the feeder with A-phase and C-phase IOC relay targets reported. The PQNode was reported to have recorded a two-phase fault on B and C phases of 4,140 amperes which would again indicate a high impedance fault, usually a transformer. The relay targets were somehow not reported and no field report of a fault was received. Therefore, seven minutes later, at 2156 hours Con Edison attempted to restore this feeder to service. The breaker tripped immediately but no relay targets were reported. The PQNode again reported fault current of 6,720 amperes on A and C phases. The fault was later determined to be a damaged transformer and its associated primary cable within the vault.

Con Edison has indicated during the investigation into the event that “due [to the] escalating nature of the event, including the high number of feeders opening auto in a short period, the

District Operator and Brooklyn/Queens Regional Control Center made reasonable and limited operational attempts to restore a selected group of feeders that opened automatically."[37] Unfortunately, Con Edison has been unable to explain the basis for the selection of this "reasonable and limited" population. In retrospect, the selection appears to be an irrational response to the escalating contingencies that subjected the network to unnecessary additional fault transients and actually delayed feeder restoration.

Con Edison's October 12th Report indicates in section 4.1.7 that seven attempts were made to immediately restore feeders to service after they had opened automatically with four (1Q20, 1Q01, 1Q16, and 1Q18) opening immediately; one (1Q19) staying in service for seven minutes; one (1Q02) staying in service for twelve hours and fifteen minutes; and only one (1Q13) remaining in service for the duration of the event. Con Edison has also reported that after the event, analysis of these feeders has shown that all seven of them had PQNode fault data indicating the presence of a fault at the time of the initial feeder open auto.

Recommendations:

FR-6 Feeder 1Q13 should be promptly scheduled for a DC Hipot test to determine whether a strongly indicated incipient fault exists on this feeder.

FR-7 Con Edison should examine the guidance provided within Rapid Restoration procedures applicable to the distribution system and take steps to improve its directions for attempting rapid restoration of feeders while operating networks under multiple contingency conditions, including lessons learned from the Long Island City network event.

8. Inrush – CIOA

Beginning with the attempted restoration of feeder 1Q18 to service on July 18th at 2357 hours, Con Edison's October 12th Report begins to attribute the cause for failing to restore feeders to service to inrush current due to transformer magnetizing upon feeder restoration. There were fifteen instances wherein a circuit breaker was closed in an attempt to restore a feeder to service but high currents triggered the operation of the protective relays that, in turn, tripped the circuit breaker. This is commonly designated in Con Edison nomenclature as a Cut-in/Open-auto or CIOA. In almost all cases, a fault on the feeder causes the excessive current flow.

Immediately after the closing of a substation breaker to restore a feeder to service all of the equipment connected to the feeder is re-energized. The cable will charge and the

[37] Con Edison response to New York City Interrogatory 196 (dated: November 14, 2006.)

transformers will draw a magnetizing current[38] or inrush for a short period of time (decaying transient). The peak magnitude will vary depending upon what point in the sinusoidal waveform the breaker is closed but it can be as high as several times the normal full load current. This situation is a perfectly normal electrical phenomenon and should have been anticipated and accounted for when establishing the protective relay settings so that they differentiate between normal energization and supply to a fault. Con Edison personnel should have been aware of the increased transformer capacity, i.e., load growth that was taking place on its feeders and properly managed and operated their system. They have reported that there was no system of periodic review of their relay protection schemes. The settings were only reviewed based upon a request that was generally initiated by a significant change in feeder configuration or loading. This was something that should have been anticipated as part of good system management.

Recommendations:

FR-8 Con Edison should review the design settings for all relay protection schemes on its distribution feeders to insure that they have been kept up-to-date and reflect the increased load growth (transformers) being supplied. A schedule for this review and any identified corrective actions should be completed before the summer of 2007.

FR-9 Con Edison should establish a periodic review process that validates the settings for all relay protection schemes on its distribution feeders to insure that they have been kept up-to-date and will operate properly when called upon.

Con Edison's post-event analysis also concluded that four of the fifteen CIOAs did not display clear evidence of a fault and may have been caused by high magnetizing inrush current levels approaching the pickup level of the instantaneous over current relay settings. Unfortunately, it is difficult to definitively verify this hypothesis because in each of these four cases a subsequent feeder fault was found. These faults may have been the result of the initial fault transients, the application of high voltage during the fault location process, or the failure of an incipient fault during the Hipot test of the feeders. Con Edison has speculated that these failures may be attributed to a failure during the Hipot test.

The suggestion that so many incipient faults are present within the in-service network feeders raises significant questions regarding the effectiveness of Con Edison's feeder testing program. As an example, are the right feeders being tested as part of the usual pre-summer DC Hipot testing program? Is Con Edison performing enough tests? Are those feeders that initially fail the test being tested again until successful completion? These issues need to be further examined because there is insufficient evidence to support a definitive positive

[38] The magnitude of the inrush current is generally characterized as 8-12 times normal load current. The magnitude will vary depending on whether the unit is energized from the inner or outer concentric winding, the connection of the winding energized, the amount of residual flux in the core and the angle of the voltage wave at the point of closure.

response to these questions. Rather, the conclusions by Con Edison indicate that there is significant basis for concern.

Recommendations:

FR-10 Con Edison should increase the number and effectiveness of its system wide feeder testing program on both a post-failure and a planned basis.

- The planned feeder Hipot selection criteria should be evaluated to verify that it is properly prioritizing all of the potential candidates.
- Feeders selected for Hipot should be tested until they pass at the designated test level so that incipient faults are not left on the partially tested feeders.

9. Other Issues

As noted earlier, some Long Island City network feeders remained ABF on a number of occasions during the event and had a negative impact on the feeder restoration process and restoration times.[39] One means of shortening the delay time associated with clearing the ABF condition is to apply a three-phase ground at the substation to blow the fuses on the closed network protector as a means of isolating the secondary system from the feeder. The fuses are selected so that they are coordinated with the cable limiters on the secondary cables in the network grid such that the fuses will operate before the limiters during back feed conditions. However, should open-mains be present or under multiple contingency conditions the designed current flows in the secondary mains will not be as calculated and the coordination on the respective blowing curves may shift. Undesirable initial limiter clearing will often lead to cascading clearing of the remaining limiters rather than blowing of the target fuse. Because of these concerns, the application of a three-phase ground to clear ABF conditions during multiple contingencies should be carefully considered due to the potential for damage to the already weakened secondary network cable system.

There are three basic reasons that a network protector will fail to open as there will always be sufficient reverse power flow to operate the network protector relays. A network protector can fail to operate because of a mechanical problem or an electrical problem, or because of

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[39] This condition results when the primary feeder remains energized from the secondary system because one or more network protector switches failed to open (remains closed). The back feed must be removed before the feeder can be processed and repair can begin and the feeder is ultimately restored to service. If the back feed needs to be cleared by field crews visiting suspect locations and ultimately opening the closed network protector or protectors it can take several hours. In Con Edison's October 12th Report it was stated that there were twelve occasions when a feeder remained alive on back feed that delayed the start of feeder processing by a total of 64 hours and 12 minutes.

insufficient secondary voltage to operate the network protector relays (see Network Protector section 3.2.4 infra). Under the condition wherein there was insufficient secondary voltage to operate the network protector relays, it should also be obvious to the operators that there will also be insufficient current available to operate the network protector fuses.

During the Long Island City network event, Con Edison applied a three-phase ground on four instances when feeders were ABF with the resultant clearing of only one of the ABF conditions (1Q16). This further confirms that there was insufficient back feed current available from the network cable system to operate the network protector fuses.

Recommendation:

FR-11 Based upon these additional, as well as previously-mentioned process failures, Con Edison should examine its training and testing program for Substation Operators and District Operators with particular emphasis on actions during stressful emergency conditions (see Recommendation FR-2, infra). Improvements need to be made to insure that the operators understand what the desired results of their actions are, as well as what undesirable consequences can result, so that they can make informed decisions that will not negatively impact the overall feeder restoration process or cause additional damage.

10. Summary

One of the most effective ways to maintain a high level of service reliability in an underground network distribution system is to keep all of the feeders in service or rapidly restore to service all of the network feeders supplying any given network. Figure 3.1.1 details the actual processing and restoration times for the Long Island City network event. Taking into account each time that a feeder was repaired and attempted to be restored to service as a process completion, the average feeder restoration time was 15 hours and 19 minutes for thirty-two events. Even while taking into account the unfaulted feeder restorations and the partial completions, this average does not meet the metric established by Con Edison as their target summer restoration time for a faulted feeder of twelve to thirteen hours. While Con Edison did face considerable challenges throughout the event, this important metric demonstrates that Con Edison was not successful in meeting this critical feeder restoration goal by more than two hours per feeder outage. Recalculating this metric based solely upon successful restoration of the feeders to service, the restoration time would be 22 hours and 17 minutes on average for twenty-two events.

The City's review of the restoration process has revealed a number of areas where there is room for the Company to improve. As an example, during the Company's summer preparation they did not completely prepare all substation equipment and tools to restore feeders, they did not effectively manage contractor work within the source substation, and they did not provide operators with adequate training and preparation to respond to the emergency operating conditions that the Company faced. As a result, the Company did not restore feeders to service in as effective a manner as possible. There are significant lessons that could be learned from this summer's events and a major effort must be undertaken by Con Edison to be better prepared on a system-wide basis to respond more effectively to the challenges that they may face next summer.

B. Transformer Cooling

1. Introduction

One of the functions of the Con Edison regional engineering team during a network multiple contingency is to monitor the status of the numerous transformers supplying the secondary network cable system. This team's principal source of information is the Remote Monitoring System ("RMS") that generally provides the network protector position (open or closed status), the loading of each phase, and some alarms on the status of transformers on the network (e.g., high water, oil in sump pit, etc.). In some instances (next generation RMS transmitters), the three-phase voltages may also be available. However, it was stated in Con Edison's October 12th Report that the original RMS transmitters represented the vast majority of the transmitters that were deployed in the field within the Long Island City network with only 48 of the next generation transmitter units being present (approximately 4%).[40]

When the regional engineering team determines that a transformer is loaded beyond its designated design rating (normal, first contingency, or second contingency), a review of the nearby transformers is performed to verify the loading level. In particular, they are looking for opportunities to reduce the load level by closing nearby network protectors that are open and should be closed or replacement of nearby blown network protector fuses. This review was hampered by the low reporting rate of the RMS system. The RMS only had a reporting rate of 79.5% at the beginning of the event, despite the system being designated by Con Edison to operate at 95% efficiency. The low report rate of the RMS greatly disadvantaged the regional engineering team in analyzing transformers that were not reporting. The low reporting rate of the RMS negatively impacted the analysis of directly reporting transformers and of nearby load pockets for transformers of interest.

After the engineering analysis is completed, locations are identified and prioritized for subsequent inspection by field crews. The number and prioritization of the transformers being identified by this process can shift and change as various feeders are restored to service or others are de-energized. This effort would be significantly enhanced and streamlined by an improved RMS reporting rate and the deployment of the newer generation RMS transmitters (including the associated new sensors) that have additional reporting capabilities such as the transformer oil temperature, oil level, tank pressure, etc.

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[40] October 12th Report, p. 5-110.

Recommendations:

TC-1 Con Edison should complete an appropriate inspection and maintenance program to improve the reporting rate of its RMS within the Long Island City network up to, at a minimum, its designated 95% reporting level before the beginning of the 2007 summer load period.

TC-2 Con Edison should improve the reporting rate of its RMS up to, at a minimum, its designated 95% reporting level on a system wide basis.

TC-3 Con Edison should expand the capability of the RMS transmitters by deploying the next generation transmitters that can provide information on the transformer operating temperature, the transformer pressure, the transformer oil level, as well as providing a voltage reporting capability.

Another tool utilized by the regional engineering team is a Real Time Transformer Temperature (RT3) program that calculates the hot spot and top oil temperature of the network transformers based on the present and historical RMS loading data. In addition to the present calculated temperature it also calculates the maximum top oil temperature that the transformer will reach within the next 24 hour period provided that no other contingency develops. These calculations are also dependent upon the data that is stored in the database which includes the size of the transformer, other nameplate statistics, and vault characteristics. If any of this data is incorrect or was not updated in the last transformer site upgrade, then the RT3 calculation will be incorrect. Other unknown physical factors also affect the calculation such as excessive debris in the transformer vault obscuring the air flow around the cooling fins of the transformer, blockages of the transformer grating, or other sources of heat which can also affect the accuracy of the calculations. Similar to what was stated above, these transformer temperature calculations are hampered by the low RMS reporting rate that limits the determination of estimates for units that are not reporting. Based upon the reports from the RT3 system additional transformer units are selected for field inspections and blended into the overall prioritized listing.

2. Long Island City Network Response

In the event that the regional engineering team and the responding field crews that have inspected a transformer found no opportunity to reduce the loading (and thereby the temperature) by actions to nearby transformers such as closing network protector switches or replacing blown fuses, they are usually then required to attempt to cool the overloaded transformer by other means. These actions are to be implemented in accordance with established Con Edison operating procedures. The prescribed methods for cooling overloaded network transformers installed underground within manholes and vaults, as described within the operating procedures, are by: (1) forced-air, using portable blowers; (2) water spray; or (3) flooding the manhole or vault with water. A newly developed method of cooling utilizes special mobile air conditioning units that circulate chilled air over the transformer to reduce top oil temperature. The flooding of transformer vaults or manholes is limited to submersible units (both transformer and network protector). Submersible transformers with ventilated network protectors can be water sprayed but not flooded.

The use of portable forced-air blowers is used almost exclusively for dry-type open coil transformers as the circulation of ambient temperature air is not very effective in reducing the transformer temperature. It must also be employed very carefully to insure that any loose debris in the vault is not blown into the open coils. This method may also be employed in cases where a mineral oil transformer is badly corroded or is suspected of not holding pressure.

By Company procedure, before spraying or flooding the manhole or vault, the inspection records of the transformer (CINDE) must be checked to ascertain that no corrosion is reported on the unit and that the transformer was successfully pressure tested during the last three years. If a visual inspection shows that there are no oil leaks, the unit is free of corrosion, and the records indicate that the transformer was previously pressure tested successfully, the transformer manhole or vault can be flooded. The final decision whether to spray or flood a transformer is ultimately the responsibility of the Supervisor on the site based on the actual inspection of the transformer unit.

The above steps are intended to prevent the introduction of water onto a transformer that may be porous and once cooled by water will naturally contract and may draw water into the tank. This result can have the potential of being extremely dangerous to both the responding Con Edison personnel and the public. If corrosion is reported, the submersible transformer cannot be flooded but could be air-cooled or carefully water sprayed.

The procedure also calls for the transformer manhole or vault to be inspected for visible oil leaks and oil stains and, if oil leaks and stains exist, they should be corrected before spraying or flooding in accordance with the provisions of operating procedure. This procedure is fundamentally flawed since it is highly unlikely that an overloaded transformer located within an enclosed space is going to be able to be accessed effectively by field crews or worked upon safely in such a confined space. Furthermore, it is doubtful that the verification of successful pressure test within the last three years is sufficient assurance that the overheated unit is not porous and will not draw in water when being cooled. The presence of positive pressure should be verified in the transformer at the time just before water is applied (via spray or flooding) onto an overloaded transformer.

Con Edison's procedure also requires that network transformers that were either water sprayed or flooded during emergency conditions should have their oil tested within 48 hours following the emergency and the test results evaluated within the subsequent 48 hours. This testing is to ensure that the water content and dielectric strength of the oil in the transformers are within allowable limits. If unacceptable readings are obtained, the transformer should be de-energized, live-end-capped and replaced promptly. Network transformers that were sprayed or flooded during a contingency should not be sprayed or flooded during a subsequent contingency unless the transformer oil was tested after the first spraying or flooding and found suitable.

This procedure should be reviewed and modified as required to reflect the above changes as well as other lessons learned from this event. Also, as recommended above, Con Edison should expand the capability of the RMS transmitters by deploying the next generation transmitters that can transmit information on the transformer operating temperature, the transformer pressure, and the transformer oil level as rapidly as possible.

<u>Recommendation:</u>

TC-4 Con Edison should improve its formal plans for operating networks under multiple contingency conditions including criteria for cooling of network transformers.

Flooding of a transformer vault or manhole should cause the transformer to cool. If the overload period is expected to extend beyond one load cycle, the water should be replenished with fresh cool water on a periodic basis. If the network transformer vault is reported steaming excessively or exhibiting other unusual behavior the transformer may be defective. The vault area should then be immediately barricaded and the primary feeder should be taken out of service under the Off On Emergency ("OOE") rules depending on loading or contingencies in the network.

From Monday, July 17, to Friday, July 21, during the Long Island City event field crews cooled 75 transformers. A number of additional transformers were addressed through the closing of nearby network protectors or replacement of blown fuses. Seventy-three of these transformers were cooled through the use of water. Two transformers were air cooled utilizing two air conditioning units at the same time and reportedly succeeded in cooling the units by approximately 10 to 15 degrees within a couple of hours. It was also reported that seven transformers that were overloaded during the incident eventually failed in-service (short circuited).

3. Summary

Con Edison appears to have managed the transformer cooling effort in an effective manner. Perhaps additional skilled resources could have expedited the initial response, but due to the varying number and magnitude of the feeder contingencies the prioritization of the transformer cooling response was subject to change. The cooling options utilized by Con Edison personnel appear to be reasonable and they are to be commended for their efforts to establish a better method of providing for emergency cooling through portable air conditioning units. However, the Company should continue to investigate alternative methods of providing this cooling, including through a thermal cooling blanket or improved air conditioning that has increased efficiency. The use of ice or dry ice should be avoided due to the localized nature of the cooling and the inherent issues involved in the handling of dry ice.

Finally, every effort should be made to complete the required post cooling oil tests as quickly as possible to insure that transformers with compromised dielectric strength are not kept energized. Consideration should also be given to procedurally requiring that all water cooled units be barricaded until the required testing is completed.

3.3.5 Demand Reduction and Voltage Reduction

A. Demand Reduction

Demand reduction is a process whereby customers are requested to voluntarily reduce their energy consumption in an effort to ensure there is sufficient capacity on the system for other customers during times of capacity shortages or system emergencies. Demand reduction is most often used on days when consumption is at its highest and there is insufficient supply to meet forecasted demand. Demand reduction may also be used during system emergencies when there is a need to quickly reduce the total demand being placed on a system. Con Edison has stated that they have in place or participate in a number of demand reduction programs, including the following:

- Targeted Demand-Side Management ("DSM") program;
- NYISO's Emergency Demand Response ("EDRP") and Special Case Resources ("SCR") programs;
- Con Edison's Distribution Load Relief Program ("DLRP");
- Direct Load-Control ("DLC") program; and
- Two-step voltage reduction (i.e., 5% and 8%).

In an effort to reduce the load on its Long Island City network, Con Edison initiated a number of demand reduction programs. As part of this initiative, Con Edison made direct requests to large and small commercial customers and requests to customers to move to alternate sources of supply wherever available. Con Edison employees in the field also made direct appeals to individual customers and appeals were broadcast by the NYPD using mobile public-address systems and public appeals were made through the broadcasting media to reduce usage, and voltage reduction.

Table 3.3.5-1 below lists the various demand management resources available to Con Edison during the Long Island City event and the impact they had on reducing customer demand.

Table 3.3.5-1 – Con Edison Demand Reduction Methods and Estimated Results[41]

	Demand Reduction (MW)			
Demand Management Resource	**July 17, 2006**	**July 18, 2006**	**July 19, 2006**	**July 20, 2006**
Voltage Reduction of 8%	21.0	16.9	12.3	12.0
Voluntary Demand Reduction	0	0	0	0
Company Facilities in Long Island City	0	0.4	0.4	0.4
Customers	0	31.3	70.6	48.3
Demand Shedding	0	0	0	0
Emergency Demand Response (EDRP) And Special Case Resources (SCR)	0	12.9	12.9	0
Distribution Load Relief Program (DLRP)	0	0.5	0.5	0.5
Direct Load Control (DLC)	0.6	0.6	0.6	0.6
Maximum estimated Demand Reduction	**21.6**	**62.6**	**97.3**	**61.8**

As demonstrated in Table 3.3.5-1 above, the estimated results from the Direct Load Control had an insignificant impact on reducing demand in the Long Island City network. The largest contribution to load reduction was provided by the customers' voluntarily load reduction and also by some unaccounted load reduction.[42] It is possible that some of the unaccounted load reduction may have been caused by the wide-spread customer outages, and some may be due to voltages which were even lower than what was intended by Con Edison through the implementation of voltage reduction, as explained later in this report.

B. General Discussion of Voltage Reduction

In general, reducing voltage will reduce the power feeding the loads. Historically, utilities use voltage reduction for peak load reduction in cases of generation shortages. However, for distribution contingencies, voltage reduction must be used with careful planning and in coordination with other control actions. Successfully using voltage reduction requires good knowledge of the impact that its use will have on the system and adequate modeling and forecasting of the loads.

The common notion in implementing voltage reduction is that reducing power and reactive power will also reduce current, which is true when the kW and kvar are "disconnected" from the circuits. However, it is not always the case when the kW and kvar are reduced by voltage reduction. When the voltage is reduced, the current flowing through the load-feeding circuits may either decrease or increase. This depends on several factors, such as:

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41 Data provided in Con Edison's October 12th Report, Table 4-8, p. 4-53.

42 *Id.*

- the real-load-to-voltage and reactive-load-to-voltage sensitivities;
- the load power factors; and
- the level to which the voltage is reduced.

As explained later in this section, it is assumed that Con Edison's initiation of voltage reduction was intended to reduce the current in the Long Island City network. A general discussion on the impacts of different operational parameters on the current-to-voltage dependency is presented in Appendix 9.

C. Impact of Voltage Reduction on the Long Island City Network

On Monday, July 17th at 1854 hours Con Edison initiated voltage reduction and maintained voltage reduction until Sunday, July 23rd at 0815 hours. The continuation of voltage reduction beyond the network being returned to a zero contingency could have contributed to the continuing problems experienced by the network customers after the primary feeders were restored.

When Con Edison initiated voltage reduction on July 17th at 1854 hours the Long Island City network was in a fifth contingency. The load normally fed by the disconnected feeders was being supplied through the remaining feeders, distribution transformers, and the secondary network. This equipment was not designed to feed this additional load. As a result, certain low-voltage mains and distribution transformers could have become overloaded. The voltage drops in those distribution transformers and secondaries which picked up the additional load would have increased and the voltages at the customer terminals, especially those at the remote points previously supplied from the disconnected feeders, might have already dropped below their normal limits. While the voltages at some customer terminals were already below normal, Con Edison initiated an overall voltage reduction in the Long Island City by 8% with the intention of reducing load.

In general, voltage reduction is a means to reduce load. However, reducing voltage did not necessarily mean that the currents flowing through the secondaries and through the distribution transformers would also be reduced. At some load points, where the voltage was already below normal due to several feeders being out of service, such additional voltage reduction could lead to motor stops and lead to an increase in reactive loads. The measurements of the feeder currents after the initial voltage reduction showed that in 10 feeders the current was increased and in 7 feeders the current was reduced. While it could not be concluded that all these low-voltage problems were caused by the voltage reduction action, it did suggest the following:

- the voltage reduction did not reduce the currents going through the secondaries and or the current flowing through the distribution transformers;

- the voltage reduction would increase the probability of the voltage dropping below the load stability limits (i.e., when the motors stalled) and overloading the secondary mains. This in turn might have caused a fault and a fire on the secondary system, which in some cases caused a primary feeder to fail. (e.g., as in Con Edison Report Case No. 5); and

- with each loss of an additional primary feeder, the loading of the secondary circuits increased, causing the voltage to be reduced even more.

The high impedance of the secondary system (some of which was damaged), coupled with the increased load current flows, in some cases caused low voltages at the network protectors. Under these conditions some of the network protectors did not operate. It was later reported that voltages were very low, as low as 26 volts in one case.[43] The currents available were below what was required to blow the fuses; and, as reported by Con Edison, if the voltage was below 60 volts, electromechanical network protector relays would not have operated and solid state network protectors would not have operated below 50 volts. Microprocessor relays would have operated down to 13 volts.[44] In some cases in order to clear these backfeeds the Company utilized the application of three phase grounds at the substation. Due to the low reverse current available from the network through the network protectors, fuses would not blow. The additional fault current running through the secondary system, as a result of the three phase ground at the substation, loaded the circuits and lowered the voltage even more. The initiation of an 8% voltage reduction did not accelerate the Long Island City network returning its feeders to service. An analysis of the Long Island City situation regarding the voltage reduction effect, based on the available information, suggests that the voltage reduction applied by Con Edison from July 17 through July 23 most likely did not reduce the over-current in the affected areas and possibly contributed to additional problems caused by already low voltages in these areas. Appendix 10 provides additional analysis of the available data that was examined in making this conclusion.

Recommendations:

VR-1 If Con Edison plans to continue using voltage reduction for unloading distribution circuits, which should mean reduction of current, the Company should perform studies to determine the conditions under which the voltage reduction would be effective for this specific objective, if at all.

VR-2 Con Edison should perform a thorough field and empirical analysis to determine the effects of voltage reduction on actual voltage and current in the network under severe contingencies.

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[43] October 12th Report, p. 5-47.

[44] October 12th Report, p. 5-46.

VR-3 After the aforementioned analyses are completed, Con Edison should develop a set of specific operating procedures and specifications to provide clear rules for the use of voltage reduction in response to distribution system contingencies. Such procedures should take into account the effect of voltage reduction on all system components as well as customers that may already be experiencing sub-standard voltage due to a multiple contingency.

As previously reported, Con Edison's system was restored to a zero contingency on Friday, July 21st. Despite the network being restored to a zero contingency condition, the Company maintained voltage reduction for two additional days, after all primary feeders were restored to service until July 23rd. The Company's action of maintaining voltage reduction after the network was restored to service negatively impacted customers that were experiencing low voltage service conditions due to damage to the secondary network. Furthermore, once Con Edison made the decision to disengage the voltage reduction system it took the Company approximately four hours to successfully do so. In summary, Con Edison's voltage reduction system failed both when the Company attempted to use it to reduce load and also when the Company attempted to disengage voltage reduction from the network.

3.3.6 <u>Mobilization and Coordination of Field Resources</u>

A. Introduction

Throughout the initial phases of the Long Island City network event, Con Edison personnel concentrated their attention and resources towards the expeditious restoration of the primary feeders that were out of service. For the most part, the personnel and tools available to them were directed towards this goal. They utilized a variety of methods to expedite the feeder restoration process including the isolation and dropping of feeder portions to restore the unfaulted portion to service, and the use of above ground primary cable shunts to bypass other faulted portions thereby reducing both the processing and repair times.

Unfortunately, the Company's focus on restoring the primary system appears to have limited their view of the secondary network cable system. Backlogs of work were created in the secondary area for customers reporting outages, low voltage conditions, flickering lights, manhole events, etc. Not until the evening hours of Wednesday, July 19, 2006, were the increasing volume of trouble tickets plotted on operating maps by engineering personnel and additional focus directed towards this area of the system. On Thursday, July 20, 2006, as the realization that significantly more customers were out of service or being provided inadequate voltage, a night time survey was ordered that then confirmed this condition. The night time survey resulted in an increase in the estimated number of customer outages from roughly 2,000 to approximately 25,000 customers. At this point, the Company began to deploy additional personnel to address the secondary system. This effort was further increased as the feeders were restored to service and the contingency level reduced.

B. Feeder Outage Response

Beginning with the failures of feeders 1Q17 and 1Q16 on Monday, July 17, 2006, the initial phase of the Long Island City network event was driven by outages of 27 kV primary feeders supplying the load area. The majority of Con Edison's efforts, beginning with first feeder outage at 1550 hours on Monday, July 17th until eighty-eight hours later at 0801 hours on Friday, July 21st when the Long Island City network was restored to a zero feeder contingency was directed towards the restoration of these primary feeders. It was Con Edison's stated primary goal to restore these primary feeders to service as rapidly as possible.

The primary feeder restoration process also included a number of process changes designed to reduce either processing or repair time, such as the following:

- Additional substation operating personnel were deployed to the North Queens substation to address the increased volume of feeder processing. This included substation operators, substation mechanics, and protective systems technicians.

- Live end capping ("LEC") a portion of the feeder believed to contain the fault by separating the transformer or cable connected to the damaged component and insulating the end of the feeder proper to permit restoration of the majority of the feeder to service.

- Reducing the feeder identification process through the use of pre-installed known point splice locations or the use of expedited feeder processing techniques permitted under emergency conditions within the Con Edison operating rules.

- Installation of above ground primary cable shunts to bypass faulted portions to reduce repair times. This is particularly effective when the underground conduit is obstructed and new cable cannot be installed without first excavating and installing new conduits.

- Application of three-phase substation grounds to clear alive on back feed ("ABF") conditions on feeders that had network protectors fail to operate properly. This action is intended to operate, blow, the network protector fuses to clear the source of the back feed and then permit the feeder processing to continue.

- Utilization of additional mobile high voltage test sets and the application of ground and test leads directly to the feeder potheads in order to process multiple feeders simultaneously.

- The rapid restoration of distribution feeders was also attempted in a number of cases. During this process a selected feeder that had opened automatically was immediately restored to service by closing its associated circuit breaker.

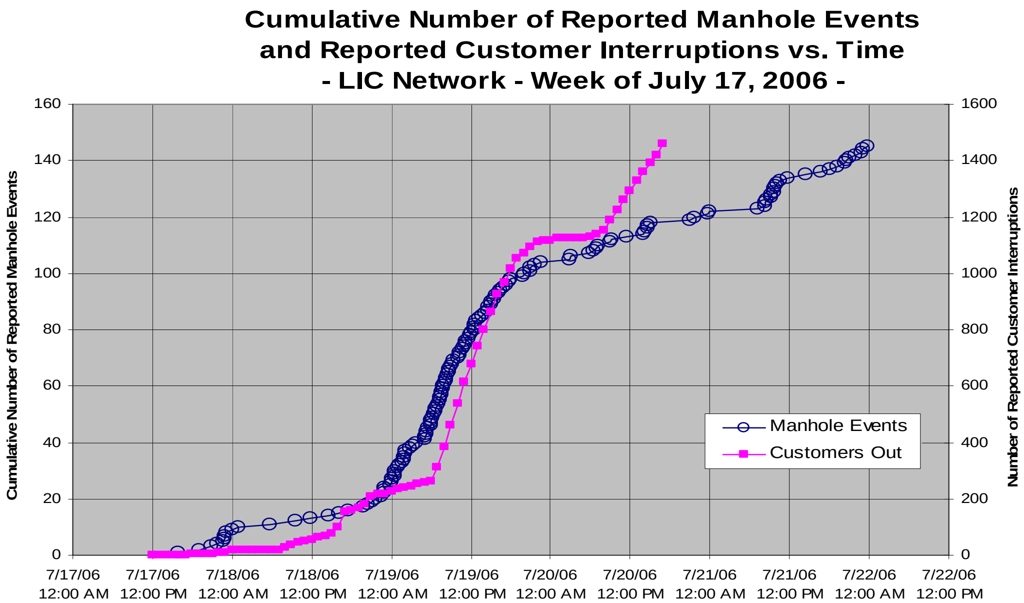
The Con Edison response to the primary feeder outages during the event appears to have been aggressive and adequate.

C. Secondary System Response

With its focus squarely on restoration effort on the primary system, Con Edison did not direct enough attention in a timely manner towards the problems it was encountering on the secondary system. During the evening hours of Wednesday, July 19th, as feeders were being restored and a more positive feeder contingency trend was being established, the Brooklyn/Queens engineering group finally began to review all of the trouble tickets that were being received for the Long Island City network. The locations of these trouble tickets were mapped on to operating plates in an effort to combine tickets into jobs that would address as many customers as possible at one time. This effort also allowed the Company to locate and identify the areas of damage to the secondary cable system and to begin to understand not only the magnitude of the problem, but also the number of customers potentially out of service or not receiving a useable voltage supply. This visual representation provided an identification of three areas of concentrated trouble tickets. These areas came to be designated as the three response zones.

During the initial phase of the Long Island City network event the emergency response crews were dedicated to the response to manhole events with priority given to those with Fire Department units on site awaiting relief by the Con Edison crews. As the number of these events continued to escalate many of the other trouble ticket items were backlogged pending the availability of crews for response. The rising number of reported manhole events (e.g., explosions, fires, smoking structures) and customer outages should have alerted Con Edison control center and management personnel to the growing problems within the secondary cable system in the early hours of Wednesday, July 19th as demonstrated by the graphical representation shown in Figure 3.3.6-1 below.

Figure 3.3.6-1



Had sufficient response personnel been mobilized at this point in time Con Edison would have been able to address the secondary damage and customer outage approximately two days in advance of when they actually began to respond appropriately to these events.

Following the Thursday overnight survey, Con Edison finally realized that the customer outage count was dramatically understated and the magnitude of the secondary system damage was much greater than it initially thought. As a result, in response to the actual magnitude of the electric system conditions, the response to this portion of the system was finally initiated at the appropriate level on Friday, July 21st.

The three identified zones were organized under a zone manager who took responsibility for coordinating all of the work activity within his respective area. This included field damage assessment, customer outage restoration, and all pertinent activities including mobile generator installation and connection, shunt installations, limiter repairs, cable installation, cable splicing, and transformer inspection and repairs. In addition, a centralized command site was established for the crews to meet and receive direction. Engineering, clerical, facility, and other support personnel were assigned to insure that these crews were self sufficient.

The Con Edison workforce, which was now drawn from all of the regions within the Company, was now supplemented with both mutual assistance and contractor personnel. Mutual assistance crews from neighboring utilities began to arrive on Friday, July 21st and continued to arrive through Sunday, July 23rd. In total, 75 underground mutual assistance crews were reported to have arrived from eight different utilities, with approximately half of the total coming from PSE&G. Additional crews also arrived at later dates, in response to another request for assistance. These additional crews were assigned to assist in the recovery effort after all of the customers had been restored to service. Contractor personnel were deployed from four different companies representing an additional 55 underground crews. At the peak of the repair effort, there were reported to be over 600 Con Edison, contractor, and mutual assistance crews deployed and working on the secondary system restoration effort within the Long Island City network.

This mobilization and deployment of resources demonstrated the capability of Con Edison to respond to significant events on their electric distribution system. It was substantial, dedicated, and directed towards the secondary cable system and the associated customer outages and substandard voltage conditions. Had this attention been directed towards this effort on a timelier basis, and in conjunction with the primary system restoration, the hardship that many customers endured could have been significantly reduced.

By midnight on Tuesday, July 25th, all customers were restored to service. This was approximately 200 hours or eight and one-half days after the start of the event the previous Monday afternoon. Even with all customers restored to service Con Edison was still facing significant challenges to restore all customers to permanent service as many customers were being supplied by service cable shunts or from emergency diesel generators. In addition, Con Edison needed to continue to make permanent repairs to remove above ground feeder cable shunts, pick up dropped portions of feeders, replace failed secondary cables, inspect and repair secondary cable limiters, replace defective transformers, and perform maintenance tasks on transformers that were loaded beyond their ratings during the event. Five months later, in January 2007, these permanent repairs are still ongoing.

D. Summary

Utilizing experience from previous multiple contingency events, Con Edison addressed its initial efforts towards the restoration of the faulted network primary feeders to service. With this initial focus, the Company utilized all the available tools and resources at its disposal to advance these efforts and made choices that relegated response to the network secondary cable system to a subordinate position.

The failures with respect to the secondary system were, in part, driven by the lack of an effective control center visualization tool that was capable of combining multiple information sources from currently available information on the secondary system as well as the trouble ticket (ECS) system and then presenting the operating information in a clear and easily understandable format. However, even accounting for the absence of this additional information, the Company failed to pay attention to the information that it did have pertaining to the secondary cable system and the increasing number of customer service outages. Virtually no attention was directed towards this component of their delivery system, other than to respond to requests from the Fire Department to address manhole events. Only after the feeder restoration process was well in progress was a response developed to address the secondary work at a reasonable level. Only after the Thursday overnight survey, which provided a realization of the magnitude of the damage to their secondary cable system and the large number of customer outages, was an adequate response plan developed and executed.

What needs to be assured, however, is that better information and visualization tools are put in place as rapidly as possible to ensure that during any future extreme multiple contingency condition, operating personnel have a better understanding of the conditions within the secondary system that are affecting the service supply to their many customers. In this way, appropriate resources can be mobilized and deployed to address the conditions within the secondary system in a more responsive way to limit the impact on customers.

Recommendations:

M-1 Con Edison should improve the way in which critical information is accumulated and presented to the control center operators especially with regard to secondary network events and customer service problems (e.g., outages, side out, low voltage, etc.).

M-2 Con Edison should expand the use of visualization tools to combine multiple information reporting systems and improve the way that critical operating information is presented to the control center operators.

M-3 Con Edison should develop and implement appropriate technology and / or systems to identify network distribution customers that are out of service (one or more phases) or are being provided inadequate voltage on a real-time basis.

M-4 Con Edison should begin the deployment of a representative population of the Secondary Underground Network Distribution Automation System (SUNDAS) system to provide three-phase voltage information on the condition of the network secondary cable system within each of their distribution networks.

M-5 Con Edison should utilize the voltage readings obtained from the RMS system and from the customer service points and develop an appropriate system algorithm to identify lost customer load as an indicator of customers out of service.

3.3.7 Network De-Energization Decision

A. Background

One of the most difficult decisions a manager can make in a network is the decision to shutdown the network. In making this decision, an operator has to carefully balance damage to the network and equipment if the network remains in service versus the social, economic and practical implications that result from a network wide outage. There is rarely a clear choice. The decision becomes essentially a selection between two undesirable outcomes. Generally, when a network is under distress, a wide range of options have already been exercised; including some or all of the following: increased rating actions including equipment cooling actions, institution of an 8% voltage reduction, direct calls to all major customers asking for load reduction, issuance of public appeals for reduction of non-essential loads, urgent requests to all hospitals and other large load customers with known emergency generators to switch their load to their emergency supply, identification and disconnection (open network protectors) of isolated and spot network loads.

The decision to shutdown a network must primarily be driven by information regarding the extent of the conditions immediately impacting the network, the potential damage that is occurring or may occur to the system and equipment, the consequences of this damage including the time to complete repairs, the expected timing of relief actions (i.e.: feeders being returned to service), as well as the load pattern for the network (i.e.: projected increase or decrease of load in the near term).

The above system considerations must be weighed against the negative impact that a network shutdown will have on the entire community served by the network including critical customers such as those with Life Sustaining Equipment ("LSE"), hospitals, airports, sewage plants, transit facilities, cooling centers, and police, fire and other City agencies. Additionally, this decision should include a consideration of the impact it will have on non-customers. For instance, riders of mass transit, vehicles dependant on area bridges and tunnels and other non-customers of a network that will be affected by a network shutdown. This impact will be further compounded should the shutdown be initiated without significant advance warning and preparation to allow sufficient time for the responding City agencies to prepare for the shutdown. There is the potential for special care customers to be stranded, elderly people to be trapped in high rise locations, people to be hurt in the dark or trapped in elevators, and the loss of water supply to many buildings. Significant resources will be needed to provide assistance, provide required police presence, and even direct traffic to protect the people within the community. There will also be further longer-term economic impacts to the community and the local businesses.

B. Analysis

Throughout the Long Island City network event, Con Edison personnel concentrated their attention and resources towards the expedited restoration of the primary feeders that were out of service. Many of the tools enumerated above were utilized to keep the network load as low as possible to assist in minimizing damage to the network and to keep the network in service.

The Company's actions assisted in limiting the total load on the network at the substation to below its 2006 peak summer forecast of 395 MW. Additionally, these actions assisted in maintaining the primary feeder loading to levels that did not significantly exceed their emergency ratings. While the loading levels on the network and the equipment greatly exceeded the system's design contingency conditions, the Company decided to maintain the network in service.

While this total focus was commendable, it appears to have limited the Company's view of the secondary network cable system. As a result, backlogs of work were created in the secondary area for customers reporting outages, low voltage conditions, flickering lights, and manhole events. Only during the evening hours of Wednesday, July 19th, were the increasing volume of trouble tickets plotted on operating maps by engineering personnel. There were no tools or systems in place at the Brooklyn/Queens Control Center to automatically create a visual display of this information. Similarly, no computer generated network feeder composite map was reportedly available at this control center to visualize the changing feeder outage conditions as was subsequently produced for illustration of the numerous cases within section 3 of the Company's October 12th Report. The operator's view of the Long Island City network transformers was further limited by the below standard reporting rate (79.5%) of the Remote Monitoring System.

Recommendations:

ND-1 Con Edison should improve the way in which critical information is accumulated and presented to its control center operators especially with regard to secondary network events and customer service problems (e.g., outages, side out, low voltage).

ND-2 Con Edison should immediately take steps to improve the way in which critical information is visually presented to the Brooklyn/Queens Control Center personnel through the installation of a large screen projector display system similar to what is installed within the other regional control centers but compatible with the space limitations at this location.

ND-3 The Company should expand the use of visualization tools at its control centers to combine multiple information reporting systems and improve the way that critical operating information is presented to the control center operators.

ND-4 Con Edison should improve its formal plans for operating networks under multiple contingency conditions including criteria for evaluating the secondary network cable system, manhole events, customer outages, and the level of secondary voltage supply to their customers. Improved guidance needs to be provided to determining when a network load area should be de-energized.

ND-5 The Company should consider the creation of a dedicated engineering team directed towards the evaluation of the secondary network cable system during multiple feeder contingencies to ensure that appropriate attention, evaluation, and planning is directed towards this area while immediate efforts are directed towards the restoration of the primary feeders.

C. Conclusions

The decision on whether to shut down a network should be made in the context of all available information, including information on the secondary system. It appears that in this instance, the Company did not have all the necessary information to make an informed decision. This Report has suggested the need for better systems to provide better information, including, among other things, an effective control center visualization tool that is capable of combining multiple information sources from currently available information on the secondary system, as well as the trouble ticket (ECS) system, and additional sensors, transmitters, and systems to gather and provide information on the status of the secondary system (e.g., load, voltage, temperature, etc.) and the service characteristics that are being supplied to their customers.

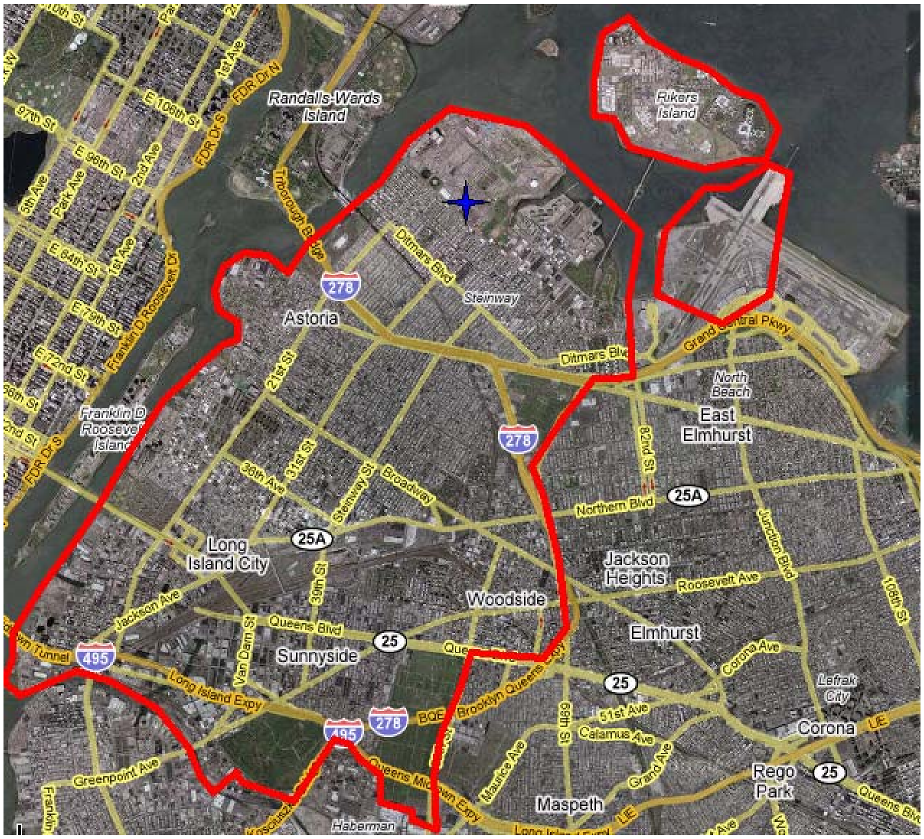
However, even in retrospect, it is impossible to state that a different course of action may have been more appropriate had this information been available during the Long Island City network event to the Con Edison operating personnel making the network de-energization decision. The recommendations set forth herein should assure that better information and visualization tools are put in place as rapidly as possible to ensure that, during any future extreme multiple contingency condition within the Con Edison service territory, operating personnel have a better understanding of the conditions within the network secondary system upon which to base their decisions.

4.0 Past Performance and Future Network Planning

A. Description of Long Island City Network

The Long Island City network feeds a mix of predominantly residential and commercial customers in the Northwest portion of the Queens borough of New York City. Figure 4-1 below shows the approximate geographic area served by the network. The network is supplied from the North Queens substation, located in the northeastern part of the network area.

Figure 4-1 – Approximate Geographic Area Served by the Long Island City Network[45]



Information about the Long Island City network is listed in Table 1 below.

Table 4-1 – Overview of Long Island City Network

Primary Feeder Voltage Level	27.0 kV
Secondary Network Voltage Level	120/208 V
Number of Primary Feeders	22
Number of Network Transformers	1198
Number of Customers	115,000 approx.
Population in Area	285,000 approx.
Peak Demand*	390 MW (2005)
Residential Customer Accounts**	94,621
Small Commercial Accounts**	14,750
General Large Commercial Accounts**	5,548
Other Accounts**	475

45 Aerial imagery provided by Google maps.

* Peak demand in 2006 was 381 MW.
**Number of accounts as of August 20, 2006. Data provided by Con Edison in response to Staff Interrogatory 17 (dated: August 21, 2006).

The blue star in Figure 4-1 represents the location of the North Queens Substation. Importantly, this substation is asymmetrically located in the network. The Long Island City network when compared with other networks on the Company's system has the highest connected capacity and demand per feeder, as well as the second highest number of customers and the third highest number of primary feeder cables miles.[46]

In 2006, it was estimated that residential load would peak at approximately 100 MW and commercial load would peak at approximately 300 MW. Entities that are at least partially supplied by the Long Island City network include the Metropolitan Transit Authority (MTA), Long Island Railroad ("LIRR"), LaGuardia Airport, Rikers Island Correctional Facility, the Bowery Bay Wastewater Treatment Plant, and the Triborough Bridge and Tunnel Authority.

4.1 Historic Network Performance

A. Customer Reliability Performance

The electric power industry commonly measures the reliability of customer service by two indices: (i) the System Average Interruption Frequency Index ("SAIFI") (or how many times is a typical customer without power in a year); and (ii) the System Average Interruption Duration Index ("SAIDI") (or how many hours is a typical customer without power in a year) The SAIFI and SAIDI indices for the Long Island City network for 1999 through 2005 are shown in Table 4.1-1 below.

Table 4.1-1 – Customer Reliability Indices for the Long Island City Network[47]

	1999	2000	2001	2002	2003	2004	2005
SAIFI (interruptions/yr)	0.002	0.002	0.004	0.002	0.002	0.001	0.002
SAIDI (minutes/yr)	0.6	0.5	1.0	0.6	0.7	0.3	0.7

Underground secondary network systems provide the best reliability of the common types of electric distribution systems. Customer interruptions on underground secondary network

[46] October 12th Report, p. 2-6.

[47] Based on Con Edison's response to Staff Interrogatory 21 (dated: August 21, 2006).

systems are typically caused by low-voltage service connection problems. Customer interruptions caused by primary feeder problems are rare. The Long Island City's network performance has been typical of secondary network systems. There was no noticeable trend in the SAIFI or SAIDI indices for the network from 1999 through 2005. Moreover, Con Edison reports that the Long Island City network had better SAIDI performance than the Company's average network for each of the past 5 years.[48]

B. Number of Open-Auto's and Feeder Outage Hours

As previously discussed, open-autos is a term used to describe the automatic operation, or opening, of a primary feeder circuit breaker. The most common cause of open-autos are faults that occur on the primary feeder system, either feeder cable, splices, terminations, transformers, or other equipment. These faults usually create higher-than-normal values of current, frequently referred to as short-circuit current. Relays connected to the feeder circuit breakers in the substation sense the short-circuit current, and provide an indication to the circuit breaker that it should open automatically.

The number of open-autos is closely correlated with the number of faults that are occurring on the primary feeder system. Open-autos are undesirable because time and effort must be expended to determine the cause of the open-auto and to place the feeder back in service. Under high-load conditions, and/or conditions in which multiple feeders are out-of-service, open-autos have the potential to result in the additional risk of higher network equipment loadings and cascading equipment failures.

Feeder-outage hours indicate the number of hours that feeders are de-energized after an open-auto. The feeders remain de-energized while the process of repairing the feeder is performed. The feeder must first be isolated from all electric sources. Then the fault must be found, the work site must be secured for safety purposes, the repair work performed, and post-repair testing completed, all while the feeder is de-energized. After successful testing, the feeder may then be reenergized and returned to service.

Figure 4.1-1 below shows the number of open-autos and the feeder-outage hours for the Long Island City network from 1999 through 2005. A least-squares regression trend line is also shown for each quantity. The trend lines indicate an increase in the number of open-autos and feeder-outage hours for this period. In 2005, the quantity of open-autos was 71, which is 73% higher than the quantity of 41 open-autos reported in 2000. Similarly, the quantity of feeder-outage hours in 2005 was 3,039, which is 179% higher than the quantity of 1,088 feeder-outage hours reported in 2002.

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[48] October 12th Report, p. 2-13.

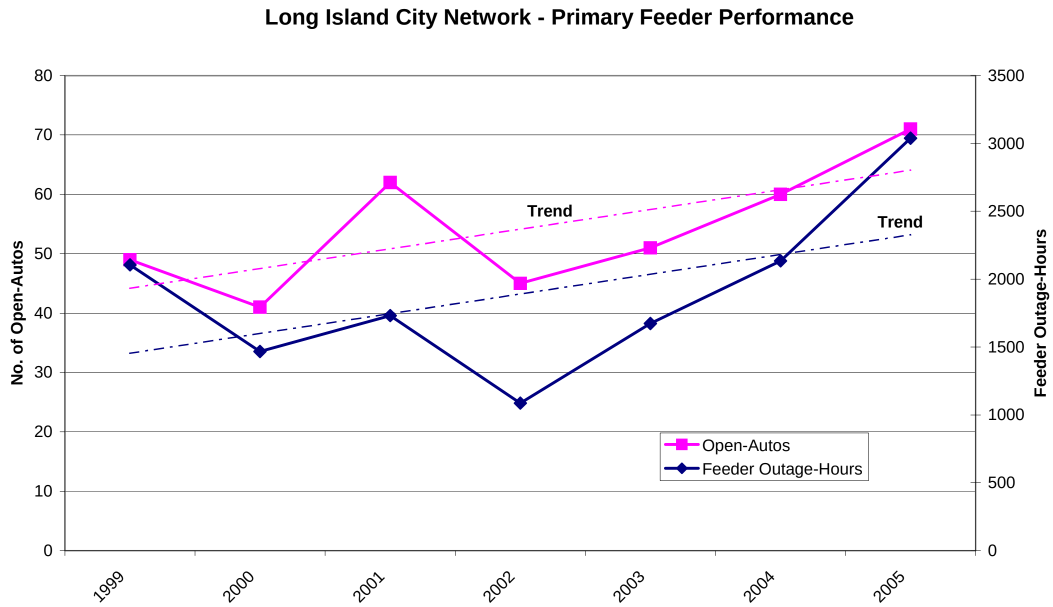


Figure 4.1-1 - Number of Open-Autos and Feeder-Outage Hours for Long Island City Network [49]

C. Cut-In Open Autos

As previously discussed, Cut-In Open-Auto ("CIOA") is the automatic opening of the feeder circuit breaker when an attempt is made to re-energize, or "cut-in," a feeder after it has been out of service. Usually CIOAs result from an additional fault that is present on the feeder. CIOAs are undesirable because they create a delay in re-energizing a feeder and require additional time and effort from operating crews to return the feeder to service. Under high-load conditions, and/or conditions in which multiple feeders are out-of-service, CIOAs have the potential to result in the additional risk of higher network equipment loadings and cascading equipment failures.

Table 4.1-2 below shows the number of CIOA's for the Long Island City network from 2003 through 2006.

[49] Based on Con Edison's response to Staff Interrogatory 21 (dated: August 21, 2006).

Table 4.1-2 – CIOA's for Long Island City Network and Remainder of Con Edison's Networks[50]

	2003	2004	2005	2006	Total
A. Long Island City Network – Total CIOA's	5	12	22	34	73
B. Average for Remaining Networks – Total CIOA's	1	2	3	2	8
C. Long Island City Network - CIOA/Feeder	0.23	0.54	1.0	1.5	3.3
D. Average for Remaining Networks – CIOA/Feeder	0.06	0.12	0.19	0.12	0.5
E. Row C / Row D	3.8	4.5	5.3	12.5	6.6

As shown in Table 4.1-2, from 2003 through 2006 the Long Island City network had 73 total CIOAs, compared to an average of 8 for the remainder of Con Edison's networks. Some of this difference can be attributed to the Long Island City network having 22 feeders, while the average number of feeders on Con Edison's remaining networks is 16. The number of feeders on Con Edison's network systems ranges from 8 to 29. Rows C and D from Table 4.1-2 above compare the CIOAs in the Long Island City network with the remaining Con Edison networks on a per-feeder basis. The CIOA/feeder for the remaining networks was calculated by dividing the average total CIOAs for the remaining networks by the average number of feeders. Omitting the year 2006, which is highly influenced by the Long Island City network event, Row E shows that for the period 2003-2005 the Long Island City network experienced approximately 4 or 5 times more CIOAs per feeder than the average for the other networks.

The CIOA/(OA + CIOA) index weights the CIOAs relative to the total number of open-autos and cut-in open-autos. The value for the Long Island City network from 2003 through 2006 was 27.2%, which was the highest on the Con Edison system during that period. The next highest network on the Con Edison system was 22.2% for the Battery Park network, which only had 2 OA's for the four year period. The third-highest network on the Con Edison system was 20.2% for the Grand Central network.[51]

Figure 4.1-2 below is a graph of Rows C and D from Table 4.1-2. Figure 4.1-2 illustrates the difference in the number of CIOA's on the Long Island City network and the CIOA's

[50] Data for Rows A and B were obtained form Con Edison's response to Staff Interrogatory 204 (dated: October 3, 2006); number of feeders per network were obtained from the Attorney General's Report investigating the 1999 Washington Heights outage (dated: March 9, 2000).

[51] Based on Con Edison's response to the Attorney General Interrogatory 12 (dated: November 7, 2006).

experienced by other Con Edison networks from 2003 through 2006. Figure 4.1-2 also illustrates that the number of CIOA's on the Long Island City network has been increasing since 2003.

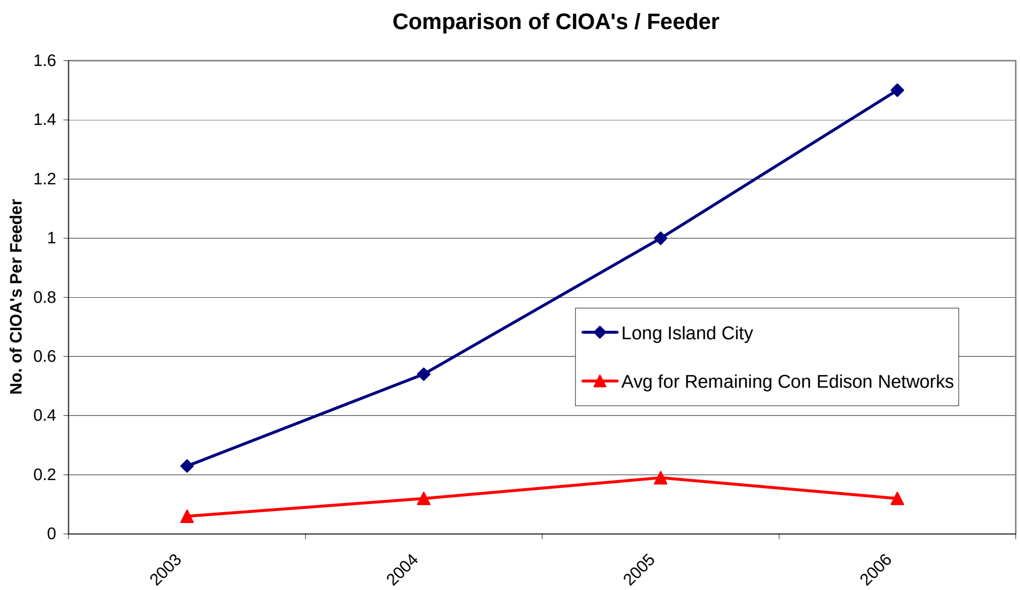


Figure 4.1-2 – Number of CIOA's/Feeder for Long Island City Network and Remainder of Con Edison Networks

The high number of CIOAs may be partially explained by the relatively long feeders on the Long Island City network. The average feeder length on Long Island City's network is 12.41 miles, which is approximately 2 times longer than the average feeder length of 6.05 miles for all of Con Edison's networks. But the average feeder length does not account for all of the difference between the number of CIOAs for the Long Island City network and the Company's other networks. The increasing number of CIOAs per feeder on the Long Island City network should have been a cause of concern for Con Edison and should have been analyzed by Con Edison before the summer of 2006.

D. Hi-Pot Index of Feeders

Con Edison has developed an index called the "Hipot index" to assist in prioritizing the feeders for Hipot testing the following year. The index is based on the failure rates and number of components with particular failure rates on a feeder, the number of open-autos the feeder experienced from June 1 to August 31 of the two previous years, the importance of the feeder in the network, and a measure of how uniformly the load is distributed in the network. Higher-ranked feeders (with "1" being the highest) are prioritized higher for Hipot testing.

Figure 4.1-3 below shows the average Hipot ranking for the Long Island City network feeders, compared to all Con Edison feeders. On average, according to this measure, the Long Island City network feeders rank consistently worse than the average Con Edison network feeder. A noticeable improvement was made in the Long Island City network average feeder ranking in 2004, but the average ranking has been declining since that time.

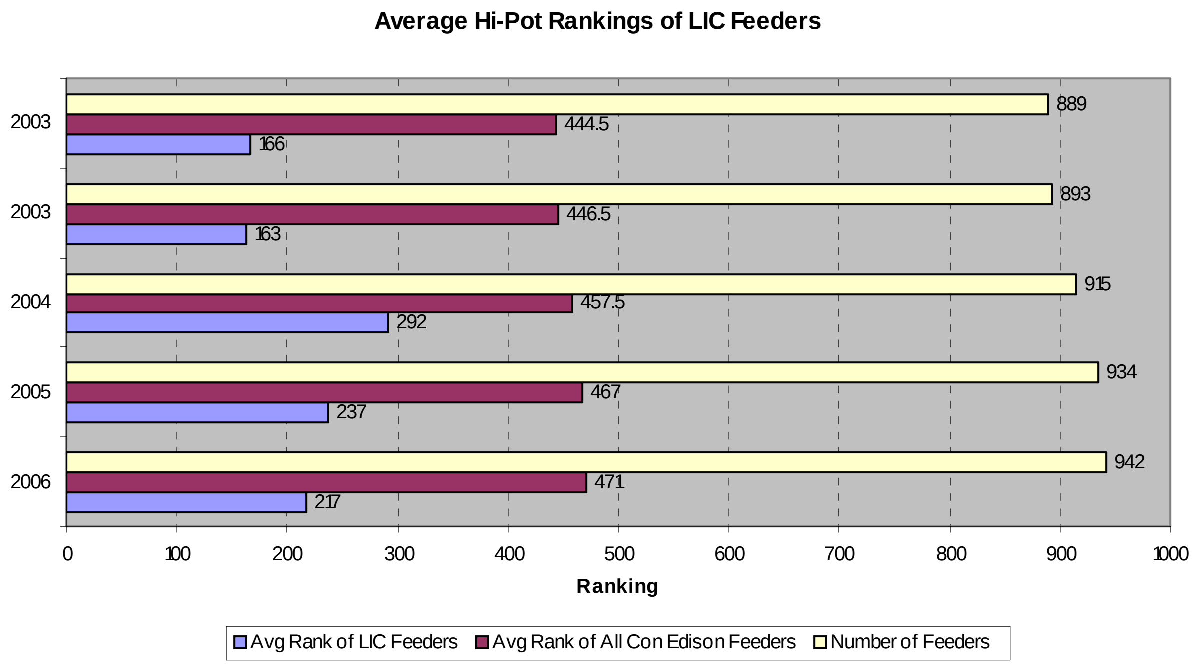


Figure 4.1-3 – Average Hi Pot Rankings of Long Island City Network Feeders Compared to All Con Edison Network Feeders[52]

E. Jeopardy Index

Con Edison has developed a Jeopardy Index to probabilistically assess feeder and network reliability. The relative reliability of networks are determined by estimating the probability for patterns of multiple associated feeder outages over time.

The Jeopardy Index rankings for the Long Island City network for the last five years are shown in Table 4.1-3 below. The networks are ranked 1 to 57, with the ranking of "1" being the lowest calculated network reliability. Table 4.1-3 shows that the Long Island City network consistently ranked as one of the least reliable networks.

[52] Based on Con Edison's response to Staff Interrogatories 71 and 72 (dated: August 23, 2006).

Table 4.1-3 – Long Island City Network Jeopardy Index Ranking[53]

Year	Jeopardy Ranking
2002	4
2003	6
2004	8
2005	8
2006	9

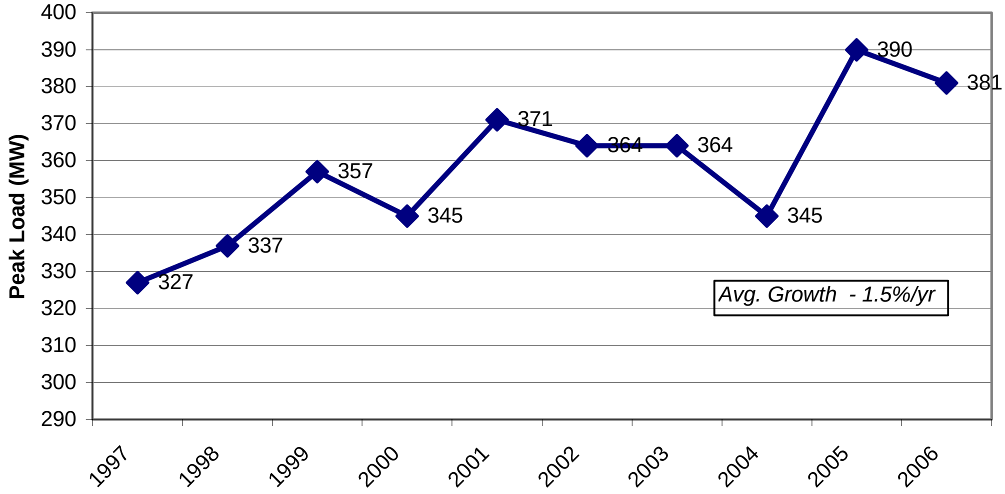
F. Peak Load Growth

Figure 4.1-4 below shows the growth in the annual peak demand on the Long Island City network for the past 10 years. The values shown are non-weather adjusted values. The average annual increase in peak demand of 1.5% per year is typical of areas in which the land has largely been developed, and growth results largely from increased demand from existing customers and small redevelopment projects.

The load growth can be stated relative to actual feeder loading. Each feeder on the Long Island City network carries an average of 17.3 MW (i.e., 381 MW/22 feeders). The total load growth of 54 MW over the last ten years is equivalent to the peak loading on three primary feeders. To accommodate the load growth, capital investments are made to add new services, and to increase the capacity of transformers, secondary mains, and primary feeders.

[53] Based on Con Edison's response to staff Interrogatory 68 (dated: August 16, 2006).

Figure 4.1-4 - Peak Demand Growth on Long Island City Network
Actual Peak Load (MW)



4.2 Future Plans for the Long Island City Network

Based upon past peak loads and weather conditions, the Long Island City network peak load is forecasted to be 406 MW in 2007, compared to the actual load of 381 MW in 2006 and 390 MW in 2005. This 2007 forecast represents an increase of 6.6% over 2006, and 4.1% over 2005. Con Edison will need to continue its investment in primary feeder, transformer, and secondary capacity to meet the network's increasing load.

Con Edison has announced its plans to construct a new substation in Queens, called Newtown, in 2015. With the establishment of that new area substation, the Sunnyside network will be created. The Sunnyside network will be created from the southern portion of the existing Long Island City network, as shown in Figure 4.2-1 below. Con Edison estimates that 230 MW will be transferred from the Long Island City network to the Sunnyside network in 2015.

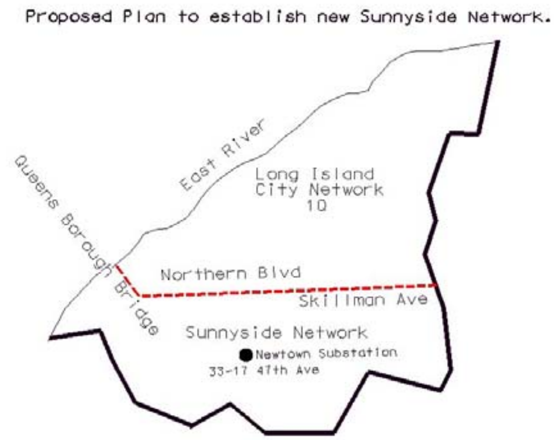


Figure 4.2-1 – Figure Showing Proposed Service Areas of the Long Island City Network and the Planned Sunnyside Network[54]

Low-voltage secondary networks are the most reliable type of electric supply in the utility industry for serving large quantities of customers. The following is an examination of some of the issues involved in the development of a new area substation and network.

A. Customer Impact

The Long Island City network serves customers for whom the impact of a network shutdown or conditions of severe low voltage is significant. During the Long Island City event, some of these customers were served by alternate supplies. For example, LaGuardia Airport is normally partially supplied by the Jackson Heights network. Circuit reconfigurations were performed, although with significant effort, so that additional LaGuardia Airport load was supplied by the Jackson Heights network. Riker's Island and the Bowery Bay Waste Treatment facility were both supplied by back-up emergency generators.

However, presently there are no practical ways of backing up the supply to the MTA subway lines and the LIRR in the area if the Long Island City network should be de-energized. There are a number of electrical converter stations that must be supplied to keep the trains operating, and signal and lighting power must also be supplied for rail operations. Planning of a new substation and a new network provides an opportunity to improve the operation of MTA and LIRR in the event of similar power outages.

The planning of the Newtown substation, and the Sunnyside network, should be completed with a consideration for the impact service disruptions may have on critical customers, specifically MTA and LIRR. The Company should consider designing its networks so that MTA and LIRR can continue to operate in this geographic area, even if the Long Island City network or the Sunnyside network should be shut down or experience power outages in

[54] Company Response to City Interrogatory 118 (dated: October 19, 2006).

portions of their networks. The proposed boundary between the Long Island City network and the Sunnyside network, shown in Figure 6, appears to be close to many of the MTA and LIRR lines in that area. Engineering analysis should be performed to determine how the supplies from these networks to the MTA and LIRR can be configured to provide adequate power in the event either network is de-energized or experiencing power outages in the network. Switching actions or mobilization of emergency generators to continue the supply to MTA and LIRR should also be considered in the development of the new network plans and contingency plans.

The Long Island City network presently serves 115,000 customers, which is the second highest number on the Con Edison system. When economically practical, the industry standard in electric power distribution engineering is to limit exposure, or the consequences of events, to as few customers or loads as possible. The construction of the Newton substation and the creation of the Sunnyside network will reduce the number of customers supplied by a single substation and a single network.

B. Substation Location and Feeder Length

The North Queens substation, which feeds the Long Island City network, is located towards the northeastern boundary of the network. In an ideal situation, the substation source is located near the center of the load that it serves. As a result, feeders in the Long Island City network are longer than they would be if the substation was located near the center.

The longer feeders increase the exposure and the likelihood of faults on the feeders. This increases the probability of OAs, as well as the chances of CIOAs. In recent years, the Long Island City network has experienced increasing numbers of OAs and CIOAs. As made evident during the Long Island City network event, during periods of high loading, OAs and CIOAs increase the risk of cascading primary and secondary equipment failures. The construction of the new substation will reduce the length of feeders, reducing the number of OAs and CIOAs per feeder, and reducing the number of network transformers removed from service during OAs and CIOAs.

C. Load Growth

The Long Island City network load will continue to grow as the number of customers increases and the usage per customer increases. The 2007 peak load forecast of 406 MW is an increases of 6.6% over the actual peak demand of 381 MW experienced in 2006. An additional substation source will reduce the MW-miles power transfer on the primary feeder system. When economically feasible, good practice in electric power distribution engineering dictates shorter feeders with relatively light loading over longer feeders with relatively heavy loading.

Recommendations:

PL-1 Con Edison should accelerate the current target date of 2015 the planned split of the Long Island City network into two networks to establish the new Sunnyside network from the new Newton substation. The Company should study designing these networks so that service to critical customers, specifically the MTA and LIRR, is not interrupted during the shutdown of either network.

PL-2 Before Summer, 2007, Con Edison should utilize the three existing vacant feeder positions at the North Queens substation to create three additional 27 kV feeders providing supply to the Long Island City network in order to increase the overall reliability of service.

4.3 Planning Process and Procedures

A. Background

Planning processes and procedures used by Con Edison were reviewed for their effectiveness in properly identifying the need for additional facilities and allocating capital expenditures. The following elements were reviewed:

- Planning criteria. This criteria defines the conditions (such as equipment loading) that will trigger the consideration of a capital project, such as capacity upgrade, new capacity, system reconfiguration, load transfer, etc. All of Con Edison's secondary networks are subject to the n-2 feeder design criteria, meaning that the system should be designed to adequately serve the load under any conditions with the loss of two primary feeders. For secondary networks, this design criterion is the most stringent used in the utility industry. There are other utilities that also apply the n-2 criteria to their secondary networks, while many utilities apply the less stringent n-1 criteria.

- Review of peak feeder and transformer loading. Con Edison's SCADA system allows distribution planning engineers to track the annual peak feeder loading. The RMS system allows engineers to track network transformer loading, including peak network transformer loading. However, it does not record any quantities of loading in the secondary network.

- Load flow programs. These programs assist planners in determining the need, placement, and timing of additional capacity. Con Edison utilizes the PVL secondary network load flow program to simulate power flow, equipment loading, and voltage drop on the primary and secondary systems. All of Con Edison's networks are modeled and updated regularly. This is more advanced than many utilities, which do not have working load flow models of their secondary networks.

- Historic and predictive reliability analysis. This analysis is used to determine the need for additional facilities or improved inspection and maintenance programs to reduce risk and meet reliability goals. Con Edison uses historic reliability data and predictive reliability analysis to estimate the reliability of the networks. The use of the Jeopardy Index, a probabilistic simulation tool, can be considered a best practice in utilities. Most utilities do not have the accumulated amount of failure rate data, nor the probabilistic reliability calculation models that Con Edison has.

- Load forecasting. Load forecasting is used to predict peak demand in future years, including the use of weather-corrected values of historic peak loads and appropriate design weather conditions. Con Edison has selected design weather conditions for weather-correcting past peak loads and designing its system. The following section analyzes this aspect of the Company's planning further.

B. Selection of Design Temperature

As part of its investigation into the Long Island City network power outage, the performance of Con Edison's networks during extreme heat events over the past several years was examined. For this analysis, performance was considered in terms of the number of feeder outages, or primary contingencies, per network. For its secondary networks in densely-populated areas, Con Edison applies an "n-2" design criterion. The n-2 design criterion is exceeded when more than two electrically-related[55] primary feeders are out of service simultaneously in a network.

For this analysis, extreme heat events are defined when Con Edison's temperature-variable design criterion is exceeded. Con Edison's temperature-variable design criterion is based upon a weighted average of the wet-bulb and dry-bulb temperatures during the three hottest consecutive hours of the present day and the two previous days. Con Edison uses 86 degrees Fahrenheit as the temperature variable design criterion.

Con Edison provided the maximum and minimum levels of network contingencies on days when the temperature-variable design criterion was exceeded. Data was provided from August, 1997 through July, 2006.

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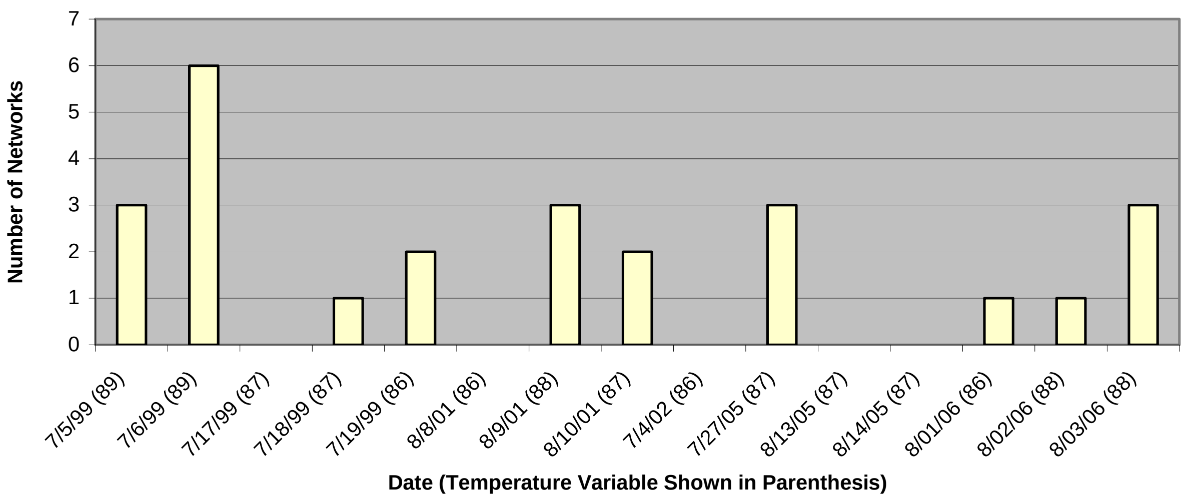
[55] Not all feeder contingencies are equal (e.g., substation bus sections may be taken out of service for planned work with the three or four related network feeders being electrically spread across the entire network so that only an equivalent first contingency exists but at multiple locations) and do not have the same cumulative effect. The n-2 criterion is based upon directly conflicting feeders.

There have been 15 days since August 1997, during which the temperature-variable design criterion of 86 degrees was exceeded.[56] Figure 4.3-1 below shows the number of networks on the Con Edison system that exceeded the n-2 design criterion on these days.[57]

Figure 4.3-1 - Number of Networks Exceeding "n-2" Design Criterion During Extreme Heat Events When Three-Day Temperature Variable Design Criterion is Exceeded



A visual examination of the data in Figure 4.3-1 above illustrates that there is no upward trend in the number of networks exceeding the n-2 design criterion during extreme heat events. This can be concluded even if July 6, 1999 is not considered. From this perspective, the performance of Con Edison's networks during heat events has not been degrading since 1997.

In the past 11 years there have been fifteen days in which the temperature-variable design criterion of 86 degrees was exceeded. This is an average of approximately 1.4 times a year in which the temperature-variable design criteria has been exceeded.

Con Edison established its 86 degree temperature variable design criterion considering only historical values of the maximum annual temperature-variable.[58] Other values of the temperature variable in any year, other than the maximum value, are not considered even if

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[56] Con Edison response to New York City Interrogatory 167 (dated: November 2, 2006).

[57] Con Edison response to Staff Interrogatory 153 (dated: September 18, 2006).

[58] Con Edison response to Staff Interrogatory 389 (dated: December 22, 2006).

they exceed the design temperature variable. The 86-degree temperature variable was established such that weather conditions should exceed the 86-degree temperature variable, on average, “one year out of every three years.” This is not equivalent to “one time out of every three years.”

For example, consider the days in which the design temperature variable of 86 degrees was exceeded, as shown in Table 4.3-1 below. Con Edison’s method for calculating the frequency with which the design weather conditions are exceeded are shown in the right column. The method in which all days are counted when the design weather conditions are exceeded is shown in the center column.

Table 4.3-1 – Analysis of Days Con Edison’s 86-Degree Temperature Variable was Exceeded from 1996 through 2006

Year	Days in which 86-degree temperature variable was exceeded	Year in which 86-degree temperature was exceeded? (1=Yes; 0=No)
1996	0	0
1997	0	0
1998	0	0
1999	5	1
2000	0	0
2001	3	1
2002	1	1
2003	0	0
2004	0	0
2005	3	1
2006	3	1
Total	15	5
Days per year that 86-degree temperature variable is exceeded	1 day every 0.7 years (1.4 days per year)	------
Frequency that peak temperature variable exceeds 86-degrees	------	1 year every 2.2 years

Due to cost limitations, it is impractical to design a system that will meet all possible weather conditions. The purpose of creating a design temperature variable is to establish a frequency for when weather conditions will exceed the system’s design limitations (e.g., one in every three or one in every five years). Not considering all occurrences in which the 86 degree temperature variable is exceeded provides a distorted picture of the frequency with which the system is actually exposed to load conditions beyond its design limit, because it does not capture all instances that the design weather conditions are exceeded.

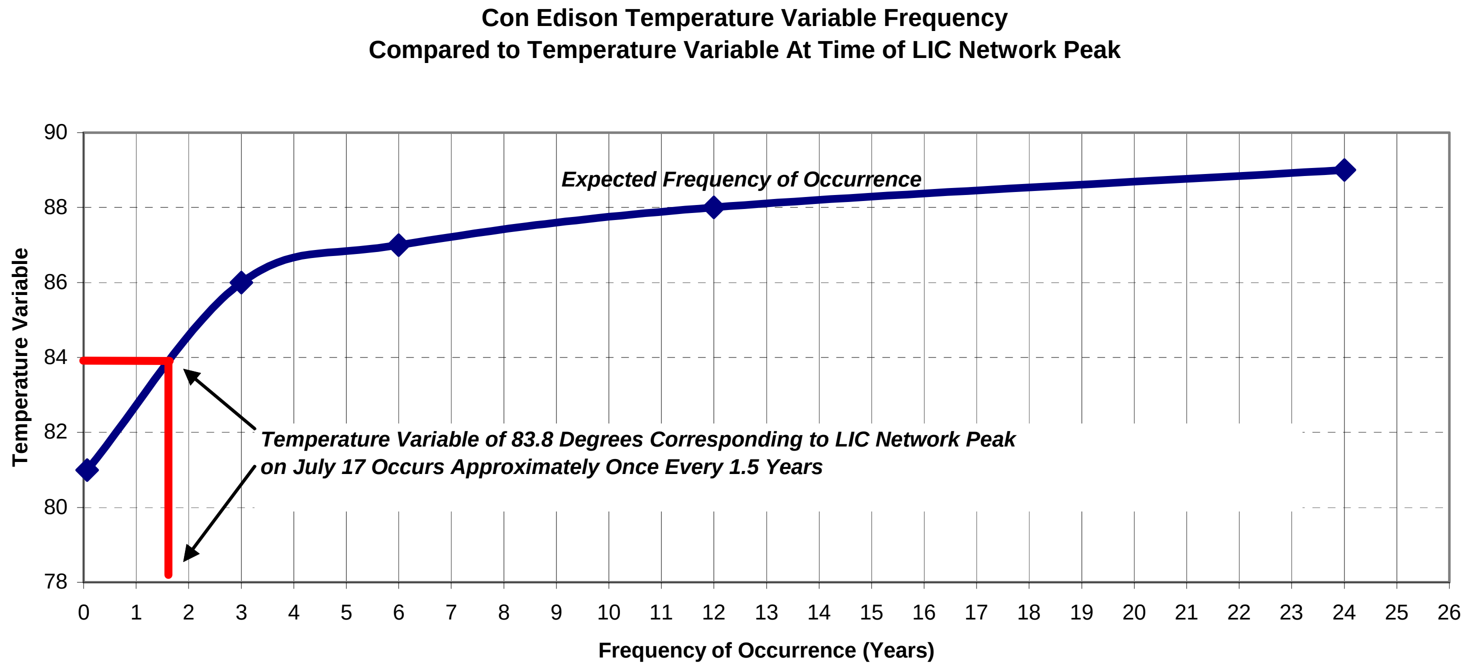
For example, a year in which the design temperature variable is exceeded three times poses greater risk to the system's ability to perform than a year in which the design temperature variable is exceeded only once. Similarly, a year in which the design temperature variable is exceeded ten times poses a much greater risk to the system's ability to perform than a year in which the design temperature variable is exceeded three times. A higher number of occurrences in which the design temperature variable is exceeded means that the system is exposed to loading beyond its design limits for a much greater interval of time. For this reason, individual occurrences (or days) in which the design temperature variable is exceeded need to be counted in calculating the design temperature variable. This will capture the true frequency with which weather conditions greater than the design level are experienced.

Recommendation:

PL-3 Con Edison should review its method for calculating its design temperature variable. A statistical analysis of weather conditions that has existed over an extended period of time (e.g., 50 – 100 years) should be performed. The analysis should consider the weather conditions of all days, and not just the maximum annual temperature variable, to gain a true measure of the expected frequency that weather conditions will exceed the system's design conditions.

As a relative comparison, the temperature variable at the time of the Long Island City network event's peak on July 17, 2006 was 83.8 degrees. The system's temperature variable design criterion of 86 degrees was not exceeded at any time during the event. Figure 4.3-2 below illustrates that a temperature variable of 83.8 degrees can be expected to occur approximately once every 1.5 years. From the perspective of this temperature variable, the weather conditions experienced during the Long Island City network event were common.

Figure 4.3-2 – Weather Conditions During Long Island City Network Peak Can Be Expected Approximately Once Every 1.5 Years[59]



4.4 Network Preparations for Summer 2006

Con Edison's activities for summer preparedness include studying the system loading using the PVL program, identifying and implementing load relief and reliability projects, reducing the number of network transformer banks off the system ("banks-off") and open secondary mains, and performing hi-pot testing of electric distribution feeders.

A. Network Transformer "Banks-off"

As noted earlier, at midnight on July 17, 2006 the total number of network transformer banks that were off-line within the Long Island City network was eighty-six:

- Forty-three banks had open network protector switches;
- Twenty-seven banks were designated as "banks-off," awaiting repair or replacement; and
- Sixteen banks were off-line due to blown network transformer fuses.

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[59] Con Edison response to New York City Interrogatory 178 (dated: November 9, 2006); Case 99-E-0930, Proceeding on Motion of the Commission to Investigate the July 6, 1999 Power Outages of Con Edison's Washington Heights Network, "Status Report on Recommendation Implementation Plans of Consolidated Edison Company of New York, Inc." (dated: June 30, 2000).

Some of the 43 banks which had open network protector switches may have been due to balanced voltage conditions between the secondary and primary that can exist at midnight due to light loading. These likely did not pose any real concern, since crews could be dispatched in the following days to close them.

The 16 banks which were off-line due to blown network transformer fuses pose more of a concern. It takes more time and effort for crews to replace fuses than it does to close a network protector switch. In light of the forecasted high temperatures and electrical usage, this number should have been minimized before Monday, July 17th. Combined with the 27 banks that were awaiting repair or replacement, these 43 transformers represented the equivalent of 0.8 feeders of transformers. From a transformer capacity perspective, the Long Island City network was approaching a single-contingency even before the first feeder went out of service.

B. RMS Reporting Rate

As discussed in other sections of this Report, and made in recommendations NWP-5 and TC-1, specific efforts should be made to improve the reporting rate of the RMS system in preparation for summer. A poor reporting rate of RMS impairs the ability of the WOLF engine to operate in contingencies, which reduces the knowledge that network operators have about the secondary system loading conditions during contingencies.

C. Circuit Breaker Ground & Test (G&T) Functionality

At the beginning of the Summer, 2006, 13 of the 22 feeder circuit breakers at the North Queens substation were retrofitted with rack-out breakers as part of a breaker replacement program. With the new breakers, new G&T devices will permit the simultaneous processing of multiple faulted feeders within a bus section. The new G&T devices were not yet in service in the summer of 2006. If they were in service, the breakers would have permitted more efficient feeder processing and reduced the amount of time that some feeders were de-energized.

D. Reactance-to-Fault (RTF) Functionality in PQNode

The PQNode installed at the North Queens substation on July 17, 2006, contains RTF functionality, which provides an estimate of the distance to fault on a faulted feeder. This functionality was not available during the Long Island City network event, since there are parameters which must be established and tuned specifically for the application at the North Queens substation. If this functionality had been present, then operators would have been provided with improved knowledge regarding the location of feeder faults. This would have likely reduced the time to process faulted feeders.

5.0 Analysis of Historic Capital and Operation and Maintenance Spending

A. Rate Case History and Treatment of Long Island City Costs

In September, 1997, the Commission approved a multi-year rate plan for Con Edison that was to expire in March, 2002.[60] The 1997 Rate Plan called for five staged rate reductions that had a cumulative effect of lowering most total bills (delivery and commodity were then bundled rates) by 10 percent, which would have equaled approximately 20% of customer's delivery charges.

The effective dates and the five staged reductions were:

January 1998	$27.7 million
April 1998	$101.7 million
April 1999	$79.9 million
April 2000	$102.9 million
April 2001	$208.7 million

The 1997 Rate Plan also lead to the divestiture of most of Con Edison's generating assets and the introduction of customer choice for obtaining commodity service for electric customers. The 1997 Rate Plan was revised by Commission order issued November, 2000. The term of the new plan was extended to March, 2005 and an additional decrease of $170 million was implemented, equivalent to a 6.8 percent reduction on the now separately-stated delivery portion of customer's electric bill.

On March 24, 2005 a new three year rate plan was adopted by the Commission that would expire in March, 2008.[61] The 2005 Rate Plan called for rate increases of $104 million in the first year and $220.4 million in the third year (increases of 4.0 and 7.4 percent, respectively, in delivery rates).

The Company's earlier rate plans contained a number of "true up" provisions that would allow the Company to be reimbursed if costs varied from target levels. Generally, true up provisions were used for costs that were difficult to predict and largely outside of the

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[60] Case 96-E-0897, In the Matter of Consolidated Edison Company of New York, Inc.'s Plans for (1) Electric Rate Restructuring Pursuant to Opinion No. 96-12; and (2) the Formation of a Holding Company Pursuant to PSC Sections 70, 108 and 110 and Certain Related Transactions, "Order Adopting Terms of Settlement Subject to Conditions and Understanding" (issued: September 23, 1997) ("1997 Rate Plan").

[61] Case 04-E-0572, Proceeding on Motion of the Commission as to the Rates, Charges, Rules and Regulations of Consolidated Edison Company of New York, Inc. for Electric Service, "Order Adopting Three-Year Rate Plan" (dated: March 24, 2005) ("2005 Rate Plan").

Company's control. Some examples of true up provisions include property and other tax changes, pension costs and interference costs (incurred when a utility must relocate its facilities to accommodate a municipality's construction).

The 2005 Rate Plan introduced a true-up provision for net transmission and distribution ("T&D") plant. True-ups on capital spending are unusual in utility ratemaking but the settling parties, including the City, wanted to ensure that Con Edison had an incentive to make needed improvements in its infrastructure. The Company also had true-up provisions that apply to some portions of its operating and maintenance ("O&M") expenses, however, they do not cover the type of O&M expenses involved in the Long Island City outages.

During the course of the investigation in the Long Island City network event, the Company stated that expenses incurred as a result of power outages will be accounted for in the current period and not deferred. The Company specifically stated:

> The expenses incurred [as a result of the Long Island City power outages] are being accounted for in the current period and the Company will not petition for deferral treatment of these expenses. If as we expect the results for 2006 will be the historic test year in our next electric case, the incremental expenses recorded in 2006 will be eliminated in presenting a normalized year. The capital costs are being treated in accordance with our electric rate plan which places all electric transmission and distribution plant additions under a tracking mechanism where the carrying cost (rate of return and depreciation) are deferred for future collection from customers.[62]

The Company's position on this issue appears to comply with the intent of the 2005 Rate Plan. While not specifically stated by Con Edison, this accounting treatment should also apply to revenue losses related to the Long Island City network event, as well as any payments made to customers for food spoilage and property damage.

Based on information the Company has provided regarding the cost to repair damage to the Long Island City network, the amount of net plant that would be added as a result of the outage (estimated at approximately $30 to $40 million) should be a relatively small portion, approximately 3 percent, of the Company's expected level of T&D capital expenditures for 2006.[63]

Prudence may also become an issue in determining payments to customers for spoilage of perishable goods caused by the event. The Company's tariff provides a cap of $350 and $7,000 to residential and non-residential customers, respectively, up to a maximum of $10

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[62] Con Edison response to Staff Interrogatory 90 (dated: August 24, 2006).

[63] *See*, Con Edison fifth updated response to Staff Interrogatory 84 (dated: November 30, 2006); *see also*, October 12th Report, p. 2-14.

million per event to cover costs related to outages that are not caused by the utility's gross negligence or willful misconduct. While the tariff limits the Company's total liability, the Commission approved a waiver requested by the Company for claims that exceed $10 million relating to the Long Island City incident.

During the course of a rate proceeding the utility has the burden of proof in establishing that only prudently incurred costs are assessed to ratepayers. However, as a practical matter, any party wishing to challenge the prudence of an historic cost will have to make a sufficient showing to have the Commission take further action. Accordingly, any party that wants to challenge the Company's historic costs in its next electric rate case will have to rebut Con Edison's filing that the costs are appropriately borne by ratepayers.

B. Historic Capital Expenditures

Table 5-1 below depicts the Company's capital expenditures from 2000 through 2005.

Table 5-1[64]
Summary of Capital Expenditures (2000 – 2005)
($ in Million)

Year	Total	T&D	Electric Distribution	Brooklyn/ Queens	Queens
2005	1,542	1,008	651	211	101
2004	1,234	755	496	166	71
2003	1,164	654	406	120	54
2002	1,097	581	416	127	58
2001	966	536	428	112	56
2000	762	478	376	96	46
Total	**$6,765**	**$4,012**	**$2,773**	**$832**	**$386**

During the investigation of the Long Island City network event Con Edison provided its view of the T&D capital expenditure included in its rate plans.[65] Table 5-2 below compares Con Edison's estimates to the actual capital expenditures shown above.

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[64] This table is reproduced from the Company's October 12th Report, Figure 2-7, p. 2.14.

[65] *See*, Con Edison response to Staff Interrogatory 85 (dated: August 24, 2006).

Table 5-2[66]
Transmission and Distribution Expenditures
Comparison of Actual Expenditures to Rate Allowance (2000 – 2005)
($ in Million)

Year	Actual Expenditures	Rate Allowance	Percent Variation
2005	$1,008	$761	132.5%
2004	$755	$401	188.3%
2003	$644	$427	150.8%
2002	$581	$425	136.7%
2001	$536	$410	130.7%
2000	$478	$373	128.2%
Total	**$4,002**	**$2,797**	**143.1%**

The Company's revenues have been increasing by approximately 2 percent from 2000 through 2005, which has been exceeding the sales forecasts that were underlying these rate cases. From this information it would appear that the Company's investment in T&D capital expenditures during this period has not been constrained by the historic rate allowance.

C. Historic Operation and Maintenance Expense

Table 5-3 below provides the Company's historic levels of non-production related O&M expenses from 2000 through 2005. Table 5-3, reproduced from the Company's October 12th Report, does not agree with those presented by Con Edison in other public documents, such as its Federal Energy Regulatory Commission ("FERC") Form 1 Annual Reports.[67] Apparently, the costs shown on Table 5-3 include only direct charges. Adders such as pensions, rents, health insurance and allocations of common costs have been excluded. These indirect costs are significant, for example, Table 5-3 shows distribution O&M expenses as $1,153 million for 2000 to 2005 where as the Form 1 Annual Reports show almost double this amount, $2,101 million, for distribution O&M expenses over the same period.[68]

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[66] *Id.*

[67] A copy of Con Edison's FERC Form 1 Annual Reports covering its electric operation and maintenance expenses from 1996 through 2005 is attached as Appendix 11.

[68] *Id.*

Table 5-3[69]
Operations and Maintenance Summary (2000-2005)
($ in Million)

Year	Total	T&D	Electric Distribution	Brooklyn / Queens
2005	1,057	332	$202	$70
2004	972	311	$199	$71
2003	929	293	$178	$59
2002	961	309	$182	$61
2001	1,002	309	$191	$60
2000	1,013	329	$201	$61
Total	**5,939**	**1,883**	**$1,153**	**$382**

Con Edison may not have included indirect costs in its calculations to facilitate the type of geographic analysis it set out to present in its October 12th Report. However, this approach makes it difficult to compare costs over a longer time frame, since breakdowns between direct and indirect costs are not publicly available. Therefore, the remainder of this analysis focuses on total O&M costs.

As part of the investigation into this event, Con Edison provided its view of the transmission and distribution operation and maintenance expenses included in its rate plans.[70] Table 5-4 below compares the Company's estimates to the actual T&D operation and maintenance expenses incurred from 2002 through 2005.

Table 5-4[71]
Transmission and Distribution O&M Expenses (2000 – 2005)
($ in Million)

Year	Actual Expenses	Rate Allowance	Percent Variation
2005	$537	$486	110.5%
2004	$481	$479	100.4%
2003	$455	$471	96.6%
2002	$478	$464	103.0%
Total	**$1,951**	**$1,900**	**102.7%**

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[69] This table is reproduced from the Company's October 12th Report, Figure 2-9, p. 2-17.

[70] *See*, Con Edison response to Staff Interrogatory 86 (dated: August 24, 2006).

[71] *Id*.

Table 5-4 above illustrates that Con Edison is investing in its transmission and distribution operation and maintenance expenses consistent with or above the levels provided in its electric rate plans.

Nonetheless, a more troubling picture results from a longer term view of the Company's transmission and distribution O&M expenses. Table 5-5 below illustrates the Company's distribution O&M and transmission O&M expenses from 1996 through 2005 and the Company's electric sales for the same period. This table also shows the Company's adjusted headcount, which begins with actual total Con Edison utility year end headcounts. The actual headcounts in this report are distorted due to the divestiture of most of Con Edison's in-City generating assets in 1999 and Indian Point in 2001. The in-City generating plants' headcounts are not publicly available, so the entire drop in headcount during 1999 of approximately 1,200 was assumed to be due to the transfer of these generating assets. For Indian Point's sale, the Commission's Supplemental Environmental Impact Assessment stated that there were approximately 700 full time employees. Therefore, the actual headcounts for year end 1996 through 1998 were reduced by 1,200 plus 700, for a total of 1,900, and headcounts for 1999 and 2000 were reduced by 700.

Table 5-5[72]
Selected Statistics
($ in Million)

Year	Distribution O&M	Transmission O&M	Adjusted Headcount	Energy Sales (GWH)
2005	$396	$141	13,191	57.34
2004	$358	$123	12,715	54.74
2003	$325	$130	12,648	53.74
2002	$342	$136	12,917	53.97
2001	$346	$127	12,651	53.05
2000	$334	$138	12,531	51.40
1999	$323	$115	12,325	50.53
1998	$288	$107	12,314	48.65
1997	$272	$105	13,069	47.17
1996	$289	$95	13,901	46.64

This same information is presented below in a chart form where the value for each of the above statistics is set at 100 for 1996.

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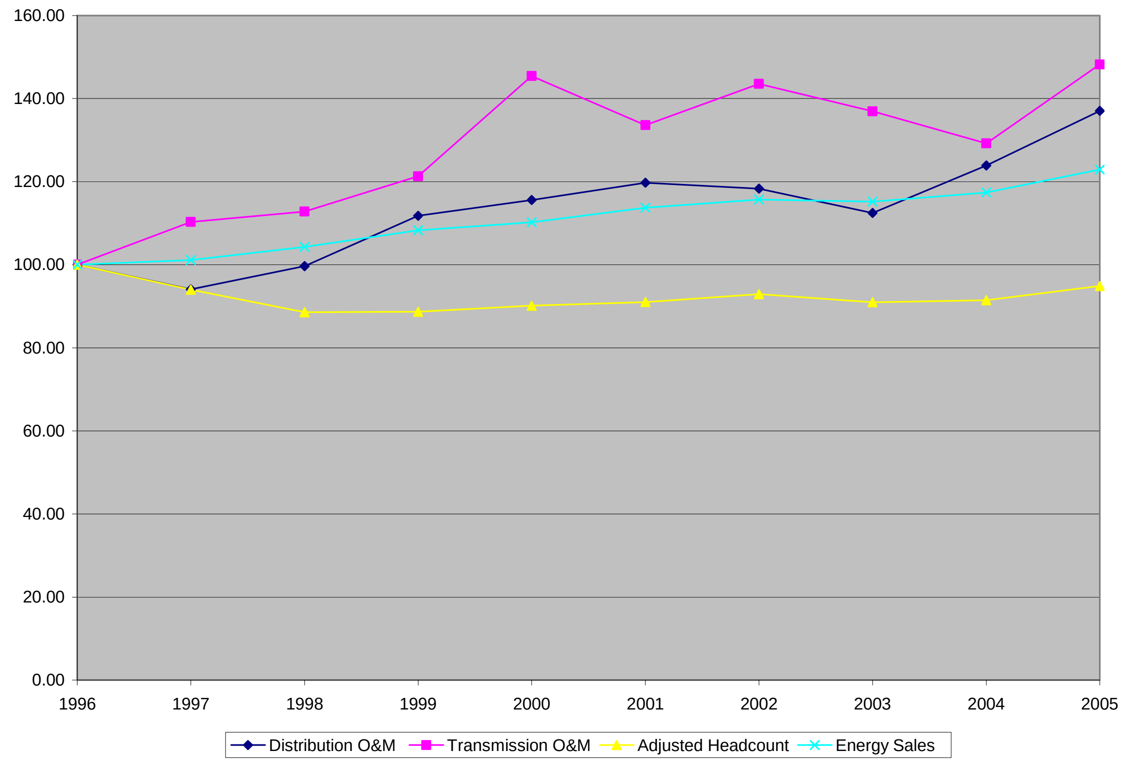
[72] Data provided by Con Edison FERC 1 Annual Report filings and Con Edison's Six-Year Financials and Operating Statistics (1995 – 2000 and 2000 – 2005).



The troubling aspects from the data presented in Table 5-5 is that for much of the period transmission and distribution O&M costs were flat or declining and headcount has been nearly flat over the same period. Meanwhile, sales are increasing at approximately 2 percent per year, Con Edison all-in labor costs have been increasing, and general inflation, while modest, has to be recognized. Further, as the section on capital expenditures suggests, that cost is growing and its share of the headcount must be growing as well. The hiring and training of skilled workers must be accelerated to meet these rising demands.

D. Conclusion on Historic Spending

It is impossible for a straight review of statistics such as was done in this section to reach a conclusion on the adequacy of the Company's spending levels. Over the ten year period that was examined, there have been technological and other improvements that have given the Company the opportunity to improve its productivity and effectiveness to the benefit of ratepayers and shareholders. There are, however, also offsetting factors that place greater costs on the Company to implement these initiatives.

The best measure of the adequacy of spending is the actual performance of the Company as measured in delivering service and quality to its customers. These measures can include whether reliability statistics are being maintained or improved, whether the system design standards are being met or exceeded, and whether the public is satisfied with the Company's performance. These are a few of the metrics that can be examined to determine if a utility is serving its customers adequately.

It is difficult to predict whether additional capital expenditures or resources for transmission and distribution and operation and maintenance would have prevented the Long Island City network event or reduced its impact on customers.

6.0 Analysis of Lessons Learned from 1999 Washington Heights Events

A. Overview

The events that caused the power outages within the Long Island City network in July, 2006 are, in many ways, very similar to those that caused the Washington Heights network power outages seven years earlier in July, 1999. In both situations, during a period of hot and humid weather the network feeders supplying these networks (27 kV and 13 kV, respectively) were subjected to high loadings and extended periods of high temperature and suffered repeated failures from a variety of components (e.g., joints, cables, transformers, etc.). These conditions resulted in the networks being exposed to loading contingencies that were significantly higher than those the electric supply facilities were designed to sustain.

This section compares the recent power outages in the Long Island City network against the recommendations that resulted from the analysis of the Washington Heights network outages seven years earlier in order to examine whether the lessons learned from that event were appropriately incorporated into the Company's operating procedures. This section does not attempt to address every recommendation that was made as a result of the Washington Heights incident but, rather, selects key recommendations or groupings of recommendations relevant to the events that have recently occurred within the Long Island City network.

B. Washington Heights Recommendations

The State of New York Department of Public Service Staff ("Staff") issued their report on the Washington Heights event in March 2000. Prior to the issuance of the Staff report, Con Edison issued two of its own reports. The first of these reports was issued by an internal Con Edison Corporate Review Committee and was entitled "The Washington Heights Network Shutdown July 6, 1999." The second Con Edison report was issued by an Independent Review Board and was titled "Washington Heights Network Shutdown of July 1999." Both of these reports were issued on December 10, 1999.

The Staff report was titled "A Report on Consolidated Edison's July 1999 System Outages" ("Staff July, 1999 Report") and included additional discussions directed towards other outages that also occurred within the Company's service territory during the summer of 1999.

The Staff report contained forty-four recommendations that are listed in Appendix 12 and for reference during the discussion that follows. Some of these recommendations were directed to the other power outages that occurred on Con Edison's system during the summer of 1999.

C. Recommendations as Applied to the Long Island City Network Outages

1. Improved Cable Ratings and Modeling

Washington Heights Recommendation II-1 directed Con Edison to improve its cable rating methods to more accurately reflect actual thermal conditions experienced on its system and to develop improved techniques to model its network systems, especially when under multiple contingency conditions. The previous Cable Ampacity Rating Program ("CARP") the Company used has been upgraded by the implementation of a new thermal modeling program called Underground Systems Ampacity Program ("USAMP") in conjunction with interfaces to the PVL load flow data to permit individual ratings of each cable within a duct bank.

The required actions to address the inherent modeling concerns (i.e., unknown open-mains, fixed high tension service loads, missing Remote Monitoring System ("RMS") data from units not reporting, etc.) do not appear to have been successfully implemented. The proposed remedies to address the inaccuracies in the load flow model as any network progresses from its design limit levels (second contingency) to multiple contingencies (or cascading) are still in progress. This incomplete effort impacted the real-time load flow program (WOLF) once a fourth contingency was exceeded. This compromised the information available to the control room operators during the Long Island City event. The remedies specifically identified following the Washington Heights event to address this issue were: (i) disperse the loads on the low voltage grids from the transformer nodes to the actual service points; (ii) extend the RMS system to monitor high-tension ("HT") customer loads; and (iii) improve the reporting rate of the existing RMS system to reduce the number of Units Not Reporting ("UNRs"). In combination these three items would provide an improved set of data inputs so that the WOLF load flow calculations would be able to converge to a reliable solution under more severe multiple contingency conditions.

Dispersing the loads was addressed by a program known as CUFLINK which is intended to link or match the mapping database containing the secondary service points to the customer metering (or billing) information. The implementation of CUFLINK requires that the data within both systems be made compatible and that both systems have the most current information. Errors or outdated information in either system can lead to unacceptably low matching rates. While progress appears to have been made in this area, significant additional effort needs to be made to ensure that the match rate for all networks reach or is as close to 100% as is possible. Furthermore, the mapping database must be kept current to reflect system configuration changes as soon as possible after they occur and that this information is then incorporated into the load flow model on a regular basis.

Recommendations:

WH-1 Con Edison should accelerate its ongoing efforts to improve the accuracy of its secondary network load flow models by insuring that all system configuration changes are rapidly reflected in the mapping database that is then frequently extracted into an updated secondary load flow model.

WH-2 Con Edison should investigate the feasibility of reflecting the known open-mains in the WOLF load flow model similar to what is currently being done at the transformer level with the banks-off information.

WH-3 Con Edison must ensure that customer load data is matched and modeled to the actual service points to insure that the secondary network cable flows are accurate and that the load flow model converges under multiple contingency conditions beyond design.

2. Monitoring of the Secondary System

Washington Heights Recommendation II-2 directed Con Edison to evaluate reasonable actions that can be taken to improve monitoring of its secondary system because the absence of information on the secondary system can result in the Company being unaware that secondary cable sections were being excessively overloaded. A real-time monitoring system for the secondary system would permit true load readings and provide a more accurate reflection on what portions of the secondary system are in service, which would in turn, provide a better assessment of the status of the entire network. This capability would have provided great value to the Con Edison operators during the Long Island City network event but was not available to them at that time.

The existing Remote Monitoring System, which was initially deployed beginning in 1982, is intended to provide near-real-time load and status data from the Company's approximately 25,000 network transformers located throughout its entire system. This system provides, at a minimum, the network protector switch position and the transformer loading for each phase. The RMS reporting rate for the Long Island City network on July 14th, going into the event, with all 22 feeders in service was only 79.5%. The Company's operating specifications require that "the RMS system of each network must be maintained to insure that at minimum 95% of the total number of units in the network are reporting properly." This critical tool, which was identified after the Washington Heights incident as requiring improvement and extension into the network secondary cable system, was not functioning at anywhere near its minimum reporting rate immediately before the Long Island City network event began. As indicated above, this low reporting rate would be a significant contributor towards the failure of the WOLF program to converge to a viable solution on contingency levels in excess of four as occurred during the Long Island City event.

It should be noted that the programmatic efforts that were completed by Con Edison to address the UNR problem were an attempt to work around the problem rather than to address the issue itself. Since the Washington Heights event, the Company has implemented a new Remote Monitoring Estimator ("RME") program that was developed to create a dynamic load model that is created in real-time based upon the available monitored load values at each of the transformers within the network. After the Long Island City event additional enhancements were made to this program. The program is intended to estimate missing data

(UNRs) by referencing past RMS data from a similar time frame and using it to correct erroneous data in an attempt to provide better information to the WOLF load flow program for contingency analysis. While this is a step forward, it is not a replacement that can compensate for a significantly under reporting RMS system.

In the absence of the recommended secondary network monitoring system, the trouble tickets for the Long Island City network were not visually plotted until the evening of Wednesday July 19th, during the ongoing outage when Brooklyn/Queens engineering personnel manually annotated a map. At this point the three areas or zones of concentrated trouble tickets were identified. Earlier compilation and visual display of this information may have enabled Con Edison to respond more quickly and effectively to the condition of its secondary network cable system. Furthermore, the Company could have enabled governmental agencies, charitable organizations, and other community support organizations to similarly respond earlier and more effectively to the conditions that the customers within the Long Island City network were experiencing. As stated in the Company's October 12th Report, they were aware of customer outages, however, they were unable to accurately determine how much demand reduction was a result of public appeals and how much demand reduction was a result of customer outages.[73]

Since 1999, Con Edison has made significant progress in developing a Secondary Underground Network Distribution Automation System ("SUNDAS"). Unfortunately, the Company has failed to deploy much of what they have developed. The initial scope of the project was to deploy a system that could report extensive functionalities such as phase current, neutral current, voltage, harmonics, and temperature from network manholes. This scope was correctly scaled back to simplify the design due to sensor limitations and is currently geared towards providing three-phase voltage and temperature as the essential information parameters from the manholes. Con Edison, as reported in their status reports to the Commission, has deferred further work on the system due to the unavailability of funding. Con Edison should consider immediately allocating the necessary funds to begin the deployment of a representative population of the SUNDAS system to provide three-phase voltage information on the condition of the network secondary cable system within each of its distribution networks.

Concurrently with the development of SUNDAS, Con Edison proceeded to develop improved RMS system components with additional capabilities. The later generation of transmitters is capable of providing the following network protector and transformer secondary information: current of each phase, network protector status (i.e., open or closed), water level alarm, fuse status, and sump oil alarm. Newly developed sensors along with transmitters incorporated with the network protector microprocessor relays can now provide all of the above information as well as voltage, phase angle, relay status and diagnosis, transformer top oil temperature, transformer pressure, and transformer oil level. The

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[73] October 12th Report, p. 4-45.

deployment of these additional capabilities is underway but should be accelerated and an established completion date should be established.

In this current era of technological advances, including Internet capabilities and high speed communications, an electric utility should be able to quantify the condition of its secondary cable system and identify and quantify the number of electric customer service outages that are occurring on one or more phases on its system. Furthermore, the Company needs to be able to identify which of its customers are receiving an inadequate voltage supply.

Recommendations:

WH-4 Con Edison should improve the reporting rate of its Remote Monitoring System up to, at a minimum, its designated 95% reporting level.

WH-5 Con Edison should expand the number of network Remote Monitoring System transmitters equipped with voltage reporting capability so that an improved voltage picture is available to the control center operators.

WH-6 Con Edison should expand the capability of the Remote Monitoring System transmitters by deploying the newer generation transmitters and sensors that can provide information on the transformer operating temperature, the transformer pressure, and the transformer oil level.

WH-7 Con Edison should begin the deployment of a representative population of SUNDAS to provide three-phase voltage information on the condition of the network secondary cable system within each of their distribution networks. The structure temperature reporting capability should be conjunctionally deployed.

WH-8 Con Edison should develop and implement appropriate technology and/or systems to identify network distribution customers that are out of service (one or more phases) or are being provided inadequate voltage on a real-time basis. Additionally, the Company should:

a. Investigate the possibility of having the cable and/or telephone service providers provide data on the loss of service from their remote devices located within customer's premises.

b. Investigate the implementation of an Automated Meter Reading system including the capability of automatic detection of customers without power.

c. Establish, along with Department of Public Service Staff, a value of service voltage that would be considered inadequate and therefore would be counted as a service outage.

WH-9 Con Edison should utilize the voltage readings obtained from the Remote Monitoring System and from the customer service points and develop an appropriate system algorithm to identify lost customer load as an indicator of customers out of service.

3. Temperature Variable

Recommendation II-3 directed Con Edison to evaluate its temperature variable ("TV") criteria utilized as the basis for determining its future load forecasts and in turn their required load relief plans to meet these forecasted load levels. The TV is based upon a weighted average of the wet-bulb and dry-bulb temperatures during the three hottest consecutive hours of the present day and the two previous days. The weighting is 70% of the present day, 20% of the previous day, and 10% of two days prior. Con Edison uses 86 degrees Fahrenheit as the temperature variable design criterion.

The 86-degree TV load forecasts are established with the expectation that they will be exceeded every third year. Data provided by Con Edison shows that for the period 1999 through 2006 the TV design criterion was exceeded in five of the last eight years for a total of fifteen days.[74] The three days in 2006 were not during the Long Island City network event. Discounting the data for 1999, the TV criterion was exceeded during four of the last seven years. Regardless of how the data is analyzed, it seems unreasonable that the weather criterion that is utilized to establish the Con Edison load forecasts should be exceeded so often.

The Con Edison status reports on this recommendation indicate that an increase of one degree in the design temperature variable to 87 degrees would reduce the estimated frequency from 1 in 3 years to 1 in 6 years. An increase of two degrees to 88 degrees further reduces the frequency to 1 in 12 years. While the studies that Con Edison completed confirmed that increasing the temperature variable design standard would improve the reliability of their networks; each of a number of alternative examined by Con Edison determined each would achieve greater improvements in reliability at lower costs. The alternative measures identified were: PILC cable replacement, reduced feeder repair time, the installation of primary feeder switches, a network split, and feeder debifurcation.[75] All of these alternatives are currently actions being undertaken by Con Edison, including several as new recommendations from the Company's October 12th Report. These recommendations should continue to be examined. Notwithstanding these efforts, Con Edison should re-

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[74] 1999: 5 days; 2001: 3 days; 2002: 1 day; 2005: 3 days; and 2006: 3 days (Con Edison response to New York City Interrogatory 167 (dated: November 2, 2006)).

[75] In some cases feeders are made up of parallel or separate component paths that come together to create a single feeder at the substation circuit breaker. Debifurcation refers to the separation of these two paths into separate feeders that are supplied from two different circuit breakers at the substation.

examine its 86-degree TV criterion to establish an appropriate criterion that will be exceeded less frequently.

Recommendation:

WH-10 Con Edison should examine its 86 degree Fahrenheit Temperature Variable criterion to determine whether a more stringent criterion is appropriate for its distribution system such that it is exceeded less frequently (e.g., once every five or ten years rather than the current three).

4. Targeted Stop Joints and PILC Cable

Washington Heights Recommendations II-6, II-7, II-8, and IV-1 were directed towards the elimination of two types of stop joints (Elastimold 2W-1W and Raychem 3W-1W) that had been identified as having a high failure rate under thermally stressful conditions, as well as the planned reduction in the population of Paper Insulated Lead Covered ("PILC") cable. PILC cable is the oldest cable within the primary distribution system with an average age of 46 years, which is roughly double that of the overall primary cable system (the system average is 25 years).[76]

In response to the above recommendations, Con Edison created two new specifications to direct and prioritize its PILC replacement program. The first specification covered the selection and prioritization process for the PILC and stop joint replacement program and is entitled "Primary Feeder Reliability Work." The second specification created a system for tracking efforts towards the completion of the targeted stop joint replacement program and is entitled "Targeted Splice Management Process."

After the Washington Heights event selected samples of Pre-World War II belted and shielded paper insulated lead covered cables were subjected to testing and statistical evaluation of the resultant data by Con Edison consultants (Cable Technology Laboratories, Inc. and Underground Systems Inc., respectively). The results of these evaluations indicated that the PILC cables would not fail when they operate under design temperatures as long as the integrity of the cable lead sheath is not compromised. The consultant's report ("Final Report on Belted Cable Thermal Test Program") concludes, "The results of this program demonstrated conclusively that cables of this vintage have substantial overload capability if they have not been damaged." The report also suggests that failures involving cables that were not seriously overloaded are probably the result of sheath damage in manholes or associated with splice problems. Based upon the consultant's report, Con Edison concluded

[76] Some progress has been made in this area; at the time of the Long Island City power outages there were still approximately 366 of these targeted stop joints (66 Elastimold 2W-1W joints and 300 Raychem 3W-1W joints) in service within the network. There was approximately 13% PILC within the primary feeder distribution system supplying the Long Island City network as compared to 27% on average for the entire Con Edison system.

that there was no need to further accelerate the plan to eliminate PILC cable from their system by 2024 or to adjust their PILC cable ratings. However, it is very difficult to determine if the lead sheath is damaged on PILC cable.

Con Edison data indicates that the Elastimold 2W-1W stop joints have continued to demonstrate a very high level of thermal sensitivity while the Raychem 3W-1W stop joints tended to demonstrate more stability. Con Edison has also utilized their predictive reliability Jeopardy model as a way to target its reliability resources. Con Edison last revised its specification covering the PILC and targeted stop joint replacement program in 2001. The failure rates for the various components have continued to evolve and they should be re-evaluated to reflect the most current data and ensure that the most failure sensitive components are being removed first.

Regardless of Con Edison's determination, the fact remains that both PILC and stop joints failed during the Long Island City event. The recommendations below address this point.

Recommendations:

WH-11 Con Edison should accelerate the programs to eliminate poor performing targeted stop joints and the associated PILC primary cable from the electric distribution system supplying the Long Island City network as rapidly as practicable.

WH-12 Con Edison should accelerate the programs to eliminate the PILC primary cable and the associated targeted stop joints from the electric distribution system as rapidly as practicable.

WH-13 Through the autopsy and examination of both failed and removed before failure components, Con Edison should work to improve the prioritization methodology to ensure that the most failure sensitive components are being removed first.

5. Feeder Testing Alternatives

Washington Heights Recommendation II-10 directed Con Edison to accelerate its evaluation of alternatives to Hipot testing of their network feeders to determine their effectiveness as an alternative for DC Hipot testing. Con Edison undertook a number of programs in response to this directive.

Partial discharge testing was examined in both the network and URD systems with DTE Energy Technologies. After an extensive series of testing it was found by Con Edison not to be a reliable indicator of problems (i.e., feeder failures) on distribution cables and joints.

Very Low Frequency AC testing was, and continues to be, utilized on a sample population of network feeders during each year's pre-summer Hipot test program. Con Edison continues to monitor the performance of feeders that pass the AC testing. This program has continued to gain in importance as the percentage of PILC cable on the Con Edison system has progressively decreased and the number of network feeders that are comprised of 100% solid dielectric cable begin to grow.

Con Edison also examined thermal testing but the size and setup complexities of the required equipment were serious limitations that were not overcome. The test methodology and simulation studies also raised concerns regarding the possibility that the network protectors on the feeder under test would cycle under the proposed test conditions resulting in equipment damage.

While the VLF testing program should be continued, there are indications that some of the same limitations that have been identified with the DC test may be inherent in this form of testing. A number of additional partial discharge systems should also be examined in order to find a better method of determining the state of their installed feeder cable system in a non-destructive manner.

Recommendation:

WH-14 Con Edison should continue their evaluation of alternatives to the use of DC high potential proof testing (i.e., low frequency AC Hipots, etc.) to assess the state of their installed feeder cable system in a non-destructive manner.

6. Voltage Reduction

Washington Heights Recommendation II-12 directed Con Edison to evaluate the effects of low voltage on customer equipment as a result of the secondary network problems experienced in Washington Heights and Recommendation II-18 directed Con Edison to perform a formal review of the effects of low voltage (below the 8% voltage reduction level) on customers in the Cooper Square network.

In response to these two recommendations, Con Edison retained consultants to perform a number of studies. Electrotek was retained to document industry standards for motor protection and determine dates of adoption of such standards to verify the age of unprotected motors. New York Polytechnic Institute was retained to evaluate the effect of very low voltage on residential and commercial customer motors. The New York Polytechnic Institute was also commissioned with the development of more accurate modeling and load flow analysis under varying voltage conditions. The first two portions of the evaluation were reported as completed while the third was still in progress when the Company concluded that the next phase of the project cannot be supported in view of the demands on Company resources resulting from the World Trade Center disaster and system reinforcement requirements. Con Edison's last report (November 1, 2002) indicates that they are reassessing how to proceed in this matter.

Despite the completion of portions of the above studies there was no evidence that the Con Edison operating personnel had any significant guidance on the effect that their voltage reduction decisions had on network conditions including the risk to customer equipment under reduced voltage conditions. There are not even simple guidelines for operators to monitor the grid voltage prior to directing the further reduction of voltage supplying the grid by applying an 8% network wide voltage reduction. Con Edison should develop a specific operating procedure that provides clear rules for the application of voltage reduction in response to system emergencies including multiple feeder contingencies. This procedure should explain the expected impacts to the secondary network grid and the customers so that the results can be monitored against the conditions before the voltage reduction is applied.

Recommendation:

WH-15 Con Edison should develop a specific operating procedure that provide clear rules for the use of voltage reduction in response to distribution system contingencies.

a. The development of the procedure should take into account the effect of voltage reduction on all system components as well the customers who may already be experiencing sub-standard voltage due to the multiple contingency.

7. Relay Protection Schemes

Washington Heights Recommendation II-13 directed Con Edison to evaluate its relay protection schemes due to a relay coordination problem at the Sherman Creek substation that resulted in an undesirable mis-operation to occur. In response to this recommendation Con Edison determined that relay settings at two substations where the substation transformers had double secondary windings (Sherman Creek and Hell Gate) required revised relay settings to ensure proper coordination with network protector fuses at 265/460 volt isolated networks in the event that a network protector should fail to open when back feeding a 13 kV fault. Directional over-current relays were added to Sherman Creek, Hell Gate, and later to East 63rd Street Nos. 1 and 2 and Leonard Street Nos. 1 and 2 substations. These relay changes were made. In addition, it was determined that due to improper operation under low voltage conditions approximately 3,000 Tempo (solid state) relays located within network protectors in isolated and spot networks as well as fringe areas of the various networks should be replaced with ETI microprocessor relays.

While Con Edison routinely inspects relay settings to ensure that they are accurate and periodically performs relay trip checks, they do not normally review the design settings unless the system configuration had changed. Similar to what happened during the Washington Heights outage, during the Long Island City network outages, Con Edison has reported a number of incorrect or undesirable relay operations that took or kept feeders out of service. The Company's October 12th Report claims that the feeder relays were originally set properly but does not explain when they were set, when they were last evaluated for correctness, nor why the Company does not have a periodic review process in place to ensue that they remain correctly set to meet the increasing needs (normal load growth) of the system.[77] Con Edison needs to put a system in place that requires a periodic review of their protective relay design settings for distribution equipment.

Recommendations:

WH-16 Con Edison should review the design settings for all relay protection schemes on its network feeders to ensure that they have been kept up-to-date and reflect the increased load growth (transformers) being supplied. A schedule for this review and any identified corrective actions should be completed before the summer of 2007.

WH-17 Con Edison should establish a periodic review process that validates the settings for all relay protection schemes on its network feeders to ensure that they have been kept up-to-date and will operate properly when called upon.

8. Emergency Procedures

Washington Heights Recommendation II-14 directed Con Edison to develop formal plans for operating networks under multiple contingency conditions, including the identification of load relief measures available for each network. Washington Heights Recommendation V-1 directed Con Edison to evaluate its emergency procedures in light of the lessons learned and modify these procedures as necessary. Similarly, Washington Heights Recommendation V-2 directed Con Edison to streamline and consolidate its emergency procedures to eliminate redundant and cumbersome material.

In response to these three recommendations, Con Edison revised its procedure entitled "Distribution System Operation under Contingency Conditions" and created an on-line database called the Emergency Operations System (EMOPSYS) that provides by network the individual customers and the amount of available customer generating capacity and the amount of load reduction that the customer is able to achieve on a voluntary basis. Other customer service procedures were reviewed and modified as required as well and a consultant Communications Research Associates was contracted to review Con Edison's procedures involving emergency communications for further improvements. While Con Edison has a wide range of design specifications and operating procedures they continue to need to be updated to reflect system changes and current conditions.

Recommendations:

WH-18 Con Edison must keep its library of procedures, specifications, and other directives up-to-date and reflective of current conditions.

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[77] October 12th Report, p. 4-32.

WH-19 Con Edison should evaluate its emergency procedures in light of lessons learned from the July 2006 outages and modify these procedures as necessary.

9. Monitoring of High Tension Customer Load

Washington Heights Recommendation II-15 directed Con Edison to monitor high-tension customer loads to improve its system modeling programs. A pilot program was established to test the feasibility of monitoring high-tension customers and then integrate their load data into the existing analytical tools (e.g., RMS, VDAMS, etc.). Two methods were developed for the proof of concept, utilization of the RMS system for data reporting and use of a telephone line. The method using the RMS provided data in the correct format so that it could be fed directly into VDAMS and has the capability of being integrated into the SUNDAS system once that is deployed. Tests of sensor components installed within the harsh environment of feeder manholes were successful but because of the large (1000+) population it was decided to examine the installation of the monitoring equipment indoors at the customer's premises near the high-tension switchgear cubicles and Company meters. Secure Wi-Fi based transceivers in each of the Company meters were demonstrated to collect and concentrate all necessary metering data, including current and voltage information that could be integrated back in the VDAMS database using existing dedicated telephone service that is available at our high-tension customers for demand meter reading. Appropriate data handing and routing software needs to be developed to make this a viable system. Sensor and metering equipment has been received but Con Edison has reported delays in the deployment due to a shortage of available field crews.

Recommendation:

WH-20 Con Edison should accelerate the planned installation of a remote monitoring capability for all of their high-tension customer installations.

10. Call Center Staffing

Washington Heights Recommendation V-12 directed Con Edison to review non-business staffing levels for its Call Center during system emergencies. In response to this recommendation Con Edison reported that they would increase the off-hour normal staffing levels so that more personnel are routinely available for extended hours in the event of a sudden emergency.

Similar to Washington Heights, during the Long Island City network event there were many customers who attempted to report outages to Con Edison and experienced significant problems including busy signals and long waiting periods on hold and either never reached a customer service representative or waited long periods of time before reporting their outage. This was one reason, Con Edison significantly under reported the number of customers out of service and thereby delayed the deployment of the required level of response personnel. The Call Center reporting process should be entirely reviewed, and if necessary revamped, to ensure that all potential bottle necks are eliminated so that customers can report their service problems to Con Edison in a timely, simple, user friendly manner under all emergency conditions.

<u>Recommendation:</u>

WH-21 Con Edison must review its entire Call Center reporting process to ensure that all potential bottlenecks are eliminated so that customers can report their service problems to the Company in a timely, simple, user-friendly manner under all emergency conditions.

11. Compensation for Spoilage Losses

Washington Heights Recommendation VI-1 directed Con Edison to increase the level of payments for both residential and non-residential customers due to the lack of refrigeration to account for twenty-seven years of cost inflation since the original tariff provisions were enacted in 1973. The Commission also directed Con Edison to consider the establishment of compensation to customers for verifiable damages to their appliance motors. The recent outages within the Long Island City network have similarly caused significant impact to the residents of Northwest Queens and associated economic hardships for which they should be compensated at an appropriate level.

Washington Heights Recommendations VI-2, VI-3, and VI-4 directed Con Edison to develop and disseminate appropriate multilingual claims forms for customers to utilize for filing for reimbursement of these losses. These recommendations appear to have been appropriately implemented during and following the Long Island City network outage.

<u>Recommendations:</u>

WH-22 Con Edison should be required to increase the current payments for distribution system failures of twelve or more hours in a 24-hour period to reflect, at a minimum, the rate of inflation from 2000 to 2007:

a. Increase the compensation for losses due to spoilage of food or other perishables for lack of refrigeration for residential users from $350 to $450 per incident;

b. Increase the compensation for losses due to spoilage of perishable merchandise for lack of refrigeration for non-residential customers from $7,000 to $9,000;

c. Increase the liability per incident to a total of $15,000,000; and

d. Provide for automatic increases equal to the rate of inflation each time that a new electric rate case is approved or every five years, which ever comes first.

WH-23 Con Edison should be required to provide compensation to customers for verifiable damages to their appliance motors, electronic equipment, and other voltage sensitive property.

WH-24 Con Edison should be required to fully implement all of the Washington Heights recommendations or explain why it cannot do so.

D. Summary

The 1999 Washington Heights outage was described within the Executive Summary of the Con Edison report by their Corporate Review Committee as "…a series of previously unmatched load demands" and the Corporate Review Committee report concluded that "The events that led to the shutdown of the Washington Heights network, if taken separately, are not unique to Washington Heights. The unusual combination of these events, however, culminated in the network shutdown." The report further state that "The recommendations contained within this report, therefore, are not limited to Washington Heights but are applicable throughout the Con Edison distribution system." Almost exactly seven years later the 2006 Long Island City network outages are similarly described within the Executive Summary of the Company's October 12th Report as "….an extraordinary series of events," that were "precipitated by three unrelated events that combined to create an unprecedented set of circumstances and strain on the network system." In fact, what can be seen from Washington Heights and Long Island City, is that events one might call "unique" or "unprecedented" do happen, and sometimes happen again, at which point they are no longer "unique" or "unprecedented."

Given the complexity of the Con Edison electric distribution system, one can understand how imperative it is for Con Edison to put in place the necessary tools and systems to better manage its system. Con Edison must be more proactive in identifying and removing the most failure prone components on their system. This is particularly true at the primary feeder level where both the Washington Heights and Long Island City network events were centered. Con Edison must also have better monitoring systems in place so that it fully understands what is occurring on its electric distribution system at all levels. Con Edison must have appropriate systems deployed to better enable its operators to respond in a more effective and timely basis. Con Edison must share information in a significantly more open way with the appropriate City agencies and the public so that they are better prepared to provide necessary community support.

Many of the recommendations from the Washington Heights event, as was detailed above, were not followed through on by Con Edison or were not fully implemented. While it is impossible to definitively state what the impact would have been if all of the recommendations had been implemented, it is reasonable to conclude that some of the damage and/or some of the outages may not have occurred, and at least some reduction in the outage durations may have been realized.

7.0 Summary of Recommendations

Listed below are the recommendations that the City considers the Company should adopt to reduce the likelihood of, or avoid entirely a similar event as the 2006 Long Island City power outages. The recommendations that follow are taken from the main body of this Report. Throughout the Report, there are occasionally similar or identical recommendations in multiple sections. This overlap of recommendations in the main body of the Report is intended to emphasize the impact that one recommendation can have on more than one aspect of the Company's operations. Following each recommendation is reference to where within the Report the recommendation and a supporting discussion can be found. As an example, NM-2 refers to the second recommendation in the Network Monitoring section and WH-14 is the fourteenth recommendation in the Washington Heights section.

1. For network contingencies where greater than two feeders are out of service during a heat storm, Con Edison should institute an improved process for the collection of failed cable, joint, and termination components for examination and analysis, including a detailed chain of custody. This should include both primary and secondary samples. (CJ-1)

2. Con Edison should accelerate its programs to eliminate the PILC primary cables and the associated targeted stop joints from the electric distribution system as rapidly as reasonably practicable given cost and other factors. (CJ-2, WH-12)

   a. Con Edison should accelerate the programs to eliminate poor performing targeted stop joints and the associated PILC primary cable from the electric distribution system supplying the Long Island City network as rapidly as practicable. (WH-11)

   b. Through the autopsy and examination of both failed and removed before failure components, Con Edison should work to improve the prioritization methodology to ensure that the most failure sensitive components are being removed first. (CJ-3, WH-13)

3. Con Edison should reconsider incorporation of flame resistant construction concepts for insulation and jackets into secondary cables employed for future use in ducts. (CJ-4)

4. Con Edison should consider use of more modern secondary cable constructions on their system for new constructions (i.e., self-sealing cables). (CJ-5)

5. Very Low Frequency testing technology should be applied to 50% of the Long Island City network feeders prior to the 2007 summer load period. The feeders that are selected for Very Low Frequency testing should not have DC Hipot testing applied to those tested feeders for a minimum of three years after Very Low Frequency testing is performed. The remaining feeders within the Long Island City network should receive a DC Hipot prior to the 2007 summer load period. (CJ-7)

   a. Additionally, Con Edison should plan to Hipot test the 3 worst performing Long Island City feeders each year until the Long Island City network is split into two networks. (CJ-7)

6. Con Edison should continue to examine the use of Very Low Frequency testing and its associated procedures, and develop results and conclusions. (CJ-6, WH-14)

   a. Con Edison should apply Very Low Frequency testing to 5% of the second tier of worst performing system feeders (those between the worst 5% and 10% of the worst performing feeders) on their system and not apply DC Hipot testing to those tested feeders for a minimum of 3 years after Very Low Frequency testing is performed. (CJ-8)

7. Con Edison should increase the number and effectiveness of its system wide feeder testing program on both a post failure and a planned basis. (FR-10)

   a. The planned feeder Hipot selection criteria should be evaluated to verify that it is properly prioritizing all of the potential candidates. (FR-10)

   b. Feeders selected for High potential proof tests (Hipots) should be tested until they pass at the designated test level so that incipient faults are not left on the partially tested feeders. (FR-10)

8. Con Edison should promptly schedule Feeder 1Q13 for a DC Hipot test to determine whether a strongly indicated incipient fault exists on this feeder. (FR-6)

9. Con Edison should initiate an aggressive plan to evaluate commercially available predictive diagnostic tools to analyze the current state of installed cables, joints, terminations and associated equipment. (CJ-9)

10. It is recommended that Con Edison conduct a study to determine the internal static pressure that would be developed under the loading conditions to which some transformers (S/N F124281 and S/N F124624) were subjected. If the results of this study demonstrate that pressures exceed the design limits of these transformers, steps should be taken to restrict loading on transformers of similar design or to modify the design to tolerate the expected level of internally developed pressure without tank weld rupture. (TR-1)

11. One transformer (S/N M105273) reportedly failed due to a weld leak resulting from stress corrosion. The presumed source of the stress corrosion was exposure to a high concentration of chlorides. It is recommended that a study be made to determine the likelihood of this problem occurring on other units of similar design. (TR-2)

12. During the course of the Long Island City network event, many network transformers were exposed to high ambient temperatures and loadings well in excess of nameplate ratings for significant time intervals. Con Edison should implement, prior to the 2007 summer load period, an inspection and test program for all network transformers in the Long Island City network that were overloaded during the event. (TR-3)

13. Con Edison has indicated that its policy is to impulse test (BIL test) reconditioned transformers before returning them to service. As an added aspect of this test, it is recommended that Con Edison consider conducting dielectric testing while the transformer is at elevated temperatures. (TR-4)

14. It is recommended that Con Edison evaluate the use of condition-based maintenance, where the service life and service conditions of transformers are used in a more prominent role in the determination as to when maintenance is required. (TR-5)

15. A review of several Con Edison Specifications reveals that there is a relatively complex method of characterizing the capability of a transformer under various operating conditions. In spite of this relatively complex system, there is no apparent consideration given to loss of life per event or cumulative aging of the transformer insulation. The major determinant of transformer life expectancy is the combined effect of the hottest spot temperature in the transformer insulation system and the duration of that exposure. Loss of life is cumulative and non-reversible. Thus, it is recommended that Con Edison determine the cumulative loss of life as a result of normal or emergency operation. (TR-6)

16. Transformer manufacturers today have the computer design capability to maximize KVA of transformation while respecting physical limitations on unit size. Thus, one could possibly design a 550 or 600 KVA unit that could physically fit into the vault that is currently occupied by a 500 KVA rated transformer. It is recommended that this issue be reviewed with manufacturers to determine whether or not and to what degree this could be accomplished. (TR-7)

17. Con Edison's specifications state that the top oil temperature is the criterion that is to be used in determining whether supplemental cooling of the unit is required. The use of top oil temperature to solely determine whether or not to use supplemental cooling is not recommended. The time constant for the transformer oil is much greater than the time constant of the winding. Therefore, the winding hottest spot temperature could be at severely elevated levels while the oil has yet to reach its ultimate value as a result of step increases in load. It is recommended that Con Edison consider changing their criteria to hottest spot temperature. (TR-8)

18. It is recommended that an analysis of the relay targets associated with suspected transformer inrush issues be made to determine if relay setting changes would have the potential of affecting the likelihood of tank rupture by changing the I^2t energy released in the transformer tank during an internal fault. (TR-10)

19. It is recommended that prior to flooding vaults or spraying transformers as a means of reducing their oil temperatures, the units should be verified as leak free. (TR-12)

20. It is recommended that gas in oil analysis also be performed for those units that have experienced significant accelerated loss of life or have reached a significant accumulated loss of life. (TR-13)

21. Con Edison should complete a testing program for each feeder within the Long Island City network prior to the 2007 summer load period that will exercise all network protector relays (including all other electrical and mechanical components) and identify non-responsive units for correction and re-test to insure improvement in the performance of these network feeders with regard to them staying improperly Alive on Back Feed when removed from service due to a fault or by operator action. (NWP-1)

    a. In addition, Con Edison should implement a system-wide testing program to insure the operation of each feeder at least once biannually to exercise all network protector relays as well as other electrical and mechanical components and identify non- responsive units for correction and re-test. (NWP-1)

22. During the analysis of the Long Island City power outages, Con Edison hired a consultant to perform an Electro Magnetic Transient Pulse ("EMTP") analysis to measure transients for the Long Island City event. Because it is suspected that several network protector microprocessor relays failed during the event as a result of transients, Con Edison should ensure that this study includes transients on the secondary system and share the results of the EMTP study with the network protector microprocessor relay manufacturers. Con Edison should work with the microprocessor relay manufacturers to conduct a design review of the relay and implement any design changes that may be required as a result of the study's findings. (NWP-2)

23. Con Edison should develop a more detailed reporting form for their network protector and transformer inspections. The form that is completed by the field personnel should be entered into a field computer and then downloaded into a database that has the ability to be accessed to produce individual equipment reports and summary reports. From this database equipment failure trends could be discerned or developed. (NWP-3)

    a. In addition, Con Edison should modify its protocol to include the "as found" position on all network protectors associated with failed transformers. (NWP-3)

    b. In reviewing inspection reports (CINDE records) on the 13 transformers that failed, it was found that transformer reporting was inconsistent and sometimes incomplete. It is recommended that completed transformer reports be subjected to a random sample audit to ensure that the database is relatively complete and up to date. (TR-11)

24. Con Edison should complete an appropriate inspection and maintenance program to improve the reporting rate of its Remote Monitoring System within the Long Island City network up to, at a minimum, its designated 95% reporting level before the beginning of the 2007 summer load period. (NWP-4, TC-1)

25. Con Edison should engage in a program to improve the reporting rate of its Remote Monitoring System, system wide, up to, at a minimum, its designated 95% reporting level within a reasonable amount of time. (NWP-4, TC-2, WH-4)

    a. Additionally, the Company should expand the number of network transformers equipped with voltage reporting capability so that an improved voltage picture is available to the control center operators. (NWP-4, WH-5)

    b. Con Edison should expand the capability of the RMS transmitters by deploying the next generation transmitters that can provide information on the transformer operating temperature, the transformer pressure, the transformer oil level, as well as providing a voltage reporting capability. (TC-3, WH-6)

    c. Moreover, the Company should examine accelerating the planned installation of a remote monitoring capability for high-tension customer installations. (NWP-4, WH-20)

    d. Con Edison should continue to improve the RMS system with increased consideration to the following:

        i. Aggressively pursue technology enhancements that will allow for an increased success rate of network protector information being available for stuck network protectors. (NWP-5)

        ii. Ensure that all new RMS transmitters have the capability to provide voltage readings. This becomes increasingly valuable as a tool to clear ABF conditions as information regarding stuck network protectors becomes more available. (NWP-5)

        iii. provide a link from NetRMS to the network protector relay information contained within the equipment database so that operators can have a quick way to determine what type of relay is installed at any location of interest. (NWP-5)

26. In order to provide voltage information to further assess backfeeding network protectors, Con Edison should consider a system to obtain voltage readings in the network at points other than the transformers (at service boxes, lamp posts, customer

premises, etc.). An automatic system with data being fed to a visualization tool would be best. However, in the interim, a program to obtain manual readings during events would provide information on the potential for network protectors to remain closed and thus become a source of backfeed. (NWP-6)

27. Con Edison should modify its procedures for operating the distribution system under contingencies to provide guidance for operator actions under severe contingency levels with potential low voltage conditions within the network of concern. (NWP-7)

    a. This should include guidance on the application of three phase grounds to clear backfeeding network protectors. (NWP-7)

    b. This should include detailed guidance on the criteria for cooling of network transformers. (TC-4)

    c. This procedure should establish a clearly defined protocol to incorporate observations made by responsible outsiders as well as its own employees regarding conditions in the field. (C-1)

    d. This should include guidance on the application of Rapid Restoration procedures applicable to the distribution system while operating networks under multiple contingency conditions. (FR-7)

    e. This should include criteria for evaluating the secondary network cable system, manhole events, customer outages, and the level of secondary voltage supply to their customers. Improved guidance needs to be provided to determining when a network load area should be de-energized. (ND-4)

28. Con Edison should consider the creation of a dedicated engineering team directed towards the evaluation of the secondary network cable system during multiple feeder contingencies to ensure that appropriate attention, evaluation, and planning is applied to this area while immediate efforts are directed towards the restoration of the primary feeders. (ND-5)

29. Con Edison should reevaluate the requirement that network protector relays prevent the network protector from closing if the network voltage is between 60 volts and 13 volts. They should also modify their procedures for operating the distribution system under contingencies to ensure that operating personnel are aware of this requirement. (NWP-8)

30. Con Edison should incorporate available outage duration information for specific locations into its call center messaging system so that customers are given the best and most recent information on their specific situation. (C-2)

31. It is recommended that Con Edison develop another way to either replace or augment the customer interruption reporting process as a means of more accurately estimating the number of customers without service. (CI-1)

32. Con Edison should begin the deployment of the Secondary Underground Network Distribution Automation System (SUNDAS) in a uniform manner with sufficient representation of these units throughout all of the networks so that sensors will provide data on the condition of the secondary network, including three-phase voltage information. (M-4, WH-7)

    a. These sensors, located in manholes and service boxes, should be used to develop a voltage profile of the network. Any problems relating to blown limiters, burned out cables, and faults would be displayed in an entire network voltage profile. (NM-1, M-4, WH-7)

    b. Con Edison should study a means to utilize automatic meter reading ("AMR") to all or selected locations at customer premises to know when there are disruptions in service. (NM-2)

    c. Con Edison should actively participate in the Department of Energy's Grid 2030, an "Advanced Metering Infrastructure" project ("AMI"). This project could assist the Company in deciding how it will collect and analyze data in the future. (NM-4)

33. Con Edison should review Alive on Back Feed occurrences which are one of the causes for feeder restoration delays and are often caused by a network protector that does not operate properly. An approach that would make it easier to locate the malfunctioning network protector is use of a local remote secure radio control device built directly into the network protector relays. (NM-3)

    a. All Alive on Backfeed events should be reviewed to determine the amount of backfeed and the duration of that backfeed and that the transformer's condition be noted with respect to any accelerated loss of life. (TR-9)

34. Con Edison should have studies conducted on how to collect real-time information supporting the real-time decision making on rapid directed load control. A combination of monitoring systems and deterministic and knowledge-based modeling methodologies should be considered. (NM-5)

35. Con Edison should examine and strengthen their contractor oversight processes from initial design, to on-site inspection, and through acceptance testing to insure that proper controls are being exercised over contractor work within its substations. (FR-1)

a. Con Edison should complete the required testing of the G&T devices at the North Queens substation to insure that they will be available to expedite the feeder processing effort before summer 2007. (FR-3)

36. Con Edison should examine its training and testing program for Substation Operators and District Operators to insure that operators are properly instructed, with particular emphasis on actions during stressful emergency conditions. (FR-2)

    a. Improvements need to be made to these processes to insure that operator errors do not impact the overall feeder restoration process by decisions being made on incomplete or incorrect data. (FR-5)

    b. Improvements need to be made to insure that the operators understand what the desired results of their actions are, as well as what undesirable consequences can result, so that they can make informed decisions that will not negatively impact the overall feeder restoration process or cause additional damage. (FR-11)

37. Con Edison should expedite the installation of substation PQNodes on a system-wide basis to insure that all of their substations are completed prior to summer 2007. Additionally, testing and tuning of the PQNode should be completed to insure that the Reactance-to-Fault application is functional for all of their networks prior to summer 2007. (FR-4)

38. Con Edison should review the design settings for all relay protection schemes on its distribution feeders to insure that they have been kept up-to-date and reflect the increased load growth (transformers) being supplied. A schedule for this review and any identified corrective actions should be completed before the summer of 2007. (FR-8, WH-16)

    a. Con Edison should establish a periodic review process that validates the settings for all relay protection schemes on its distribution feeders to insure that they have been kept up-to-date and will operate properly when called upon. (FR-9, WH-17)

39. If Con Edison plans to continue using voltage reduction for unloading distribution circuits, which should mean reduction of current, the Company should perform studies to determine the conditions under which the voltage reduction would be effective for this specific objective, if at all. (VR-1)

    a. Con Edison should perform a thorough field and empirical analysis to determine the effects of voltage reduction on actual voltage and current in the network under severe contingencies. (VR-2)

    b. After the aforementioned analyses are completed, Con Edison should develop a set of specific operating procedures and specifications to provide clear rules for the use of voltage reduction in response to distribution system contingencies.

Such procedures should take into account the effect of voltage reduction on all system components as well as customers that may already be experiencing sub-standard voltage due to a multiple contingency. (VR-3, WH-15)

40. Con Edison should improve the way in which critical information is accumulated and presented to the control center operators especially with regard to secondary network events and customer service problems (e.g., outages, side out, low voltage, etc.). (M-1)

    a. Con Edison should expand the use of visualization tools to combine multiple information reporting systems and improve the way that critical operating information is presented to the control center operators. (M-2)

41. Con Edison should develop and implement appropriate technology and / or systems to identify network distribution customers that are out of service (one or more phases) or are being provided inadequate voltage on a real-time basis. Additionally, the Company should: (M-3, WH-8)

    a. Investigate the possibility of having the cable and/or telephone service providers provide data on the loss of service from their remote devices located within customer's premises. (WH-8)

    b. Investigate the implementation of an Automated Meter Reading system including the capability of automatic detection of customers without power. (WH-8)

    c. Establish, along with Department of Public Service Staff, a value of service voltage that would be considered inadequate and therefore would be counted as a service outage. (WH-8)

42. Con Edison should utilize the voltage readings obtained from the RMS system and from the customer service points to develop an appropriate system algorithm to identify lost customer load as an indicator of customers out of service. (M-5, WH-9)

43. Con Edison should improve the way in which critical information is accumulated and presented to its control center operators especially with regard to secondary network events and customer service problems (e.g., outages, side out, low voltage). (ND-1)

    a. Con Edison should immediately take steps to improve the way in which critical information is visually presented to the Brooklyn/Queens Control Center personnel through the installation of a large screen projector display system similar to what is installed within the other regional control centers compatible with the space limitations at this location. (ND-2)

b. Con Edison should expand the use of visualization tools at its control centers to combine multiple information reporting systems and improve the way that critical operating information is presented to the control center operators. (ND-3)

44. Con Edison should accelerate from its current target date of 2015 the planned split of the Long Island City network into two networks to establish the new Sunnyside network from the new Newton substation. Con Edison should study designing these networks so that service to critical customers, specifically the MTA and LIRR, is not interrupted during the shutdown of either network. (PL-1)

45. Before summer 2007, Con Edison should utilize the three existing vacant feeder positions at the North Queens substation to create three additional 27 kV feeders providing supply to the Long Island City network in order to increase the overall reliability of service. (PL-2)

46. Con Edison should review its method for calculating its design temperature variable. A statistical analysis of weather conditions that has existed over an extended period of time (e.g., 50 – 100 years) should be performed. The analysis should consider the weather conditions of all days, and not just the maximum annual temperature variable, to gain a true measure of the expected frequency that weather conditions will exceed the system's design conditions. (PL-3)

    a. The Company should determine whether a more stringent criterion is appropriate for its distribution system such that it is exceeded less frequently (e.g., once every five or ten years rather than the current three). (WH-10)

47. Con Edison should accelerate its ongoing efforts to improve the accuracy of its secondary network load flow models by insuring that all system configuration changes are rapidly reflected in the mapping database that is then frequently extracted into an updated secondary load flow model. (WH-1)

    a. Con Edison should investigate the feasibility of reflecting the known open-mains in the WOLF load flow model similar to what is currently being done at the transformer level with the banks-off information. (WH-2)

    b. Con Edison must ensure that customer load data is matched and modeled to the actual service points to insure that the secondary network cable flows are accurate and that the load flow model converges under multiple contingency conditions beyond design. (WH-3)

48. Con Edison must keep its library of procedures, specifications, and other directives up-to-date and reflective of current conditions. (WH-18)

49. Con Edison should evaluate its emergency procedures in light of lessons learned from the July 2006 outages and modify these procedures as necessary. (WH-19)

50. Con Edison must review its entire Call Center reporting process to ensure that all potential bottlenecks are eliminated so that customers can report their service problems to them in a rapid, simple, user-friendly manner under all emergency conditions. (WH-21)

51. Con Edison should be required to increase the current payments for distribution system failures of twelve or more hours in a 24-hour period to reflect, at a minimum, the rate of inflation from 2000 to 2007: (WH-22)

    a. Increase the compensation for losses due to spoilage of food or other perishables for lack of refrigeration for residential users from $350 to $450 per incident;

    b. Increase the compensation for losses due to spoilage of perishable merchandise for lack of refrigeration for non-residential customers from $7,000 to $9,000;

    c. Increase the liability per incident to a total of $15,000,000; and

    d. Provide for automatic increases equal to the rate of inflation each time that a new electric rate case is approved or every five years, which ever comes first.

52. Con Edison should be required to provide compensation to customers for verifiable damages to their appliance motors, electronic equipment, and other voltage sensitive property. (WH-23)

53. Con Edison should be required to fully implement all of the Washington Heights recommendations or explain why it cannot do so. (WH-24)

APPENDICES

Appendix 1A

Sequence of Events – Primary Feeder Outages

Case 1 Monday, July 17, 2006 1550 hours

Feeder 1Q17 opened automatically[78] due to a fault. The feeder was isolated by its respective circuit breaker.

The fault was found to be in a section of cable and was caused by collateral damage from the failure of a secondary (low voltage) cable in an adjacent duct.

The network was now in a **1st Contingency**.

Case 2 Monday, July 17, 2006 1622 hours

Feeder 1Q16 opened automatically due to a fault. The feeder was isolated by its respective circuit breaker.

The fault was found to be in a section of cable and was caused by collateral damage from the same failure of a secondary cable that caused the damage to feeder 1Q17.

The network was now in a **2nd Contingency**.

Case 3 Monday, July 17, 2006 1848 Hours

Feeders 1Q07, 1Q15 and 1Q21 opened automatically. These three feeders are all supplied by Bus Section[79] 3S at the North Queens substation.

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[78] A feeder opens automatically when an in-service defect (fault) occurs on a feeder and a large amount of current is drawn to that defect. This current is sensed at the substation and a signal is automatically sent to the circuit breaker supplying the feeder to open and disconnect the defective feeder.

[79] Feeders are supplied from a substation through individual circuit breakers. The circuit breakers are supplied in groups from a Bus Section at the substation. If a fault occurs on a feeder and the feeder is not opened automatically by opening its respective circuit breaker then back-up operations are performed and the Bus Section supplying the feeder (and several others) is automatically removed from service.

The fault was determined to be a termination failure at a transformer on feeder 1Q21. A joint failure was also found associated with this 1Q21 outage. The Bus Section outage was caused by a failure of the circuit breaker associated with that feeder to clear the fault. The failure to clear the fault was caused by a misalignment of contacts in the trip circuit of the breaker. This misalignment went unnoticed by the operators due to incorrect wiring of the trip circuit monitoring circuit.

The network was now in a **5th Contingency**.

Monday, July 17, 2006 1854 hours

At this time, in response to this 5th contingency Con Edison attempted to implement a rapid 8% Voltage Reduction at the North Queens substation. However, due to a malfunction of the automatic circuitry associated with the Voltage Reduction system, this Voltage Reduction had to be done manually and was not completed until approximately 2200 hours on July 17, 2006.

Monday, July 17, 2006 1902 hours

An attempt was made to restore Bus Section 3S to service by closing the bus tie breaker without first isolating the individual feeders. Since the faulted 1Q21 was still connected to the Bus Section, the attempt failed.

Monday, July 17, 2006 1903 hours

The fault on feeder 1Q21 was isolated by tripping the associated circuit breaker remotely via supervisory control.

Monday, July 17, 2006 1904 hours

A second attempt was made to restore Bus Section 3S. However, the failure to reset a lockout relay[80] prevented the Bus Tie breaker from closing.

Monday, July 17, 2006 1909 hours

After resetting the lockout relay and isolating the remaining feeders on the section by opening their circuit breakers, Bus Section 3S was restored to service.

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[80] When multiple functions have to be carried out simultaneously such as tripping several circuit breakers on a Bus Section an intermediate device called a lockout relay is used to carry out the required functions.

Monday, July 17, 2006 1909 hours

An attempt was made to restore feeder 1Q07 to service. The feeder was Cut In and Opened Auto ("CIOA").[81]

The fault on feeder 1Q07 was found to be in a joint.

The network remained in a **5th Contingency**.

Case 4 Monday, July 17, 2006 1910 hours

Feeder 1Q15 was restored to service by closing its associated circuit breaker.

The network was back to a **4th Contingency**.

Case 5 Monday, July 17, 2006 1948 hours

Feeder 1Q02 opened automatically. The feeder was isolated by its respective circuit breaker.

Although relay targets[82] were reported, no fault was found at this time. Restoration was unsuccessfully attempted at 2008 hours.

The network was now in a **5th Contingency**.

Case 6 Monday, July 17, 2006 2008 Hours

Feeder 1Q02 was restored to service.

The network was now in a **4th Contingency**.

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[81] Cut In and Opened Auto is a situation when a primary feeder is restored to service and upon energization a problem arises on the feeder that prevents it from being restored to service.

[82] A relay is a device at the substation that monitors the current into the feeder and signals the circuit breaker to open if the current exceeds its present value, indicating a presence of excessive current on the feeder. When the circuit breaker opens a target (indicator) is displayed on the relay.

Case 7 Monday, July 17, 2006 2143 hours

Feeder 1Q20 opened automatically. The feeder was isolated by its respective circuit breaker.

Although relay targets were reported, no fault was found at this time.

The network was back to a **5th Contingency**.

Monday, July 17, 2006 2143 hours

An attempt was made to restore feeder 1Q20 and it CIOA.
The fault was found to be in a transformer.

The network remained in a **5th Contingency**.

Case 8 Monday, July 17, 2006 2149 hours

Feeder 1Q01 opened automatically due to a fault. The feeder was isolated by its respective circuit breaker.

Although relay targets were available they were not reported by the substation operator, and no fault was found at this time.

At 2156 hours an attempt was made to restore the feeder to service and it CIOA.

The fault was found to be a transformer and cable.

The network was now in a **6th Contingency**.

Case 9 Monday, July 17, 2006 2321 hours

Feeder 1Q17 was restored to service.

The network was now in a **5th Contingency**.

Monday, July 17, 2006 2337 hours

An attempt was made to restore feeder 1Q16 at this time and it CIOA.

The fault was determined to be in a joint.

The network remained in a **5th Contingency**.

Tuesday, July 18, 2006 0249hrs

An attempt was made to restore feeder 1Q21 and it CIOA upon an attempt to reenergize the feeder.

The fault was determined to be in a joint.

The network remained in a **5th Contingency**.

Tuesday July 18, 2006 0553 hours.

An attempt was made to restore feeder 1Q20 and it CIOA.

The fault was determined to be in a joint.

The network remained in a **5th Contingency**.

Case 10 Tuesday, July 18, 2006 0823 hours

Feeder 1Q02 opened automatically due to a fault on the feeder. The feeder was isolated by its respective circuit breaker.

Two faults were found. One fault was in a cable and the second was in a joint.
The network was back to a **6th Contingency**.

Case 11 Tuesday July 18, 2006 0933 hours

Feeder 1Q16 was restored to service.

The network was now in a **5th Contingency**.

Case 12 Tuesday, July 18, 2006 1137 hours

Feeder 1Q07 was restored to service.

The network was now in a **4th Contingency**.

Case 13 Tuesday, July 18, 2006 1155 hours

Feeder 1Q17 opened automatically. The feeder was isolated by its respective circuit breaker.

No fault was found at this time.

The network was back to a **5th Contingency**.

Case 14 Tuesday, July 18, 2006 1514 hours

Feeder 1Q18 opened automatically due to a fault on the feeder. The feeder was isolated by its respective circuit breaker.

The fault was found to be in a transformer.

The network was back to a **6th Contingency**.

Tuesday, July 18, 2006 1711 hours

An attempt was made to restore feeder 1Q21 at this time and it CIOA.

The fault was determined to be in a joint.

The network remained in a **6th Contingency**.

Tuesday, July 18, 2006 1856 hours

An attempt was made to restore feeder 1Q02 and it CIOA.

The fault was determined to be in a joint.

The network remained in a **6th Contingency**.

Case 15 Tuesday, July 18, 2006 2005 hours

Feeder 1Q13 opened automatically. The feeder was isolated by its respective circuit breaker.

No fault was found at this time.

The network was now in a **7th Contingency**.

Case 16 Tuesday, July 18, 2006 2033 hours

Feeder 1Q12 opened automatically due to a fault on the feeder. The feeder was isolated by its respective circuit breaker.

Two faults were found. One fault was determined to be a transformer and the second was a cable, both in the same structure.

The network was now in an **8th Contingency**.

Case 17 Tuesday, July 18, 2006 2033 hours

Feeder 1Q15 opened automatically due to a fault on the feeder. The feeder was isolated by its respective circuit breaker.

The fault was determined to be in a transformer.

The network was now in a **9th Contingency**.

Case 18 Tuesday, July 18, 2006 2038 hours

Feeder 1Q16 opened automatically due to a fault on the feeder. The feeder was isolated by its respective circuit breaker.

The network was now in a **10th contingency**.

Tuesday, July 18, 2006 2149 hours

An attempt was made to restore feeder 1Q16 to service and it CIOA.

Faults were determined to be in a transformer and a cable.

The network remained in a **10th Contingency**.

Case 19 Tuesday, July 18, 2006 2053 hours

Feeder 1Q01 was restored to service.

The network was now in a **9th Contingency**.

Tuesday, July 18, 2006 2055 hours

An attempt was made to restore feeder 1Q17 and it CIOA.

The fault was determined to be in a transformer.

The network remained in a **9th Contingency**.

Case 20 Tuesday, July 18, 2006 2126 hours

Feeder 1Q13 was restored to service.

The network was now in an **8th Contingency**.

Case 21 Tuesday, July 18, 2006 2146 hours

Feeder 1Q18 was restored to service.

The network was now in a **7th Contingency**.

Case 22 Tuesday, July 18, 2006 2151 hours

Feeder 1Q18 opened automatically. The feeder was isolated by its respective circuit breaker.

Although there were relay targets, no fault was found at this time.

The network was back to an **8th Contingency**.

Case 23 Tuesday, July 18, 2006 2225 hours

Feeder 1Q19 opened automatically. The feeder was isolated by its respective circuit breaker.

Although relay targets were reported no fault was found at this time.

The network was back to a **9th Contingency**.

Tuesday, July 18, 2006 2357 hours

An attempt was made to restore feeder 1Q18 and it CIOA.

A fault was determined to have been in a transformer.

The network remained in a **9th Contingency**.

Case 24 Wednesday, July 19, 2006 0000 hours

Feeder 1Q19 was restored to service.

The network was now in an **8th Contingency**.

Case 25 Wednesday, July 19, 2006 0006 hours

Feeder 1Q19 opened automatically due to a fault on the feeder. The feeder was isolated by its respective circuit breaker.

The fault was determined to be in a transformer.

The network was back to a **9th Contingency**.

Case 26 Wednesday, July 19, 2006 0619 hours

Feeder 1Q21 was restored to service.

The network was now in an **8th Contingency**.

Wednesday, July 19, 2006 0850 hours

An attempt was made to restore 1Q17 and it CIOA.

The fault was found to be in a joint.

The network remained in an **8th Contingency**.

Case 27 Wednesday, July 19, 2006 0851 hours

Feeder 1Q14 opened automatically due to a fault on the feeder. The feeder was isolated by its respective circuit breaker.

The fault was determined to be in a joint

The network was back to a **9th Contingency**.

Wednesday, July 19, 2006 1115 hours

Feeder 1Q12 failed a modified Hipot[83] test.

The network remained in a **9th Contingency**.

Case 28 Wednesday, July 19, 2006 1133 hours

Feeder 1Q01 opened automatically due to a fault on the feeder. The feeder was isolated by its respective circuit breaker.

The fault was determined to be in a cable.

The network was back to a **10th Contingency**.

Case 29 Wednesday, July 19, 2006 1310 hours

Feeder 1Q20 was restored to service.

The network was now in a 9th Contingency.

Case 30 Wednesday, July 19, 2006 1337 hours

Feeder 1Q12 was restored to service.

The network was now in an **8th Contingency**.

Wednesday, July 19, 2006 1605 hours

Feeder 1Q15 failed a modified Hipot test.

The fault was determined to be in a Live End Cap[84] (termination).

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[83] A modified Hipot test is when a feeder is subjected to the application of a DC test voltage (with a small amount of current available) for a period of time in an attempt to uncover any incipient faults while the feeder is in a test mode. This test prevents the feeder components from being subjected to high currents that are present when the feeder is in service. A full Hipot test on the 27 kV system is 60 kV DC applied for 15 minutes. A modified Hipot on the 27 kV system is usually 30 kV DC for 5 minutes.

[84] A Live End Cap is a termination that is applied to a primary cable, after damaged equipment has been temporally removed, so that the cable can be returned to service.

The network remained in an 8th Contingency.

Case 31 Wednesday, July 19, 2006 1905 hours

Feeder 1Q02 was restored to service.

The network was now in a **7th Contingency**.

Wednesday, July 19, 2006 1943 hours

Feeder 1Q16 failed an ammeter clear[85] test.

No fault was found at this time.

The network remained in a **7th Contingency**.

Case 32 Wednesday, July 19, 2006 2041 hours

Feeder 1Q17 was restored to service.

The network was now in a **6th Contingency**.

Case 33 Wednesday, July 19, 2006 2129 hours

Feeder 1Q17 opened automatically due to a fault on the feeder. The feeder was isolated by its respective circuit breaker.

The fault was found to be in a transformer.

The network was back to a **7th Contingency**.

Case 34 Thursday, July 20, 2006 0046 hours

Feeder 1Q18 was restored to service.

The network was now in a **6th Contingency**.

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[85] An ammeter clear test is a low voltage AC test signal that is used to determine if all field grounds have been removed before a feeder is restored to service.

Case 35 Thursday, July 20, 2006 0433 hours

Feeder 1Q19 was restored to service.

The network was now in a **5th Contingency**.

Case 36 Thursday, July 20, 2006 0636 hours

Feeder 1Q14 was restored to service.

The network was now in a **4th Contingency**.

Thursday, July 20, 2006 0811 hours

Feeder 1Q16 failed an ammeter clear test.

The fault was found in a transformer.

The network remained in a **4th Contingency**.

Case 37 Thursday, July 20, 2006 1238 hours

Feeder 1Q17 was restored to service.

The network was now in a **3rd Contingency**.

Case 38 Thursday, July 20, 2006 1337 hours

Feeder 1Q07 opened automatically due to a fault on the feeder. The feeder was isolated by its respective circuit breaker.

The fault was found to be in a joint.

The network was back to a **4th Contingency**.

Case 39 Thursday, July 20, 2006 1348 hours

Feeder 1Q15 was restored to service.

The network was now in a **3rd Contingency**.

Thursday, July 20, 2006 1943 hours

Feeder 1Q16 failed an ammeter clear test .

No fault was found on the feeder.

The network remained in a **3rd Contingency**.

Thursday, July 20, 2006 2022 hours

Feeder 1Q01 failed a modified Hipot test.

The fault was found in a joint.

The network remained in a **3rd Contingency**.

Thursday, July 20, 2006 2103 hours

Feeder 1Q07 failed a modified Hipot test.

The fault was found in joint.

The network remained in a **3rd Contingency**.

Case 40 Friday, July 21, 2006 0637 hours

Feeder 1Q07 was restored to service.

The network was now in a **2nd Contingency**.

Case 41 Friday, July 21, 2006 0749 hours

Feeder 1Q16 was restored to service.

The network was now in a 1st Contingency.

Case 42 Friday, July 21, 2006 0801 hours

Feeder 1Q01 was restored to service.

The network now had no **primary Contingencies**.

Sunday, July 23, 2006 0815 hours

Voltage was restored to normal at the North Queens Substation.

Appendix 1B

Sequence of Events – Secondary System

Case 1 Monday, July 17, 2006 1550 hours

Customer outage reports	1
Low voltage complaints	3
Flickering lights	1
Manhole events	
Explosions	1
Smoking	0
Burning wires[86]	0

Case 2 Monday, July 17, 2006 1622 hours

Customer outage reports	3
Low voltage complaints	4
Flickering lights	2
Manhole events	
Explosions	1
Smoking	0
Burning wires	0

Case 3 Monday, July 17, 2006 1848 hours

Customer outage reports	3
Low voltage complaints	6
Flickering lights	2
Manhole events	
Explosions	1
Smoking	1
Burning wires	0

[86] Portions of the Long Island City secondary network are located overhead on poles. Burning wires refer to conditions on these overhead secondaries. The overhead secondary wires are supplied by the underground secondary grid.

Case 4 Monday, July 17, 2006 1910 hours

Customer outage reports	5
Low voltage complaints	7
Flickering lights	5
Manhole events	
Explosions	1
Smoking	1
Burning wires	0

Case 5 Monday, July 17, 2006 1948 hours

Customer outage reports	5
Low voltage complaints	7
Flickering lights	7
Manhole events	
Explosions	1
Smoking	1
Burning wires	0

Case 6 Monday, July 17, 2006 2008 hours

Customer outage reports	7
Low voltage complaints	11
Flickering lights	10
Manhole events	
Explosions	1
Smoking	3
Burning wires	0

Case 7 Monday, July 17, 2006 2143 hours

Customer outage reports	7
Low voltage complaints	12
Flickering lights	10
Manhole events	
Explosions	1
Smoking	3
Burning wires	0

Case 8 Monday, July 17, 2006 2149 hours

Customer outage reports	15
Low voltage complaints	16
Flickering lights	15
Manhole events	
Explosions	1
Smoking	7
Burning wires	1

Case 9 Monday, July 17, 2006 2321 hours

Customer outage reports	33
Low voltage complaints	39
Flickering lights	18
Manhole events	
Explosions	1
Smoking	10
Burning wires	2

Case 10 Tuesday, July 18, 2006 0823 hours

Customer outage reports	56
Low voltage complaints	65
Flickering lights	27
Manhole events	
Explosions	1
Smoking	11
Burning wires	2

Case 11 Tuesday, July 18, 2006 0933 hours

Customer outage reports	89
Low voltage complaints	91
Flickering lights	29
Manhole events	
Explosions	1
Smoking	11
Burning wires	2

Case 12 Tuesday, July 18, 2006 1137 hours

Customer outage reports	92
Low voltage complaints	93
Flickering lights	29
Manhole events	
Explosions	1
Smoking	12
Burning wires	2

Case 13 Tuesday, July 18, 2006 1155 hours

Customer outage reports	132
Low voltage complaints	148
Flickering lights	37
Manhole events	
Explosions	1
Smoking	13
Burning wires	2

Case 14 Tuesday, July 18, 2006 1514 hours

Customer outage reports	280
Low voltage complaints	211
Flickering lights	44
Manhole events	
Explosions	1
Smoking	16
Burning wires	2

Case 15 Tuesday, July 18, 2006 2005 hours

Customer outage reports	292
Low voltage complaints	217
Flickering lights	44
Manhole events	
Explosions	1
Smoking	17
Burning wires	2

Case 16 Tuesday, July 18, 2006 2033 hours

Customer outage reports	292
Low voltage complaints	217
Flickering lights	44
Manhole events	
Explosions	1
Smoking	17
Burning wires	2

Case 17 Tuesday, July 18, 2006 2033 hours

Customer outage reports	299
Low voltage complaints	218
Flickering lights	44
Manhole events	
Explosions	1
Smoking	17
Burning wires	2

Case 18 Tuesday, July 18, 2006 2038 hours

Customer outage reports	306
Low voltage complaints	221
Flickering lights	44
Manhole events	
Explosions	1
Smoking	17
Burning wires	2

Case 19 Tuesday, July 18, 2006 2053 hours

Customer outage reports	334
Low voltage complaints	226
Flickering lights	44
Manhole events	
Explosions	1
Smoking	18
Burning wires	3

Case 20 Tuesday, July 18, 2006 2126 hours

Customer outage reports	346
Low voltage complaints	228
Flickering lights	45
Manhole events	
Explosions	1
Smoking	19
Burning wires	3

Case 21 Tuesday, July 18, 2006 2146 hours

Customer outage reports	346
Low voltage complaints	228
Flickering lights	45
Manhole events	
Explosions	1
Smoking	19
Burning wires	2

Case 22 Tuesday, July 18, 2006 2151 hours

Customer outage reports	358
Low voltage complaints	230
Flickering lights	45
Manhole events	
Explosions	1
Smoking	20
Burning wires	3

Case 23 Tuesday, July 18, 2006 2225 hours

Customer outage reports	371
Low voltage complaints	231
Flickering lights	46
Manhole events	
Explosions	1
Smoking	23
Burning wires	2

Case 24 Wednesday, July 19, 2006 0000 hours

Customer outage reports	371
Low voltage complaints	231
Flickering lights	46
Manhole events	
Explosions	1
Fires	1
Smoking	25
Burning wires	3

Case 25 Wednesday, July 19, 2006 0006 hours

Customer outage reports	434
Low voltage complaints	245
Flickering lights	46
Manhole events	
Explosions	1
Fires	4
Smoking	44
Burning wires	6

Case 26 Wednesday, July 19, 2006 0619 hours

Customer outage reports	596
Low voltage complaints	265
Flickering lights	50
Manhole events	
Explosions	1
Fires	7
Smoking	58
Burning wires	6

Case 27 Wednesday, July 19, 2006 0851 hours

Customer outage reports	880
Low voltage complaints	304
Flickering lights	52
Manhole events	
Explosions	1
Fires	8

Smoking	67
Burning wires	6

Case 28 Wednesday, July 19, 2006 1133 hours

Customer outage reports	1027
Low voltage complaints	318
Flickering lights	46
Manhole events	
Explosions	1
Fires	10
Smoking	72
Burning wires	6

Case 29 Wednesday, July 19, 2006 1310 hours

Customer outage reports	1064
Low voltage complaints	324
Flickering lights	53
Manhole events	
Explosions	1
Fires	10
Smoking	73
Burning wires	6

Case 30 Wednesday, July 19, 2006 1337 hours

Customer outage reports	1450
Low voltage complaints	356
Flickering lights	56
Manhole events	
Explosions	1
Fires	11
Smoking	86
Burning wires	11

Case 31 Wednesday, July 19, 2006 1905 hours

Customer outage reports	1508
Low voltage complaints	356
Flickering lights	53

Manhole events	
Explosions	1
Fires	11
Smoking	88
Burning wires	11

Case 32 Wednesday, July 19, 2006 2041 hours

Customer outage reports	1535
Low voltage complaints	358
Flickering lights	56
Manhole events	
Explosions	1
Fires	11
Smoking	90
Burning wires	2

Case 33 Wednesday, July 19, 2006 2129 hours

Customer outage reports	1595
Low voltage complaints	359
Flickering lights	57
Manhole events	
Explosions	1
Fires	11
Smoking	92
Burning wires	13

Case 34 Thursday, July 20, 2006 0046 hours

Customer outage reports	1606
Low voltage complaints	360
Flickering lights	57
Manhole events	
Explosions	1
Fires	11
Smoking	94
Burning wires	13

Case 35 Thursday, July 20, 2006 0433 hours

Customer outage reports	1615
Low voltage complaints	360
Flickering lights	57
Manhole events	
Explosions	1
Fires	11
Smoking	96
Burning wires	15

Case 36 Thursday, July 20, 2006 0636 hours

Customer outage reports	1870
Low voltage complaints	381
Flickering lights	60
Manhole events	
Explosions	1
Fires	12
Smoking	100
Burning wires	16

Case 37 Thursday, July 20, 2006 1238 hours

Customer outage reports	1923
Low voltage complaints	382
Flickering lights	61
Manhole events	
Explosions	1
Fires	12
Smoking	100
Burning wires	17

Case 38 Thursday, July 20, 2006 1337 hours

Customer outage reports	1930
Low voltage complaints	382
Flickering lights	61
Manhole events	
Explosions	1
Fires	12

Smoking	100
Burning wires	18

Case 39 Thursday, July 20, 2006 1348 hours

Customer outage reports	2649
Low voltage complaints	474
Flickering lights	63
Manhole events	
Explosions	1
Fires	15
Smoking	106
Burning wires	22

Case 40 Friday, July 21, 2006 0637 hours

Customer outage reports	2701
Low voltage complaints	475
Flickering lights	64
Manhole events	
Explosions	2
Fires	15
Smoking	106
Burning wires	22

It should be pointed out that while the Company's information systems were reporting what is provided in this sequence, the Company performed a field survey of customer outages on the night of July 20 (Thursday) to July 21 (Friday). From the results of this survey, the Company concluded that the number of customers out of service was approximately 25,000. This estimate was later determined to be significantly incorrect.

Case 41 Friday, July 21, 2006 0749 hours

Customer outage reports	2708
Low voltage complaints	476
Flickering lights	65
Manhole events	
Explosions	2
Fires	15
Smoking	106
Burning wires	22

Case 42 Friday, July 21, 2006 0801 hours

Customer outage reports	2848
Low voltage complaints	496
Flickering lights	65
Manhole events	
Explosions	2
Fires	16
Smoking	113
Burning wires	23

Sunday, July 23, 2006 0815 hours

Voltage was restored to normal at the North Queens Substation.

Appendix 2

Examination of Failed Cables, Joints, and Terminations Through Case 42

Case 1: Feeder 1Q 17. 7/17/06 1550 hours

This was a 21 year old section of Cross Linked Polyethylene cable (XLPE).

Probable Cause: External damage from secondary fire; no sign of electrical failure.

One of the cable samples was found to have an indentation (defect) on the exterior of the lead sheath that could still be seen on the inside of that spot as an area of black dots. The semiconducting shield[87] was also marked in that area and was a glossy smooth spot. The interior of the lead sheath was evenly covered with a white coating, probably lead carbonate from oxidation of the lead sheath. Microscopic examination did not reveal anything unusual.

Conclusion: The proximity of a secondary cable fire in a wooden duct that was located a few feet away from the cable supports the base determination that a secondary fire severely damaged this primary cable. It is likely that the indentation in the lead sheath occurred during the installation or even at the factory. The result was an area of low resistance between the insulation semiconducting layer and the lead sheath, and was a path for concentrated flow of charging current.

Case 2: Feeder 1Q 16. 7/17/06 1622 hours

This was a 6 year old section of EPR cable.

Probable Cause: External damage from secondary fire.

Several pieces were examined and there was, overall, evidence of external damage: missing insulation, missing shield, loose semiconducting shield; exposed, discolored and/or missing conductor (at a fault), and burned-off jacket. Where the jacket remained, there was considerable heat-induced damage and the cable was no longer round. Signs of heat-induced damage were evident.

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[87] The semiconducting shield is a material which neither conducts nor insulates the flow of electricity. In most medium-voltage cable designs, the insulation is surrounded by a semiconducting layer at ground potential. This layer distributes electrostatic stress evenly around the conductor, and drains surface charges to ground.

Conclusion: The proximity of a secondary cable-fire in a wooden duct that was located a few feet away from the primary cable supports the base determination that a secondary fire severely damaged this primary cable.

Case 9: Feeder 1Q 16. 7/17/06 2337 hours

This was a 12 year old heat shrink transition joint[88] manufactured by Raychem.

Probable Cause: Design, but PILC was aged and had brittle tapes.

The XLPE side of the joint showed that one phase failed and damaged the other two phases. The PILC side of the joint showed moisture on the outside paper tapes but less moisture inside. The failure occurred in one of the phases. However, all three phases were affected by moisture. The paper tapes were more brittle closer to the conductor. Failure occurred on the paper side of the transition joint.

Conclusion: There is no question that the paper insulation had seen high heat at some point in its life, but the degree of thermal degradation seen in this sample was probably not the cause of the failure. Because this cable was only loaded to 4% of its rating at the time of the failure, it cannot conclusively be stated when the cable was overloaded. The probable cause is moisture penetration into the paper insulation, which causes a dramatic increase in losses that leave the appearance of overheating. For a detailed discussion of this topic, see Appendix 4 on dielectrophoresis examining the way moisture can enter the paper insulation in these splices. This joint design has been targeted for replacement because of numerous previous failures. Design is the probable root cause of failure.

Case 9: Feeder 1Q 21. 7/18/06 0249 hours

This was a premolded transition joint likely manufactured by Elastimold.

Probable Cause: Design.

This fault began as an apparent phase-to-ground failure, and then progressed to arcing between phases. The PILC side showed indications of moisture.

Conclusion: Design is the probable root cause of failure. Moisture penetration into the paper insulation causes a dramatic increase in losses that leave an appearance of overheating. This joint design has been targeted for replacement because of numerous previous failures.

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[88] A transition joint is used to connect solid dielectric cable (XLPE or EPR) to paper insulated cable (PILC). This is also referred to as a Stop Joint.

Case 10: Feeder 1Q 02. 7/18/06 0823 hours

This was a 1 year old section of EPR cable.

Probable Cause: External damage from secondary fire.

This cable appeared to be damaged by external heat. On one end there were remains of a 3 inch wide tape over all 3 phases – apparently arc-proofing. It was light tan in color on the outside and black on the inside. This material was very difficult to remove as it was brittle and fused together. A flame resistant tape was partially volatilized (polypropylene jacket and tape fused). On one of the three phases the EPR was "whitish". The polypropylene jacket on each phase had melted to the other phases.[89] The tinned copper straps showed evidence of very high heat because of a golden to blue hue of the tin coating on the straps. The semiconducting layer was split at the edge of each strap from the expansion caused by the high heat. Some semiconducting material was missing to expose the EPR but no electrical failure was seen at that area.

At the area of the fault, the insulation had been burned away or mechanically abraded. The copper conductor had been melted and removed by the fault. The cable was out of round in this area.

Conclusion: The root cause of this failure was external damage from a secondary fire that severely damaged the primary cable.

Case 27: Feeder 1Q 14. 7/19/06 0851 hours

This sample was a 15 year old premolded joint probably manufactured by Elastimold.

Probable Cause: Unknown; insufficient sample length.

Only the connector for this joint was provided for examination. There were no signs of failure.

Conclusion: There were insufficient components to determine the cause of this failure.

Case 30: Feeder 1Q 15. 7/19/06 1605 hours

This was initially identified as a failure in a section of XLPE cable that was 15 years old. However, in Con Edison's October 12th Report it was identified as a failure of a Live End Cap.

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[89] Melting of the polypropylene jacket requires the cable to be exposed to a temperature in the range of 300º F.

Probable Cause: Unknown, because of insufficient components to examine.

The cable was inspected and no failure was found. Electrical tests were satisfactory and microscopic examination showed no abnormalities

Conclusion: This is believed to be a termination failure, but no information on the termination is available. Because there were insufficient components available for examination, no conclusion as to the cause of this failure could be determined.

Case 39: Feeder 1Q 07. 7/20/06 2103 hours

This sample was a 14 year old Stop Joint manufactured by Elastimold.

Probable Cause: Design. It appears that moisture entered the splice housing and then into the paper insulation. The failure was in the paper insulation at the end of the premolded adapter and just beyond the silicone tape that was used for an oil stop. A moisture test indicated that water entered the paper. The inside of the lead sheath looked clean upon examination with no darkening.

Conclusion: This joint design has been targeted for replacement because of numerous previous failures. See Appendix 4 regarding the discussion of dielectrophoresis for the way moisture can enter the paper insulation in these splices. Design is the probable root cause, leading to susceptibility to partial discharge.

Appendix 3

Examination of Failed Cables, Joints and Terminations that Occurred After Case 42

Feeder 1Q 15. 7/21/06 1004 hours

This was a hand made lead wiped joint of unknown age.

Probable cause: Workmanship and overheating; defective seal on wiped joint.

A hole was blown in the joint just off center in one of the phases. There was a PILC failure in the joint near one end of the specimen. The outer lead sleeve was not deformed. When the lead sleeve on the failed joint was removed, there was no compound in any of these joints. The sleeve was blown out and split remote from the fault hole. The inside of the sleeve was blackened probably from the failure. The tape and shield were removed down to the connector exposing a well-made soldered connector. The paper insulation was properly prepared but was burned away on the side that was under the hole in the sleeve. The lead wipes looked as though they were well made and did not appear to be cracked or damaged in any way. In the other two phases, the sleeves had collapsed.

Conclusion: There were strong indications that the paper insulation had been degraded by overheating at some time in its life. Another possible reason for the failure was a leak in the structure. This could have allowed moisture to enter and degrade the paper, making the cause of the failure workmanship. The heat of the failure could have elevated the temperature sufficiently to melt the solder that ran out from under the connector.

Feeder 1Q 15. 7/22/06 0734 hours

This sample was an 11 year old Stop Joint manufactured by Elastimold.

Probable Cause: Unknown.

Only one side and premolded central portions of the joint were available for examination. The housing from the failed phase had been previously cut open. No evidence of burning was visible inside. The failure destroyed the housing. There was a black deposit on the connector and adapter. There was no cable to examine and no apparent reason for the fault. Moisture penetration appears likely.

Conclusion: Unknown because of insufficient components to examine.

Feeder 1Q 14. 7/23/06 2208 hours

This specimen was a 12 year old Raychem heat shrink Stop Joint.

Probable Cause: Design defect.

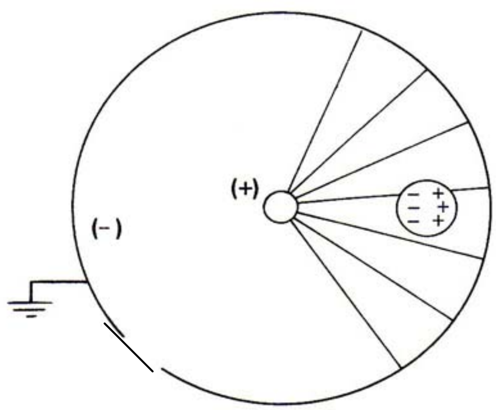
The PILC cable in this joint was 48 years old and it had failed. There was water in the sample bag when it was opened. However, the paper tapes near the conductor were dry.

Conclusion: The likely causes of this failure were design and workmanship. Complete shrinking of this style of Raychem heat shrinkable housings has proven to be very difficult for workmen. Later design changes have been made to help field personnel determine when sufficient heat has been applied for complete shrinking, hence eliminating voids and making superior seals.

Dielectrophoresis

Dielectrophoresis describes the movement of uncharged but polarized particles or molecules (such as moisture) in a divergent electrical field. In the example of an otherwise uniform single conductor electrical cable, the field increases as a particle or molecule gets closer to the conductor. An uncharged particle will be polarized at any given point in time so that it will have a negatively charged dipole with its negative side, for instance, toward the conductor that is positive at that instant. Since the negative side of this dipole exists in a stronger field than the positive side, the particle will be attracted toward the field of greatest field intensity (see Figure 1 below). In an alternating current system, as the conductor becomes negatively charged, the polarization process is reversed. This means that the particle is still attracted toward the conductor with its higher electric field.

Figure 1



The practical effect of dielectrophoresis is that moisture will be drawn to the higher dielectric field region even in an alternating field. This high stress point in a perfect cable is the conductor and if moisture is available on the outside of a cable or joint, it will be drawn toward the conductor. This may present some problems for extruded or solid dielectric cables (XLPE or EPR), but it creates a much more serious problem for paper insulated cables.

The practical aspect of this for stop joints is that moisture can be drawn toward the conductor through paper insulation even though there is a rubber like covering (EPR, silicone, XLPE) over the outside layer. As long as there is a voltage drop across the material, moisture will be drawn toward the paper insulation. A metallic barrier (such as the lead sheath of a PILC cable) solves this problem as long as it remains undamaged. An insulating jacket over the semi-conducting surface is generally used, but must be completely sealed to the jacket or sheath of the cable to prevent this occurrence.

A similar force is exerted on the stop joint as the load changes since the interior of the joint expands and contracts with the changing heat that is generated there. On the cooling cycle, there is a tendency to pull moisture into the center of the joint when it is available. Again, the EPR and XLPE are somewhat resistant to this small intrusion of moisture, but the paper insulation is not at all tolerant.

Appendix 5

Proposed Method to Prioritize Removal of Old Stop Joints

If aging-induced 'loss of life' of the paper insulation contributed to making the joint more susceptible to failure due to other internal causes, then that would be a significant observation for future consideration. This information could be used to prioritize removal of the more susceptible joints. Thus, joints of the same vintage and the same manufacturer that showed loss of life could be focused on and prioritized for scheduled removal / replacement.

The assumptions are that:

(a) aging-induced changes (loss of life) is related to failure of the joint,

(b) loss of life is NOT related to aging time in service (i.e., how old the joint is) but is related to local conditions, including the effect of dielectrophoresis,

(c) regardless of (b) joints of similar vintage and manufacturer are anticipated to respond similarly due to design and handling issues, and

(d)) if the degree of degradation can be determined on paper from stop joints of similar vintage and manufacturer, that information would provide guidance on what joints to remove first.

Con Edison has a planned replacement program in place for removal of 'targeted' stop joints but the removal process has stretched out over years due to the size of the population. It is clear that an improved prioritization process is worthy of consideration. This approach could also be useful for potential removal of stop joints Con Edison does not presently have targeted for removal.

The simplest manner to determine if the failed PILC portion is deteriorated is to perform a Degree of Polymerization (DP) test on the PILC. This test is identical to what is commonly performed for transformer insulation. The DP test could possibly provide guidance on whether moisture entered before or after failure (if paper is wet but DP did not drop). This approach would require removal of specimens from aged transition joints from the Con Edison system. Since the evidence for this analytical approach is suggestive but not definitive it is best evaluated via an R&D effort.

Appendix 6

Background on Secondary Cables

Secondary network cables on the Con Edison system operate at a nominal voltage on conductor to ground of 120 volts and have an insulation wall of 80 mils. This results in a voltage stress of 1.5 volts per mil (a mil is one thousandth of an inch). The 27 kV primary cables operate at a nominal level of 15,590 volts to ground with a nominal insulation wall of 275 mils – 56.7 volts per mil, or 37.8 times the stress of a secondary cable. The basic reason for the lower stress level design for secondary cables is to give them mechanical ruggedness rather than because of electrical strength.

The secondary cables used in the early network systems had copper conductors, paper insulation, and bare lead sheaths. By the 1940s many of the users began eliminating the lead sheath and using rubber (both natural and synthetics such as GRS and butyl) for the insulation. The 1970s saw a change in the insulation to ethylene propylene rubber (EPR) that has become the material of choice for such cables. Hence, secondary cables have had the same general design for the past 60 to 70 years although materials have changed.

This design philosophy has led to an excellent electrical performance of cables rated for 600 volts throughout the United States as well as around the world. This performance level has resulted in utilities concentrating on secondary cable loading and voltage drop for maintenance and replacement purposes.

Failure mechanisms for these 600-volt cables generally have been mechanical damage or overheating due to excessive current flow. Mechanical damage has been reported as possibly being due to manufacturing defects, storage and handling factors such as fork lift impact or surface abrasion (scoring), or damage during installation. Pinholes and/or surface defects represent a source of concern for secondary cables. To alleviate this concern, the industry developed a series of modified constructions that possesses a tough abrasion resistant outer layer (often high density polyethylene) over an inner layer (sometimes low density polyethylene) over the conductor. These modified constructions helped impart resistance to some defects, but not all.

More recently, the industry has developed improved constructions that possess a ‘self sealing’ capability. If a defect forms, a viscous fluid insulating material (incorporated into the construction) migrates to the defect site and fills the void region and thereby prevents water entry. Numerous construction variations presently exist, all intended to improve resistance of secondary cables to mechanical damage. However, as with primary cables, the Con Edison system is comprised of a variety of older constructions that are not expected to posses these ‘newer’ materials, and may vary in their resistance to mechanical abuse. Numerous construction variations presently exist, all intended to improve reliability.

It should also be noted that material changes have also been incorporated for the conductors of secondary cables; copper has, in some cases, been replaced with aluminum. Water entry into the aluminum conductor of secondary cables later led to problems due to a different failures mechanism – corrosion of the conductor (water entering through the defects noted above. Corrosion of Aluminum conductors was a primary reason for development of ‘self-sealing’ cable technology noted above. The mechanism of corrosion is understood, and has been discussed in the technical literature.

Mechanical damage conditions can exist for many months (such as a hole completely through the insulating wall) without detection since the voltage stress is so low that service failures do not occur until water is added to the mix. Salt water is the most damaging. This type of failure is usually reported as a manhole incident: a situation where an explosion occurs in a manhole that can send the cover off, fire erupts from the manhole, or smoke is seen coming out around the manhole cover.

Appendix 7

DC Hipot Testing

The DC Hi Pot test has been employed for many years in the cable industry after originally being successfully applied to paper-insulated cables. When extruded (solid dielectric) cables entered the market many years ago, the test was applied industry-wide in a similar manner without any consideration being given to the possibility that extruded cables may respond differently to the applied stress.

That the test itself may not pick out weakened links in XLPE-insulated cables is well established; whether it 'works' depends on the specific cable construction, the DC test voltage and duration (determined by industry specifications), and the degree of degradation of the cable at the time of test.

The test has also been used for many years to 'factory test' new extruded cables to pick out defects and has worked satisfactorily there: there is no evidence that the DC Hi Pot test has any harmful effect on new, un-aged cable.

Staying with the subject of aged cables, the key issue relates to the response of the extruded cable to the applied stress. The evidence is overwhelming that if extruded XLPE-insulated cable has been subjected to water treeing, the response to DC Hi Pot testing will not be favorable; but the exact nature of that response depends on the degree of water treeing and degree of 'loss of life" and the environment (not age). The complication arises from the fact that if the DC Hi Pot test does not induce failure at the time of testing, the applied stress due to the DC test may change the nature of the insulation to make it more susceptible to premature failure at a later time (trap induced space charge and reduce the ability of the insulation to serve its intended role). Hence a DC Hi Pot test is a 'mixed bag.' It may induce failure at the intended time of testing, or it may shorten the life of the un-failed-but-tested cable.

With specific reference to Con Edison cable constructions, the lead sheath employed is an excellent water barrier, and the XLPE-insulated cable should be superbly protected from water treeing, hence slowing down the aging process that would take place more rapidly if the lead were not employed. In a sense, the lead-sheathed aged XLPE insulated cable would be 'like new' for many more years than a cable construction that employed a polymeric jacket. Even with a lead sheath, aging does occur but it takes much longer for the dielectric strength to drop thereby decreasing susceptibility to the DC-induced stress application.

For EPR-insulated cable, the indications are not so clear and what applies to XLPE may not apply to EPR. The volume of installed XLPE from past years far exceeds the usage of the newer EPR.

A similar situation applies to XLPE-insulated cable within a transition joint; however, the limited amount of test data does not indicate that XLPE (or EPR) aging is a factor, perhaps because for a transition joint, the PILC segment is always older than the newer extruded cable employed.

Appendix 8

Analysis of Five Remaining Transformers

1. Serial Number M133783:

The October 12th Report concludes that this unit failed due to overheating as evidenced by the damage observed in phases B and C at teardown.[90] The damage in phase B is described as "…melted aluminum across the layers" and the damage in phase C is described as "…primary turns bundled, indented and distorted, both turn to turn and layer to layer." [91]

The damage described is typical of what one would expect to see as a result of an internal failure, but would not necessarily be indicative of the cause of that failure and is not characteristic of advanced loss of life. In the case of this particular unit, it is of recent vintage (21 yrs) and there is little data available regarding the loading or temperatures that this unit reached during the event. The only data available indicated that the unit had a load of 185% on July 17, 2006, at 2149 hours.[92] This loading is over the 2nd contingency rating of this transformer of 170%. The degree of polymerization (DP) analysis on two insulation samples from the coils of this unit indicated a remaining life of 87%.

The loading of the feeder associated with this transformer does indicate an increased feeder loading after July 17, 2006, at 2149 hours until the time of the unit's failure on July 18, 2006, at 2033 hours. How much of this increased load might have been picked up by this unit due to the increase in the feeder loading is unknown. Feeder loading is not an indication of individual transformer loading. An individual transformer will load up based on load in its area and nearby contingencies. A key issue that cannot be resolved would be the service history of this unit over its service life.

In summary, the lack of supporting data does not permit a firm conclusion as to the cause of failure of this unit, other than it originated in the primary winding.

2. Serial Number F124281:

The October 12th Report attributes the failure of this unit to overloading of the unit that resulted in over-pressurization of the transformer tank with the result that two "button welds"

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[90] October 12th Report, p. 5-120.

[91] *Id.*

[92] Company Response to Staff Interrogatory 168 (dated: September 27, 2006).

on the cooler panels failed, resulting in loss of dielectric fluid and subsequent dielectric failure.[93] Finite element and metallurgical analysis were performed on the failed radiator. From this analysis, Con Edison concluded that the weld could have failed due to over-pressurization caused by overheating of the transformer oil beyond the maximum 125^0C operating design temperature. Our analysis did not verify Con Edison's conclusion.

The Calculated Real Time Transformer Temperature ("RT3") results provided in the October 12th Report only indicates a top oil temperature of about 112^0C up to the time of failure. Although the top oil temperature gauge did indicate a maximum temperature of 140^0C, it is possible that a mechanical shock could have caused the maximum indicating hand to move. This shock could have been the result of the dynamic pressure buildup resulting from internal failure or movement of the unit. The RT3 also indicated loads that did not exceed 140% of its rating, which is the 2nd contingency rating of this unit. Data obtained during the investigation does indicate that loading of the unit was as much as 158% at one point, although this was approximately 24 hours prior to failure.[94]

An additional failure scenario would involve the pinholes found in the upper portion of the segment 4 wall and the possibility of moisture entering the transformer, resulting in reduced dielectric levels and subsequent failure.

The observed failure of the two cooler "button welds" on this unit and one of the welds on an additional unit (S/N F124624) are typical of what has been observed on units that have experienced significant internal faults with rapid dynamic pressure rises as a result of the internal arcing and breakdown of oil and insulation products in the transformer.

3. Serial Number F124624:

The October 12th Report attributes this unit's failure to the same cause and mechanism as that of unit F124281 (above).[95] There is no data available with respect to loading or temperatures of this unit that can support or refute this presumed cause. The concerns expressed with respect to F124281 apply equally here. It should be noted that this unit is very similar to the preceding unit – both in date of manufacture and serial number. They are possibly of the same design family. For the reasons stated above, we could not verify Con Edison's conclusion.

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[93] October 12th Report, p. 5-123.

[94] Company Response to Staff Interrogatory 168 (dated: September 27, 2006).

[95] October 12th Report, p. 5-126.

Two transformers (S/N F124281 and S/N F124624) were reported to have failed due to reduced oil volume resulting from cooler panel weld failure and ensuing oil leaks. The cause of the weld failure has been determined to be excessive static pressure buildup caused by overloading during this event.[96] It is recommended that a study be conducted to determine the internal static pressure that would be developed under the loading conditions to which these units were subjected. If the results of this study indicate that the developed pressures exceed the design limits of the identified welds, then steps should be taken to restrict loading on transformers of similar design or to modify the design to tolerate the expected level of internally developed pressure without tank weld rupture. This action likely will ameliorate further failures and the associated environmental, safety and operational difficulties that might ensue. Discussion with manufacturers may also be appropriate. Inquiries should be made of the manufacturers as to any testing or theoretical calculations they may have conducted with respect to this issue and the results of those tests or calculations.

4. Serial Number H309368:

The October 12th Report attributes this unit's failure to overheating of the transformer due to overloading.[97] Data collected throughout the investigation of this event does not provide much assistance in determining if this and other units were overloaded or the temperatures these units reached. Based on the age of this unit, 34 years, and some evidence observed at its teardown, it is possible that this unit failed as a result of overheating. Another possible cause of this unit's failure is the result of a dielectric fault resulting from mechanical movement sustained when the feeder was reclosed 50 minutes before this failure. Additionally, the combination of loading and the associated thermal stresses, in concert with the four feeder reclosures during this event, may have precipitated this unit's failure.

5. Serial Number M105273:

The October 12th Report attributes the failure of this unit to a stress corrosion induced weld leak on the low-voltage secondary bushing assembly.[98] This stress corrosion was the result of exposure to high concentrations of chlorides.[99] This conclusion was determined through metallurgical analysis of the weld of the bushing assembly.

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[96] October 12th Report, pp. 5-122 and 5-125.

[97] *Id.*, p. 5-135.

[98] *Id.*, p. 5-126.

[99] *Id.*, p. 5-135.

This unit experienced relatively high overloads and operating temperatures as indicated by the data from RT3. Unfortunately, this data recording ends at midnight on July 17, 2006, and the unit failed on July 21, 2006, at 1725 hours. It is known that loading as high as 192% was recorded earlier in the event[100] and the last data point provided is on July 18th at 2126 hours. It is possible that the loading resulted in gas evolution that precipitated a failure in the superstructure or HV switch area. This would not necessarily have resulted in coil failures. The coils were subsequently subjected to ratio tests and passed. The leak that was discovered could have been the result of the failure of the weld due to the high dynamic pressures developed during the internal fault experienced by the transformer. Of the thirteen failures reported and examined, this unit experienced the second highest level of fault current and the second longest breaker clearing time. The effect of this high level and high duration of fault current and the internal pressure associated with the internal energy release can be seen in the failure of the cover weld for almost the entire length of one of the long tank walls.

Because there is no data available characterizing the unit's load or temperatures closer to the time of failure, it is impossible to know the validity of this latter scenario. If this failure was the result of stress corrosion of the weld attaching the bushing assembly plate to the tank wall, Con Edison should immediately begin an inspection program to address this concern, starting with all units of similar design. This would be prudent based on the potential operating problems that could result from additional similar failures.

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[100] Company Response to Staff Interrogatory 168 (dated: September 27, 2006).

Appendix 9

Load Dependency on Voltage

Voltage reduction does not always result in current reduction. Current reduction, not just MW reduction, should have been the desired result during the Long Island City network event.

Both real (active, MW) and reactive (MVAR) loads have a dependence on voltage. Based on the information provided by Con Edison, 8% of voltage reduction produces 5.2% of real power reduction. This means that on the average, 1% of voltage reduction reduces the real load by 0.65%. This is referred to as the sensitivity factor.

During the course of this investigation, Con Edison did not provide any data on the impact of reactive load dependencies on voltage. Field tests by other utilities and publications[101] suggest that the sensitivity of reactive load to voltage is much higher than the real load sensitivities. A significant portion of reactive load is associated with core losses in transformers and motors. Reactive load sensitivities decrease with voltage decrease due to the non-linear nature of the saturation function of induction motors and transformers.[102] For the purpose of a qualitative study of the impact of voltage on load current, let us assume a linear dependency of real load on voltage and a quadratic[103] dependency of reactive load on voltage. Let us consider different degrees of sensitivity of the reactive load on voltage in the vicinity of the nominal voltage and diminishing sensitivity with voltage reduction with zero-sensitivity at 85% of nominal voltage. The curves representing these sensitivities are

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[101] [1] Load Representation for Dynamic Performance Analysis, IEEE task Force on Load Representation on Dynamic Performance, IEEE Transactions on power Systems, Vol. 8, No.2, May 1993.

[2] Power System Voltage Stability, Carson W. Taylor, McGraw-Hill, Inc., 1994, pp. 71-73.

[3] Power System Stability and Control, P. Kundur, McGraw-Hill, Inc., 1994, pp. 310, 311.

[4] Impact of Automated Voltage/Var Control in Distribution on Power System Operations, N. S. Markushevich (UCI), R. E. Nielsen (B.C. Hydro), J. M. Hall (GPC), A. K. Nakamura (HECO), R. L. Nuelk (NSP); DA/DSM Conference January 1996, Tampa, Florida.

[102] Standard Load Models for Power Flow and Dynamic Performance Simulation, IEEE Task Force on Load Representation for Dynamic Performance, 94 SM 579-3 PWRS, San Francisco, CA

[103] Power System Voltage Stability, Carson W. Taylor, McGraw-Hill, Inc., 1994, p.71-73

presented in Figure 1. As seen in the figure, there are four dependencies with sensitivity factors near the nominal voltage 2%, 3%, 4%, and 5% in voltage change.

If the load-to-voltage sensitivity is equal to unity (1% change in voltage provides a 1% change on power), then the corresponding component of the current (active or reactive) does not depend on voltage. If the sensitivity is smaller than one, the voltage reduction results in current increase. If the sensitivity factor is greater than one, the current decreases. Therefore, since the active load to voltage dependency at Con Edison is 0.65%, the active component of the load current at Con Edison increases by 0. 35%, when the voltage is reduced by 1%: Amps = kW/kV = [(1-0.0065)/(1-0.01) = 1.0035]. The reactive component of the current decreases as long as the sensitivity factor is greater than 1, and increases when the sensitivity factor becomes smaller than 1. The value of this sensitivity factor for reactive power is not known to us at this time. If the load were real (active) load only, voltage reduction would reduce the Watts, but would increase the Amps. However, the actual (apparent) current consists of two components: active and reactive. The reactive Amps = kvar/kV, and the Apparent Amp = $[(\text{Active Amp})^2 + (\text{Reactive Amp})^2]^{0.5}$.

The reactive component of the current reduces as long as the sensitivity factor is greater than one. For instance, if the reactive load to voltage sensitivity factor is 2%, and the voltage is reduced by one percent, the reactive Amps, p.u. = (1-0.02)/(1-0.01) = 0.99 p.u. The actual (apparent) current may either reduce or increase depending on the contribution of the reactive component (the higher the power factor of the load, the smaller is the contribution of the reactive component into the apparent current). The actual (apparent) current, being a square root of the sum of the squares of the active and reactive components, depends on the load power factor. For instance, if the reactive component is 0.5 of the active component (Power Factor ~ 0.9), the apparent current before the voltage reduction is Amp (apparent) = $(1^2 + 0.5^2)^{0.5} = 1.118$ p.u. After voltage reduction by one percent, the Amp (apparent) = $[(1.0035^2 + (0.5 \times 0.99)^2]^{0.5} = 1.119$p.u. This example assumes a sensitivity factor of 0.65% for the active and 2% for the reactive power.

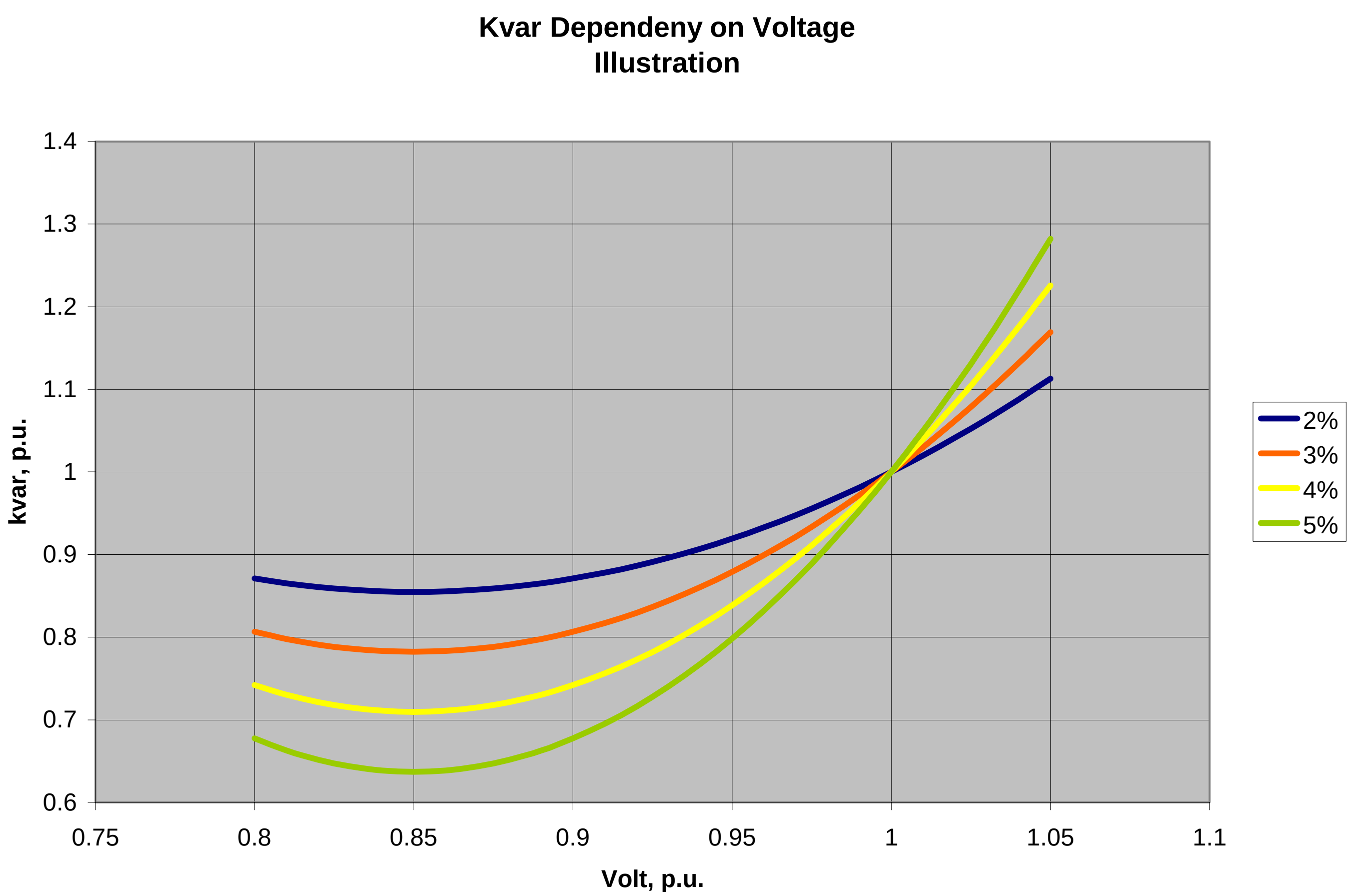
As seen in this example, the reduction of the reactive component of current does not outweigh the increase of the active component, because the contribution of the reactive component is too small. If the power factor were 0.8, the reactive component before voltage reduction would be 0.75. In this case the apparent Amps before voltage reduction would be = $(1^2 + 0.75^2)^{0.5} = 1.25$ p.u. After voltage reduction by one percent, the Amp (apparent) = $[(1.0035^2 + (0.75 \times 0.99)^2]^{0.5} = 1.248$ p.u. in this case, the reduction of the reactive component of the current compensated the increase of the active component, and the apparent current is slightly smaller than before voltage reduction.

If the reactive load to voltage sensitivity is greater than 2%, then the current (with Power Factor 0.8) would reduce even more. The value of this sensitivity factor for Con Edison loads is not known to us at this time. The reactive load to voltage sensitivities mentioned above are the sensitivities in the vicinity of the nominal voltage. When the voltage becomes lower, the reactive sensitivities become smaller. This factor makes the current dependency on voltage even more nonlinear. For illustration of possible dependencies of the apparent current on voltage, several combinations of reactive load to voltage dependencies and load power factors were calculated.

Figure 1 below illustrates several second degree polynomials for dependencies with reactive load to voltage sensitivity in the vicinity of the nominal voltage 2%, 3%, 4%, and 5% in voltage.

The results of the calculations of the current dependencies on voltage for some of these dependencies are presented in Figures 2 through 7.

Figure 1



Reactive load dependencies on voltage. (Examples of second polynomial curves with different sensitivity factors in the vicinity of the nominal voltage).

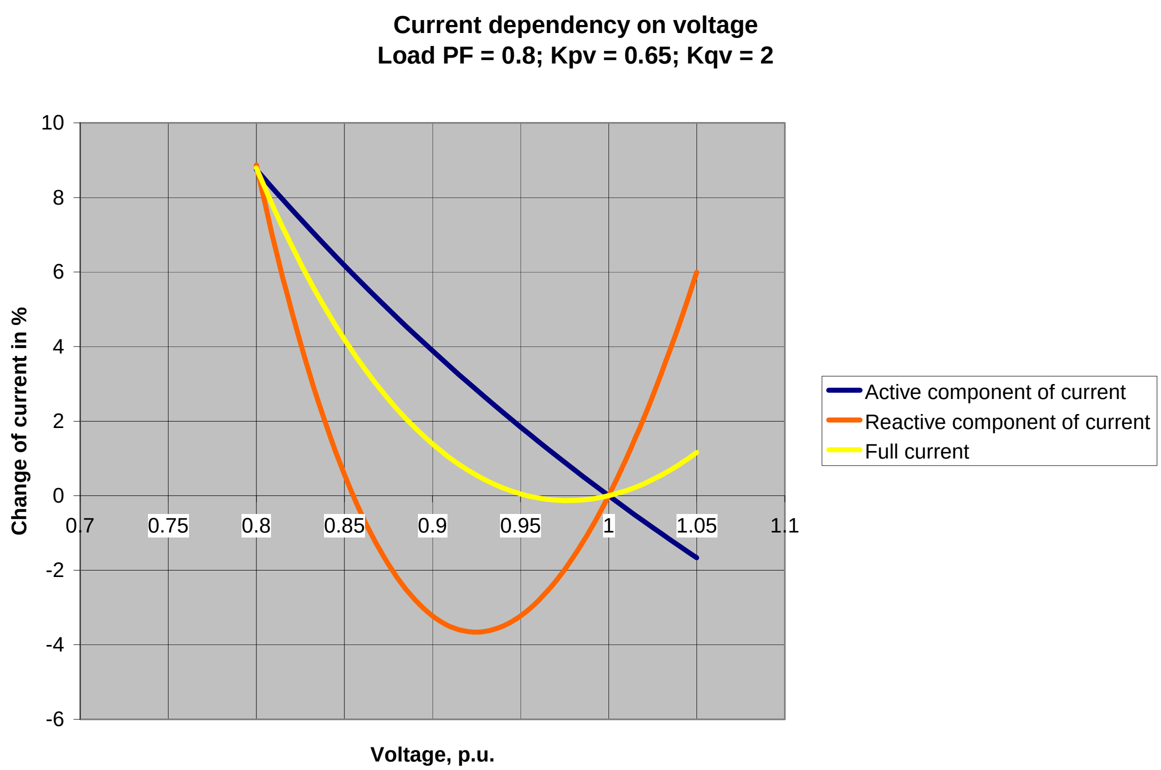
As seen in figures 2 through 7 the active component of the current (blue curve) increases when the voltage is reduced below the nominal (or initial) value, because the real load to voltage sensitivity is 0.65 <1. The reactive component (red curve) is reduced or increased depending on the voltage level which impacts the reactive load sensitivities. The actual (apparent) current (yellow curve) change depends on the contribution of the reactive component change, which is different with different power factors.

Also seen in Figure 2, when the load power factor is 0.8 and the initial reactive load sensitivity factor is 2, the actual current does not practically change with voltage reduction down to 95% of nominal. After that, the current increases, due to the reduction of the reactive load sensitivity. According to the static reactive load-to voltage sensitivities for air conditioners and refrigerators, they are in the range of 2.3 – 2.5%.

With the same initial sensitivity of the reactive load (2%), but with higher power factors (smaller portion of the reactive component), the apparent (full) current increases with voltage below the nominal (*See*, Figures 3 and 4).

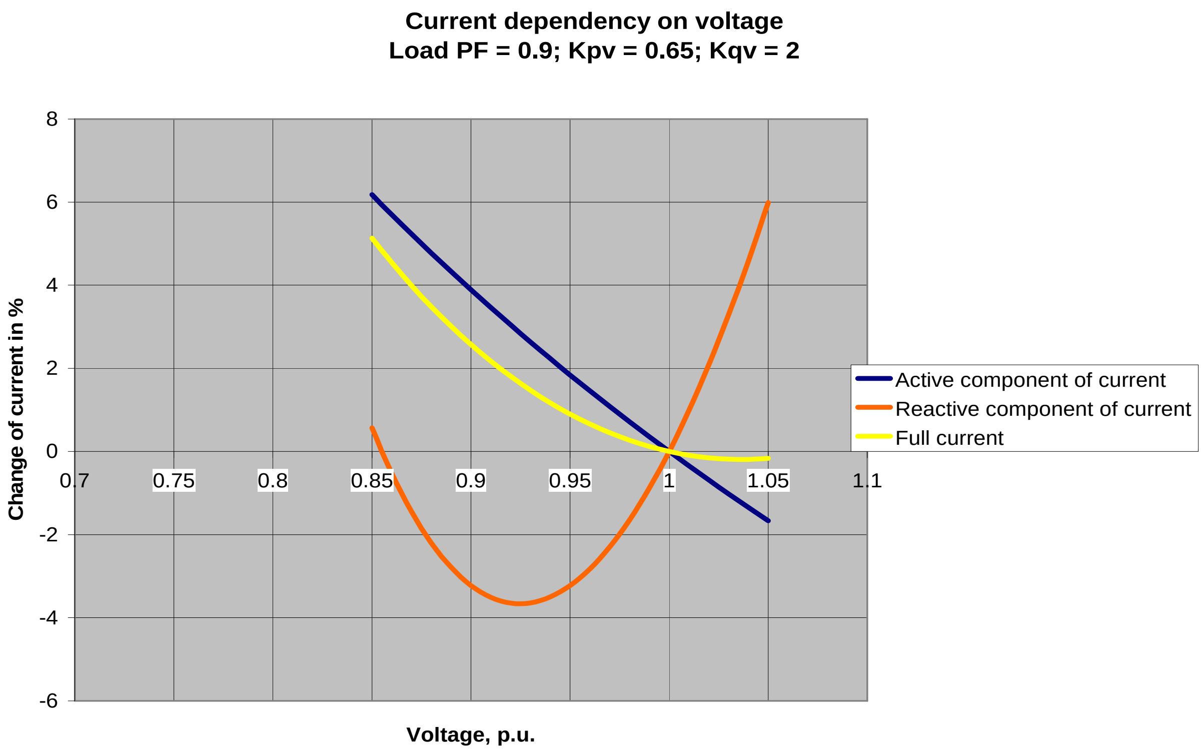
If the sensitivities of the reactive load are higher, then a reduction of the actual load current with voltage reduction is more likely. As seen in Figure 5 below, when the load power factor is 0.8, and the initial reactive load sensitivity is 4%, the actual current is reduced, if the voltage is below nominal. With a power factor of 0.9, the current starts increasing, when the voltage is below 90% of the nominal, and only with a power factor greater than 0.95 does the current increase below the nominal voltage (*See,* Figures 6 and 7). The reactive load to voltage sensitivities in a large network depend on the composition of different loads. Static reactive load to voltage sensitivities for residential load in summer is 2.9%, for commercial load it is 3.5%, and for industrial loads it is 6.0%. A mix of loads, which provides a sensitivity factor about 4%, is very realistic.

Figure 2



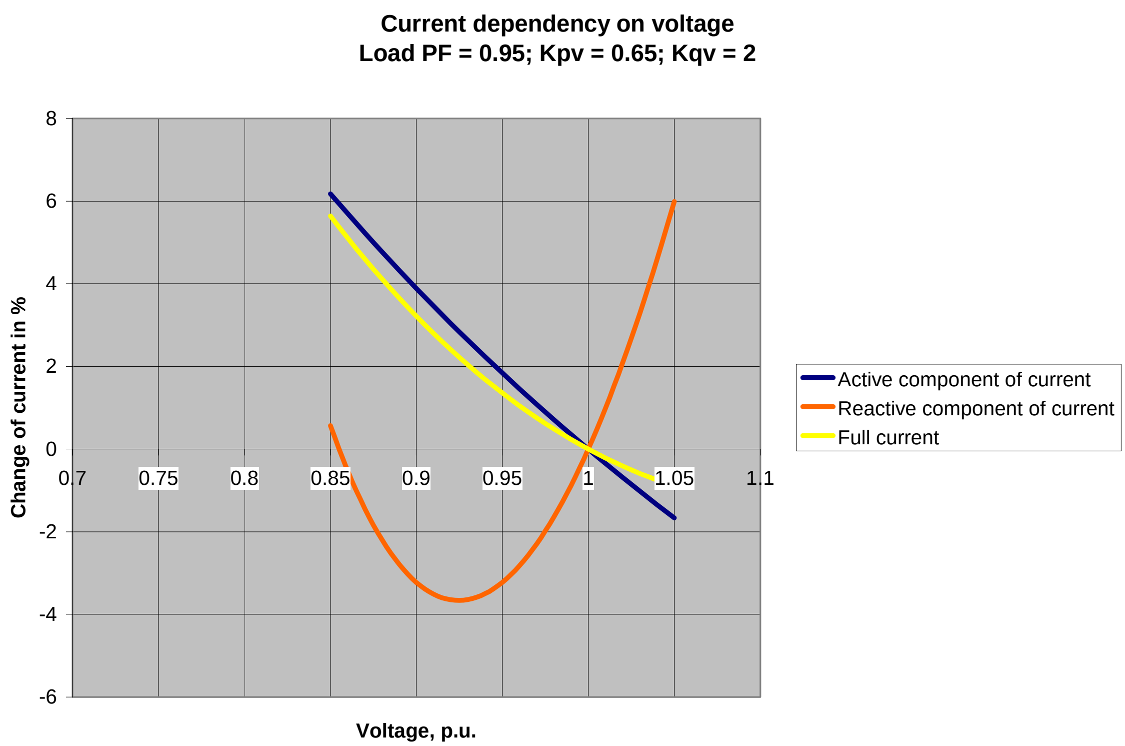
Current dependency on voltage. Apparent current increases when the voltage is below 95% of the nominal voltage and reaches four percent of increase, when the voltage is 0.85 p.u. The real component of the current is increased by 6% at voltage 0.85 p.u., while the reactive component of current returns close to the nominal value. (Kpv is the real load to voltage sensitivity factor, and Kqv is the reactive load to voltage sensitivity factor).

Figure 3



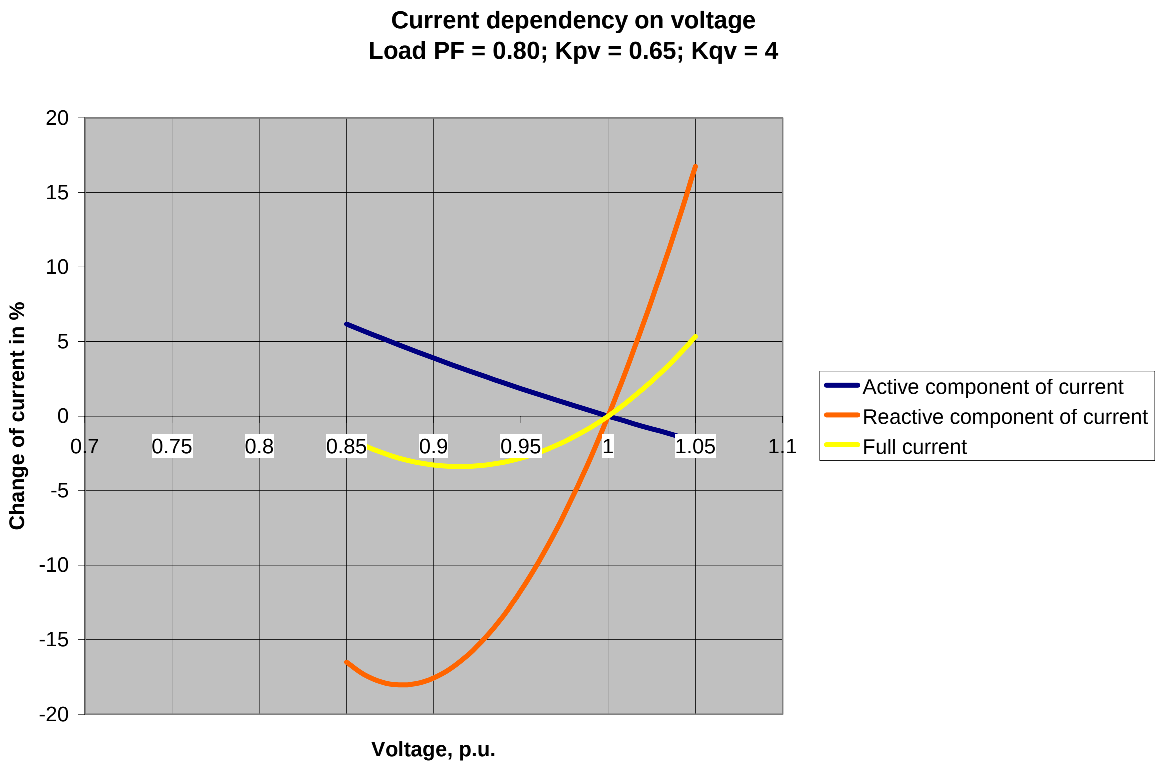
Current dependency on voltage. Current increases when the voltage is below the nominal voltage.

Figure 4



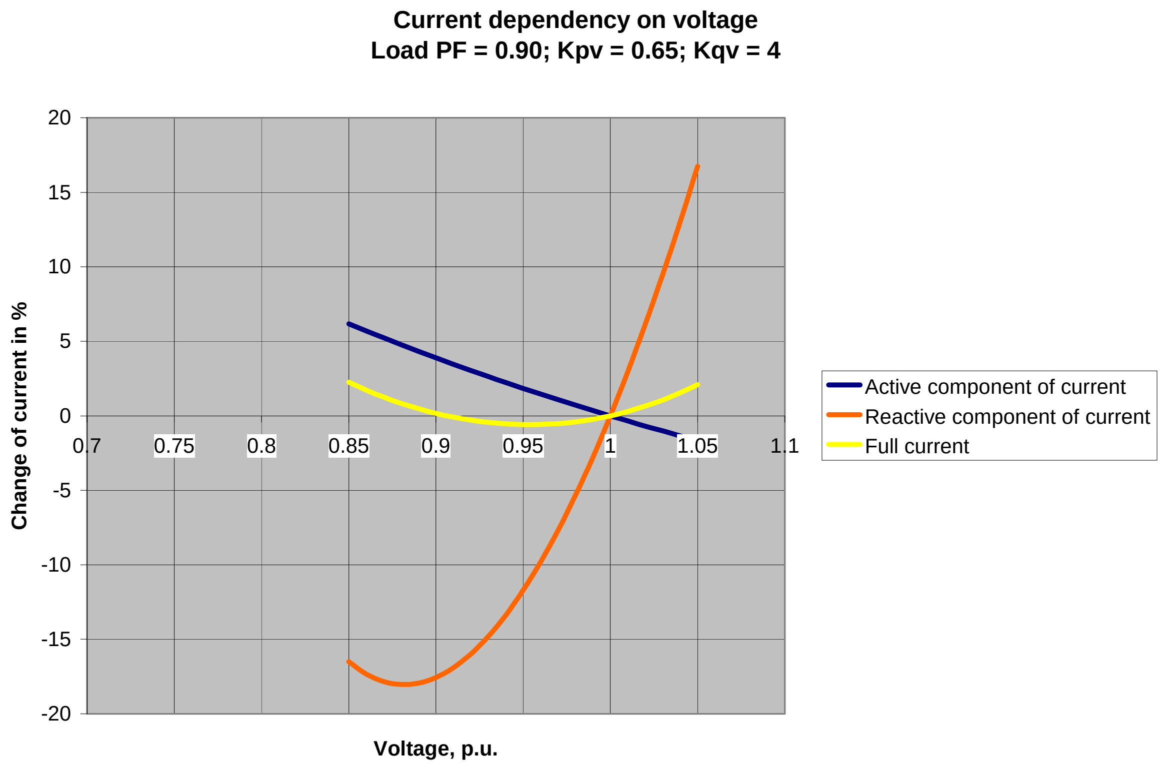
Current dependency on voltage. Current increases when the voltage is below the nominal voltage.

Figure 5



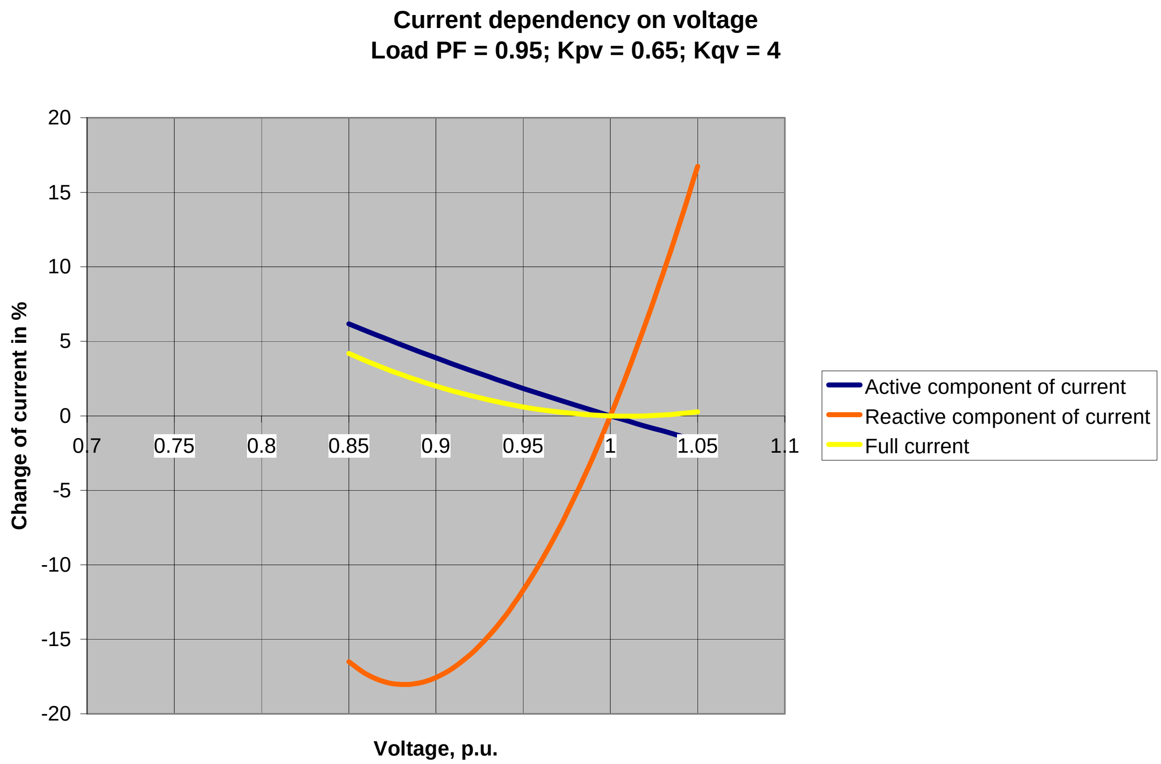
Current dependency on voltage. Current is reduced when voltage is below the nominal voltage due to low power factor and high reactive load sensitivity to voltage.

Figure 6



Current dependency on voltage. Current is increased when the voltage is below 90% of the nominal.

Figure 7



Current dependency on voltage. Current is increased when the voltage is below nominal due to high load power factor.

As follows from the above examples, voltage reduction, which practically always leads to reduction in real and reactive loads, does not always result in reduction of load currents. The change of the apparent current following voltage reduction depends on the combination of the load to voltage sensitivities and the load power factor. Therefore, the application of voltage reduction for demand reduction (demand response) might be different from the application of voltage reduction for current reduction.

As follows from this section, if Con Edison plans to use voltage reduction for unloading distribution circuits, which means reduction of current, studies should be conducted to determine the conditions, under which the voltage reduction would be efficient for this particular objective, if at all.

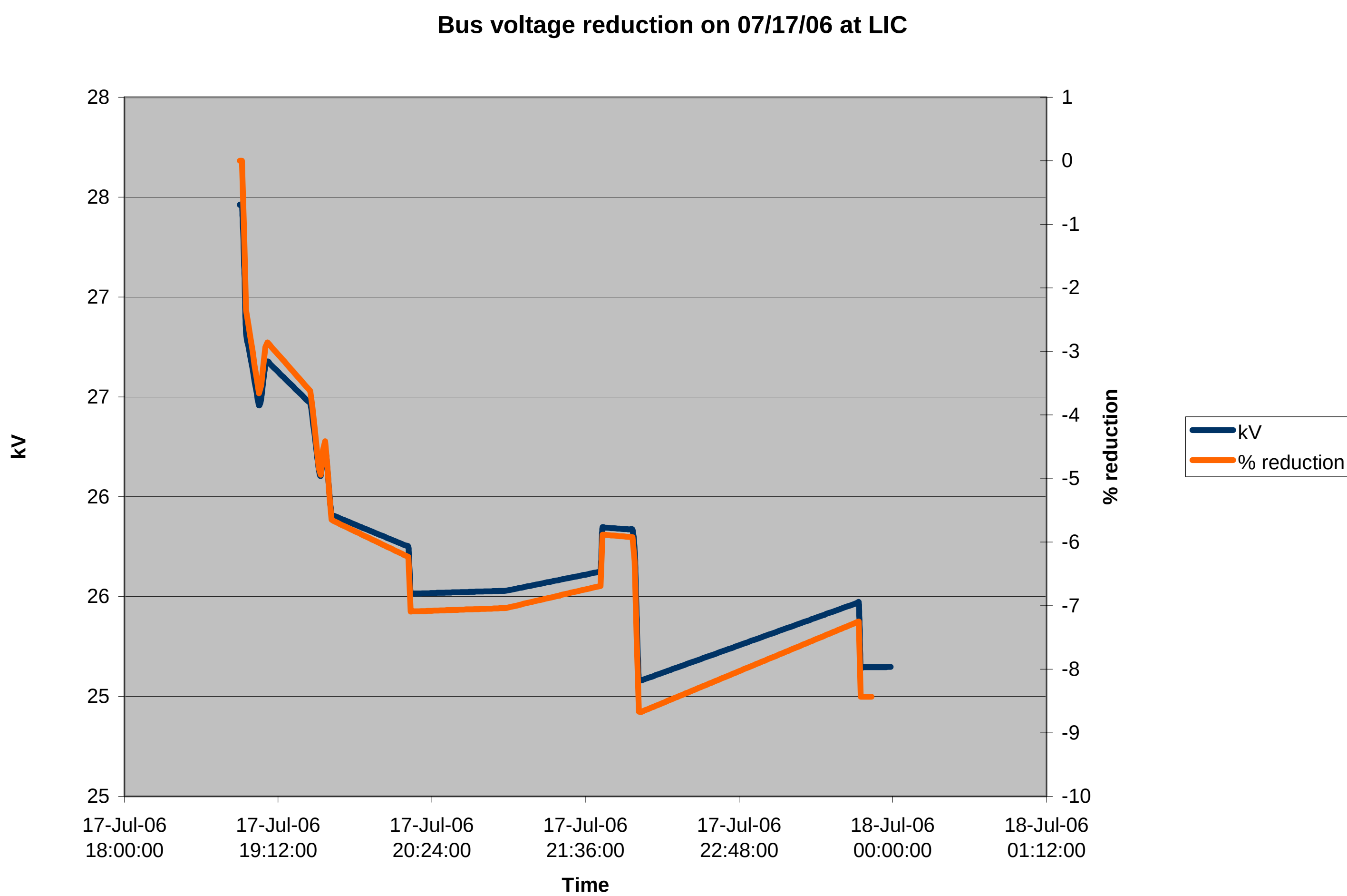
Appendix 10

Data Analyses of the Recorded Voltage Reduction Measurements

It can be seen from data that was provided by Con Edison that it took approximately three hours to reduce voltage by 8 percent.[104] (*See*, Figure 1). The voltage was reduced by about 4% in the first change of tap positions, which was executed in transformers # 2 and # 3 at the North Queens substation. The tap positions were not changed at the same time in all parallel transformers because of a malfunctioning of the voltage reduction scheme (*See*, Figure 2). Con Edison reported that the voltage reduction circuit did not work and that the taps had to be moved manually. The second step of voltage reduction happened approximately 30-40 minutes later, and all transformers came to the last tap position at 19:48 on July 17, 2006. The voltage at this time was approximately 5.7% lower than it was at 18:54. Hence, the change of Load Tap changer (LTC) tap positions did not provide the 8% of voltage reduction at this time. The 8% voltage reduction was not achieved until approximately 22:00 hours, sometime after the tap changers has reached their lowest position. It is not known what the Company did to further reduce the voltage.

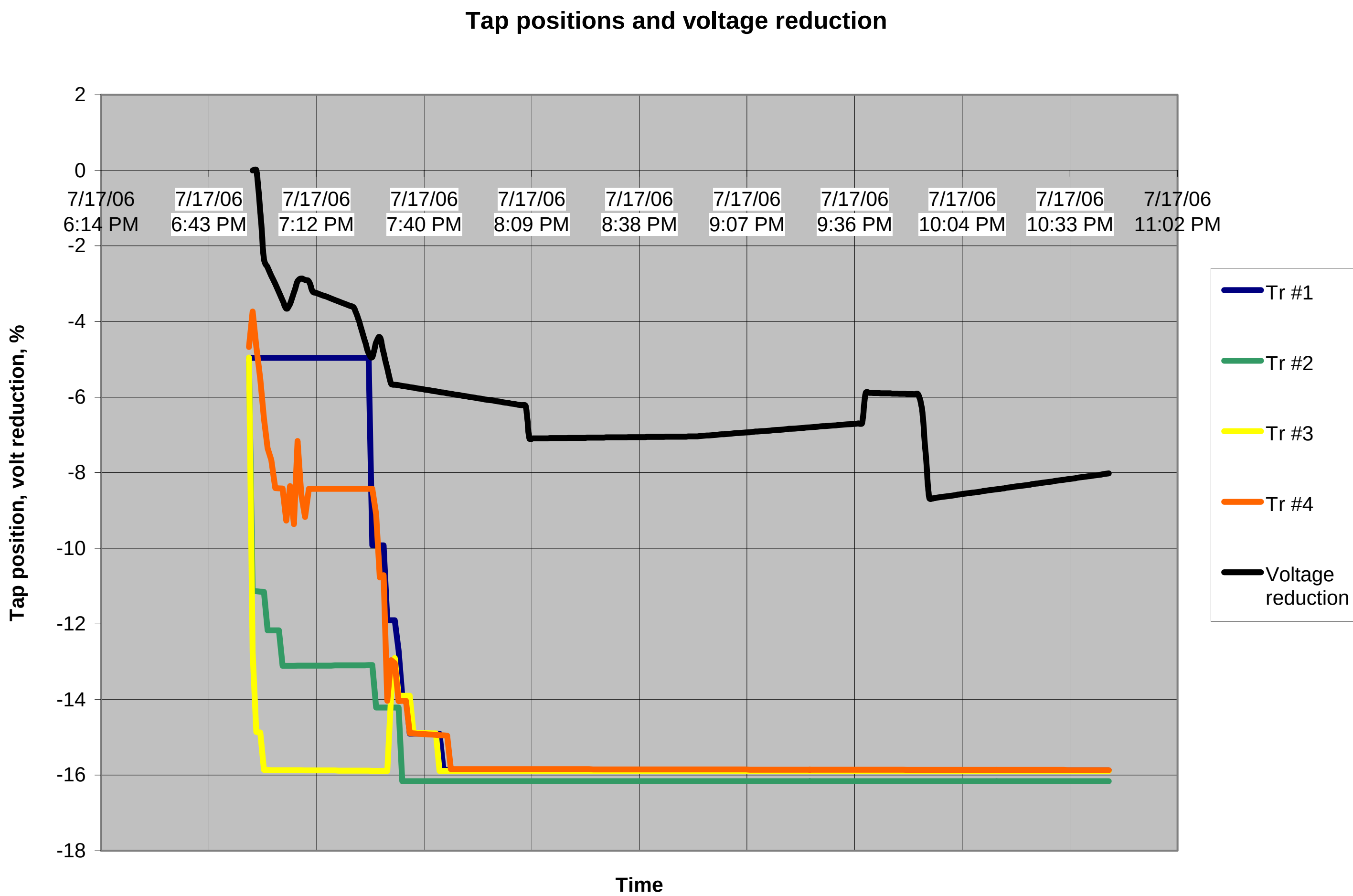
[104] Company Response to City Interrogatory 133 (dated: October 24, 2006).

Figure 1



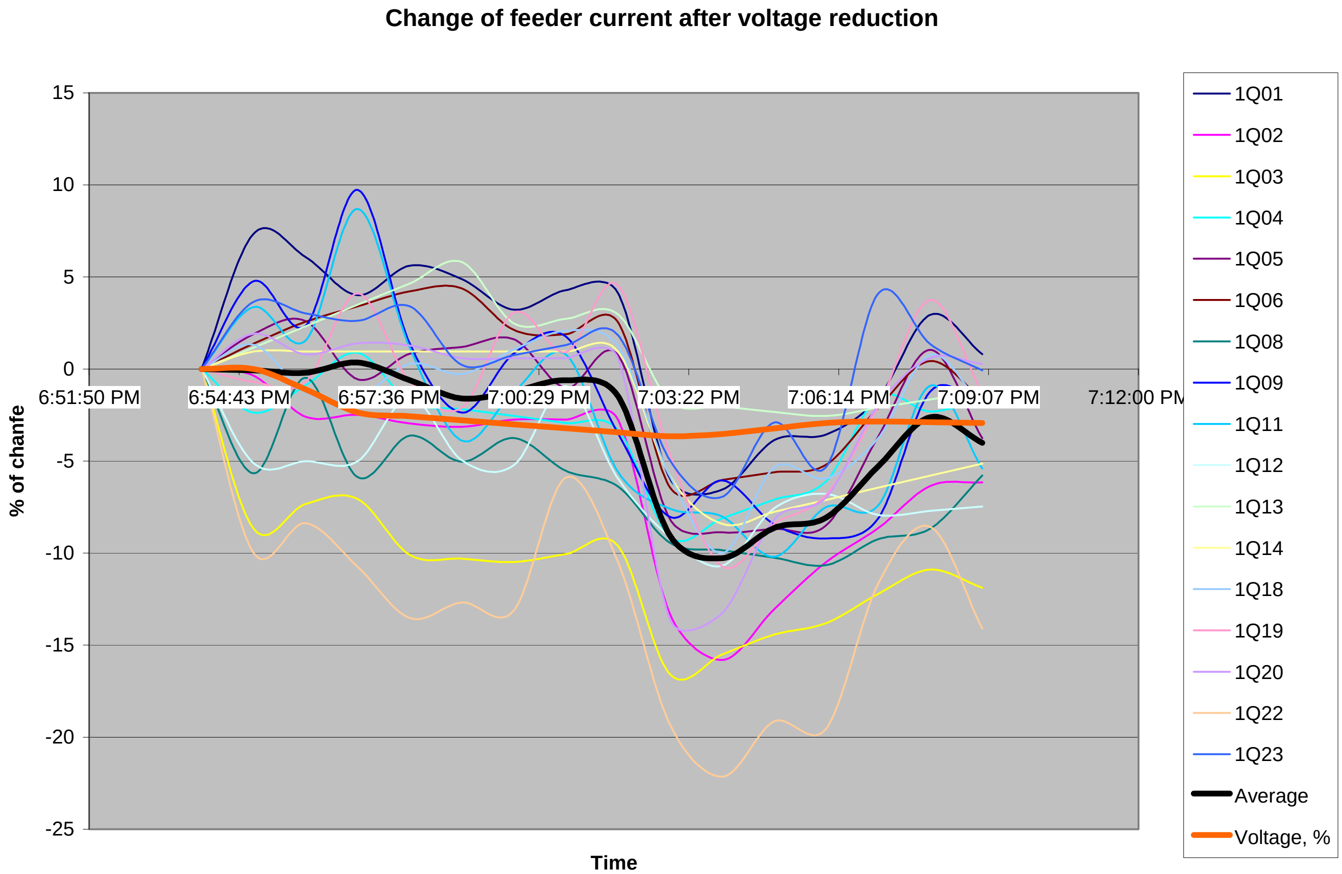
Voltage reduction on 07/17/06 during the Long Island City event

Figure 2



Change of tap position during voltage reduction

Figure 3



Change of feeder currents after voltage reduction

Figure 3 above shows the feeder loading between 18:54 and 19:03 on July 17, 2006. The data for this time interval could be used to associate the voltage reduction with currents through the feeders. There was only one activity recorded during this time interval, namely initiation of voltage reduction at 18:54. From Figure 3, it can be seen that the current increased in 10 feeders of 17, and decreased in 7 feeders right after this time. The average feeder current practically did not change.

There were certainly factors other than voltage reduction involved impacting currents. It must be noted that on a typical day the overall load is declining at this time. Hence, no conclusion on the relieving effect of voltage reduction could be made. A more thorough field and theoretical study should be performed to determine the impact of voltage reduction on current.

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FERC Form No. 1:
ANNUAL REPORT OF MAJOR ELECTRIC UTILITIES, LICENSEES AND OTHERS

This report is mandatory under the Federal Power Act, Sections 3, 4(a), 304 and 309, and 18 CFR 141.1. Failure to report may result in criminal fines, civil penalties and other sanctions as provided by law. The Federal Energy Regulatory Commission does not consider this report to be of a confidential nature.

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Exact Legal Name of Respondent (Company)	Year of Report
CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.	Dec. 31, 1995

Name of Respondent CONSOLIDATED EDISON CO. OF NEW YORK, INC.	This Report Is: (1) [x] An Original (2) [ ] A Resubmission	Date of Report (Mo, Da, Yr) 04/30/96	Year of Report Dec. 31, 1995

ELECTRIC OPERATION AND MAINTENANCE EXPENSES(Continued)

	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
	C. Hydraulic Power Generation (Continued)		
52	Maintenance		
53	(541) Maintenance Supervision and Engineering		
54	(542) Maintenance of Structures		
55	(543) Maintenance of Reservoirs, Dams, and Waterways		
56	(544) Maintenance of Electric Plant		
57	(545) Maintenance of Miscellaneous Hydraulic Plant		
58	TOTAL Maintenance (Enter Total of lines 53 thru 57)		
59	TOTAL Power Production Expenses-Hydraulic Power(Enter total of lines 50 and 58)	0	0
60	D. Other Power Generation		
61	Operation		
62	(546) Operation Supervision and Engineering	$317,042	$591,321
63	(547) Fuel	22,006,247	20,989,491
64	(548) Generation Expenses	3,646,115	3,102,154
65	(549) Miscellaneous Other Power Generation Expenses	573,241	440,536
66	(550) Rents	8,816	2,299
67	TOTAL Operation (Enter Total of lines 62 thru 66)	$26,551,461	$25,125,801
68	Maintenance		
69	(551) Maintenance Supervision and Engineering	$1,170,430	$1,653,465
70	(552) Maintenance of Structures	4,144,667	2,750,848
71	(553) Maintenance of Generating and Electric Plant	9,911,103	14,936,110
72	(554) Maintenance of Miscellaneous Other Power Generation Plant	2,051,093	764,765
73	TOTAL Maintenance (Enter Total of lines 69 thru 72)	$17,277,293	$20,105,188
74	TOTAL Power Production Expenses--Other Power (Enter Total of lines 67 and 73)	$43,828,754	$45,230,989
	E. Other Power Supply Expenses		
	(555) Purchased Power	$1,107,222,889	$787,454,740
77	(556) System Control and Load Dispatching	10,759,355	9,357,402
78	(557) Other Expenses	10,620,192	7,795,305
79	TOTAL Other Power Supply Expenses (Enter Total of lines 76 thru 78)	$1,128,602,436	$804,607,447
80	TOTAL Power Production Expenses (Enter Total of lines 21,41,59,74,and 79)	$1,832,282,507	$1,566,702,584
81	2. TRANSMISSION EXPENSES		
82	Operation		
83	(560) Operation Supervison and Engineering	$1,774,983	$1,587,067
84	(561) Load Dispatching	7,522,178	7,883,114
85	(562) Station Expenses	12,923,811	12,859,622
86	(563) Overhead Lines Expenses	385,597	403,501
87	(564) Underground Lines Expenses	574,488	974,699
88	(565) Transmission of Electricity by Others	0	0
89	(566) Miscellaneous Transmission Expenses	4,424,674	4,259,793
90	(567) Rents	19,842,426	19,973,503
91	TOTAL Operation (Enter Total of lines 83 thru 90)	$47,448,157	$47,941,299
92	Maintenance		
93	(568) Maintenance Supervision and Engineering	$2,072,212	$1,912,477
94	(569) Maintenance of Structures	5,058,514	5,920,403
95	(570) Maintenance of Station Equipment	25,261,372	24,501,320
96	(571) Maintenance of Overhead Lines	2,049,741	1,895,799
97	(572) Maintenance of Underground Lines	12,159,699	9,252,760
98	(573) Maintenance of Miscellaneous Transmission Plant	0	0
99	TOTAL Maintenance (Enter Total of lines 93 thru 98)	$46,601,538	$43,482,759
100	TOTAL Transmission Expenses (Enter Total of lines 91 and 99)	$94,049,695	$91,424,058
	3. DISTRIBUTION EXPENSES		
	Operation		
103	(580) Operation Supervision and Engineering	$11,311,164	$10,287,469

Name of Respondent CONSOLIDATED EDISON CO. OF NEW YORK, INC.	This Report Is: (1) [x] An Original (2) [ ] A Resubmission	Date of Report (Mo, Da, Yr) 04/30/96	Year of Report Dec. 31, 1995

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

Line No.	Account (a)	Amount for Current Year (b)	Amount For Previous Year (c)
104	3. DISTRIBUTION Expenses (Continued)		
105	(581) Load Dispatching	$3,293,609	$3,165,578
106	(582) Station Expenses	16,643,560	17,895,689
107	(583) Overhead Line Expenses	8,160,344	6,629,591
108	(584) Underground Line Expenses	28,842,934	29,579,340
109	(585) Street Lighting and Signal System Expenses	180,194	229,322
110	(586) Meter Expenses	13,732,501	14,284,707
111	(587) Customer Installations Expenses	11,929,814	11,999,544
112	(588) Miscellaneous Expenses	14,654,366	12,026,952
113	(589) Rents	22,603,754	20,785,245
114	TOTAL Operation (Enter Total of lines 103 thru 113)	$131,352,240	$126,883,437
115	Maintenance		
116	(590) Maintenance Supervision and Engineering	$12,577,855	$13,703,811
117	(591) Maintenance of Structures	2,695,150	2,848,593
118	(592) Maintenance of Station Equipment	8,665,409	9,059,706
119	(593) Maintenance of Overhead Lines	24,152,786	21,032,034
120	(594) Maintenance of Underground Lines	78,619,202	82,854,017
121	(595) Maintenance of Line Transformers	21,072,004	20,751,623
122	(596) Maintenance of Street Lighting and Signal Systems	2,549,544	2,645,859
123	(597) Maintenance of Meters	2,240,737	2,316,014
124	(598) Maintenance of Miscellaneous Distribution Plant	4,631,597	4,587,390
125	TOTAL Maintenance (Enter Total of lines 116 thru 124)	$157,204,284	$159,799,047
126	TOTAL Distribution Expenses (Enter Total of lines 114 and 125)	$288,556,524	$286,682,484
127	4.CUSTOMER ACCOUNTS EXPENSES		
128	Operation		
129	(901) Supervision	$2,967,625	$4,760,192
130	(902) Meter Reading Expenses	25,456,672	25,913,894
131	(903) Customer Records and Collection Expenses	101,486,054	97,546,864
132	(904) Uncollectible Accounts	28,026,606	26,323,026
133	(905) Miscellaneous Customer Accounts Expenses	3,933,833	2,481,590
134	TOTAL Customer Accounts Expenses (Enter Total of lines 129 thru 133)	$161,870,790	$157,025,566
135	5. CUSTOMER SERVICE AND INFORMATIONAL EXPENSES		
136	Operation		
137	(907) Supervision	$3,606,602	$689,041
138	(908) Customer Assistance Expenses	3,684,444	929,805
139	(909) Information and Instructional Expenses	1,342,226	1,064,887
140	(910) Miscellaneous Customer Service and Information Expenses	86,560,750	73,629,525
141	TOTAL Cust. Service and Informational Exp.(Enter Total of lines 137 thru 140)	$95,194,022	$76,313,258
142	6. SALES EXPENSES		
143	Operation		
144	(911) Supervision		
145	(912) Demonstrating and Selling Expenses		
146	(913) Advertising Expenses	1,517,295	1,689,151
147	(916) Miscellaneous Sales Expenses		
148	TOTAL Sales Expenses (Enter Total of lines 144 thru 147)	$1,517,295	$1,689,151
149	7. ADMINISTRATIVE AND GENERAL EXPENSES		
150	Operation		
151	(920) Administrative and General Salaries	$103,876,175	$101,734,290
152	(921) Office Supplies and Expenses	40,396,031	42,753,311
153	(Less) (922) Administrative Expenses Transferred--Credit	43,684,538	42,590,66

Name of Respondent	This Report Is:	Date of Report	Year of Report
CONSOLIDATED EDISON CO. OF NEW YORK, INC.	(1) [x] An Original (2) [ ] A Resubmission	(Mo, Da, Yr) 04/30/96	Dec. 31, 1995

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
154	7. ADMINISTRATIVE AND GENERAL EXPENSES (Continued)		
155	(923) Outside Services Employed	$2,311,168	$4,553,184
156	(924) Property Insurance	6,768,898	8,227,811
157	(925) Injuries and Damages	45,407,732	37,344,812
158	(926) Employee Pensions and Benefits	159,319,102	186,072,368
159	(927) Franchise Requirements	9,008	8,986
160	(928) Regulatory Commission Expenses	14,362,885	17,046,763
161	(929) (Less) Duplicate Charges--Cr.	(8,140,729)	(7,628,430)
162	(930.1) General Advertising Expenses	0	0
163	(930.2) Miscellaneous General Expenses	40,952,852	46,951,297
164	(931) Rents		
165	TOTAL Operation (Enter Total of lines 151 Thru 164)	$361,578,584	$394,473,726
166	Maintenance		
167	(935) Maintenance of General Plant		
168	TOTAL Administrative and General Expenses (Enter total of lines 165 thru 167)	$361,578,584	$394,473,726
169	TOTAL Electric Operation and Maintenance Expenses (Enter total of lines 80,100,126,134,141,148 and 168)	$2,835,049,417	$2,574,310,827

NUMBER OF ELECTRIC DEPARTMENT EMPLOYEES

1. The data on number of employees should be reported for the payroll period ending nearest to October 31, or any payroll period ending 60 days before or after October 31.

2. If the respondent's payroll for the reporting period includes any special construction personel, include such employees on line 3, and show the number of such special construction employees in a footnote.

3. The number of employees assignable to the electric department from joint functions of combination utilities may be dete mined by estimate, on the basis of employee equivalents. Show the estimated number of equivalent employees attributed to the electric department from joint functions.

1. Payroll Period Ended (Date)	12/31/95
2. Total Regular Full-Time Employees	13,189
3. Total Part-Time and Temporary Employees	140
4. Total Employees	13,329

THIS FILING IS (CHECK ONE BOX FOR EACH ITEM)		
Item 1: ☒ An Initial (Original) Submission	OR ☐	Resubmission No. ____
Item 2: ☒ An Original Signed Form	OR ☐	Conformed Copy

Form Approved
OMB No. 1902–0021
(Expires 7/31/98)

OFFICE OF THE SECRETARY
97 MAY -2 PM 2:54
FEDERAL ENERGY REGULATORY COMMISSION

FERC Form No. 1:
ANNUAL REPORT OF MAJOR ELECTRIC UTILITIES, LICENSEES AND OTHERS

This report is mandatory under the Federal Power Act, Sections 3, 4(a), 304 and 309, and 18 CFR 141.1. Failure to report may result in criminal fines, civil penalties and other sanctions as provided by law. The Federal Energy Regulatory Commission does not consider this report to be of a confidential nature.

Exact Legal Name of Respondent (Company)	Year of Report
CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.	Dec. 31, 1996

Name of Respondent CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.	This Report Is: (1) [X] An Original (2) [ ] A Resubmission	Date of Report (Mo, Da, Yr) 04/30/97	Year of Report Dec. 31, 1996

ELECTRIC OPERATION AND MAINTENANCE EXPENSES(Continued)

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
51	C. Hydraulic Power Generation (Continued)		
52	Maintenance		
53	(541) Maintenance Supervision and Engineering		
54	(542) Maintenance of Structures		
55	(543) Maintenance of Reservoirs, Dams, and Waterways		
56	(544) Maintenance of Electric Plant		
57	(545) Maintenance of Miscellaneous Hydraulic Plant		
58	TOTAL Maintenance (Enter Total of lines 53 thru 57)		
59	TOTAL Power Production Expenses-Hydraulic Power(Enter total of lines 50 and 58)	0	0
60	D. Other Power Generation		
61	Operation		
62	(546) Operation Supervision and Engineering	$435,013	$317,042
63	(547) Fuel	24,723,782	22,006,247
64	(548) Generation Expenses	3,878,165	3,646,115
65	(549) Miscellaneous Other Power Generation Expenses	(127,880)	573,241
66	(550) Rents	2,299	8,816
67	TOTAL Operation (Enter Total of lines 62 thru 66)	$28,911,379	$26,551,461
68	Maintenance		
69	(551) Maintenance Supervision and Engineering	$1,358,893	$1,170,430
70	(552) Maintenance of Structures	3,007,486	4,144,667
71	(553) Maintenance of Generating and Electric Plant	10,235,273	9,911,103
72	(554) Maintenance of Miscellaneous Other Power Generation Plant	808,401	2,051,093
73	TOTAL Maintenance (Enter Total of lines 69 thru 72)	$15,410,053	$17,277,293
74	TOTAL Power Production Expenses--Other Power (Enter Total of lines 67 and 73)	$44,321,432	$43,828,754
75	E. Other Power Supply Expenses		
76	(555) Purchased Power	$1,269,092,562	$1,107,222,889
77	(556) System Control and Load Dispatching	9,246,103	10,759,355
78	(557) Other Expenses	6,776,737	10,620,192
79	TOTAL Other Power Supply Expenses (Enter Total of lines 76 thru 78)	$1,285,115,402	$1,128,602,436
80	TOTAL Power Production Expenses (Enter Total of lines 21,41,59,74,and 79)	$1,929,994,831	$1,832,282,507
81	2. TRANSMISSION EXPENSES		
82	Operation		
83	(560) Operation Supervison and Engineering	$1,504,171	$1,774,983
84	(561) Load Dispatching	7,776,344	7,522,178
85	(562) Station Expenses	13,781,614	12,923,811
86	(563) Overhead Lines Expenses	345,983	385,597
87	(564) Underground Lines Expenses	562,055	574,488
88	(565) Transmission of Electricity by Others		
89	(566) Miscellaneous Transmission Expenses	3,775,702	4,424,674
90	(567) Rents	19,593,706	19,842,426
91	TOTAL Operation (Enter Total of lines 83 thru 90)	$47,339,575	$47,448,157
92	Maintenance		
93	(568) Maintenance Supervision and Engineering	$1,575,907	$2,072,212
94	(569) Maintenance of Structures	5,177,120	5,058,514
95	(570) Maintenance of Station Equipment	26,756,179	25,261,372
96	(571) Maintenance of Overhead Lines	1,687,778	2,049,741
97	(572) Maintenance of Underground Lines	12,505,803	12,159,699
98	(573) Maintenance of Miscellaneous Transmission Plant		
99	TOTAL Maintenance (Enter Total of lines 93 thru 98)	$47,702,787	$46,601,538
100	TOTAL Transmission Expenses (Enter Total of lines 91 and 99)	$95,042,362	$94,049,695
101	3. DISTRIBUTION EXPENSES		
102	Operation		
103	(580) Operation Supervision and Engineering	$9,719,810	$11,311,164

Name of Respondent CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.	This Report Is: (1) [X] An Original (2) [ ] A Resubmission	Date of Report (Mo, Da, Yr) 04/30/97	Year of Report Dec. 31, 1996

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

Line No.	Account (a)	Amount for Current Year (b)	Amount For Previous Year (c)
104	3. DISTRIBUTION Expenses (Continued)		
105	(581) Load Dispatching	$3,517,980	$3,293,609
106	(582) Station Expenses	18,609,172	16,643,560
107	(583) Overhead Line Expenses	8,756,393	8,160,344
108	(584) Underground Line Expenses	26,777,315	28,842,934
109	(585) Street Lighting and Signal System Expenses	197,472	180,194
110	(586) Meter Expenses	13,210,552	13,732,501
111	(587) Customer Installations Expenses	12,204,058	11,929,814
112	(588) Miscellaneous Expenses	12,615,548	14,654,366
113	(589) Rents	22,666,018	22,603,754
114	TOTAL Operation (Enter Total of lines 103 thru 113)	$128,274,318	$131,352,240
115	Maintenance		
116	(590) Maintenance Supervision and Engineering	$12,712,600	$12,577,855
117	(591) Maintenance of Structures	2,872,783	2,695,150
118	(592) Maintenance of Station Equipment	7,981,646	8,665,409
119	(593) Maintenance of Overhead Lines	33,806,200	24,152,786
120	(594) Maintenance of Underground Lines	76,497,924	78,619,202
121	(595) Maintenance of Line Transformers	19,831,255	21,072,004
122	(596) Maintenance of Street Lighting and Signal Systems	1,967,944	2,549,544
123	(597) Maintenance of Meters	2,150,463	2,240,737
124	(598) Maintenance of Miscellaneous Distribution Plant	3,353,654	4,631,597
125	TOTAL Maintenance (Enter Total of lines 116 thru 124)	$161,174,469	$157,204,284
126	TOTAL Distribution Expenses (Enter Total of lines 114 and 125)	$289,448,787	$288,556,524
127	4.CUSTOMER ACCOUNTS EXPENSES		
128	Operation		
129	(901) Supervision	$2,924,515	$2,967,625
130	(902) Meter Reading Expenses	27,176,793	25,456,672
131	(903) Customer Records and Collection Expenses	100,301,562	101,486,054
132	(904) Uncollectible Accounts	26,462,862	28,026,606
133	(905) Miscellaneous Customer Accounts Expenses	2,046,192	3,933,833
134	TOTAL Customer Accounts Expenses (Enter Total of lines 129 thru 133)	$158,911,924	$161,870,790
135	5. CUSTOMER SERVICE AND INFORMATIONAL EXPENSES		
136	Operation		
137	(907) Supervision	$167,387	$3,606,602
138	(908) Customer Assistance Expenses	2,701,802	3,684,444
139	(909) Information and Instructional Expenses	4,471,453	1,342,226
140	(910) Miscellaneous Customer Service and Information Expenses	66,953,153	86,560,750
141	TOTAL Cust. Service and Informational Exp.(Enter Total of lines 137 thru 140)	$74,293,795	$95,194,022
142	6. SALES EXPENSES		
143	Operation		
144	(911) Supervision		
145	(912) Demonstrating and Selling Expenses		
146	(913) Advertising Expenses	309,501	1,517,295
147	(916) Miscellaneous Sales Expenses		
148	TOTAL Sales Expenses (Enter Total of lines 144 thru 147)	$309,501	$1,517,295
149	7. ADMINISTRATIVE AND GENERAL EXPENSES		
150	Operation		
151	(920) Administrative and General Salaries	$107,167,847	$103,876,175
152	(921) Office Supplies and Expenses	38,476,634	40,396,031
153	(Less) (922) Administrative Expenses Transferred--Credit	44,692,621	43,684,538

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
154	7. ADMINISTRATIVE AND GENERAL EXPENSES (Continued)		
155	(923) Outside Services Employed	$1,996,954	$2,311,168
156	(924) Property Insurance	5,834,616	6,768,898
157	(925) Injuries and Damages	56,754,152	45,407,732
158	(926) Employee Pensions and Benefits	215,558,038	159,319,102
159	(927) Franchise Requirements	9,267	9,008
160	(928) Regulatory Commission Expenses	17,795,263	14,362,885
161	(929) (Less) Duplicate Charges--Cr.	8,399,434	8,140,729
162	(930.1) General Advertising Expenses		
163	(930.2) Miscellaneous General Expenses	38,994,883	40,952,852
164	(931) Rents		
165	TOTAL Operation (Enter Total of lines 151 Thru 164)	$429,495,599	$361,578,584
166	Maintenance		
167	(935) Maintenance of General Plant		
168	TOTAL Administrative and General Expenses (Enter total of lines 165 thru 167)	$429,495,599	$361,578,584
169	TOTAL Electric Operation and Maintenance Expenses (Enter total of lines 80,100,126,134,141,148 and 168)	$2,977,496,799	$2,835,049,417

NUMBER OF ELECTRIC DEPARTMENT EMPLOYEES

1. The data on number of employees should be reported for the payroll period ending nearest to October 31, or any payroll period ending 60 days before or after October 31.

2. If the respondent's payroll for the reporting period includes any special construction personel, include such employees on line 3, and show the number of such special construction employees in a footnote.

3. The number of employees assignable to the electric department from joint functions of combination utilities may be dete mined by estimate, on the basis of employee equivalents. Show the estimated number of equivalent employees attributed to the electric department from joint functions.

1. Payroll Period Ended (Date)	12/31/96
2. Total Regular Full-Time Employees	12,448
3. Total Part-Time and Temporary Employees	128
4. Total Employees	12,576

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THIS FILING IS (CHECK ONE BOX FOR EACH ITEM)		
Item 1: ☒ An Initial (Original) Submission	OR ☐	Resubmission No. ____
Item 2: ☐ An Original Signed Form	OR ☐	Conformed Copy

Form Approved
OMB No. 1902–0021
(Expires 7/31/98)

FERC Form No. 1:
ANNUAL REPORT OF MAJOR ELECTRIC UTILITIES, LICENSEES AND OTHERS

This report is mandatory under the Federal Power Act, Sections 3, 4(a), 304 and 309, and 18 CFR 141.1. Failure to report may result in criminal fines, civil penalties and other sanctions as provided by law. The Federal Energy Regulatory Commission does not consider this report to be of a confidential nature.

980602-0048-1

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Exact Legal Name of Respondent (Company)	Year of Report
CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.	Dec. 31, 1997

Name of Respondent	This Report Is:	Date of Report (Mo, Da, Yr)	Year of Report
CONSOLIDATED EDISON CO. OF NEW YORK, INC.	(1) [X] An Original (2) [ ] A Resubmission	04/30/98	Dec. 31, 1997

ELECTRIC OPERATION AND MAINTENANCE EXPENSES(Continued)

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
51	C. Hydraulic Power Generation (Continued)		
52	Maintenance		
53	(541) Maintenance Supervision and Engineering		
54	(542) Maintenance of Structures		
55	(543) Maintenance of Reservoirs, Dams, and Waterways		
56	(544) Maintenance of Electric Plant		
57	(545) Maintenance of Miscellaneous Hydraulic Plant		
58	TOTAL Maintenance (Enter Total of lines 53 thru 57)		
59	TOTAL Power Production Expenses-Hydraulic Power(Enter total of lines 50 and 58)		
60	D. Other Power Generation		
61	Operation		
62	(546) Operation Supervision and Engineering		$435,013
63	(547) Fuel	23,193,296	24,723,782
64	(548) Generation Expenses	4,036,364	3,878,165
65	(549) Miscellaneous Other Power Generation Expenses	42,486	(127,880)
66	(550) Rents	2,299	2,299
67	TOTAL Operation (Enter Total of lines 62 thru 66)	$27,274,445	$28,911,379
68	Maintenance		
69	(551) Maintenance Supervision and Engineering	$1,308,392	$1,358,893
70	(552) Maintenance of Structures	6,915,217	3,007,486
71	(553) Maintenance of Generating and Electric Plant	10,969,041	10,235,273
72	(554) Maintenance of Miscellaneous Other Power Generation Plant	1,279,764	808,401
73	TOTAL Maintenance (Enter Total of lines 69 thru 72)	$20,472,414	$15,410,053
74	TOTAL Power Production Expenses--Other Power (Enter Total of lines 67 and 73)	$47,746,859	$44,321,432
75	E. Other Power Supply Expenses		
76	(555) Purchased Power	$1,319,471,690	$1,269,092,562
77	(556) System Control and Load Dispatching	7,899,983	9,246,103
78	(557) Other Expenses	7,168,765	6,776,737
79	TOTAL Other Power Supply Expenses (Enter Total of lines 76 thru 78)	$1,334,540,438	$1,285,115,402
80	TOTAL Power Production Expenses (Enter Total of lines 21,41,59,74,and 79)	$2,115,579,651	$1,929,994,831
81	2. TRANSMISSION EXPENSES		
82	Operation		
83	(560) Operation Supervison and Engineering	$7,280,387	$1,504,171
84	(561) Load Dispatching	6,898,818	7,776,344
85	(562) Station Expenses	14,209,498	13,781,614
86	(563) Overhead Lines Expenses	348,318	345,983
87	(564) Underground Lines Expenses	489,531	562,055
88	(565) Transmission of Electricity by Others		
89	(566) Miscellaneous Transmission Expenses	5,540,745	3,775,702
90	(567) Rents	19,378,281	19,593,706
91	TOTAL Operation (Enter Total of lines 83 thru 90)	$54,145,578	$47,339,575
92	Maintenance		
93	(568) Maintenance Supervision and Engineering	$1,558,528	$1,575,907
94	(569) Maintenance of Structures	4,518,960	5,177,120
95	(570) Maintenance of Station Equipment	29,251,948	26,756,179
96	(571) Maintenance of Overhead Lines	2,427,771	1,687,778
97	(572) Maintenance of Underground Lines	12,932,165	12,505,803
98	(573) Maintenance of Miscellaneous Transmission Plant		
99	TOTAL Maintenance (Enter Total of lines 93 thru 98)	$50,689,372	$47,702,787
100	TOTAL Transmission Expenses (Enter Total of lines 91 and 99)	$104,834,950	$95,042,362
101	3. DISTRIBUTION EXPENSES		
102	Operation		
103	(580) Operation Supervision and Engineering	$14,436,441	$9,719,810

Name of Respondent CONSOLIDATED EDISON CO. OF NEW YORK, INC.	This Report Is: (1) [X] An Original (2) [ ] A Resubmission	Date of Report (Mo, Da, Yr) 04/30/98	Year of Report Dec. 31, 1997

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

Line No.	Account (a)	Amount for Current Year (b)	Amount For Previous Year (c)
104	3. DISTRIBUTION Expenses (Continued)		
105	(581) Load Dispatching	$2,898,396	$3,517,980
106	(582) Station Expenses	17,072,680	18,609,172
107	(583) Overhead Line Expenses	7,220,318	8,756,393
108	(584) Underground Line Expenses	25,055,747	26,777,315
109	(585) Street Lighting and Signal System Expenses	227,068	197,472
110	(586) Meter Expenses	11,400,340	13,210,552
111	(587) Customer Installations Expenses	11,251,689	12,204,058
112	(588) Miscellaneous Expenses	14,985,174	12,615,548
113	(589) Rents	23,871,979	22,666,018
114	TOTAL Operation (Enter Total of lines 103 thru 113)	$128,419,832	$128,274,318
115	Maintenance		
116	(590) Maintenance Supervision and Engineering	$12,239,143	$12,712,600
117	(591) Maintenance of Structures	2,246,434	2,872,783
118	(592) Maintenance of Station Equipment	8,398,137	7,981,646
119	(593) Maintenance of Overhead Lines	36,866,454	33,806,200
120	(594) Maintenance of Underground Lines	61,136,626	76,497,924
121	(595) Maintenance of Line Transformers	13,784,385	19,831,255
122	(596) Maintenance of Street Lighting and Signal Systems	2,219,325	1,967,944
123	(597) Maintenance of Meters	2,002,609	2,150,463
124	(598) Maintenance of Miscellaneous Distribution Plant	4,237,273	3,353,654
125	TOTAL Maintenance (Enter Total of lines 116 thru 124)	$143,130,386	$161,174,469
126	TOTAL Distribution Expenses (Enter Total of lines 114 and 125)	$271,550,218	$289,448,787
127	4.CUSTOMER ACCOUNTS EXPENSES		
128	Operation		
129	(901) Supervision	$3,183,158	$2,924,515
130	(902) Meter Reading Expenses	28,668,097	27,176,793
131	(903) Customer Records and Collection Expenses	99,647,647	100,301,562
132	(904) Uncollectible Accounts	26,605,096	26,462,862
133	(905) Miscellaneous Customer Accounts Expenses	2,854,184	2,046,192
134	TOTAL Customer Accounts Expenses (Enter Total of lines 129 thru 133)	$160,958,182	$158,911,924
135	5. CUSTOMER SERVICE AND INFORMATIONAL EXPENSES		
136	Operation		
137	(907) Supervision	$165,318	$167,387
138	(908) Customer Assistance Expenses	2,885,583	2,701,802
139	(909) Information and Instructional Expenses	4,153,274	4,471,453
140	(910) Miscellaneous Customer Service and Information Expenses	59,207,624	66,953,153
141	TOTAL Cust. Service and Informational Exp.(Enter Total of lines 137 thru 140)	$66,411,799	$74,293,795
142	6. SALES EXPENSES		
143	Operation		
144	(911) Supervision		
145	(912) Demonstrating and Selling Expenses		
146	(913) Advertising Expenses	38,022	309,501
147	(916) Miscellaneous Sales Expenses		
148	TOTAL Sales Expenses (Enter Total of lines 144 thru 147)	$38,022	$309,501
149	7. ADMINISTRATIVE AND GENERAL EXPENSES		
150	Operation		
151	(920) Administrative and General Salaries	$86,273,059	$107,167,847
152	(921) Office Supplies and Expenses	34,096,347	38,476,634
153	(Less) (922) Administrative Expenses Transferred--Credit	40,423,984	44,692,621

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
154	7. ADMINISTRATIVE AND GENERAL EXPENSES (Continued)		
155	(923) Outside Services Employed	$2,027,523	$1,996,954
156	(924) Property Insurance	5,351,118	5,834,616
157	(925) Injuries and Damages	51,030,527	56,754,152
158	(926) Employee Pensions and Benefits	161,459,864	215,558,038
159	(927) Franchise Requirements	9,339	9,267
160	(928) Regulatory Commission Expenses	24,261,878	17,795,263
161	(929) (Less) Duplicate Charges--Cr.	8,603,528	8,399,434
162	(930.1) General Advertising Expenses	642,880	
163	(930.2) Miscellaneous General Expenses	25,281,464	38,994,883
164	(931) Rents		
165	TOTAL Operation (Enter Total of lines 151 Thru 164)	$341,406,487	$429,495,599
166	Maintenance		
167	(935) Maintenance of General Plant		
168	TOTAL Administrative and General Expenses (Enter total of lines 165 thru 167)	$341,406,487	$429,495,599
169	TOTAL Electric Operation and Maintenance Expenses (Enter total of lines 80,100,126,134,141,148 and 168)	$3,060,779,309	$2,977,496,799

NUMBER OF ELECTRIC DEPARTMENT EMPLOYEES

1. The data on number of employees should be reported for the payroll period ending nearest to October 31, or any payroll period ending 60 days before or after October 31.

2. If the respondent's payroll for the reporting period includes any special construction personel, include such employees on line 3, and show the number of such special construction employees in a footnote.

3. The number of employees assignable to the electric department from joint functions of combination utilities may be dete mined by estimate, on the basis of employee equivalents. Show the estimated number of equivalent employees attributed to the electric department from joint functions.

1. Payroll Period Ended (Date)	12/31/97	
2. Total Regular Full-Time Employees	11,723	
3. Total Part-Time and Temporary Employees	108	
4. Total Employees	11,831	

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COMMISSION

FERC Form No. 1:
ANNUAL REPORT OF MAJOR ELECTRIC UTILITIES, LICENSEES AND OTHERS

This report is mandatory under the Federal Power Act, Sections 3, 4(a), 304 and 309, and 18 CFR 141.1. Failure to report may result in criminal fines, civil penalties and other sanctions as provided by law. The Federal Energy Regulatory Commission does not consider this report to be of a confidential nature.

9905060321-2

Exact Legal Name of Respondent (Company)	Year of Report
CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.	Dec. 31, 1998

D

Name of Respondent	This Report Is:	Date of Report (Mo, Da, Yr)	Year of Report
Consolidated Edison Company of New York, Inc.	(1) [X] An Original (2) [ ] A Resubmission	04/30/1999	Dec. 31, 1998

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
51	C. Hydraulic Power Generation (Continued)		
52	Maintenance		
53	(541) Mainentance Supervision and Engineering		
54	(542) Maintenance of Structures		
55	(543) Maintenance of Reservoirs, Dams, and Waterways		
56	(544) Maintenance of Electric Plant		
57	(545) Maintenance of Miscellaneous Hydraulic Plant		
58	TOTAL Maintenance (Enter Total of lines 53 thru 57)		
59	TOTAL Power Production Expenses-Hydraulic Power (tot of lines 50 & 58)		
60	D. Other Power Generation		
61	Operation		
62	(546) Operation Supervision and Engineering		
63	(547) Fuel	22,120,337	23,193,296
64	(548) Generation Expenses	3,806,677	4,036,364
65	(549) Miscellaneous Other Power Generation Expenses	500,865	42,486
66	(550) Rents	3,078	2,299
67	TOTAL Operation (Enter Total of lines 62 thru 66)	26,430,957	27,274,445
68	Maintenance		
69	(551) Maintenance Supervision and Engineering	1,525,330	1,308,392
70	(552) Maintenance of Structures	6,983,188	6,915,217
71	(553) Maintenance of Generating and Electric Plant	10,998,909	10,969,041
72	(554) Maintenance of Miscellaneous Other Power Generation Plant	2,121,992	1,279,764
73	TOTAL Maintenance (Enter Total of lines 69 thru 72)	21,629,419	20,472,414
74	TOTAL Power Production Expenses-Other Power (Enter Tot of 67 & 73)	48,060,376	47,746,859
75	E. Other Power Supply Expenses		
76	(555) Purchased Power	1,221,581,632	1,319,471,690
77	(556) System Control and Load Dispatching	7,272,603	7,899,983
78	(557) Other Expenses	5,127,046	7,168,765
79	TOTAL Other Power Supply Exp (Enter Total of lines 76 thru 78)	1,233,981,281	1,334,540,438
80	TOTAL Power Production Expenses (Total of lines 21, 41, 59, 74 & 79)	2,075,955,745	2,115,579,651
81	2. TRANSMISSION EXPENSES		
82	Operation		
83	(560) Operation Supervision and Engineering	9,479,604	7,280,387
84	(561) Load Dispatching	5,078,741	6,898,818
85	(562) Station Expenses	13,913,143	14,209,498
86	(563) Overhead Lines Expenses	381,263	348,318
87	(564) Underground Lines Expenses	605,370	489,531
88	(565) Transmission of Electricity by Others		
89	(566) Miscellaneous Transmission Expenses	4,614,532	5,540,745
90	(567) Rents	19,334,400	19,378,281
91	TOTAL Operation (Enter Total of lines 83 thru 90)	53,407,053	54,145,578
92	Maintenance		
93	(568) Maintenance Supervision and Engineering	4,840,100	1,558,528
94	(569) Maintenance of Structures	5,670,544	4,518,960
95	(570) Maintenance of Station Equipment	28,632,389	29,251,948
96	(571) Maintenance of Overhead Lines	1,630,929	2,427,771
97	(572) Maintenance of Underground Lines	13,013,078	12,932,165
98	(573) Maintenance of Miscellaneous Transmission Plant		
99	TOTAL Maintenance (Enter Total of lines 93 thru 98)	53,787,040	50,689,372
100	TOTAL Transmission Expenses (Enter Total of lines 91 and 99)	107,194,093	104,834,950
101	3. DISTRIBUTION EXPENSES		
102	Operation		
103	(580) Operation Supervision and Engineering	16,677,366	14,436,441

Name of Respondent	This Report Is:	Date of Report (Mo, Da, Yr)	Year of Report
Consolidated Edison Company of New York, Inc.	(1) [X] An Original (2) [ ] A Resubmission	04/30/1999	Dec. 31, 1998

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
104	3. DISTRIBUTION Expenses (Continued)		
105	(581) Load Dispatching	3,284,613	2,898,396
106	(582) Station Expenses	15,068,841	17,072,680
107	(583) Overhead Line Expenses	6,334,978	7,220,318
108	(584) Underground Line Expenses	26,860,035	25,055,747
109	(585) Street Lighting and Signal System Expenses	233,340	227,068
110	(586) Meter Expenses	11,219,301	11,400,340
111	(587) Customer Installations Expenses	11,323,629	11,251,689
112	(588) Miscellaneous Expenses	16,253,186	14,985,174
113	(589) Rents	24,687,366	23,871,979
114	TOTAL Operation (Enter Total of lines 103 thru 113)	131,942,655	128,419,832
115	Maintenance		
116	(590) Maintenance Supervision and Engineering	13,371,207	12,239,143
117	(591) Maintenance of Structures	2,107,844	2,246,434
118	(592) Maintenance of Station Equipment	7,392,146	8,398,137
119	(593) Maintenance of Overhead Lines	32,601,084	36,866,454
120	(594) Maintenance of Underground Lines	73,520,128	61,136,626
121	(595) Maintenance of Line Transformers	17,765,020	13,784,385
122	(596) Maintenance of Street Lighting and Signal Systems	2,046,199	2,219,325
123	(597) Maintenance of Meters	2,000,283	2,002,609
124	(598) Maintenance of Miscellaneous Distribution Plant	5,293,584	4,237,273
125	TOTAL Maintenance (Enter Total of lines 116 thru 124)	156,097,495	143,130,386
126	TOTAL Distribution Exp (Enter Total of lines 114 and 125)	288,040,150	271,550,218
127	4. CUSTOMER ACCOUNTS EXPENSES		
128	Operation		
129	(901) Supervision	4,867,469	3,183,158
130	(902) Meter Reading Expenses	27,937,324	28,668,097
131	(903) Customer Records and Collection Expenses	105,983,299	99,647,647
132	(904) Uncollectible Accounts	24,332,430	26,605,096
133	(905) Miscellaneous Customer Accounts Expenses	975,607	2,854,184
134	TOTAL Customer Accounts Expenses (Total of lines 129 thru 133)	164,096,129	160,958,182
135	5. CUSTOMER SERVICE AND INFORMATIONAL EXPENSES		
136	Operation		
137	(907) Supervision	571,354	165,318
138	(908) Customer Assistance Expenses	2,636,937	2,885,583
139	(909) Informational and Instructional Expenses	4,468,837	4,153,274
140	(910) Miscellaneous Customer Service and Informational Expenses	51,431,206	59,207,624
141	TOTAL Cust. Service and Information. Exp. (Total lines 137 thru 140)	59,108,334	66,411,799
142	6. SALES EXPENSES		
143	Operation		
144	(911) Supervision		
145	(912) Demonstrating and Selling Expenses		
146	(913) Advertising Expenses		38,022
147	(916) Miscellaneous Sales Expenses		
148	TOTAL Sales Expenses (Enter Total of lines 144 thru 147)		38,022
149	7. ADMINISTRATIVE AND GENERAL EXPENSES		
150	Operation		
151	(920) Administrative and General Salaries	83,496,568	86,273,059
152	(921) Office Supplies and Expenses	39,872,891	34,096,347
153	(Less) (922) Administrative Expenses Transferred-Credit	33,461,876	40,423,984

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
154	7. ADMINISTRATIVE AND GENERAL EXPENSES (Continued)		
155	(923) Outside Services Employed	4,158,797	2,027,523
156	(924) Property Insurance	2,640,824	5,351,118
157	(925) Injuries and Damages	69,667,449	51,030,527
158	(926) Employee Pensions and Benefits	104,725,938	161,459,864
159	(927) Franchise Requirements	8,748	9,339
160	(928) Regulatory Commission Expenses	12,898,969	24,261,878
161	(929) (Less) Duplicate Charges-Cr.	8,465,528	8,603,528
162	(930.1) General Advertising Expenses	795,854	642,880
163	(930.2) Miscellaneous General Expenses	45,899,682	25,281,464
164	(931) Rents		
165	TOTAL Operation (Enter Total of lines 151 thru 164)	322,238,316	341,406,487
166	Maintenance		
167	(935) Maintenance of General Plant		
168	TOTAL Admin & General Expenses (Total of lines 165 thru 167)	322,238,316	341,406,487
169	TOTAL Elec Op and Maint Expn (Tot 80, 100, 126, 134, 141, 148, 168)	3,016,632,767	3,060,779,309

NUMBER OF ELECTRIC DEPARTMENT EMPLOYEES

1. The data on number of employees should be reported for the payroll period ending nearest to October 31, or any payroll period ending 60 days before or after October 31.
2. If the respondent's payroll for the reporting period includes any special construction personnel, include such employes on line 3, and show the number of such special construction employees in a footnote.
3. The number of employees assignable to the electric department from joint functions of combination utilities may be determined by estimate, on the basis of employee equivalents. Show the estimated number of equivalent employees attributed to the electric department from joint functions.

1. Payroll Period Ended (Date)	12/31/1998
2. Total Regular Full-Time Employees	11,283
3. Total Part-Time and Temporary Employees	115
4. Total Employees	11,398

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FERC Form No. 1:
ANNUAL REPORT OF MAJOR ELECTRIC UTILITIES, LICENSEES AND OTHERS

Original Copy of 1999 FERC Annual Report

This report is mandatory under the Federal Power Act, Sections 3, 4(a), 304 and 309, and 18 CFR 141.1. Failure to report may result in criminal fines, civil penalties and other sanctions as provided by law. The Federal Energy Regulatory Commission does not consider this report to be of a confidential nature.

Exact Legal Name of Respondent (Company)	Year of Report
Consolidated Edison Company of New York, Inc.	Dec. 31, 1999

Name of Respondent	This Report Is:	Date of Report (Mo, Da, Yr)	Year of Report
Consolidated Edison Company of New York, Inc.	(1) [X] An Original (2) [ ] A Resubmission	04/30/2000	Dec. 31, 1999

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
51	C. Hydraulic Power Generation (Continued)		
52	Maintenance		
53	(541) Mainentance Supervision and Engineering		
54	(542) Maintenance of Structures		
55	(543) Maintenance of Reservoirs, Dams, and Waterways		
56	(544) Maintenance of Electric Plant		
57	(545) Maintenance of Miscellaneous Hydraulic Plant		
58	TOTAL Maintenance (Enter Total of lines 53 thru 57)		
59	TOTAL Power Production Expenses-Hydraulic Power (tot of lines 50 & 58)		
60	D. Other Power Generation		
61	Operation		
62	(546) Operation Supervision and Engineering		
63	(547) Fuel	19,018,070	22,120,337
64	(548) Generation Expenses	2,767,065	3,806,677
65	(549) Miscellaneous Other Power Generation Expenses	-296,398	500,865
66	(550) Rents	2,498	3,078
67	TOTAL Operation (Enter Total of lines 62 thru 66)	21,491,235	26,430,957
68	Maintenance		
69	(551) Maintenance Supervision and Engineering	933,932	1,525,330
70	(552) Maintenance of Structures	3,641,418	6,983,188
71	(553) Maintenance of Generating and Electric Plant	9,438,578	10,998,909
72	(554) Maintenance of Miscellaneous Other Power Generation Plant	4,476,252	2,121,992
73	TOTAL Maintenance (Enter Total of lines 69 thru 72)	18,490,180	21,629,419
74	TOTAL Power Production Expenses-Other Power (Enter Tot of 67 & 73)	39,981,415	48,060,376
75	E. Other Power Supply Expenses		
76	(555) Purchased Power	1,640,243,490	1,221,581,632
77	(556) System Control and Load Dispatching	5,612,313	7,272,603
78	(557) Other Expenses	4,479,886	5,127,046
79	TOTAL Other Power Supply Exp (Enter Total of lines 76 thru 78)	1,650,335,689	1,233,981,281
80	TOTAL Power Production Expenses (Total of lines 21, 41, 59, 74 & 79)	2,221,497,256	2,075,955,745
81	2. TRANSMISSION EXPENSES		
82	Operation		
83	(560) Operation Supervision and Engineering	9,660,379	9,479,604
84	(561) Load Dispatching	7,058,714	5,078,741
85	(562) Station Expenses	17,329,527	13,913,143
86	(563) Overhead Lines Expenses	419,661	381,263
87	(564) Underground Lines Expenses	520,403	605,370
88	(565) Transmission of Electricity by Others		
89	(566) Miscellaneous Transmission Expenses	4,656,532	4,614,532
90	(567) Rents	19,609,607	19,334,400
91	TOTAL Operation (Enter Total of lines 83 thru 90)	59,254,823	53,407,053
92	Maintenance		
93	(568) Maintenance Supervision and Engineering	4,121,015	4,840,100
94	(569) Maintenance of Structures	8,751,388	5,670,544
95	(570) Maintenance of Station Equipment	25,337,310	28,632,389
96	(571) Maintenance of Overhead Lines	1,916,612	1,630,929
97	(572) Maintenance of Underground Lines	15,919,704	13,013,078
98	(573) Maintenance of Miscellaneous Transmission Plant		
99	TOTAL Maintenance (Enter Total of lines 93 thru 98)	56,046,029	53,787,040
100	TOTAL Transmission Expenses (Enter Total of lines 91 and 99)	115,300,852	107,194,093
101	3. DISTRIBUTION EXPENSES		
102	Operation		
103	(580) Operation Supervision and Engineering	27,771,925	16,677,366

Name of Respondent	This Report Is:	Date of Report (Mo, Da, Yr)	Year of Report
Consolidated Edison Company of New York, Inc.	(1) [X] An Original (2) [ ] A Resubmission	04/30/2000	Dec. 31, 1999

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
104	3. DISTRIBUTION Expenses (Continued)		
105	(581) Load Dispatching	3,426,418	3,284,613
106	(582) Station Expenses	16,527,315	15,068,841
107	(583) Overhead Line Expenses	6,408,420	6,334,978
108	(584) Underground Line Expenses	25,516,975	26,860,035
109	(585) Street Lighting and Signal System Expenses	149,111	233,340
110	(586) Meter Expenses	10,462,395	11,219,301
111	(587) Customer Installations Expenses	15,508,275	11,323,629
112	(588) Miscellaneous Expenses	15,895,882	16,253,186
113	(589) Rents	25,420,476	24,687,366
114	TOTAL Operation (Enter Total of lines 103 thru 113)	147,087,192	131,942,655
115	Maintenance		
116	(590) Maintenance Supervision and Engineering	13,109,272	13,371,207
117	(591) Maintenance of Structures	3,666,928	2,107,844
118	(592) Maintenance of Station Equipment	10,639,301	7,392,146
119	(593) Maintenance of Overhead Lines	36,061,126	32,601,084
120	(594) Maintenance of Underground Lines	83,740,897	73,520,128
121	(595) Maintenance of Line Transformers	19,409,651	17,765,020
122	(596) Maintenance of Street Lighting and Signal Systems	1,949,407	2,046,199
123	(597) Maintenance of Meters	1,934,322	2,000,283
124	(598) Maintenance of Miscellaneous Distribution Plant	5,687,036	5,293,584
125	TOTAL Maintenance (Enter Total of lines 116 thru 124)	176,197,940	156,097,495
126	TOTAL Distribution Exp (Enter Total of lines 114 and 125)	323,285,132	288,040,150
127	4. CUSTOMER ACCOUNTS EXPENSES		
128	Operation		
129	(901) Supervision	5,318,772	4,867,469
130	(902) Meter Reading Expenses	29,326,227	27,937,324
131	(903) Customer Records and Collection Expenses	104,374,384	105,983,299
132	(904) Uncollectible Accounts	21,817,457	24,332,430
133	(905) Miscellaneous Customer Accounts Expenses	1,132,684	975,607
134	TOTAL Customer Accounts Expenses (Total of lines 129 thru 133)	161,969,524	164,096,129
135	5. CUSTOMER SERVICE AND INFORMATIONAL EXPENSES		
136	Operation		
137	(907) Supervision	157,553	571,354
138	(908) Customer Assistance Expenses	3,675,621	2,636,937
139	(909) Informational and Instructional Expenses	2,975,741	4,468,837
140	(910) Miscellaneous Customer Service and Informational Expenses	40,495,962	51,431,206
141	TOTAL Cust. Service and Information. Exp. (Total lines 137 thru 140)	47,304,877	59,108,334
142	6. SALES EXPENSES		
143	Operation		
144	(911) Supervision		
145	(912) Demonstrating and Selling Expenses		
146	(913) Advertising Expenses		
147	(916) Miscellaneous Sales Expenses		
148	TOTAL Sales Expenses (Enter Total of lines 144 thru 147)		
149	7. ADMINISTRATIVE AND GENERAL EXPENSES		
150	Operation		
151	(920) Administrative and General Salaries	73,852,966	83,496,568
152	(921) Office Supplies and Expenses	33,353,580	39,872,891
153	(Less) (922) Administrative Expenses Transferred-Credit	31,328,419	33,461,876

Name of Respondent	This Report Is:	Date of Report (Mo, Da, Yr)	Year of Report
Consolidated Edison Company of New York, Inc.	(1) [X] An Original (2) [ ] A Resubmission	04/28/2000	Dec. 31, 1999

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
154	7. ADMINISTRATIVE AND GENERAL EXPENSES (Continued)		
155	(923) Outside Services Employed	3,125,978	4,158,797
156	(924) Property Insurance	-1,149	2,640,824
157	(925) Injuries and Damages	65,103,480	69,667,449
158	(926) Employee Pensions and Benefits	81,045,230	104,725,938
159	(927) Franchise Requirements	4,681	8,748
160	(928) Regulatory Commission Expenses	18,371,167	12,898,969
161	(929) (Less) Duplicate Charges-Cr.	8,869,797	8,465,528
162	(930.1) General Advertising Expenses	1,434,916	795,854
163	(930.2) Miscellaneous General Expenses	48,988,956	45,899,682
164	(931) Rents		
165	TOTAL Operation (Enter Total of lines 151 thru 164)	285,081,589	322,238,316
166	Maintenance		
167	(935) Maintenance of General Plant		
168	TOTAL Admin & General Expenses (Total of lines 165 thru 167)	285,081,589	322,238,316
169	TOTAL Elec Op and Maint Expn (Tot 80, 100, 126, 134, 141, 148, 168)	3,154,439,230	3,016,632,767

NUMBER OF ELECTRIC DEPARTMENT EMPLOYEES

1. The data on number of employees should be reported for the payroll period ending nearest to October 31, or any payroll period ending 60 days before or after October 31.

2. If the respondent's payroll for the reporting period includes any special construction personnel, include such employes on line 3, and show the number of such special construction employees in a footnote.

3. The number of employees assignable to the electric department from joint functions of combination utilities may be determined by estimate, on the basis of employee equivalents. Show the estimated number of equivalent employees attributed to the electric department from joint functions.

1. Payroll Period Ended (Date)	12/31/1999
2. Total Regular Full-Time Employees	9,926
3. Total Part-Time and Temporary Employees	127
4. Total Employees	10,053

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(Expires 3/31/2005)

FERC Form No. 1:
ANNUAL REPORT OF MAJOR ELECTRIC UTILITIES, LICENSEES AND OTHERS

Exact Legal Name of Respondent (Company)	Year of Report
Consolidated Edison Company of New York, Inc.	Dec. 31, 2000

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
51	C. Hydraulic Power Generation (Continued)		
52	Maintenance		
53	(541) Mainentance Supervision and Engineering		
54	(542) Maintenance of Structures		
55	(543) Maintenance of Reservoirs, Dams, and Waterways		
56	(544) Maintenance of Electric Plant		
57	(545) Maintenance of Miscellaneous Hydraulic Plant		
58	TOTAL Maintenance (Enter Total of lines 53 thru 57)		
59	TOTAL Power Production Expenses-Hydraulic Power (tot of lines 50 & 58)		
60	D. Other Power Generation		
61	Operation		
62	(546) Operation Supervision and Engineering		
63	(547) Fuel	602,509	19,018,070
64	(548) Generation Expenses	19,251	2,767,065
65	(549) Miscellaneous Other Power Generation Expenses	85,130	-296,398
66	(550) Rents	2,406	2,498
67	TOTAL Operation (Enter Total of lines 62 thru 66)	709,296	21,491,235
68	Maintenance		
69	(551) Maintenance Supervision and Engineering	2,000	933,932
70	(552) Maintenance of Structures	33,457	3,641,418
71	(553) Maintenance of Generating and Electric Plant	533,496	9,438,578
72	(554) Maintenance of Miscellaneous Other Power Generation Plant	-918,744	4,476,252
73	TOTAL Maintenance (Enter Total of lines 69 thru 72)	-349,791	18,490,180
74	TOTAL Power Production Expenses-Other Power (Enter Tot of 67 & 73)	359,505	39,981,415
75	E. Other Power Supply Expenses		
76	(555) Purchased Power	2,944,881,345	1,640,243,490
77	(556) System Control and Load Dispatching	31,031	5,612,313
78	(557) Other Expenses	3,212,915	4,479,886
79	TOTAL Other Power Supply Exp (Enter Total of lines 76 thru 78)	2,948,125,291	1,650,335,689
80	TOTAL Power Production Expenses (Total of lines 21, 41, 59, 74 & 79)	3,348,329,558	2,221,497,256
81	2. TRANSMISSION EXPENSES		
82	Operation		
83	(560) Operation Supervision and Engineering	9,108,004	9,660,379
84	(561) Load Dispatching	16,595,887	7,058,714
85	(562) Station Expenses	16,878,145	17,329,527
86	(563) Overhead Lines Expenses	321,211	419,661
87	(564) Underground Lines Expenses	545,173	520,403
88	(565) Transmission of Electricity by Others		
89	(566) Miscellaneous Transmission Expenses	5,881,896	4,656,532
90	(567) Rents	20,008,287	19,609,607
91	TOTAL Operation (Enter Total of lines 83 thru 90)	69,338,603	59,254,823
92	Maintenance		
93	(568) Maintenance Supervision and Engineering	5,039,943	4,121,015
94	(569) Maintenance of Structures	10,387,134	8,751,388
95	(570) Maintenance of Station Equipment	30,846,328	25,337,310
96	(571) Maintenance of Overhead Lines	2,574,642	1,916,612
97	(572) Maintenance of Underground Lines	20,029,667	15,919,704
98	(573) Maintenance of Miscellaneous Transmission Plant		
99	TOTAL Maintenance (Enter Total of lines 93 thru 98)	68,877,714	56,046,029
100	TOTAL Transmission Expenses (Enter Total of lines 91 and 99)	138,216,317	115,300,852
101	3. DISTRIBUTION EXPENSES		
102	Operation		
103	(580) Operation Supervision and Engineering	27,973,487	27,771,925

Name of Respondent	This Report Is:	Date of Report (Mo, Da, Yr)	Year of Report
Consolidated Edison Company of New York, Inc.	(1) [X] An Original (2) [ ] A Resubmission	04/30/2001	Dec. 31, 2000

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
104	3. DISTRIBUTION Expenses (Continued)		
105	(581) Load Dispatching	2,619	3,426,418
106	(582) Station Expenses	17,515,049	16,527,315
107	(583) Overhead Line Expenses	6,272,115	6,408,420
108	(584) Underground Line Expenses	26,367,604	25,516,975
109	(585) Street Lighting and Signal System Expenses	178,318	149,111
110	(586) Meter Expenses	9,519,366	10,462,395
111	(587) Customer Installations Expenses	14,370,259	15,508,275
112	(588) Miscellaneous Expenses	17,684,759	15,895,882
113	(589) Rents	26,390,292	25,420,476
114	TOTAL Operation (Enter Total of lines 103 thru 113)	146,273,868	147,087,192
115	Maintenance		
116	(590) Maintenance Supervision and Engineering	13,648,514	13,109,272
117	(591) Maintenance of Structures	4,215,386	3,666,928
118	(592) Maintenance of Station Equipment	11,127,130	10,639,301
119	(593) Maintenance of Overhead Lines	27,983,564	36,061,126
120	(594) Maintenance of Underground Lines	97,611,166	83,740,897
121	(595) Maintenance of Line Transformers	21,150,068	19,409,651
122	(596) Maintenance of Street Lighting and Signal Systems	2,146,840	1,949,407
123	(597) Maintenance of Meters	2,012,559	1,934,322
124	(598) Maintenance of Miscellaneous Distribution Plant	7,125,509	5,687,036
125	TOTAL Maintenance (Enter Total of lines 116 thru 124)	187,020,736	176,197,940
126	TOTAL Distribution Exp (Enter Total of lines 114 and 125)	333,294,604	323,285,132
127	4. CUSTOMER ACCOUNTS EXPENSES		
128	Operation		
129	(901) Supervision	4,742,436	5,318,772
130	(902) Meter Reading Expenses	26,946,727	29,326,227
131	(903) Customer Records and Collection Expenses	104,004,423	104,374,384
132	(904) Uncollectible Accounts	27,673,119	21,817,457
133	(905) Miscellaneous Customer Accounts Expenses	1,133,527	1,132,684
134	TOTAL Customer Accounts Expenses (Total of lines 129 thru 133)	164,500,232	161,969,524
135	5. CUSTOMER SERVICE AND INFORMATIONAL EXPENSES		
136	Operation		
137	(907) Supervision	142,564	157,553
138	(908) Customer Assistance Expenses	3,837,946	3,675,621
139	(909) Informational and Instructional Expenses	4,636,708	2,975,741
140	(910) Miscellaneous Customer Service and Informational Expenses	27,735,789	40,495,962
141	TOTAL Cust. Service and Information. Exp. (Total lines 137 thru 140)	36,353,007	47,304,877
142	6. SALES EXPENSES		
143	Operation		
144	(911) Supervision		
145	(912) Demonstrating and Selling Expenses		
146	(913) Advertising Expenses		
147	(916) Miscellaneous Sales Expenses		
148	TOTAL Sales Expenses (Enter Total of lines 144 thru 147)		
149	7. ADMINISTRATIVE AND GENERAL EXPENSES		
150	Operation		
151	(920) Administrative and General Salaries	69,751,098	73,852,966
152	(921) Office Supplies and Expenses	29,438,918	33,353,580
153	(Less) (922) Administrative Expenses Transferred-Credit	32,285,446	31,328,419

Name of Respondent	This Report Is:	Date of Report (Mo, Da, Yr)	Year of Report
Consolidated Edison Company of New York, Inc.	(1) [X] An Original (2) [ ] A Resubmission	04/30/2001	Dec. 31, 2000

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
154	7. ADMINISTRATIVE AND GENERAL EXPENSES (Continued)		
155	(923) Outside Services Employed	4,072,798	3,125,978
156	(924) Property Insurance	-2,756,152	-1,149
157	(925) Injuries and Damages	63,863,753	65,103,480
158	(926) Employee Pensions and Benefits	-46,823,800	81,045,230
159	(927) Franchise Requirements		4,681
160	(928) Regulatory Commission Expenses	17,674,610	18,371,167
161	(929) (Less) Duplicate Charges-Cr.	9,077,237	8,869,797
162	(930.1) General Advertising Expenses	5,608,007	1,434,916
163	(930.2) Miscellaneous General Expenses	57,251,325	48,988,956
164	(931) Rents		
165	TOTAL Operation (Enter Total of lines 151 thru 164)	156,717,874	285,081,589
166	Maintenance		
167	(935) Maintenance of General Plant		
168	TOTAL Admin & General Expenses (Total of lines 165 thru 167)	156,717,874	285,081,589
169	TOTAL Elec Op and Maint Expn (Tot 80, 100, 126, 134, 141, 148, 168)	4,177,411,592	3,154,439,230

NUMBER OF ELECTRIC DEPARTMENT EMPLOYEES

1. The data on number of employees should be reported for the payroll period ending nearest to October 31, or any payroll period ending 60 days before or after October 31.

2. If the respondent's payroll for the reporting period includes any special construction personnel, include such employes on line 3, and show the number of such special construction employees in a footnote.

3. The number of employees assignable to the electric department from joint functions of combination utilities may be determined by estimate, on the basis of employee equivalents. Show the estimated number of equivalent employees attributed to the electric department from joint functions.

1. Payroll Period Ended (Date)	12/31/2000
2. Total Regular Full-Time Employees	10,200
3. Total Part-Time and Temporary Employees	106
4. Total Employees	10,306

THIS FILING IS (CHECK ONE BOX FOR EACH ITEM)		
Item 1: [X] An Initial (Original) Submission	OR	[ ] Resubmission No. ____
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Form Approved
OMB No. 1902-0021
(Expires 3/31/2005)

FERC Form No. 1:
ANNUAL REPORT OF MAJOR ELECTRIC UTILITIES, LICENSEES AND OTHERS

This report is mandatory under the Federal Power Act, Sections 3, 4(a), 304 and 309, and 18 CFR 141.1. Failure to report may result in criminal fines, civil penalties and other sanctions as provided by law. The Federal Energy Regulatory Commission does not consider this report to be of a confidential nature.

Exact Legal Name of Respondent (Company)	Year of Report
Consolidated Edison Company of New York, Inc.	Dec. 31, 2001

Name of Respondent	This Report Is:	Date of Report (Mo, Da, Yr)	Year of Report
Consolidated Edison Company of New York, Inc.	(1) [X] An Original (2) [ ] A Resubmission	04/30/2002	Dec. 31, 2001

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
51	C. Hydraulic Power Generation (Continued)		
52	Maintenance		
53	(541) Mainentance Supervision and Engineering		
54	(542) Maintenance of Structures		
55	(543) Maintenance of Reservoirs, Dams, and Waterways		
56	(544) Maintenance of Electric Plant		
57	(545) Maintenance of Miscellaneous Hydraulic Plant		
58	TOTAL Maintenance (Enter Total of lines 53 thru 57)		
59	TOTAL Power Production Expenses-Hydraulic Power (tot of lines 50 & 58)		
60	D. Other Power Generation		
61	Operation		
62	(546) Operation Supervision and Engineering		
63	(547) Fuel	1,014,239	602,509
64	(548) Generation Expenses	1,653	19,251
65	(549) Miscellaneous Other Power Generation Expenses		85,130
66	(550) Rents	2,350	2,406
67	TOTAL Operation (Enter Total of lines 62 thru 66)	1,018,242	709,296
68	Maintenance		
69	(551) Maintenance Supervision and Engineering	-14,000	2,000
70	(552) Maintenance of Structures	4,085	33,457
71	(553) Maintenance of Generating and Electric Plant	1,453,169	533,496
72	(554) Maintenance of Miscellaneous Other Power Generation Plant	22,052	-918,744
73	TOTAL Maintenance (Enter Total of lines 69 thru 72)	1,465,306	-349,791
74	TOTAL Power Production Expenses-Other Power (Enter Tot of 67 & 73)	2,483,548	359,505
75	E. Other Power Supply Expenses		
76	(555) Purchased Power	2,766,685,953	2,944,881,345
77	(556) System Control and Load Dispatching	5,938	31,031
78	(557) Other Expenses	2,073,956	3,212,915
79	TOTAL Other Power Supply Exp (Enter Total of lines 76 thru 78)	2,768,765,847	2,948,125,291
80	TOTAL Power Production Expenses (Total of lines 21, 41, 59, 74 & 79)	3,060,699,190	3,348,329,558
81	2. TRANSMISSION EXPENSES		
82	Operation		
83	(560) Operation Supervision and Engineering	9,922,040	9,108,004
84	(561) Load Dispatching	17,387,876	16,595,887
85	(562) Station Expenses	18,446,294	16,878,145
86	(563) Overhead Lines Expenses	363,018	321,211
87	(564) Underground Lines Expenses	1,098,406	545,173
88	(565) Transmission of Electricity by Others		
89	(566) Miscellaneous Transmission Expenses	4,685,788	5,881,896
90	(567) Rents	20,436,499	20,008,287
91	TOTAL Operation (Enter Total of lines 83 thru 90)	72,339,921	69,338,603
92	Maintenance		
93	(568) Maintenance Supervision and Engineering	3,890,663	5,039,943
94	(569) Maintenance of Structures	9,030,513	10,387,134
95	(570) Maintenance of Station Equipment	20,928,466	30,846,328
96	(571) Maintenance of Overhead Lines	2,556,977	2,574,642
97	(572) Maintenance of Underground Lines	18,241,213	20,029,667
98	(573) Maintenance of Miscellaneous Transmission Plant		
99	TOTAL Maintenance (Enter Total of lines 93 thru 98)	54,647,832	68,877,714
100	TOTAL Transmission Expenses (Enter Total of lines 91 and 99)	126,987,753	138,216,317
101	3. DISTRIBUTION EXPENSES		
102	Operation		
103	(580) Operation Supervision and Engineering	27,719,739	27,973,487

Name of Respondent	This Report Is:	Date of Report (Mo, Da, Yr)	Year of Report
Consolidated Edison Company of New York, Inc.	(1) [X] An Original (2) [ ] A Resubmission	04/30/2002	Dec. 31, 2001

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
104	3. DISTRIBUTION Expenses (Continued)		
105	(581) Load Dispatching		2,619
106	(582) Station Expenses	16,430,230	17,515,049
107	(583) Overhead Line Expenses	9,715,894	6,272,115
108	(584) Underground Line Expenses	21,116,559	26,367,604
109	(585) Street Lighting and Signal System Expenses	463,389	178,318
110	(586) Meter Expenses	8,108,127	9,519,366
111	(587) Customer Installations Expenses	12,086,437	14,370,259
112	(588) Miscellaneous Expenses	19,175,634	17,684,759
113	(589) Rents	27,001,372	26,390,292
114	TOTAL Operation (Enter Total of lines 103 thru 113)	141,817,381	146,273,868
115	Maintenance		
116	(590) Maintenance Supervision and Engineering	18,253,175	13,648,514
117	(591) Maintenance of Structures	5,766,635	4,215,386
118	(592) Maintenance of Station Equipment	12,014,470	11,127,130
119	(593) Maintenance of Overhead Lines	27,591,525	27,983,564
120	(594) Maintenance of Underground Lines	112,422,056	97,611,166
121	(595) Maintenance of Line Transformers	17,339,360	21,150,068
122	(596) Maintenance of Street Lighting and Signal Systems	2,356,128	2,146,840
123	(597) Maintenance of Meters	1,851,372	2,012,559
124	(598) Maintenance of Miscellaneous Distribution Plant	7,027,174	7,125,509
125	TOTAL Maintenance (Enter Total of lines 116 thru 124)	204,621,895	187,020,736
126	TOTAL Distribution Exp (Enter Total of lines 114 and 125)	346,439,276	333,294,604
127	4. CUSTOMER ACCOUNTS EXPENSES		
128	Operation		
129	(901) Supervision	5,260,929	4,742,436
130	(902) Meter Reading Expenses	26,723,872	26,946,727
131	(903) Customer Records and Collection Expenses	106,154,139	104,004,423
132	(904) Uncollectible Accounts	37,024,956	27,673,119
133	(905) Miscellaneous Customer Accounts Expenses	1,119,736	1,133,527
134	TOTAL Customer Accounts Expenses (Total of lines 129 thru 133)	176,283,632	164,500,232
135	5. CUSTOMER SERVICE AND INFORMATIONAL EXPENSES		
136	Operation		
137	(907) Supervision	133,340	142,564
138	(908) Customer Assistance Expenses	3,874,450	3,837,946
139	(909) Informational and Instructional Expenses	4,101,098	4,636,708
140	(910) Miscellaneous Customer Service and Informational Expenses	14,949,769	27,735,789
141	TOTAL Cust. Service and Information. Exp. (Total lines 137 thru 140)	23,058,657	36,353,007
142	6. SALES EXPENSES		
143	Operation		
144	(911) Supervision		
145	(912) Demonstrating and Selling Expenses		
146	(913) Advertising Expenses		
147	(916) Miscellaneous Sales Expenses		
148	TOTAL Sales Expenses (Enter Total of lines 144 thru 147)		
149	7. ADMINISTRATIVE AND GENERAL EXPENSES		
150	Operation		
151	(920) Administrative and General Salaries	75,027,197	69,751,098
152	(921) Office Supplies and Expenses	28,445,985	29,438,918
153	(Less) (922) Administrative Expenses Transferred-Credit	37,127,790	32,285,446

Name of Respondent	This Report Is:	Date of Report (Mo, Da, Yr)	Year of Report
Consolidated Edison Company of New York, Inc.	(1) [X] An Original (2) [ ] A Resubmission	04/30/2002	Dec. 31, 2001

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
154	7. ADMINISTRATIVE AND GENERAL EXPENSES (Continued)		
155	(923) Outside Services Employed	2,362,014	4,072,798
156	(924) Property Insurance	-3,248,857	-2,756,152
157	(925) Injuries and Damages	61,029,317	63,863,753
158	(926) Employee Pensions and Benefits	-83,079,601	-46,823,800
159	(927) Franchise Requirements		
160	(928) Regulatory Commission Expenses	25,396,838	17,674,610
161	(929) (Less) Duplicate Charges-Cr.	16,623,204	9,077,237
162	(930.1) General Advertising Expenses	10,970,404	5,608,007
163	(930.2) Miscellaneous General Expenses	92,497,289	57,251,325
164	(931) Rents		
165	TOTAL Operation (Enter Total of lines 151 thru 164)	155,649,592	156,717,874
166	Maintenance		
167	(935) Maintenance of General Plant		
168	TOTAL Admin & General Expenses (Total of lines 165 thru 167)	155,649,592	156,717,874
169	TOTAL Elec Op and Maint Expn (Tot 80, 100, 126, 134, 141, 148, 168)	3,889,118,100	4,177,411,592

NUMBER OF ELECTRIC DEPARTMENT EMPLOYEES

1. The data on number of employees should be reported for the payroll period ending nearest to October 31, or any payroll period ending 60 days before or after October 31.

2. If the respondent's payroll for the reporting period includes any special construction personnel, include such employes on line 3, and show the number of such special construction employees in a footnote.

3. The number of employees assignable to the electric department from joint functions of combination utilities may be determined by estimate, on the basis of employee equivalents. Show the estimated number of equivalent employees attributed to the electric department from joint functions.

1. Payroll Period Ended (Date)	12/31/2001
2. Total Regular Full-Time Employees	9,726
3. Total Part-Time and Temporary Employees	99
4. Total Employees	9,825

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OMB No. 1902-0021
(Expires 3/31/2005)

FERC Form No. 1:
ANNUAL REPORT OF MAJOR ELECTRIC UTILITIES, LICENSEES AND OTHERS

This report is mandatory under the Federal Power Act, Sections 3, 4(a), 304 and 309, and 18 CFR 141.1. Failure to report may result in criminal fines, civil penalties and other sanctions as provided by law. The Federal Energy Regulatory Commission does not consider this report to be of a confidential nature.

Exact Legal Name of Respondent (Company)	**Year of Report**
Consolidated Edison Company of New York, Inc.	**Dec. 31,** 2002

Name of Respondent	This Report Is:	Date of Report (Mo, Da, Yr)	Year of Report
Consolidated Edison Company of New York, Inc.	(1) [X] An Original (2) [ ] A Resubmission	04/30/2003	Dec. 31, 2002

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
51	C. Hydraulic Power Generation (Continued)		
52	Maintenance		
53	(541) Mainentance Supervision and Engineering		
54	(542) Maintenance of Structures		
55	(543) Maintenance of Reservoirs, Dams, and Waterways		
56	(544) Maintenance of Electric Plant		
57	(545) Maintenance of Miscellaneous Hydraulic Plant		
58	TOTAL Maintenance (Enter Total of lines 53 thru 57)		
59	TOTAL Power Production Expenses-Hydraulic Power (tot of lines 50 & 58)		
60	D. Other Power Generation		
61	Operation		
62	(546) Operation Supervision and Engineering		
63	(547) Fuel	645,272	1,014,239
64	(548) Generation Expenses		1,653
65	(549) Miscellaneous Other Power Generation Expenses		
66	(550) Rents	2,324	2,350
67	TOTAL Operation (Enter Total of lines 62 thru 66)	647,596	1,018,242
68	Maintenance		
69	(551) Maintenance Supervision and Engineering		-14,000
70	(552) Maintenance of Structures	10,473	4,085
71	(553) Maintenance of Generating and Electric Plant	379,715	1,453,169
72	(554) Maintenance of Miscellaneous Other Power Generation Plant	3,125	22,052
73	TOTAL Maintenance (Enter Total of lines 69 thru 72)	393,313	1,465,306
74	TOTAL Power Production Expenses-Other Power (Enter Tot of 67 & 73)	1,040,909	2,483,548
75	E. Other Power Supply Expenses		
76	(555) Purchased Power	2,592,094,698	2,766,685,953
77	(556) System Control and Load Dispatching		5,938
78	(557) Other Expenses	2,002,015	2,073,956
79	TOTAL Other Power Supply Exp (Enter Total of lines 76 thru 78)	2,594,096,713	2,768,765,847
80	TOTAL Power Production Expenses (Total of lines 21, 41, 59, 74 & 79)	2,719,538,278	3,060,699,190
81	2. TRANSMISSION EXPENSES		
82	Operation		
83	(560) Operation Supervision and Engineering	10,263,354	9,922,040
84	(561) Load Dispatching	18,138,212	17,387,876
85	(562) Station Expenses	22,065,326	18,446,294
86	(563) Overhead Lines Expenses	474,474	363,018
87	(564) Underground Lines Expenses	1,377,293	1,098,406
88	(565) Transmission of Electricity by Others		
89	(566) Miscellaneous Transmission Expenses	6,420,736	4,685,788
90	(567) Rents	22,354,911	20,436,499
91	TOTAL Operation (Enter Total of lines 83 thru 90)	81,094,306	72,339,921
92	Maintenance		
93	(568) Maintenance Supervision and Engineering	4,576,202	3,890,663
94	(569) Maintenance of Structures	9,170,000	9,030,513
95	(570) Maintenance of Station Equipment	22,902,135	20,928,466
96	(571) Maintenance of Overhead Lines	2,484,578	2,556,977
97	(572) Maintenance of Underground Lines	16,195,522	18,241,213
98	(573) Maintenance of Miscellaneous Transmission Plant		
99	TOTAL Maintenance (Enter Total of lines 93 thru 98)	55,328,437	54,647,832
100	TOTAL Transmission Expenses (Enter Total of lines 91 and 99)	136,422,743	126,987,753
101	3. DISTRIBUTION EXPENSES		
102	Operation		
103	(580) Operation Supervision and Engineering	27,755,885	27,719,739

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
104	3. DISTRIBUTION Expenses (Continued)		
105	(581) Load Dispatching		
106	(582) Station Expenses	16,963,394	16,430,230
107	(583) Overhead Line Expenses	8,256,215	9,715,894
108	(584) Underground Line Expenses	26,304,808	21,116,559
109	(585) Street Lighting and Signal System Expenses	219,619	463,389
110	(586) Meter Expenses	7,838,731	8,108,127
111	(587) Customer Installations Expenses	13,291,802	12,086,437
112	(588) Miscellaneous Expenses	23,563,823	19,175,634
113	(589) Rents	28,796,645	27,001,372
114	TOTAL Operation (Enter Total of lines 103 thru 113)	152,990,922	141,817,381
115	Maintenance		
116	(590) Maintenance Supervision and Engineering	17,470,752	18,253,175
117	(591) Maintenance of Structures	4,983,591	5,766,635
118	(592) Maintenance of Station Equipment	11,840,460	12,014,470
119	(593) Maintenance of Overhead Lines	31,656,928	27,591,525
120	(594) Maintenance of Underground Lines	101,939,631	112,422,056
121	(595) Maintenance of Line Transformers	10,702,322	17,339,360
122	(596) Maintenance of Street Lighting and Signal Systems	1,775,851	2,356,128
123	(597) Maintenance of Meters	1,669,842	1,851,372
124	(598) Maintenance of Miscellaneous Distribution Plant	6,718,948	7,027,174
125	TOTAL Maintenance (Enter Total of lines 116 thru 124)	188,758,325	204,621,895
126	TOTAL Distribution Exp (Enter Total of lines 114 and 125)	341,749,247	346,439,276
127	4. CUSTOMER ACCOUNTS EXPENSES		
128	Operation		
129	(901) Supervision	5,638,614	5,260,929
130	(902) Meter Reading Expenses	30,579,375	26,723,872
131	(903) Customer Records and Collection Expenses	103,152,884	106,154,139
132	(904) Uncollectible Accounts	29,841,706	37,024,956
133	(905) Miscellaneous Customer Accounts Expenses	1,109,148	1,119,736
134	TOTAL Customer Accounts Expenses (Total of lines 129 thru 133)	170,321,727	176,283,632
135	5. CUSTOMER SERVICE AND INFORMATIONAL EXPENSES		
136	Operation		
137	(907) Supervision	174,172	133,340
138	(908) Customer Assistance Expenses	2,995,025	3,874,450
139	(909) Informational and Instructional Expenses	4,983,400	4,101,098
140	(910) Miscellaneous Customer Service and Informational Expenses	7,245,923	14,949,769
141	TOTAL Cust. Service and Information. Exp. (Total lines 137 thru 140)	15,398,520	23,058,657
142	6. SALES EXPENSES		
143	Operation		
144	(911) Supervision		
145	(912) Demonstrating and Selling Expenses		
146	(913) Advertising Expenses		
147	(916) Miscellaneous Sales Expenses		
148	TOTAL Sales Expenses (Enter Total of lines 144 thru 147)		
149	7. ADMINISTRATIVE AND GENERAL EXPENSES		
150	Operation		
151	(920) Administrative and General Salaries	83,062,268	75,027,197
152	(921) Office Supplies and Expenses	20,511,493	28,445,985
153	(Less) (922) Administrative Expenses Transferred-Credit	35,699,923	37,127,790

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
154	7. ADMINISTRATIVE AND GENERAL EXPENSES (Continued)		
155	(923) Outside Services Employed	1,732,801	2,362,014
156	(924) Property Insurance	-182,588	-3,248,857
157	(925) Injuries and Damages	55,335,779	61,029,317
158	(926) Employee Pensions and Benefits	-86,810,582	-83,079,601
159	(927) Franchise Requirements		
160	(928) Regulatory Commission Expenses	22,301,837	25,396,838
161	(929) (Less) Duplicate Charges-Cr.	10,285,634	16,623,204
162	(930.1) General Advertising Expenses	1,366,830	10,970,404
163	(930.2) Miscellaneous General Expenses	90,675,867	92,497,289
164	(931) Rents		
165	TOTAL Operation (Enter Total of lines 151 thru 164)	142,008,148	155,649,592
166	Maintenance		
167	(935) Maintenance of General Plant		
168	TOTAL Admin & General Expenses (Total of lines 165 thru 167)	142,008,148	155,649,592
169	TOTAL Elec Op and Maint Expn (Tot 80, 100, 126, 134, 141, 148, 168)	3,525,438,663	3,889,118,100

THIS FILING IS (CHECK ONE BOX FOR EACH ITEM)			
Item 1: [X] An Initial (Original) Submission	OR	[ ] Resubmission No. ____	
Item 2: [ ] An Original Signed Form	OR	[ ] Conformed Copy	

Form Approved
OMB No. 1902-0021
(Expires 3/31/2005)

FERC Form No. 1: ANNUAL REPORT OF MAJOR ELECTRIC UTILITIES, LICENSEES AND OTHERS

Exact Legal Name of Respondent (Company)	Year of Report
Consolidated Edison Company of New York, Inc.	Dec. 31, 2003

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
51	C. Hydraulic Power Generation (Continued)		
52	Maintenance		
53	(541) Mainentance Supervision and Engineering		
54	(542) Maintenance of Structures		
55	(543) Maintenance of Reservoirs, Dams, and Waterways		
56	(544) Maintenance of Electric Plant		
57	(545) Maintenance of Miscellaneous Hydraulic Plant		
58	TOTAL Maintenance (Enter Total of lines 53 thru 57)		
59	TOTAL Power Production Expenses-Hydraulic Power (tot of lines 50 & 58)		
60	D. Other Power Generation		
61	Operation		
62	(546) Operation Supervision and Engineering		
63	(547) Fuel	265,624	645,272
64	(548) Generation Expenses	-2,450	
65	(549) Miscellaneous Other Power Generation Expenses		
66	(550) Rents	2,299	2,324
67	TOTAL Operation (Enter Total of lines 62 thru 66)	265,473	647,596
68	Maintenance		
69	(551) Maintenance Supervision and Engineering		
70	(552) Maintenance of Structures	-4,436	10,473
71	(553) Maintenance of Generating and Electric Plant	563,133	379,715
72	(554) Maintenance of Miscellaneous Other Power Generation Plant	10,132	3,125
73	TOTAL Maintenance (Enter Total of lines 69 thru 72)	568,829	393,313
74	TOTAL Power Production Expenses-Other Power (Enter Tot of 67 & 73)	834,302	1,040,909
75	E. Other Power Supply Expenses		
76	(555) Purchased Power	3,068,629,961	2,592,094,698
77	(556) System Control and Load Dispatching		
78	(557) Other Expenses	1,968,789	2,002,015
79	TOTAL Other Power Supply Exp (Enter Total of lines 76 thru 78)	3,070,598,750	2,594,096,713
80	TOTAL Power Production Expenses (Total of lines 21, 41, 59, 74 & 79)	3,216,917,293	2,719,538,278
81	2. TRANSMISSION EXPENSES		
82	Operation		
83	(560) Operation Supervision and Engineering	9,521,437	10,263,354
84	(561) Load Dispatching	17,598,769	18,138,212
85	(562) Station Expenses	23,656,894	22,065,326
86	(563) Overhead Lines Expenses	618,568	474,474
87	(564) Underground Lines Expenses	1,345,223	1,377,293
88	(565) Transmission of Electricity by Others		
89	(566) Miscellaneous Transmission Expenses	5,953,968	6,420,736
90	(567) Rents	21,945,908	22,354,911
91	TOTAL Operation (Enter Total of lines 83 thru 90)	80,640,767	81,094,306
92	Maintenance		
93	(568) Maintenance Supervision and Engineering	5,495,299	4,576,202
94	(569) Maintenance of Structures	6,853,403	9,170,000
95	(570) Maintenance of Station Equipment	20,446,660	22,902,135
96	(571) Maintenance of Overhead Lines	2,324,770	2,484,578
97	(572) Maintenance of Underground Lines	14,377,143	16,195,522
98	(573) Maintenance of Miscellaneous Transmission Plant		
99	TOTAL Maintenance (Enter Total of lines 93 thru 98)	49,497,275	55,328,437
100	TOTAL Transmission Expenses (Enter Total of lines 91 and 99)	130,138,042	136,422,743
101	3. DISTRIBUTION EXPENSES		
102	Operation		
103	(580) Operation Supervision and Engineering	27,333,968	27,755,885

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
104	3. DISTRIBUTION Expenses (Continued)		
105	(581) Load Dispatching		
106	(582) Station Expenses	17,983,875	16,963,394
107	(583) Overhead Line Expenses	6,603,488	8,256,215
108	(584) Underground Line Expenses	21,395,220	26,304,808
109	(585) Street Lighting and Signal System Expenses	248,307	219,619
110	(586) Meter Expenses	7,380,561	7,838,731
111	(587) Customer Installations Expenses	13,864,233	13,291,802
112	(588) Miscellaneous Expenses	25,809,908	23,563,823
113	(589) Rents	29,200,385	28,796,645
114	TOTAL Operation (Enter Total of lines 103 thru 113)	149,819,945	152,990,922
115	Maintenance		
116	(590) Maintenance Supervision and Engineering	14,647,855	17,470,752
117	(591) Maintenance of Structures	4,112,157	4,983,591
118	(592) Maintenance of Station Equipment	9,452,701	11,840,460
119	(593) Maintenance of Overhead Lines	31,870,066	31,656,928
120	(594) Maintenance of Underground Lines	98,335,445	101,939,631
121	(595) Maintenance of Line Transformers	9,299,770	10,702,322
122	(596) Maintenance of Street Lighting and Signal Systems	1,973,989	1,775,851
123	(597) Maintenance of Meters	630,448	1,669,842
124	(598) Maintenance of Miscellaneous Distribution Plant	5,214,250	6,718,948
125	TOTAL Maintenance (Enter Total of lines 116 thru 124)	175,536,681	188,758,325
126	TOTAL Distribution Exp (Enter Total of lines 114 and 125)	325,356,626	341,749,247
127	4. CUSTOMER ACCOUNTS EXPENSES		
128	Operation		
129	(901) Supervision	4,559,669	5,638,614
130	(902) Meter Reading Expenses	30,081,967	30,579,375
131	(903) Customer Records and Collection Expenses	102,240,329	103,152,884
132	(904) Uncollectible Accounts	31,027,182	29,841,706
133	(905) Miscellaneous Customer Accounts Expenses	716,149	1,109,148
134	TOTAL Customer Accounts Expenses (Total of lines 129 thru 133)	168,625,296	170,321,727
135	5. CUSTOMER SERVICE AND INFORMATIONAL EXPENSES		
136	Operation		
137	(907) Supervision	91,937	174,172
138	(908) Customer Assistance Expenses	2,736,266	2,995,025
139	(909) Informational and Instructional Expenses	4,770,150	4,983,400
140	(910) Miscellaneous Customer Service and Informational Expenses	4,823,402	7,245,923
141	TOTAL Cust. Service and Information. Exp. (Total lines 137 thru 140)	12,421,755	15,398,520
142	6. SALES EXPENSES		
143	Operation		
144	(911) Supervision		
145	(912) Demonstrating and Selling Expenses		
146	(913) Advertising Expenses		
147	(916) Miscellaneous Sales Expenses		
148	TOTAL Sales Expenses (Enter Total of lines 144 thru 147)		
149	7. ADMINISTRATIVE AND GENERAL EXPENSES		
150	Operation		
151	(920) Administrative and General Salaries	80,054,979	83,062,268
152	(921) Office Supplies and Expenses	22,636,508	20,511,493
153	(Less) (922) Administrative Expenses Transferred-Credit	45,521,846	35,699,923

Name of Respondent	This Report Is:	Date of Report (Mo, Da, Yr)	Year of Report
Consolidated Edison Company of New York, Inc.	(1) [X] An Original (2) [ ] A Resubmission	04/30/2004	Dec. 31, 2003

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
154	7. ADMINISTRATIVE AND GENERAL EXPENSES (Continued)		
155	(923) Outside Services Employed	1,516,243	1,732,801
156	(924) Property Insurance	4,628,697	-182,588
157	(925) Injuries and Damages	55,107,569	55,335,779
158	(926) Employee Pensions and Benefits	-12,886,225	-86,810,582
159	(927) Franchise Requirements		
160	(928) Regulatory Commission Expenses	21,636,101	22,301,837
161	(929) (Less) Duplicate Charges-Cr.	10,466,629	10,285,634
162	(930.1) General Advertising Expenses	770,830	1,366,830
163	(930.2) Miscellaneous General Expenses	97,941,208	90,675,867
164	(931) Rents		
165	TOTAL Operation (Enter Total of lines 151 thru 164)	215,417,435	142,008,148
166	Maintenance		
167	(935) Maintenance of General Plant		
168	TOTAL Admin & General Expenses (Total of lines 165 thru 167)	215,417,435	142,008,148
169	TOTAL Elec Op and Maint Expn (Tot 80, 100, 126, 134, 141, 148, 168)	4,068,876,447	3,525,438,663

THIS FILING IS		
Item 1: [X] An Initial (Original) Submission	OR [ ]	Resubmission No. ____

Form 1 Approved
OMB No. 1902-0021
(Expires 6/30/2007)
Form 1-F Approved
OMB No. 1902-0029
(Expires 6/30/2007)
Form 3-Q Approved
OMB No. 1902-0205
(Expires 6/30/2007)

FERC FINANCIAL REPORT
FERC FORM No. 1: Annual Report of Major Electric Utilities, Licensees and Others and Supplemental Form 3-Q: Quarterly Financial Report

These reports are mandatory under the Federal Power Act, Sections 3, 4(a), 304 and 309, and 18 CFR 141.1 and 141.400. Failure to report may result in criminal fines, civil penalties and other sanctions as provided by law. The Federal Energy Regulatory Commission does not consider these reports to be of confidential nature

Exact Legal Name of Respondent (Company)	Year/Period of Report
Consolidated Edison Company of New York, Inc.	End of 2004/Q4

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
51	C. Hydraulic Power Generation (Continued)		
52	Maintenance		
53	(541) Mainentance Supervision and Engineering		
54	(542) Maintenance of Structures		
55	(543) Maintenance of Reservoirs, Dams, and Waterways		
56	(544) Maintenance of Electric Plant		
57	(545) Maintenance of Miscellaneous Hydraulic Plant		
58	TOTAL Maintenance (Enter Total of lines 53 thru 57)		
59	TOTAL Power Production Expenses-Hydraulic Power (tot of lines 50 & 58)		
60	D. Other Power Generation		
61	Operation		
62	(546) Operation Supervision and Engineering		
63	(547) Fuel	579,263	265,624
64	(548) Generation Expenses		-2,450
65	(549) Miscellaneous Other Power Generation Expenses		
66	(550) Rents	2,299	2,299
67	TOTAL Operation (Enter Total of lines 62 thru 66)	581,562	265,473
68	Maintenance		
69	(551) Maintenance Supervision and Engineering		
70	(552) Maintenance of Structures	2,191	-4,436
71	(553) Maintenance of Generating and Electric Plant	289,322	563,133
72	(554) Maintenance of Miscellaneous Other Power Generation Plant	90,824	10,132
73	TOTAL Maintenance (Enter Total of lines 69 thru 72)	382,337	568,829
74	TOTAL Power Production Expenses-Other Power (Enter Tot of 67 & 73)	963,899	834,302
75	E. Other Power Supply Expenses		
76	(555) Purchased Power	2,988,682,875	3,068,629,961
77	(556) System Control and Load Dispatching		
78	(557) Other Expenses	2,043,270	1,968,789
79	TOTAL Other Power Supply Exp (Enter Total of lines 76 thru 78)	2,990,726,145	3,070,598,750
80	TOTAL Power Production Expenses (Total of lines 21, 41, 59, 74 & 79)	3,176,964,607	3,216,917,293
81	2. TRANSMISSION EXPENSES		
82	Operation		
83	(560) Operation Supervision and Engineering	9,868,939	9,521,437
84	(561) Load Dispatching	18,288,785	17,598,769
85	(562) Station Expenses	18,511,462	23,656,894
86	(563) Overhead Lines Expenses	683,833	618,568
87	(564) Underground Lines Expenses	1,473,549	1,345,223
88	(565) Transmission of Electricity by Others		
89	(566) Miscellaneous Transmission Expenses	5,003,131	5,953,968
90	(567) Rents	21,579,232	21,945,908
91	TOTAL Operation (Enter Total of lines 83 thru 90)	75,408,931	80,640,767
92	Maintenance		
93	(568) Maintenance Supervision and Engineering	4,023,449	5,495,299
94	(569) Maintenance of Structures	6,079,287	6,853,403
95	(570) Maintenance of Station Equipment	20,757,085	20,446,660
96	(571) Maintenance of Overhead Lines	2,684,683	2,324,770
97	(572) Maintenance of Underground Lines	13,844,344	14,377,143
98	(573) Maintenance of Miscellaneous Transmission Plant		
99	TOTAL Maintenance (Enter Total of lines 93 thru 98)	47,388,848	49,497,275
100	TOTAL Transmission Expenses (Enter Total of lines 91 and 99)	122,797,779	130,138,042
101	3. DISTRIBUTION EXPENSES		
102	Operation		
103	(580) Operation Supervision and Engineering	27,718,352	27,333,968

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
104	3. DISTRIBUTION Expenses (Continued)		
105	(581) Load Dispatching		
106	(582) Station Expenses	20,313,138	17,983,875
107	(583) Overhead Line Expenses	6,805,958	6,603,488
108	(584) Underground Line Expenses	39,116,693	21,395,220
109	(585) Street Lighting and Signal System Expenses	1,191,338	248,307
110	(586) Meter Expenses	7,569,170	7,380,561
111	(587) Customer Installations Expenses	14,620,807	13,864,233
112	(588) Miscellaneous Expenses	28,979,831	25,809,908
113	(589) Rents	31,065,816	29,200,385
114	TOTAL Operation (Enter Total of lines 103 thru 113)	177,381,103	149,819,945
115	Maintenance		
116	(590) Maintenance Supervision and Engineering	14,218,800	14,647,855
117	(591) Maintenance of Structures	3,867,035	4,112,157
118	(592) Maintenance of Station Equipment	9,222,221	9,452,701
119	(593) Maintenance of Overhead Lines	29,624,840	31,870,066
120	(594) Maintenance of Underground Lines	100,355,565	98,335,445
121	(595) Maintenance of Line Transformers	11,424,678	9,299,770
122	(596) Maintenance of Street Lighting and Signal Systems	4,496,934	1,973,989
123	(597) Maintenance of Meters	750,447	630,448
124	(598) Maintenance of Miscellaneous Distribution Plant	6,802,541	5,214,250
125	TOTAL Maintenance (Enter Total of lines 116 thru 124)	180,763,061	175,536,681
126	TOTAL Distribution Exp (Enter Total of lines 114 and 125)	358,144,164	325,356,626
127	4. CUSTOMER ACCOUNTS EXPENSES		
128	Operation		
129	(901) Supervision	5,504,194	4,559,669
130	(902) Meter Reading Expenses	29,961,453	30,081,967
131	(903) Customer Records and Collection Expenses	100,155,587	102,240,329
132	(904) Uncollectible Accounts	33,383,827	31,027,182
133	(905) Miscellaneous Customer Accounts Expenses	734,457	716,149
134	TOTAL Customer Accounts Expenses (Total of lines 129 thru 133)	169,739,518	168,625,296
135	5. CUSTOMER SERVICE AND INFORMATIONAL EXPENSES		
136	Operation		
137	(907) Supervision	107,690	91,937
138	(908) Customer Assistance Expenses	2,811,982	2,736,266
139	(909) Informational and Instructional Expenses	5,591,269	4,770,150
140	(910) Miscellaneous Customer Service and Informational Expenses	3,806,200	4,823,402
141	TOTAL Cust. Service and Information. Exp. (Total lines 137 thru 140)	12,317,141	12,421,755
142	6. SALES EXPENSES		
143	Operation		
144	(911) Supervision		
145	(912) Demonstrating and Selling Expenses		
146	(913) Advertising Expenses		
147	(916) Miscellaneous Sales Expenses	744	
148	TOTAL Sales Expenses (Enter Total of lines 144 thru 147)	744	
149	7. ADMINISTRATIVE AND GENERAL EXPENSES		
150	Operation		
151	(920) Administrative and General Salaries	79,376,946	80,054,979
152	(921) Office Supplies and Expenses	22,220,196	22,636,508
153	(Less) (922) Administrative Expenses Transferred-Credit	51,275,265	45,521,846

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
154	7. ADMINISTRATIVE AND GENERAL EXPENSES (Continued)		
155	(923) Outside Services Employed	2,060,451	1,516,243
156	(924) Property Insurance	5,704,155	4,628,697
157	(925) Injuries and Damages	57,486,434	55,107,569
158	(926) Employee Pensions and Benefits	18,723,289	-12,886,225
159	(927) Franchise Requirements		
160	(928) Regulatory Commission Expenses	20,464,025	21,636,101
161	(929) (Less) Duplicate Charges-Cr.	11,668,768	10,466,629
162	(930.1) General Advertising Expenses	770,830	770,830
163	(930.2) Miscellaneous General Expenses	100,514,547	97,930,630
164	(931) Rents		
165	TOTAL Operation (Enter Total of lines 151 thru 164)	244,376,840	215,406,857
166	Maintenance		
167	(935) Maintenance of General Plant		
168	TOTAL Admin & General Expenses (Total of lines 165 thru 167)	244,376,840	215,406,857
169	TOTAL Elec Op and Maint Expn (Tot 80, 100, 126, 134, 141, 148, 168)	4,084,340,793	4,068,865,869

THIS FILING IS		
Item 1: [X] An Initial (Original) Submission	OR [ ]	Resubmission No. ____

Form 1 Approved
OMB No. 1902-0021
(Expires 7/31/2008)
Form 1-F Approved
OMB No. 1902-0029
(Expires 6/30/2007)
Form 3-Q Approved
OMB No. 1902-0205
(Expires 6/30/2007)

FERC FINANCIAL REPORT
FERC FORM No. 1: Annual Report of Major Electric Utilities, Licensees and Others and Supplemental Form 3-Q: Quarterly Financial Report

These reports are mandatory under the Federal Power Act, Sections 3, 4(a), 304 and 309, and 18 CFR 141.1 and 141.400. Failure to report may result in criminal fines, civil penalties and other sanctions as provided by law. The Federal Energy Regulatory Commission does not consider these reports to be of confidential nature

Exact Legal Name of Respondent (Company)	**Year/Period of Report**
Consolidated Edison Company of New York, Inc.	**End of** 2005/Q4

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
51	C. Hydraulic Power Generation (Continued)		
52	Maintenance		
53	(541) Mainentance Supervision and Engineering		
54	(542) Maintenance of Structures		
55	(543) Maintenance of Reservoirs, Dams, and Waterways		
56	(544) Maintenance of Electric Plant		
57	(545) Maintenance of Miscellaneous Hydraulic Plant		
58	TOTAL Maintenance (Enter Total of lines 53 thru 57)		
59	TOTAL Power Production Expenses-Hydraulic Power (tot of lines 50 & 58)		
60	D. Other Power Generation		
61	Operation		
62	(546) Operation Supervision and Engineering		
63	(547) Fuel	5,023,282	579,263
64	(548) Generation Expenses		
65	(549) Miscellaneous Other Power Generation Expenses		
66	(550) Rents	2,299	2,299
67	TOTAL Operation (Enter Total of lines 62 thru 66)	5,025,581	581,562
68	Maintenance		
69	(551) Maintenance Supervision and Engineering		
70	(552) Maintenance of Structures	4,463	2,191
71	(553) Maintenance of Generating and Electric Plant	6,231,085	289,322
72	(554) Maintenance of Miscellaneous Other Power Generation Plant	49,294	90,824
73	TOTAL Maintenance (Enter Total of lines 69 thru 72)	6,284,842	382,337
74	TOTAL Power Production Expenses-Other Power (Enter Tot of 67 & 73)	11,310,423	963,899
75	E. Other Power Supply Expenses		
76	(555) Purchased Power	3,284,799,272	2,988,682,875
77	(556) System Control and Load Dispatching		
78	(557) Other Expenses	2,008,137	2,043,270
79	TOTAL Other Power Supply Exp (Enter Total of lines 76 thru 78)	3,286,807,409	2,990,726,145
80	TOTAL Power Production Expenses (Total of lines 21, 41, 59, 74 & 79)	3,653,818,188	3,176,964,607
81	2. TRANSMISSION EXPENSES		
82	Operation		
83	(560) Operation Supervision and Engineering	11,033,987	9,868,939
84	(561) Load Dispatching	19,450,692	18,288,785
85	(562) Station Expenses	22,399,967	18,511,462
86	(563) Overhead Lines Expenses	628,532	683,833
87	(564) Underground Lines Expenses	1,608,228	1,473,549
88	(565) Transmission of Electricity by Others		
89	(566) Miscellaneous Transmission Expenses	6,681,509	5,003,131
90	(567) Rents	21,416,004	21,579,232
91	TOTAL Operation (Enter Total of lines 83 thru 90)	83,218,919	75,408,931
92	Maintenance		
93	(568) Maintenance Supervision and Engineering	4,625,315	4,023,449
94	(569) Maintenance of Structures	8,153,882	6,079,287
95	(570) Maintenance of Station Equipment	23,411,816	20,757,085
96	(571) Maintenance of Overhead Lines	3,905,681	2,684,683
97	(572) Maintenance of Underground Lines	17,569,393	13,844,344
98	(573) Maintenance of Miscellaneous Transmission Plant		
99	TOTAL Maintenance (Enter Total of lines 93 thru 98)	57,666,087	47,388,848
100	TOTAL Transmission Expenses (Enter Total of lines 91 and 99)	140,885,006	122,797,779
101	3. DISTRIBUTION EXPENSES		
102	Operation		
103	(580) Operation Supervision and Engineering	30,764,820	27,718,352

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
104	3. DISTRIBUTION Expenses (Continued)		
105	(581) Load Dispatching		
106	(582) Station Expenses	23,649,584	20,313,138
107	(583) Overhead Line Expenses	7,346,489	6,805,958
108	(584) Underground Line Expenses	29,477,918	39,116,693
109	(585) Street Lighting and Signal System Expenses	998,445	1,191,338
110	(586) Meter Expenses	7,052,223	7,569,170
111	(587) Customer Installations Expenses	15,603,899	14,620,807
112	(588) Miscellaneous Expenses	48,783,111	28,979,831
113	(589) Rents	31,277,645	31,065,816
114	TOTAL Operation (Enter Total of lines 103 thru 113)	194,954,134	177,381,103
115	Maintenance		
116	(590) Maintenance Supervision and Engineering	13,996,855	14,218,800
117	(591) Maintenance of Structures	4,283,038	3,867,035
118	(592) Maintenance of Station Equipment	12,174,097	9,222,221
119	(593) Maintenance of Overhead Lines	30,115,954	29,624,840
120	(594) Maintenance of Underground Lines	115,344,808	100,355,565
121	(595) Maintenance of Line Transformers	14,119,783	11,424,678
122	(596) Maintenance of Street Lighting and Signal Systems	2,518,867	4,496,934
123	(597) Maintenance of Meters	880,631	750,447
124	(598) Maintenance of Miscellaneous Distribution Plant	7,903,321	6,802,541
125	TOTAL Maintenance (Enter Total of lines 116 thru 124)	201,337,354	180,763,061
126	TOTAL Distribution Exp (Enter Total of lines 114 and 125)	396,291,488	358,144,164
127	4. CUSTOMER ACCOUNTS EXPENSES		
128	Operation		
129	(901) Supervision	5,957,514	5,504,194
130	(902) Meter Reading Expenses	31,005,108	29,961,453
131	(903) Customer Records and Collection Expenses	102,727,772	100,155,587
132	(904) Uncollectible Accounts	42,867,231	33,383,827
133	(905) Miscellaneous Customer Accounts Expenses	471,463	734,457
134	TOTAL Customer Accounts Expenses (Total of lines 129 thru 133)	183,029,088	169,739,518
135	5. CUSTOMER SERVICE AND INFORMATIONAL EXPENSES		
136	Operation		
137	(907) Supervision	170,539	107,690
138	(908) Customer Assistance Expenses	2,246,086	2,811,982
139	(909) Informational and Instructional Expenses	5,381,602	5,591,269
140	(910) Miscellaneous Customer Service and Informational Expenses	8,825,728	3,806,200
141	TOTAL Cust. Service and Information. Exp. (Total lines 137 thru 140)	16,623,955	12,317,141
142	6. SALES EXPENSES		
143	Operation		
144	(911) Supervision		
145	(912) Demonstrating and Selling Expenses		
146	(913) Advertising Expenses		
147	(916) Miscellaneous Sales Expenses		744
148	TOTAL Sales Expenses (Enter Total of lines 144 thru 147)		744
149	7. ADMINISTRATIVE AND GENERAL EXPENSES		
150	Operation		
151	(920) Administrative and General Salaries	82,331,737	79,376,946
152	(921) Office Supplies and Expenses	28,409,608	22,220,196
153	(Less) (922) Administrative Expenses Transferred-Credit	61,349,926	51,275,265

ELECTRIC OPERATION AND MAINTENANCE EXPENSES (Continued)

If the amount for previous year is not derived from previously reported figures, explain in footnote.

Line No.	Account (a)	Amount for Current Year (b)	Amount for Previous Year (c)
154	7. ADMINISTRATIVE AND GENERAL EXPENSES (Continued)		
155	(923) Outside Services Employed	2,151,021	2,060,451
156	(924) Property Insurance	3,551,462	5,704,155
157	(925) Injuries and Damages	64,698,875	57,486,434
158	(926) Employee Pensions and Benefits	87,983,157	18,723,289
159	(927) Franchise Requirements		
160	(928) Regulatory Commission Expenses	22,680,454	20,464,025
161	(929) (Less) Duplicate Charges-Cr.	20,088,730	11,668,768
162	(930.1) General Advertising Expenses	777,878	770,830
163	(930.2) Miscellaneous General Expenses	98,625,125	100,514,548
164	(931) Rents		
165	TOTAL Operation (Enter Total of lines 151 thru 164)	309,770,661	244,376,841
166	Maintenance		
167	(935) Maintenance of General Plant		
168	TOTAL Admin & General Expenses (Total of lines 165 thru 167)	309,770,661	244,376,841
169	TOTAL Elec Op and Maint Expn (Tot 80, 100, 126, 134, 141, 148, 168)	4,700,418,386	4,084,340,794

Appendix 12

Recommendations from Staff's Report on Consolidated Edison's July, 1999 System Outages

II-1 Con Edison should improve its cable rating methods to more accurately reflect actual thermal conditions and develop techniques to better model its network systems, especially those under multiple contingency conditions.

II-2 Con Edison should evaluate reasonable actions that can be taken to improve monitoring of its secondary system, including use of additional monitoring devices where feasible, and report to the Commission by June 1, 2000 on its findings.

II-3 Con Edison should examine its 86 degree Fahrenheit wet bulb/dry bulb design criterion to determine whether a more stringent criterion is appropriate for its distribution system. The study should estimate the costs of implementing various scenarios (e.g., one in five or ten year criteria).

II-4 If Con Edison water cools a transformer during a multiple contingency event, it should review the transformer's load capacity after the system emergency.

II-5 Con Edison should require basic impulse level (BIL) testing in its network transformer rebuild specifications.

II-6 Con Edison should establish clearer criteria for prioritizing the order in which paper cable should be replaced. Con Edison's unwritten policy of removing and replacing sections of paper/lead cable in both directions between splices when making repairs associated with stop joints or paper/lead cable, needs to be formalized.

II-7 Con Edison should develop a program for eliminating stop joints with high failure rates that are still in service.

II-8 Con Edison should accelerate efforts to better understand the susceptibility of various age groupings of paper/lead cables to failure to help prioritize the replacement efforts.

II-9 Con Edison should implement its cable rejuvenation program associated with manholes and reassess its manhole inspection program.

II-10 Con Edison should accelerate its evaluation of alternatives to high potential testing, such as low frequency AC testing, to determine their possible effectiveness and report to the Commission on its efforts by June 1, 2000.

II-11 Con Edison should consider installation of feeder sectionalizers for all networks in order to return customers to service more quickly and to help stabilize the network during multiple contingencies.

II-12 Con Edison should evaluate the effects of low voltage on customer equipment as a result of the secondary network problems experienced in Washington Heights. As part of its evaluation, all equipment damage claims should be reviewed. The company should report its findings to the Commission by June 1, 2000.

II-13 Con Edison should review the design for all relay protection schemes on its network feeders similar to those on 1M05 to ensure proper relay operation.

II-14 Con Edison should develop, before June 1, 2000, formal plans for operating networks under multiple contingency conditions, including the identification of load relief measures available for each network.

II-15 Con Edison should monitor the loading of high-tension customers' transformers as part of its system modeling programs.

II-16 Con Edison should revise its procedures to ensure that upgrades required for load relief and load distribution changes experienced during the previous year are implemented in time for the next year's summer season.

II-17 Con Edison should determine which recommendations in its report on the July 1999 outage, and in the report of the Review Board, need to be completed immediately to improve reliability for the summer of 2000 and implement them expeditiously. The company should report to the Commission on all of the recommendations, explaining its implementation plans and status.

II-18 Con Edison should perform a formal review of the effects of low voltage (below the 8% voltage reduction level) on customers in the Cooper Square network and report to the Commission by June 1, 2000. Con Edison should also report to the Commission on its analysis of the fire at the Cooper Square MTA station within 30 days after the New York City's Fire Department's report is completed.

II-19 Con Edison should review its design criteria for non-network distribution equipment and report to the Commission by June 1, 2000 on steps it is taking to reduce the likelihood of widespread problems in future heat waves.

IV-1 Con Edison should evaluate the further acceleration of its paper/lead cable removal program. The evaluation should include, at a minimum, an assessment of the cost and benefits of further acceleration.

IV-2 Con Edison should report annually to the Commission on its capital and operations and maintenance expenditures for electric distribution and substation operations and the progress of the associated programs.

V-1 Con Edison should evaluate its emergency procedures in light of lessons learned from the July 1999 outages and modify these procedures as necessary.

V-2 Con Edison should streamline and consolidate its emergency procedures to eliminate redundant and cumbersome material.

V-3 Con Edison should implement a rigorous training program to ensure that all its employees are adequately trained in emergency procedures.

V-4 Con Edison should review its process of appealing to the public for conservation during system emergencies to determine the effectiveness of its approach and whether other actions might be more effective (e.g., appeals from appropriate government officials, working with public officials to spread information, coordinating with agencies of the City of New York, etc.).

V-5 Con Edison should evaluate the efficiency and effectiveness of its processes for dispatching and setting up its mobile command center.

V-6 Con Edison should evaluate its processes for supplying up-to-date status reports to its mobile command centers. It should also ensure that information provided to customers during system emergencies support current emergency needs.

V-7 Con Edison should convene focus groups with customers in areas affected by the July 1999 outages to discuss how communication can be improved during emergency situations. Con Edison should seek the participation of the advisory boards in this process.

V-8 Con Edison should strengthen its emergency procedures to ensure that a knowledgeable and trained Emergency Information Coordinator is assigned in a timely way to support the communication processes during emergencies.

V-9 Con Edison should run practice drills to simulate emergency situations. These drills should involve all employees likely to be involved if a system emergency arises and should ensure that clear communications are maintained between staff from the electric control center, field operations, call center, public affairs, and media relations.

V-10 Con Edison should develop more detailed procedures for providing information to public officials and community leaders during system emergencies, including a broader list of community leaders.

V-11 Con Edison should take advantage of the existing network of community-based organizations to assist in its efforts to provide affected customers with information about the problem, restoration information, updates, and the claims process.

V-12 Con Edison should review non-business hours staffing levels for its Call Center during system emergencies.

V-13 Con Edison should implement procedures to monitor the quality and timeliness of information conveyed to customers during an emergency situation.

V-14 Con Edison should review its procedures for contacting "Concern" customers during system emergencies; revise these procedures, as needed; and follow these policies.

V-15 Con Edison should ensure that it has properly identified and obtained appropriate contact information for all large and/or sensitive customers in its service territory. This information should be updated on an ongoing basis.

V-16 Con Edison should provide appropriate contact information to all large and/or sensitive customers in its service territory to ensure that they have access to information to support their planning needs. This information should be updated and provided to these customers on a regular basis.

V-17 Con Edison should work with its large and/or sensitive customers to develop an accurate current inventory of the emergency generating capacity installed on these customers' premises. The company should provide assistance, when requested, to ensure that these emergency generators will be utilized optimally in possible future events.

V-18 Con Edison should consider developing a more formal program for using customer-owned emergency generators as a strategic load management tool during critical distribution system events like that of July 1999.

V-19 Con Edison should, as part of its formal reporting responsibilities for system emergencies, prepare a comprehensive evaluation of the effectiveness of its internal and external communication processes.

VI-1 The Commission should direct Con Edison to show cause why, for distribution failures of 12 hours or more hours in a 24 hour period, it should not:

a. increase the compensation for losses due to spoilage of food for lack of refrigeration for residential users from $100 to $350 per incident;

b. increase the compensation for losses due to spoilage of perishable merchandise for lack of refrigeration for non-residential customers from $2,000 to $7,000;

c. increase the liability per incident to a total of $10,000,000; and

d. file a proposal to provide compensation to customers for verifiable damages to their appliance motors.

VI-2 The Company should develop and submit for Staff review, a form for customers to submit to the company for damage claims.

VI-3 In the event of another sustained outage, the company should provide claim forms, in English and other widely used languages, and mail them to each customer in the affected area.

VI-4 Con Edison should develop ways to disseminate information about the claims process so that customers have realistic expectations about how much reimbursement they can obtain.

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STATE OF NEW YORK
PUBLIC SERVICE COMMISSION

Proceeding on Motion of the Commission to Investigate the Electric Power Outages in Consolidated Edison Company of New York, Inc.'s Long Island City Electric Network	**Case 06-E-0894**

REPLY COMMENTS OF THE CITY OF NEW YORK ON STAFF'S REPORT

Dated: March 30, 2007

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PRELIMINARY STATEMENT

In accordance with the schedule established by Administrative Law Judge Eleanor Stein in Case 06-E-0894, Proceeding on Motion of the Commission to Investigate the Electric Power Outages in Consolidated Edison Company of New York, Inc.'s Long Island City Electric Network, the City of New York (the "City") hereby submits its Reply Comments ("Reply Comments") in response to Initial Comments made by parties in this proceeding to the report that the Department of Public Service Staff ("Staff") filed with the Commission on February 9, 2007 ("Staff Report").[1] The City has been an active participant in this proceeding since it was instituted on July 26, 2006.

As part of this proceeding, the City has conducted its own independent investigation into the causes of the power outages in the Long Island City electric network ("LIC Outage"). The City submitted its Initial Comments[2] in this proceeding on March 2, 2007, and also filed as an appendix to its Initial Comments a copy of its report entitled *Investigation by the City of New York into the Northwest Queens July 2006 Power Outages* ("City Report"). The City responds herein to the following: (i) the argument by TransGas and PULP that a deficiency of reactive power was a major contributor to the LIC Outage; (ii)

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[1] *Department of Public Service Staff Report on its Investigation of the July 2006 Equipment Failures and Power Outages in Con Edison's Long Island City Network in Queens County, New York* (issued: February 9, 2007).

[2] The other parties filing Initial Comments on the Staff Report were: Con Edison, Attorney General of the State of New York ("Attorney General"), Assembly Committee on Corporations, Authorities and Commissions, Consumer Protection Board ("CPB"), Public Utility Law Project ("PULP"), Utility Workers Union of America, TransGas Energy Systems ("TransGas"), and Western Queens Power for the People Campaign. Citations to other parties' Initial Comments are preceded by the party's name, as abbreviated herein, and "Initial Comments" (e.g., Con Edison Initial Comments, p. __).

Con Edison's effort to justify its network shutdown procedures, monitoring of its secondary network and its Summer, 2006 preparation; (iii) CPB's request for implementation of a STAR program and for a monitoring role with respect to Con Edison's implementation of recommendations resulting from this proceeding; and (iv) the Attorney General's recommendations with respect to splitting large networks.

POINT I

THERE IS NO CREDIBLE EVIDENCE THAT A REACTIVE POWER DEFICIENCY CAUSED THE LIC OUTAGE

In their comments, both TransGas and PULP allege that a deficiency of reactive power (VARS) caused excessive current to flow in the secondary system of the Long Island City network.[3] TransGas and PULP further speculate that this deficiency of reactive power caused the failure of the initial secondary cable and resulting fire, which then caused the outage of feeders 1Q17 and 1Q16.[4] For the reasons set forth below, the Commission should reject this theory because it is based on flawed analyses and is not supported by the evidence collected during the discovery phase of this investigation.

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[3] TransGas Initial Comments, p. 2; PULP Initial Comments, p. 10.

[4] *Id*.

A. Ohm's Law

In its Initial Comments, TransGas states that "Ohm's Law provides that voltage is inversely proportional to current (amperage) in an electrical circuit . . . "[5] This is a misstatement of Ohm's Law. Ohm's Law is defined as follows:

> the strength of a . . . current is directly proportional to the potential difference [across the two terminal points] and inversely proportional to the resistance of the circuit.[6]

As set forth in this definition, the current in a conductor is directly proportional to the voltage drop across its terminals. Because this is a direct proportionality, the converse of TransGas' statement is true; that is, the voltage drop across a conductor is **directly** proportional to the current flowing through the conductor.[7] Inasmuch as TransGas' argument is based on this misstatement of Ohm's Law and misapplication of basic electrical engineering theory, its remaining positions must be seriously questioned.

B. Reactive Power

TransGas' Initial Comments also state that "[a]lthough the taps on transformers that supply the secondary will attempt to boost the reactive supply by adjusting the tap-step, if a reactive deficiency is present, the tap changers can reach their tap changing

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[5] TransGas Initial Comments, p. 3.

[6] Webster's College Dictionary, eleventh edition, p. 862.

[7] *Id*.

limit allowing secondary voltages to drop."[8] This statement is accurate when referring to the tap-changing equipment located on the transformers at the North Queens substation. However, the statement does not take into consideration what the starting position was or the movement that was actually occurring to the tap changers at the North Queens substation during the peak demand period of July 17, 2006. Data supplied by Con Edison as part of this investigation provides this information and indicates that the VAR supply was more than adequate to meet demand.[9]

By way of background, there were four transformers that were supplying load to the North Queens substation bus on July 17, 2006.[10] Each of these transformers has a tap changer installed that regulates the North Queens 27 kV substation bus voltage. These tap changers can raise or lower the voltage as system conditions require. The tap changers have a total of 33 positions (16 raise, 1 neutral and 16 lower, sometimes referred to as +16, N, -16). The voltage would be raised as load increases to compensate for the *voltage drop* through the transformers due to the increased load current, or to compensate for a voltage drop on the supply feeders due to a lack of VAR support.

TransGas has alleged that the Long Island City network's "access to reactive power through the transmission system was handicapped . . . because the Con Edison Dunwoodie-Rainey 345 kV transmission line . . . was out of service."[11] The Company has

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[8] TransGas Initial Comments, p. 4.

[9] Company Response to City Interrogatory 133 (dated: October 24, 2006).

[10] *Id*.

stated that preceding 1525 hours on July 17, 2006, the tap changers at the North Queens substation were operating in the vicinity of tap position -9 to -5.[12] The raising of the taps is to be expected as load increased throughout the day. At approximately 1528 hours on July 17th, the data shows a change on three transformers to the -4 tap position and on one transformer to the -3 position.[13] This demonstrates that the tap changers were functional and responsive to whatever changes were occurring on the system. On July 17, 2006, prior to the Long Island City event, the tap changers never reached their upper tap changing limit (in this case +16) and there were still a minimum of 19 tap positions available to raise the voltage.[14] This data supports the conclusion that the supply feeder voltage was actually slightly higher than required, which disproves the TransGas contention.

Moreover, the fact that the transformer taps had to be moved to the -16 position to achieve an 8% voltage reduction further proves that there was not a deficiency of VARS on the system.[15] Had there been a deficiency of VARS, these tap changers would not have been lowered to the -16 tap position. In other words, the data made available during discovery disproves TransGas' argument that there was a deficiency of reactive power that helped to cause the LIC Outage.

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[11] TransGas Initial Comments, p. 4.

[12] Company Response to City Interrogatory 133 (dated: October 24, 2006).

[13] *Id*.

[14] Company Response to City Interrogatory 133 (dated: October 24, 2006).

[15] *Id*.

C. Remote Monitoring System

In their comments, both TransGas and PULP state that the Remote Monitoring System ("RMS") provided data that showed 193 monitors with low voltage readings.[16] TransGas characterizes this as "widespread low voltage conditions" and PULP further defines the voltage as being below 126 volts.[17] Con Edison's specification defines the service voltage under normal conditions with all supply facilities available as being between 126 and 118 volts.[18] As a result, the 126 volt level cited by TransGas and PULP is not "low voltage."

In discussing low voltage conditions, it is more appropriate to focus on the lower end of the range, namely 118 volts. However, because the RMS provides the voltage at the transformer secondary, and not the customer's service point, some margin must be provided to allow for the voltage drop from the transformer to the customer. This voltage drop is typically in the range of 2 to 3 volts. Thus, "low voltage" would require a voltage measurement of less than 121 volts at the transformer. Data obtained during the investigation of the LIC event demonstrates that 17 transformers reported a voltage below 121 volts (A phase), and 5 of these readings were questionable due to erratic readings.[19] Therefore, considering that there are approximately 1,200 transformers in the Long Island

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[16] TransGas Initial Comments, p. 8; PULP Initial Comments, p. 8, f.n. 15.

[17] *Id*.

[18] Con Edison Specification EO-2065 entitled "Low Tension A.C. Service Voltage Limits" (Revision 4, dated: August, 1993).

[19] Company Response to City Interrogatory 114 (dated: October 24, 2006).

City network, TransGas' conclusion that there were "widespread low voltage conditions" prior to the event simply is not supportable.

D. Reference to the City Report

PULP in its Initial Comments quotes the City Report as follows:

> An analysis of the Long Island City situation regarding the voltage reduction effect, based on the available information, suggests that the voltage reduction applied by Con Edison from July 17 through July 23 most likely did not reduce the over-current in the affected areas and possibly contributed to additional problems caused by already low voltages in these areas.[20]

This quote is used by PULP to support its contention that there was a deficiency of VARS. However, PULP has incorrectly interpreted the City's statement.

As an initial matter, this statement in the City Report must be read in the context of the complete section in which it is contained.[21] The statement is intended to support recommendations examining the use of voltage reduction as a means to reduce current on the secondary system. While PULP correctly states "New York City has suggested that the voltage reduction may have increased current . . . ", it must be pointed out that nowhere in this section of the City Report is there any discussion of this being a result of a deficiency of VARS.[22] To the contrary, as noted above, the tap changers at the North Queens substation were able to adequately maintain the 27 kV voltage. Accordingly, the

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[20] PULP Initial Comments, p. 11.

[21] PULP Initial Comments, p. 10; *see also*, City Report, p. 81.

[22] *Id*.

City Report does not raise any concern with regard to voltage due to pre-event transmission or generation outages or deficiencies because there is no evidence to support the link that TransGas and PULP seek to create.

E. Review of Con Edison's Ability to Measure and Manage Reactive Power

In PULP's Initial Comments, it recommends that: "[t]he Commission should direct Staff to conduct further investigation and improvement of Con Edison's ability to measure and manage reactive power loads within its networks."[23] Data provided by Con Edison as part of this investigation illustrates that voltage at the 27 kV bus at the North Queens substation was adequately maintained by the Company's Voltage VAR Control (VVC) system prior to the Long Island City network event.[24] Moreover, and as previously stated, the tap changers had to be moved to their lowest position in order to establish voltage reduction, further indicating that there was no deficiency of reactive power. Accordingly, there is no basis for PULP's recommendation that there is a need for investigation of the Company's ability to measure reactive power.[25]

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[23] PULP Initial Comments, p. 18.

[24] Company Response to City Interrogatory 133 (dated: October 24, 2006); *see also*, Company Response to City Interrogatory 141 for a description of the VVC System (dated: October 24, 2006).

[25] Definitions for what constitutes low voltage already exist within Con Edison's service voltage specification. As stated in the City Report, what is required is for Con Edison to "[e]stablish, along with Department of Public Service Staff, a value of service voltage that should be considered inadequate and therefore would be counted as a service outage" (City Report, Section 7.0, Recommendation 41c).

F. Reactive Power and LIC Outage

TransGas and PULP's Initial Comments assert that a condition of low voltage including insufficient reactive power initiated the LIC outage.[26] In PULP's Initial Comments, they state that "[o]n July 17, 2006, a day with near peak load, it does appear that there was a low voltage problem in the LIC network."[27] As demonstrated through discovery in this proceeding, this was not the case.[28] Rather, the voltage supplying the Long Island City network on July 17, 2006, as the event began, was sufficient to meet demand and there was no shortage of active power (MW) or reactive power (VARS).[29]

TransGas and PULP both cite to reliability concerns caused by transmission line outages as potential contributors to a low voltage condition occurring on the Long Island City network.[30] Specifically, TransGas cites to testimony of Federal Energy Regulatory Commission ("FERC") Chairman Kelliher and New York Independent System Operator ("NYISO") CEO Mark Lynch wherein they discuss overall reliability concerns of the New York City load area caused by unplanned outages of two major subterranean transmission lines.[31] TransGas and PULP are confused. FERC and NYISO were concerned with a

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[26] TransGas Initial Comments, p. 2; PULP Initial Comments, pp. 11-12.

[27] PULP Initial Comments, p. 13.

[28] Company Response to City Interrogatory 133 (dated: October 24, 2006).

[29] *Id*.

[30] TransGas Initial Comments, p. 4; PULP Initial Comments, pp. 5-7.

reduction in active power import capability, not a shortage of reactive power. The loss of transmission line(s) servicing the New York City load area, and their associated active power import capability, could impact overall system reliability and, if severe enough, result in voltage reduction, initiation of demand reduction programs and potentially controlled, localized load shedding. However, the record in this case does not support a finding of any deficiency in active power (or reactive power) at the start of the Long Island City event on July 17, 2006.[32]

Further evidence that there was sufficient reactive power serving the Long Island City network during the event is that the tap changers at the North Queens substation still had sufficient range to adjust for any anticipated voltage corrections due to any Long Island City network load increases or transmission system voltage excursions. In fact, and as explained above, the opposite occurred when the Company implemented 8% voltage reduction. On July 17, 2006, when the Company initiated an 8% voltage reduction the tap changers at the source substation had to be moved to the -16 position. Had there been any shortage of reactive power, these tap changers would have been close to the +16 position to correct for any shortage of VARS.

Finally, the Con Edison Investigation Committee Report reviews in great detail the secondary condition in the vicinity of the first secondary fire.[33] This review clearly indicates that there were local secondary contingency conditions which caused the load on

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[31] PULP Initial Comments, pp. 5-6.

[32] Company Response to City Interrogatory 133 (dated: October 24, 2006).

[33] Con Edison's *Long Island City Network July 17 – 25, 2006: Incident Investigation Committee* (issued: February 12, 2007) ("Investigation Committee Report"), pp. 47-49.

the failed secondary cables to be above their ratings. This is a more plausible reason for the failure of these secondary cables than a shortage of reactive power. It is for these reasons that there is no support in the record to establish a correlation between a deficiency in reactive power or low voltage condition and the initial burning of the secondary cable that caused the first two primary feeders to fail.

POINT II

COMPANY'S DEFENSE OF CERTAIN OPERATING PROCEDURES

A. Network Shutdown

Con Edison's Initial Comments state that its Contingency Operations procedure[34] provides adequate guidance for when a network shutdown is appropriate.[35] The City does not agree. While the City recognizes that a certain amount of flexibility must be left to managers and operators to respond to contingency events and to allow them to use their training and experience to respond to these unique events as they unfold, the recommended improvements to the Company's operating procedure, along with recommended improvements to the Company's processes for providing accurate and timely information to operators, will ensure that the operators are considering all relevant factors in making the decision on shutting down or maintaining a network. Thus, Con Edison should

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[34] Specification EO-4095 entitled "Distribution System Operation under Contingency Conditions."

[35] Con Edison Initial Comments, pp. 10-11.

investigate opportunities to improve its network shutdown procedures as well as the training provided to its managers and operating personnel.[36]

For example, the City Report highlights the need for the following improvements to the Company's network shutdown procedure: (1) instruction on the application and use of voltage reduction under multiple contingency conditions and/or known low voltage conditions within their secondary cable networks;[37] (2) more granular guidance on when a network is considered to be under significant jeopardy with regard to creating extensive equipment and/or cable damage that may result in extended customer service outages should the network not be de-energized;[38] and (3) application of three-phase substation grounds to clear faulted feeders that are alive-on-backfeed while networks are operating under multiple feeder contingency conditions.[39]

The Company's current operating procedure regarding a network shutdown also should be strengthened to outline specific factors managers and operators are to consider when a network system is operating in a multiple contingency condition and they are deciding whether to de-energize the network. While the City recognizes that a certain amount of flexibility must be left to managers and operators to respond to contingency

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[36] In addition, as indicated within the Feeder Restoration and Transformer Cooling section of the City Report (City Report, p. 63), and elsewhere within the City Report, Con Edison guidelines for operating under emergency conditions need to be strengthened.

[37] City Report, Section 7.0, Recommendation 39b.

[38] City Report, Section 7.0, Recommendation 27e.

[39] City Report, Section 7.0, Recommendation 27a.

events, the Company's current policy is inadequate and should be revised to reflect specific factors that should be examined before a decision on shutting down a network is made.

At a minimum, the Company's network shutdown policy should be revised to include consideration of, *inter alia*, the condition of the secondary system (including escalating number of secondary events), expected system restoration time and resources required (e.g., number of primary feeders restored to service) if the network is de-energized, a comparison of estimated damage to the network if it remains in service versus a shutdown and a comparison of customer outages of maintaining the network versus shutting it down. The Company's operating procedures on a network shutdown can be adequately revised to provide a balance that will allow managers and operators the discretion they require to address the unique characteristics of a contingency event while also applying a uniform set of standards in making the decision.

Accordingly, the Company's procedures on network shutdown decisions should be strengthened to provide additional guidance and clarity on how the various inputs should be quantified and accounted for in making the shutdown decision in the areas outlined above. In addition, increased training needs to be performed to ensure managers and operators are able to correctly perform these functions during emergency and stressful times.

B. Monitoring Of Secondary Network

In Con Edison's Initial Comments, it states that "[t]he operators were continually monitoring conditions to the secondary network and at no point disregarded the information they were receiving."[40] The Company makes this statement despite significant evidence to the contrary. While the Company's claim may have been true on an individual report, or ticket basis, it clearly was not the case from a global perspective.[41]

It is evident that Con Edison personnel concentrated their attention and resources on the expeditious restoration of the primary feeders that were out of service during the initial phases of the Long Island City network event. In so doing, the Company's view of the deteriorating condition of the secondary network cable system was limited. As the Company's records have indicated, throughout the event backlogs of work were created in the secondary area for customers reporting outages, low voltage conditions, flickering lights, and manhole events.[42] Not until the evening hours of Wednesday, July 19, 2006, were the increasing volume of trouble tickets plotted on operating maps by engineering personnel and additional focus directed towards this area of the system.[43] On Thursday, July 20, 2006, as the realization that significantly more customers were out of service or being provided inadequate voltage, a night time survey was ordered that then confirmed this condition.[44] The night time survey resulted in an increase in the estimated number of customer outages from roughly 2,000 to approximately 25,000 customers.[45] Only at this point did the

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[40] Con Edison Initial Comments, pp. 31-32.

[41] Company's Investigation Committee Report, pp. 88-89.

[42] *Con Edison's Comprehensive Report on the Power Outages in Northwest Queens in July 2006* (issued: October 12, 2006) ("October 12th Report"), p. 4-34.

[43] *Id*.

[44] *Id*.

Company begin to deploy additional personnel and resources to address the true magnitude of the problems on the secondary system in a significant way. Accordingly, the Company's contention that its monitoring of the secondary system was adequate is contradicted by the evidence developed during discovery, and its response was seriously hampered by this lack of accurate information.

C. 2006 Summer Preparations

Con Edison's Initial Comments state that "all 57 networks were put on a state of high readiness" in anticipation of pending heat waves.[46] This statement is contradicted by the record developed during the course of this investigation and as documented in the City Report.[47] The Long Island City network cannot be described as being in a high state of readiness prior to the event. Con Edison reported that as of 1200 hours on July 17, 2006, there were 86 transformers within the network that were not supporting the secondary grid.[48] This number of non-operating transformers represents more than 7% of the roughly 1,200 transformers within the Long Island City network. The non-operating transformers were the equivalent to having one and one-half feeders out of service before the event even began on July 17, 2006. What is even more telling is that only twenty-seven of these transformers were listed as being banks-off the system (i.e., units dropped off of their respective

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[45] October 12th Report, p. 4-70.

[46] Con Edison Initial Comments, p. 7

[47] City Report, pp. 107-108.

[48] October 12th Report, p. 3-6.

feeders).[49] The remaining transformers are listed as sixteen transformers with presumed blown fuses in their network protectors, and forty-three transformers that had their associated network protectors open.[50] These fifty-nine transformers should all have been repaired or closed in advance of the 2006 summer load period, or prior to a state of "high readiness." Had these fifty-nine transformers been repaired or closed, it would of reduced the equivalent of 1.5 feeders out of service to a lower level.

Furthermore, as detailed in the City Report, the RMS had a significantly poor reporting level (79.5% compared to its designated reporting rate of 95%), the WOLF program was not functioning properly in the Brooklyn/Queens control center, the voltage reduction capability at the source substation was known to not be functioning, the new Ground & Test devices at the North Queens substation was not yet ready for use to expedite feeder processing, and the PQNode installation was not completed on a timely basis to permit the use of the Reactance To Fault application to reduce primary fault location times.[51] Based on this series of problems, it is clear that Con Edison's claim that the Long Island City network was in a "state of high readiness" on July 17, 2006 is unsupportable.

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[49] Company Response to City Interrogatory 211 (dated: November 15, 2006).

[50] *Id*.

[51] City Report, p. 108.

POINT III

REPLY TO THE CPB COMMENTS

A. The STAR Program Should Not Be Implemented Right Away But Should Continue To Be Developed

In its Initial Comments, CPB suggests that the Commission should provide a "date by which the Company's operating regions must implement the STAR program."[52] The City cautions against establishing a hard deadline at this time. As stated in the Staff Report, STAR was primarily designed for application in radial systems.[53] To date, the STAR program has not been shown to be a proven tool for managing customer counts in an underground network system.[54]

In the Staff Report, Staff provides a table showing a comparison of predicted customers out of service between the STAR program and the Outage Management System and states that: "[a]lthough the [STAR] program did not produce the same number of metered customer outages as provided by the Company surveys, Staff believes its use would at least have identified the severity of metered customer outages much sooner than relying solely on customer calls."[55] While Staff's statement is generally accurate, it must be emphasized that on July 25, 2006, the STAR program had estimated customer outages at 4,036 while the Outage Management System was reporting no customers without service

[52] CPB Initial Comments, pp. 7-8.

[53] Staff Report, p. 25.

[54] *See id*.

[55] *Id.*, at 26.

(which in fact was the situation).[56] The STAR program also can show where the outage is occurring and how it might progress within a non-network system.

Given that this feature and the customer outage count in the STAR program have not been adequately tested for underground networks, it is recommended that additional testing be conducted before the program's widespread installation throughout the Company's network systems. An alternative approach to immediate implementation of the STAR program may be to require Con Edison to develop a thorough and mutually agreed upon test schedule and plan for the STAR program (or an entirely new alternative network system) in order to assess its capabilities and establish a realistic date for its system-wide implementation in network systems.

B. Increased Transparency Regarding The Implementation Of The Recommendations From This Proceeding Is Recommended

In its comments, CBP recognizes that the Staff Report states that Con Edison is to "provide a report on the status of the Company's compliance with individual recommendations" and that "[i]nterested parties should also be provided a copy of this information, as well as other status reports ordered by the Commission in this proceeding."[57] The City strongly supports CPB's position and would expand it to require that Con Edison's status reports be posted on either the Con Edison or Commission websites. Given the

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[56] *Id*.

[57] CPB Initial Comments, p. 5.

Company's failure to fully implement the recommendations arising from the Washington Heights event, the widest distribution of the status reports to active parties and the public will aid in ensuring that Con Edison is complying with the recommendations that follow from the Long Island City event. Moreover, increased ongoing participation by the active parties and the public in the implementation of these recommendations will provide additional transparency and assurances that the Company is complying with any recommendations ordered by the Commission.

POINT IV

THE ATTORNEY GENERAL'S RECOMMENDATION FOR THE SPLITTING OF ALL LARGE NETWORKS SHOULD BE REJECTED

In the Attorney General's Initial Comments, he recommends that "networks of large size or poor performance records . . . should be examined to determine whether to reduce the size . . ."[58] First, this statement mistakes the Con Edison jeopardy ranking system for a performance measure, which it is not. The jeopardy model creates a ranking of the Company's 57 networks based upon a probabilistic estimate of their relative probability of failure.[59] In actuality, the Long Island City network has performed more reliably than the system as a whole as measured by the System Average Interruption Frequency Index ("SAIFI") and Customer Average Interruption Duration Index ("CAIDI").[60]

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[58] Attorney General Initial Comments, p. 28.

[59] City Report, p. 97.

[60] City Report, p. 91; Staff Report, p. 17.

The Attorney General's further recommendation that all large networks be examined for reduction in size would create an entirely new basis for system reinforcement that is not currently included in rates. The City's recommendation to split the LIC network is based both on its size and the severe stress that it experienced during the 2006 event. The stress that the LIC network experienced during the multiple contingencies is the primary reason for the City's recommendation to split the network. While the City supports the splitting of large networks, such as Long Island City, where factual and engineering analyses support such a course of action, not all large networks would benefit from splitting. Moreover, network splitting may require the acquisition of new land and construction of new substations, the extension of new feeders to the network to be divided, and the installation of new sub-transmission feeders to supply the new substations. The cost of these major undertakings may not be justified by the improvements in reliability, if any, that might be realized.

CONCLUSION

For the reasons set forth in the City's Initial Comments, the City Report and herein, the Commission should review Con Edison's operating practices and procedures thoroughly and adopt the conclusions and recommendations set forth in the City Report to help to reduce the possibility that an event similar to the Long Island City power outages will occur again or, if it occurs, is responded to more effectively and promptly.

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Respectfully submitted,

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