CON EDISON'S JULY 1999 ELECTRIC SERVICE OUTAGES

A REPORT TO THE PEOPLE OF THE STATE OF NEW YORK

FROM THE

OFFICE OF THE ATTORNEY GENERAL

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EXECUTIVE SUMMARY

In the first week of July 1999, hundreds of thousands of people in New York City and Westchester County, all customers of the Consolidated Edison Company of New York, Inc. ("Con Edison"), lost their electric power during a heat wave. The most widespread blackout occurred in the Washington Heights-Inwood neighborhood north of 155th Street in Manhattan, where, on July 6, Con Edison shut down electric service for over eighteen hours.

Because of the extent of the problem and the depth of public concern, the New York State Attorney General initiated an inquiry to determine what happened, why, and what Con Edison must do to prevent a reoccurrence of such extensive and severe outages. During the course of its inquiry, the Attorney General's Telecommunications and Energy Bureau reviewed voluminous documents, conducted many interviews and on-site visits, and made numerous requests for information.

FINDINGS

Even though the peak electricity demand on Con Edison's system during the first week of July 1999, 11,850 megawatts, was higher than it had ever been in Con Edison's service territory, Con Edison always had sufficient electrical power available to it to meet the extraordinary demand. In fact, the peak demand was within two percentage points of the level Con Ed had forecast earlier in the year. The problems which arose in July 1999 were not caused by a failure either in the power supply or in the transmission of that power to Con Edison's distribution system.

Rather, the Washington Heights-Inwood blackout and the other outages were caused by failures of equipment within Con Edison's electricity distribution system. Con Edison's service

territory consists of numerous separate geographical areas, called load areas. Each area has its own distribution system, and the aggregate of these systems is referred to as Con Edison's distribution system. Equipment failures within the distribution system in any one load area do not affect the delivery of electric power to other areas and did not do so last summer. Thus, we found no evidence that Con Edison created or acquiesced in electric outages in any neighborhood in early July 1999 so as to be able to maintain service to other parts of its service territory.

We conclude that Con Edison entered the 1999 summer cooling season, the time of year when demand on the system is highest and the effects of heat on the system are most pronounced, with a distribution system containing numerous defective or inadequate components. When the weather got very hot in early July, the components that were susceptible to failure were unable to withstand the high temperatures to which they were subjected by the combination of the hot weather itself and the heat generated by the large volume of electric current demanded by customers. As a result, a large number of customers lost their electric power.

Distribution system equipment failures revealed themselves most starkly in the Washington Heights-Inwood load area, where they led to an extensive blackout. But the same types of failures also caused significant outages in other parts of Con Edison's distribution system. Indeed, our inquiry leads us to conclude that the weaknesses in the distribution system in Washington Heights-Inwood are not unique to that load area, but appear to be endemic to much of Con Edison's whole distribution system.

In particular, Con Edison's distribution system failed dramatically in early July 1999 because:

* In designing its distribution system, Con Edison did not take sufficient account of or seek to minimize the effects of heat on underground components of the

system, and did not adequately ensure that equipment was not placed too close together and was not otherwise exposed to excessive heat.

* In maintaining its distribution system, Con Edison did not take into account the fact that, as a result of three summers in a row in which the overall temperatures were not as hot as usual, there were a greater number of components with weakened ability to withstand heat in the system, and Con Edison did not take adequate steps to identify, repair and replace such components.

* In maintaining its distribution system, Con Edison did not have adequate means to identify components that would be susceptible to failing when heated to the levels their immediate environment would reach during a heat wave.

* In maintaining its distribution system, Con Edison did not undertake an effort to develop a means to identify components most likely to fail and to replace such components.

* In maintaining its distribution system in Manhattan, Con Edison failed to use its most recent 1998 data, when planning load relief for 1999, and as a result, failed to adjust more than one hundred portions of the system to eliminate load bottlenecks.

* In repairing its distribution system, at least in the Washington Heights-Inwood neighborhood, Con Edison took too long to restore a failed feeder cable at a time when the network serving that neighborhood was at serious risk of a blackout.

The Washington Heights-Inwood blackout, as well as the other outages experienced by Con Edison's customers, appear to be the result of these design and maintenance deficiencies. Con Edison has not sufficiently addressed the effect on its distribution system of high temperatures in equipment carrying high electricity loads in combination with the effect on equipment of sustained high ambient temperatures. These conditions can be expected to exist during the summer in Con Edison's service territory.

Based upon the information at hand, we are not able to conclude that the Washington Heights-Inwood network is unique or different from other Con Edison networks with regard to these deficiencies. The fact that design and maintenance problems endemic to Con Edison's

distribution system led to a total blackout of this network only heightens the urgency for Con Edison to address these problems in Washington Heights-Inwood and elsewhere in its service territory.

We also inquired into the adequacy of Con Edison's communications with its customers, governmental agencies, institutions and the general public during this time period. Criticisms were made after the events of early July 1999 that the company's efforts leading up to the Washington Heights-Inwood blackout to provide the public with necessary information were inadequate. We conclude that Con Edison should do more to ensure that adequate and timely information is provided to the affected public in the event of an imminent power emergency such as that experienced in early July 1999. We also inquired into the adequacy of the reimbursement Con Edison made to compensate its customers for the losses they suffered because of the electrical outages. We conclude that the tariff pursuant to which Con Edison compensates customers for losses suffered during outages is out of date and thus provides inadequate reimbursement limits. We also conclude that Con Edison's procedures for notifying customers of the opportunity for reimbursement and for processing applications should be improved.

RECOMMENDATIONS

The information we have obtained in the course of our inquiry leads us to make the following recommendations:

* Con Edison should fully implement its Action Plan dated January 15, 2000, which commits Con Edison to carry out sixteen specific efforts to improve the reliability of its distribution system.[1]

[1] The Action Plan is summarized in Appendix C.

* If Con Edison determines that any of the efforts proposed in its Action Plan cannot be accomplished promptly or are impractical, it should disclose such determination publicly and propose an alternative means to achieve the same goal.

* Con Edison should redesign its distribution system to ensure that underground components are not overcrowded into limited space, creating greater susceptibility to heat; to ensure that components are not otherwise subject to excessive heat; and to ensure that all portions of its system can carry the load to which they will be subject during a summer heat wave.

* Con Edison should develop a test to identify distribution equipment with impaired heat resistance. If Con Edison determines that a practical test is not readily achievable in the near future, it should state so publicly, and propose an alternative means to ensure that such defective equipment is identified and removed from its distribution system.

* Con Edison should determine whether splitting the Washington Heights-Inwood network into two independent networks would improve the reliability of service in that neighborhood, and should report publicly the reasons for its decision.

* Con Edison should ensure that equipment repairs are carried out as quickly as possible whenever there is any indication that a network or any appreciable number of customers are at risk of losing service.

* Con Edison should aggregate by network, in a readily retrievable form, its records on capital improvements and maintenance expenditures for the four years prior to 1999 and make them publicly available. Going forward, Con Edison should aggregate its records on capital improvements and maintenance expenditures by network in a readily retrievable form and make them publicly available on an annual basis.

* Con Edison should aggregate its data regarding the dispatch of work crews during early July 1999 by network, in a readily retrievable form, and make that information publicly available. Going forward, Con Edison should aggregate such records by network in an easily retrievable format so that the information is readily accessible.

* Con Edison should report periodically to the communities affected by last July's blackouts and other outages on its progress in implementing the Action Plan and its other efforts to ensure and improve service reliability.

* Con Edison should improve its policies and procedures for alerting and informing its customers, government, institutions and the public during actual outages and when there is a serious risk of an outage.

* Con Edison should amend the tariff it files with the New York State Public Service Commission to increase the amount of compensation a customer can receive for losses due to a power outage, expand the definition of "losses" for which compensation can be provided, and improve its policies and practices for submission of claims by customers who suffer losses attributable to a power outage.

* With such a tariff revision in mind, Con Edison should review customer compensation claims filed after the July 1999 outages and upwardly supplement its refunds to reflect a revised tariff's compensation levels and loss definition.

* The New York State Public Service Commission should review its distribution service quality standards for Con Edison to determine whether amending those standards would improve the reliability of Con Edison's electric service.

Every person, household, business, and institution that suffered through an outage during last July's heat wave, knows firsthand the discomfort and inconvenience it caused. When outages assumed large scale proportions, covering entire neighborhoods, and lasting for many hours or even days, the hardship only increased. The outages of early July 1999 underscore the fact that the loss of electricity can cause physical and emotional distress, create significant financial losses, especially for small businesses, and, when widespread, threaten the public safety and welfare. In the 21st century, the millions of residents of New York City and Westchester County depend upon electricity to light our streets; to power our homes, businesses, and hospitals; and to provide relief from oppressively hot weather. While some outages cannot be avoided, Con Edison must not run the risk of another major outage such as occurred last July. To do so is unacceptable. We urge Con Edison to heed the warning of the summer of 1999, and to ensure that this summer, everywhere in its service territory, the power stays on.

CON EDISON'S JULY 1999 ELECTRIC SERVICE OUTAGES

I. INTRODUCTION

A. The Con Edison Outages

Between July 3 and July 7, 1999, during a heat wave, a great many Con Edison[2] customers[3] in New York City and Westchester County lost electric power in a large number of outages[4] that were scattered as to time, place, duration, and number of customers affected. The most dramatic outage occurred in the Washington Heights-Inwood neighborhood, north of 155th Street in Manhattan, which was totally blacked out from 10:11 p.m. on Tuesday, July 6, 1999, until 5:05 p.m. on Wednesday, July 7, 1999,[5] as a result of the decision by Con Edison to shut off power. That shut-off put 68,888 Con Edison customers out of service (representing over 200,000

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[2] Consolidated Edison Company of New York, Inc. ("Con Edison") is the largest supplier of retail electric service in New York and one of the largest in the United States. Under Section 65 of New York's Public Service Law, Con Edison is obligated to provide "safe and adequate" service at "just and reasonable" rates. The New York State Public Service Commission is charged by law with the responsibility to oversee Con Edison's operations and to determine its rates. With minor exceptions, Con Edison has the sole right to distribute retail electric power in New York City and Westchester County, New York. Con Edison also provides gas and steam service in portions of New York City and Westchester County.

[3] In 1998, the latest year for which there is complete data, Con Edison served an average of 3,030,746 retail electric customers, including 2,622,074 (86.5%) residential customers, 404,016 (13.3%) commercial customers and 4,656 (0.2%) industrial, government or other service customers. *Annual Report of Consolidated Edison Company of New York, Inc. for the Period Ending December 31, 1998 to the State of New York Public Service Commission*, pp. 304-304A. ("Customer" means a metered service account that could supply an individual household, containing one to many persons in it, or could supply an entire apartment building, institution or office complex used by thousands.)

[4] An "outage" refers to a discrete loss of electrical power to customers. An outage could affect one customer or thousands of customers.

[5] Con Edison, Response to Attorney General Information Request ("AG IR") dated July 19, 1999.

people and several health care facilities and other large institutions, including the Columbia Presbyterian Hospital complex, the Columbia University Nursing Home, the New York Psychiatric Hospital, the Isabelle Nursing Home, and Yeshiva University).[6] The Washington Heights-Inwood blackout also affected subway service in northern Manhattan.[7] The Washington Heights-Inwood blackout was the most extensive blackout in New York City or Westchester County since July 1977, when Con Edison lost power overnight in its entire service territory.

In addition to the extensive loss of power in Washington Heights-Inwood, there were concentrations of power outages in the East Village and Lower East Side of Manhattan, in Long Island City in Queens, and in Williamsburg in Brooklyn, during the same period, as well as scattered outages throughout the City.[8] On the Lower East Side more than 800 buildings lost power and a Metropolitan Transit Authority electric substation supplying the subways caught fire and went out of service.

During the same period, almost 49,000 homes and businesses in Westchester County (in Cortlandt, Greenburgh, Harrison, Mamaroneck, Mount Vernon, New Castle, New Rochelle, Rye, Scarsdale, White Plains, and Yonkers) lost their electric service. The Westchester County

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[6] Con Edison, Response to AG IR No. 141.

[7] The blackout caused signal failures, deprived stations of lighting, elevators and escalators, and affected the power capacity of the third rail, thereby disrupting subway service on the A, C, 1 and 9 lines. Testimony of Barbara Spencer, Executive Vice President, MTA, New York City Transit Authority, *Public Hearing: New York City Power Black-out of July 6 and 7, 1999*, New York State Assembly Speaker Sheldon Silver, Assembly Standing Committee on Energy, Assembly Standing Committee on Corporations, Authorities and Commissions, Assembly Standing Committee on Ways and Means, and Assembly Member Adriano Espaillat, New York, New York, July 15, 1999 ("*Assembly Hearing*"), tr. p. 263.

[8] Con Edison, September 3, 1999 Response to AG July 28, 1999 and August 10, 1999 IRs.

outages were scattered geographically and varied in duration, but many of them lasted 24 hours or longer.

The sheer number of outages in New York City and Westchester County during the first ten days of July 1999 was extraordinary compared with the same ten day period in July 1998, as shown by the following table:

Comparison of Customer Outages

July 1-10, 1998 and 1999[9]

	1999	**1998**
Bronx	1,838	61
Brooklyn	5,223	826
Manhattan	70,371	72
Queens	30,327	80
Staten Island	14,343	2,685
Westchester	48,919	5,428
Total	170,993	9,152

The unusually large number of Con Edison customers losing electric power in July 1999 occurred during a heat wave which peaked during and after the Fourth of July holiday weekend. From Sunday, July 4 through Wednesday, July 7, daily temperatures in New York City and

[9] Con Edison, Response to AG IR No. 132.

Westchester County hit the 90's and low 100's and were accompanied by high humidity.[10] In the days immediately before and after the heat wave peak, the daily high temperatures were in the 80's, with the same high humidity. Under these conditions Con Edison customers, both residential and business, relied upon electric-powered air conditioning and fans to counter the heat. Electric demand in Con Edison's service territory, which is greatest during the summer, reached an all-time peak of 11,850 megawatts[11] at 1:00 p.m. on Tuesday, July 6, 1999.[12]

After power was restored, many of Con Edison's residential, institutional, commercial and small business customers found that food and medicine had spoiled because refrigerators and freezers had been out of service for extended periods. Columbia Presbyterian Medical Center reported that numerous scientific and medical experiments that were dependent on refrigeration were lost. Con Edison customers also reported damage to electrical equipment, such as air conditioners, computers, televisions, VCRs, refrigerators and freezers, damage customers attributed to low voltage or power surges during the heat wave.[13]

There was an intense public outcry following the July 6 blackout in Washington Heights-Inwood and the numerous Con Edison outages elsewhere in early July. Individual citizens and public officials expressed grave concern as to why the blackout and other outages had occurred,

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[10] U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center: Monthly Local Climatological Data, Central Park Observatory, July 1999.

[11] A "watt" is a measure of electric power. A "megawatt" is a million watts.

[12] Con Edison, Press Release, "Con Edison Projects Record Demand for Power This Summer; Increased Electric Use Driven by Healthy Economy," June 6, 1999.

[13] *Assembly Hearing*, pp. 290, 292.

how Con Edison had responded, how customer losses would be compensated, and what could be done to prevent another blackout. [14]

B. Attorney General's Inquiry

Because of the magnitude of the Washington Heights-Inwood blackout and the extensiveness of the other Con Edison outages, the Attorney General immediately opened an inquiry. The Attorney General's inquiry focused on the following concerns:

* What caused the Washington Heights-Inwood blackout and other Con Edison power outages?

* What did Con Edison do, or fail to do, that contributed to creating the outages?

* Did the July 6, 1999 Washington Heights-Inwood blackout result from different treatment of that neighborhood as compared to the rest of Con Edison's system?

* What has Con Edison done since July, 1999 to reduce the likelihood of such outages in the future?

* Should Con Edison improve its emergency response and its ability to communicate with its customers, affected institutions, government and the public in the event of another power service crisis?

* Should Con Edison increase the amount of customer compensation for power outages and improve the process for claiming compensation?

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[14] The New York State Assembly and the New York City Council held hearings. The New York State Public Service Commission ("PSC") opened an inquiry, and Con Edison itself commissioned two reports on the outages of early July 1999, an internal review and a review by a panel of outside experts. Some affected parties, including the City of New York, the New York City Housing Authority, the New York City Board of Education, the Town of Harrison and various individuals in a class action filed lawsuits seeking recovery for damages and other relief. The United States Department of Energy looked at last summer's energy problems throughout the country, including the Con Edison outages.

In order to answer these questions, the Attorney General's Telecommunications and Energy Bureau sought, and received from Con Edison, scores of documents relating to the blackouts in early July 1999 and to the design, maintenance and operation of the company's electricity distribution system. The office also reviewed transcripts of New York State and New York City legislative hearings[15] and of New York State Public Service Commission ("PSC") public statement hearings,[16] an interim report of the United States Department of Energy,[17] and numerous other documents. Appendix A to this report lists documents we reviewed during the course of our inquiry and found relevant. The list includes both documents in the public domain and others Con Edison prepared to comply with our specific requests.

In addition, members of the Attorney General's staff made on-site visits to Con Edison's Energy Control Center, Manhattan Control Center and the Sherman Creek Substation (involved in the July 6, 1999 blackout that put the entire Washington Heights-Inwood neighborhood out of

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[15] Transcript, Assembly Hearing. Transcript, *Public Hearing,, Committee on Consumer Affairs*, City Counsel, City of New York, New York, New York, July 14, 1999 ("*City Counsel Hearing*").

[16] Public Statement Hearings, PSC Case No. 99-E-0930, "Consolidated Edison Electric Service Interruptions," held August 31, September 1 & 2, in Manhattan, and October 12 & 13, 1999, in Queens and Westchester County.

[17] *Interim Report of the U.S. Department of Energy's Power Outage Study Team*, United States Department of Energy (January 2000) ("*DOE Report*"). The Department of Energy's report covers electric power problems in the summer of 1999 throughout the United States and in addition to electric power outages, raises issues concerning potential electric power generation and transmission problems. For Con Edison, the report addresses (at pages 1-9 through 1-13) only what happened on July 6 and 7, 1999 and makes but 3 findings: (1) existing distribution cable testing methods do not identify the equipment problems Con Edison experienced and may contribute to them; (2) Con Edison had no means of determining in real time what was happening to its distribution system; and (3) the conditions in which Con Edison's underground distribution equipment operates contributed to the company's distribution equipment failures.

service for almost 19 hours), and attended physical examinations and dissections of failed equipment conducted by Con Edison's independent consultants. The office also communicated several times with the staff of the PSC.

Finally, this office also reviewed Con Edison's own internal report,[18] and the outside report it commissioned,[19] on the early July power outages, as well as its Action Plan formulated in response to address the conclusions and recommendations in both reports.[20] We interviewed one of the three experts who prepared the outside report, along with members of the committee that prepared the internal report.[21] This office interviewed numerous Con Edison technical and managerial staff responsible for planning, designing, constructing, maintaining and operating the company's electrical systems.

The CRC Report describes Con Edison's systems, sets out a narrative of the technical events in the Washington Heights-Inwood network from Sunday, July 4, 1999 through the network blackout on the evening of Tuesday, July 6,1999, makes an analysis of the blackout, and states conclusions and recommendations applicable to Con Edison's entire system. The IRB

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[18] *The Washington Heights Network Shutdown July 6, 1999, Report By The Corporate Review Committee* (December 10, 1999) ("*CRC Report*"). A summary of the CRC Report can be found in Appendix B.

[19] *Washington Heights Network Shutdown Of July 1999, Independent Review Board Report* (December 10, 1999) ("*IRB Report*"). A summary of the IRB Report can be found in Appendix B.

[20] *Con Edison Action Plan for Washington Heights Network Shutdown Reports* (January 15, 2000) ("*Action Plan*"). A summary of the Action Plan is set forth in Appendix C.

[21] The member of the IRB interviewed was Lionel O. Barthold, Chairman and Principal Consultant, Power Technologies, Schenectady, New York, January 25, 2000. CRC members Peter Zarakas and Charles Durkin also participated in this interview.

Report addresses technical problems the authors found throughout Con Edison's distribution system. The company's Action Plan proposes to carry out sixteen efforts responsive to the CRC and IRB recommendations.

This office examined events preceding, during, and following the Washington Heights-Inwood blackout, as well as the other Con Edison outages occurring during early July 1999. Every outage, even if it affected a single household, inflicted inconvenience and discomfort. Because of the scope and duration of the Washington Heights-Inwood blackout and because the problems uncovered there were relevant to an analysis of the outages elsewhere, this report concentrates primarily on the Washington Heights-Inwood blackout.

II. CON EDISON'S ELECTRICITY DELIVERY SYSTEM

To analyze the July 1999 Con Edison outages requires knowledge about how Con Edison provides electricity to its customers.[22] There are three basic physical components of the electricity delivery system : (1) electric supply; (2) transmission; and (3) distribution. The electric supply refers to the electrical power a retail utility like Con Edison obtains from power generating plants. The transmission system encompasses the movement of the electricity over transmission wires at very high voltages[23] from the sources of its generation to points

[22] Con Edison supplied its retail customers 36,374 million kilowatt-hours of electricity in 1998, as follows, 11,283 million kilowatt-hours (31.0%) to residential customers, 23,566 million kilowatt-hours (64.8%) to commercial customers and 11,525 million kilowatt-hours (4.2%) to other types of customers. *See "Financial Statistics of the Major Investor-Owned Utilities in New York State: Electric - Gas - Telecommunications - Water - Cable 1998*," New York State Department of Public Service (1999). A "kilowatt-hour" is a measurement of the quantity of electricity used.

[23] "Voltage" is a measurement of the strength of an electric current.

(transformers in substations) at which it is stepped down to lower voltages for distribution to retail customers. The distribution system includes the substation transformers at which the very high voltage is stepped down, the cables and wires which carry the electrical current to the customer, and the transformers along the way which step down the current even further to the 120/240 volts that most retail customers use.[24]

A. Electric Power Supply

Con Edison generates some of its own electricity and buys the rest from many sources, some as far away as Canada.[25] Last summer Con Edison was able to obtain all the electric power it needed. Con Edison forecast that on the hottest day of 1999 it would need 11,650 megawatts to supply its customers.[26] Con Edison was required by the New York Power Pool[27] to

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[24] Appendix D is a schematic representation of the flow of electricity from the point of generation to the point of customer use.

[25] For example, in 1998 (the latest period for which there is completely reported data) Con Edison purchased 3,604 megawatt-hours of electricity from Ontario Hydro. *Annual Report of Consolidated Edison Company Of New York, Inc. For The Year Ending December 31, 1998 To The State Of New York Public Service Commission*, pp. 326-A - 327-A. Con Edison can import power from far away through a special transmission system shared by all electric utilities and devoted to moving electric power at very high voltages from one utility to another. Con Edison used to own numerous power generating plants but has sold all of them except its Indian Point 3 nuclear plant and its interest in a conventionally-fueled plant located outside of its service territory.

[26] Con Edison, Press Release, "Con Edison Projects Record Demand for Power This Summer; Increased Electric Use Driven by Healthy Economy," June 6, 1999.

[27] In 1999, as in previous years, Con Edison was required to report its expected summer peak demand to the New York Power Pool ("NYPP") in time for the NYPP to report the expected summer peak in New York State to the Federal Energy Regulatory Commission by February 15. *Con Edison, February 9, 2000 e-mail, Response to AG IR.*. The NYPP dispatched power throughout New York and managed the interconnection of the New York inter-utility high-voltage bulk power transmission system with neighboring systems. These functions were transferred on December 1, 1999 to the New York Independent Service Operator ("NYISO").

maintain an 18% reserve margin above what it expected to need. Con Edison thus contracted for and otherwise arranged to have 13,747 megawatts available to its system at the time of peak demand. Demand on Con Edison actually peaked at 11,850 megawatts during the afternoon of July 6, 1999.[28] This was 1.7% above the company's forecast but well within the power supply it had available.[29] Thus, the blackouts and outages were not the result of a lack of power supply to Con Edison's system.

B. Transmission

Transmission lines carry electricity at very high voltage, often over long distances, from generating plants and other electricity sources to substations that convert the power into voltages that are lower but still well above household current strength and send the adjusted current along to the distribution system.[30]

The NYPP went out of existence upon its transfer of control of the transmission system to the NYISO.

[28] *CRC Report*, p. 2-25.

[29] At 1:23 p.m. on Tuesday, July 6, 1999, Con Edison instituted a 5% voltage reduction throughout it service area, at the request of the NYPP, which was concerned about maintaining state-wide electric power reserves. This voltage reduction had no effect on Con Edison's access to electric power supplies. *See, e.g., CRC Report*, p. 2-34. Con Edison ended the NYPP-requested voltage reduction at 6:16 p.m., July 6, 1999.

[30] Con Edison's transmission voltages are at 69 kilovolts, 138 kilovolts, and 345 kilovolts. *CRC Report*, p. 1-1. A "kilovolt" is a thousand volts.

Con Edison owns and maintains the transmission lines located within its own service territory but, to the extent the company buys power from other sources, it relies on transmission lines owned by others to transmit that purchased power to Con Edison's transmission system.[31]

Transmission lines used by other companies to deliver bulk power to Con Edison and Con Edison's own transmission lines functioned adequately last summer, and there is no evidence that Con Edison's ability to bring in power from outside its service territory or its ability to move power within its service territory to its substations was hampered.

C. Distribution

The distribution system starts at the substation where the high-voltage power delivered by a transmission line is stepped down to a lower voltage.[32] Feeder cables, sometimes referred to simply as "feeders," connect to one or more distribution transformers, which make the final reduction to the 120/240 volt electricity used in homes, institutions and small businesses.[33] Distribution wires then connect to retail customers' actual electric meters. There are several different ways in which substations, feeder cables, distribution transformers and distribution wires are connected to each other.[34]

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[31] Con Edison has 4,700 miles of transmission cables in its service territory. Con Edison, *New York State Attorney General Briefing Book, November 19th, 1999,* ("*Briefing Book*") Tab B.

[32] The voltage is reduced to 27 kilovolts in Brooklyn and Queens, 33 kilovolts and 13 kilovolts in Staten Island, and 13 kilovolts in Manhattan, the Bronx, and Westchester. *CRC Report*, p. 1-1.

[33] Con Edison has approximately 70,000 distribution transformers. *Briefing Book,* Tab B.

[34] Con Edison's feeder cables should not be thought of as continuous wires. In almost all instances a feeder cable is made up of many different segments spliced together at manholes. Nor are the cable segments or the splices uniform. A feeder cable can be, and usually is, made

Our inquiry soon established that failures in Con Edison's distribution system were the immediate cause of the blackout and other outages.

III. THE DESIGN OF CON EDISON'S ELECTRIC DISTRIBUTION SYSTEM

A. Load Areas

The basic unit of electrical distribution organization is the "load area," which is a geographic area receiving electrical power through a distribution system supplied by one substation. "Load" in this context refers to the amount of electric power, expressed in watts, used by the customers in a geographical area.

Con Edison's load areas are independent of each other. If problems occur in the distribution system within one load area, the problems will not "cascade" into other load areas, that is, they will not spread to other load areas, overload those areas, or create system-wide power outages.

Con Edison's load areas are of two basic types, "radial" and "network."[35]

B. Radial Load Areas

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up of several types of cable and several types of splices installed or replaced at many different times.

[35] "Radial" and "network" load areas can each be modified to incorporate features of the other type, and often are. Appendix E is a simplified diagram showing the configuration of a radial load area and a network load area.

Con Edison serves 800,000 of its customers (27%) through radial load areas,[36] most of which are in Westchester County and on Staten Island.[37] Westchester has 12 radial load areas[38] and Staten Island has five radial load areas.[39] In its simplest form a radial load area distributes power from a substation through one or more feeder cables to which distribution transformers are attached. If a radial feeder cable suffers a fault between the substation and a distribution transformer, such as a break in the cable caused by a falling tree, the distribution transformer loses contact with the substation and the customers who get their power from that distribution transformer suffer an outage.

A radial load area usually has many feeder cables, each with its own set of distribution transformers. Each feeder cable-distribution transformer set delivers electricity to a specific group of customers. Thus, within a radial load area, customers on one side of a street may lose power while customers on the other side of the street do not, because they are served by different feeder cables.

C. Network Load Areas

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[36] Con Edison, *Annual Report on 1998 Electric Service and Power Quality,* (March 31, 1999), p. 1-3.

[37] *Id., passim.*

33 Con Edison, Response to AG IR No. 25(a).

[39] Con Edison, *Annual Report on 1998 Service and Power Quality,* (March 31, 1999), p. 8-4.

Con Edison serves all of Manhattan, and most of Brooklyn, Queens and the Bronx through 55 networks.[40] In fact, Con Edison has half of the electric distribution networks in the world.[41]

In a network load area, each feeder cable delivers power to several distribution transformers that, in turn, supply retail voltage current to a grid of distribution wiring to which customers' meters are connected. If one transformer or feeder cable fails, other feeders and transformers still connect the grid to the substation and the power continues to flow.

However, networks are not infinitely resilient. Multiple breaks in the network distribution system can overly stress the remaining parts. Con Edison indicates that it has designed its networks so that any two feeder cables supplying power to a network can fail without substantial risk of losing electric service to any of its customers. Con Edison refers to this as a "second contingency" design.

Con Edison's network load areas are significantly more reliable than radial load areas.[42] However, if a situation occurs in which more than two feeder cables are out at the same time, the reliability of the network begins to be at risk. Moreover, despite the overall reliability of networks, customers can lose service without an entire network's failing. If a section of the grid that connects feeder cables to customer meters fails because of deteriorated insulation or any

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[40] Appendix F is a map showing Con Edison's networks in New York City, which exist in all boroughs except Staten Island.

[41] *DOE Report*, p. 1-9.

[42] For 1998, the latest year for which complete data has been reported, Con Edison reported that about 4 customers out of every thousand served by networks lost electric service, while the rate for customers served by radials was approximately 451 per thousand. Con Edison, *Annual Report On 1998 Electric Service And Power Quality* (March 31, 1999), p. 1-5.

other reason, that section will automatically break its connection with the rest of the grid and the customers who are connected to that section will lose their electric service.

D. Underground Distribution

In addition to having a large proportion of networks in its distribution system, Con Edison is unique among New York electric utilities in having much of its distribution system underground. Out of a total of 122,400 miles of distribution cable in its entire system, 90,000 miles of it is underground.[43] One major reason Con Edison placed so much of its distribution system underground is the density of customers in much of its service territory.[44]

Con Edison's distribution system is almost entirely underground in Manhattan and predominantly underground in the Bronx, Brooklyn and Queens. In Staten Island and Westchester County, most of the company's distribution system is above ground.[45] The advantage of undergrounding is that buried cables, transformers, wiring and other equipment are less vulnerable to certain acute kinds of damage, such as a tree falling on an overhead cable, or a lightning strike. The disadvantages of undergrounding are that the equipment is more vulnerable to shorting out due to the cumulative effect over time of moisture, corrosion from sources such as road salt seepage, accidental breakage during excavations and, especially, overheating. When an underground distribution component fails, damage tends to be more difficult to locate and

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[43] *Briefing Book*, Tab B.

[44] As early as 1884, the New York State Legislature required that "telegraph, telephonic and electric light wires and cables...be placed under the streets, lanes and avenues" of New York City. (Laws of 1884, Chapter 534, Section 1.)

[45] Con Edison, *Annual Report On 1998 Electric Service And Power Quality* (March 31, 1999), *passim*.

repair.[46] For these reasons, an underground distribution system needs to be carefully designed to minimize the possibility of heat stress and other damage.

IV. THE JULY 6, 1999 WASHINGTON HEIGHTS-INWOOD BLACKOUT

In early July, 1999, in New York City and Westchester County, the temperature reached 86˚ Fahrenheit on Friday, July 2; 87˚ on Saturday, July 3; and 96˚ on Sunday, July 4. The temperature peaked at 101˚ on both Monday July 5 and Tuesday, July 6. It dropped to 93˚ on Wednesday, July 7, and to 87˚ on Thursday, July 8.

During this time period, daily peak loads for electricity usage in the Washington Heights-Inwood network were as follows:[47]

Day	Daily Peak Load (Megawatts)
July 2	144
July 3	137
July 4	141
July 5	156[48]

[46] Interview with CRC, January 25, 2000.

[47] Con Edison, Response to AG IR No. 25a.

[48] The maximum load on the Washington Heights-Inwood network occurred on Monday, July 5, 1999 at 10:00 a.m. at 156 megawatts. *Ibid.* However, it is likely that the load would have been at least equally high on Tuesday, July 6, but for the fact that the northern part of the network

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Con Edison designed the Washington Heights-Inwood network to carry a load of up to 277 megawatts of electricity.[49]

A. The Sequence of Events Leading to the Blackout

The Washington Heights-Inwood network serves Manhattan north of 155th Street. The events leading up to the Washington Heights-Inwood blackout began with two feeder cable failures on June 30, 1999. Between June 30, and the blackout on July 6, eleven of the fourteen feeder cables that supply this network went out of service a total of fifteen times.[50]

As with all its other networks, Con Edison designed the Washington Heights-Inwood network to operate without any disruption of power to customers when as many as two feeder cables fail.[51] For most of the time between July 2 and July 6, two or more feeder cables were not

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experienced outages starting just before 2:00 a.m. that day. (Con Edison, February 8, 2000 Response to AG IR.) The Washington Heights-Inwood network load peak on July 6 was 137 megawatts at 2:00 a.m. On July 5, it was also 137 megawatts, at 10:00 a.m., but went up to 156 megawatts by 10:00 p.m. (Con Edison, Response to AG IR No. 25a.) On both days, the temperature reached 101˚.

[49] Con Edison, Response to AG IR No. 3a.

[50] Con Edison, to AG IR dated July 17, 1999.

[51] Con Edison uses the term "contingency" to identify the number of feeder cables out of service in a given network at a given time. Thus, a "second contingency" means that a network has two feeder cables out of service. As noted earlier, Con Edison's networks are designed to operate with one or two feeders out of service, but are not designed to operate fully with more than two cables out of service.

working in the Washington Heights-Inwood network. Until July 6, Con Edison was nonetheless able to keep the network running without any customer power outages.[52]

Electric power outages began in Inwood, the northern part of the neighborhood, just before 2:00 a.m. on Tuesday, July 6. Three hundred customers on Park Terrace West between West 217th Street and West 218th Street lost power following a fire in a Con Edison manhole on West 218th Street.[53] The New York City Police Department reported this fire to Con Edison at 1:55 a.m. that morning. According to Con Edison, the fire, which occurred in the distribution grid wiring that connects distribution transformers to customers' meters, caused a breakdown of power delivery to a specific limited area within Inwood.[54] Additional distribution grid wiring failed shortly after 6:14 a.m., and this outage spread to West 215th Street.

At 5:53 a.m., July 6, feeder cable 1M04 failed.[55] This put a total of four feeder cables out of service in the Washington Heights-Inwood network, out of a total of fourteen.[56] The northern part of the network, in Inwood, was left with only two feeder cables supplying power directly to that section.[57] At 6:14 a.m., Con Edison reduced the voltage in the entire Washington

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[52] *CRC Report*, p.2-42. The CRC provides a narrative account of what feeders went down when and what Con Edison did to repair them during this time

[53] Con Edison, Response to AG IR No. 141.

[54] Con Edison, February 8, 2000 Response to AG IR.

[55] *CRC Report*, p. 2-21. Con Edison assigns each feeder cable a unique alphanumeric code number. For networks the code number for a feeder begins with a number identifying the network the feeder is part of and a letter identifying the borough in which the network is located. Con Edison has designated the Washington Heights-Inwood network as network number one ("1") in Manhattan ("M").

[56] The failed feeder cables were: 1M01, 1M04, 1M06, and 1M11.

[57] *CRC Report*, p. 2-23. The two remaining cables were 1M03 and 1M05.

Heights-Inwood network by 8%.[58] This reduction was aimed at lowering the amount of current the remaining ten operating network feeder cables had to carry.[59] The Washington Heights-Inwood network remained at an 8% voltage reduction until Con Edison shut it down at 10:11 p.m. that night. (At 1:23 p.m. on July 6, Con Edison imposed a 5% voltage reduction across its entire service territory, at the request of the New York Power Pool.[60])

At 8:30 a.m., Con Edison began issuing appeals to the general public to reduce electricity use in the Washington Heights-Inwood neighborhood and asked six large customers in Washington Heights-Inwood[61] to reduce their electricity use voluntarily.

At 10:40 a.m., about 15,000 additional Con Edison customers in Inwood lost electric service as additional distribution wiring failed and disconnected from the network. Other customers began experiencing lower voltage because the remaining distribution wiring had difficulty carrying the additional amount of electricity it was being asked to carry.[62]

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[58] *CRC Report*, p. 2-24.

[59] Although in actual operation the relationship between the voltage of a distribution system and the amount of electricity that is flowing through the system is highly complex, in general lowering the voltage of the Washington Heights-Inwood network by 8% reduced the amount of current flowing over the network's feeders by 1.4%. *CRC Report*, p. 2-24.

[60] Con Edison Response to AG IR dated July 19,1999.

[61] Bell Atlantic, Columbia University Nursing Home, George Washington Bridge Apartments, Isabella Nursing Home, New York Psychiatric Hospital and Yeshiva University. *CRC Report*, p. 2-25.

[62] Voltage in this part of the Washington Heights-Inwood network dropped significantly when the last two feeder cables connected directly to this part of the network failed. *Id.*, pp. 2-27 through 2-31. Low voltage places additional stress on a distribution grid because electric motors in appliances such as air conditioners and refrigerators attempt to maintain the constant speeds that they are designed to work at and can do this only by placing a higher demand for amperage on the distribution system to make up for the loss in voltage. Increasing amperage tends to

By 9:50 p.m. on July 6, seven feeder cables were out of service in the Washington Heights-Inwood network; that is, half the number of feeder cables serving the network were not functioning.[63] This is an extraordinarily high number of cables to be out of service at the same time, especially considering that the network is designed to continue in operation without power outages only when up to two feeder cables are out at the same time. Nonetheless, except for the earlier outages in the Inwood section, the network continued to provide power.

Con Edison returned two of the failed feeders, 1M04 and 1M06, to service at 10:04 p.m.[64] However, just sixteen seconds after it was put back in service, feeder cable 1M06 had a short circuit in the equipment connecting the feeder to the substation and failed. (Con Edison identified the component that failed as a "through bushing.")[65] The short circuit that knocked out feeder cable 1M06 also started a fire in the substation section housing the connectors to 1M06 and three other feeders, one of which, feeder cable 1M14, was still active and providing power to Washington Heights-Inwood.

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increase the amount of heat a current flow generates. The increased heat can burn out a motor as well as the distribution grid. *See,* e.g., *Discussion and chronology of the outage affecting the Inwood neighborhood of the Washington Heights network; City Counsel Hearing*, p. 228.

[63] These failed feeder cables were 1M01, 1M03, 1M04, 1M05, 1M06, 1M07, and 1M18. *CRC Report*, p. 2-39.

[64] *Id.*, p. 2-42.

[65] *Ibid.*, p. 2-42.

Three minutes after feeder cable 1M06 shorted out, another Washington Heights-Inwood feeder, 1M02, failed.[66] The failure of feeder cable 1M02 meant that, once again, seven feeder cables were out in the network.

In response to the fire caused by the short in feeder cable 1M06**,** Con Edison isolated the substation section in which the fire was located and turned off power to all the feeder cable connectors in it at 10:09 p.m.[67] Con Edison indicates that the fire was an imminent danger to the substation and anyone there, and that the actions taken were required by standing company operating instructions.[68] Shutting off power to the section that housed feeder cable 1M06's connection to the substation also shut down feeder 1M14. The loss of these three feeder cables, 1M02, 1M06, and 1M14, in the space of less than five minutes put the Washington Heights-Inwood network into an eighth contingency at 10:09 p.m. on Tuesday, July 6, 1999.[69]

Thus, as of 10:09 p.m., only six out of the Washington Height-Inwood network's fourteen feeder cables were operating, trying to supply power to almost the entire network (except for the parts of Inwood that had been out since that morning). Con Edison feared that six cables could not handle the whole network's load, and that serious damage would quickly be done to the remaining functioning cables, causing additional damage to electrical equipment and eventually forcing the whole network to go down. If the whole network went down because the remaining

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[66] *Id.*, p. 2-45.

[67] *Id.*, p. 2-47.

[68] *Ibid.*, p. 2-47. Con Edison identifies the standing instructions as its General Instructions Governing Work on System Electrical Equipment, Section 6.2-1a.

[69] *Ibid.*, p. 2-47.

cables failed, Con Ed believed it would significantly increase the amount of time needed to return the network to operation. The lesser of two evils, Con Edison believed, was to shut down the whole network at once.[70] Therefore, at 10:11 p.m., Tuesday, July 6, 1999, Con Edison shut down the remaining feeder cables still providing electricity to the neighborhood, knowing that, as a result, all of Washington Heights-Inwood would go dark.[71] At 10:11 p.m., the entire neighborhood in Manhattan north of 155th Street was blacked out. Power was not restored to any part of the network until 5:05 p.m., July 7,[72] and some customers continued to be without power until 5:00 p.m., July 9.[73]

B. Feeder Cable Failures

To determine how the Washington Heights-Inwood network descended into blackout on the evening of Tuesday, July 6, we examined the detailed descriptions Con Edison provided for the thirteen feeder cable failures in that network over the four days immediately prior to and on the day of the blackout. With two exceptions,[74] each of these feeders failed when a component

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[70] *See, e.g., City Counsel Hearing,* pp. 34-36, Testimony of Eugene McGrath, Chairman and Chief Executive Officer ("CEO"), Con Edison.

[71] The actual shutdown was effectuated in Con Edison's central control center for its entire service territory. *CRC Report,* p. 2-49.

[72] Con Edison, Response to AG IR dated July 19, 1999.

[73] Con Edison, Response to AG IR No. 114.

[74] One exception is the last feeder failure (no. 13; 1M14) just before Con Edison shut down the Washington Heights-Inwood network. Con Edison intentionally shut down 1M14 to remove the risk that a fire in the building where 1M14 was connected to the Sherman Creek Substation would cause a short in 1M14 and possibly injure personnel in the substation or do further damage to the Washington Heights-Inwood network; the other was the protective relay that caused 1M05 (no. 8) to fail. *CRC Report*, pp. 2-47, 2-28.

suffered a short circuit in which the current in the cable or in the component overcame insulating material and caused a surge of electricity to flow to a "ground" (as electricity always seeks to do). The result of the short circuit was that the feeder cable or other distribution equipment burned and broke, thus causing the feeder to lose contact with the network and rendering it unable to carry current to distribution transformers for ultimate delivery to customers. Set out below is a synopsis of these feeder cable failures and their causes in chronological order:[75]

1. Feeder cable 1M06
   Friday, July 2, 1999, 9:30 a.m.
   Failure due to heat exposure
   after mechanical damage to the lead sheath
   covering paper insulated cable;

2. Feeder cable 1M04
   Saturday, July 3, 1999, 2:13 a.m.
   Failed due to heat at disturbed tape spacing
   on paper insulated cable in a cable splice;

3. Feeder cable 1M09
   Monday, July 5, 1999, 8:49 a.m.
   Failed from heat at point where metal fatigue in the
   lead sheath exposed cable to the environment in a manhole;

4. Feeder cable 1M11
   Monday, July 5, 1999, 10:23 p.m.
   Transformer short circuited while operating within design
   limits; Con Edison originally described cause of failure merely
   as 'independent" but later indicated concern that failure may
   have been due to technical flaw overlooked when the transformer

[75] *Id.*, pp. 2-1 through 2-49.

was refurbished;[76]

5. Feeder cable 1M01
Monday, July 5, 1999, 10:59 p.m.
Manufacturer's defect in cable splice allowed
water to enter a cable and reduced the cable's
ability to withstand heat;

6. Feeder cable 1M04 fails again after being restored to service
Tuesday, July 6, 1999, 5:53 a.m.
Transformer short circuit due to water entering
through a hole caused by corrosion;

7. Feeder cable 1M03
Tuesday, July 6, 1999, 10:29 a.m.
Power flow overloaded paper insulated cable section;
ascribed to use of 1997 load data when
designing modification for this cable section;

8. Feeder cable 1M05
Tuesday, July 6, 1999, 10:29 a.m.
Failure of network protector relay to disengage
faulted feeder cable 1M03 (*see* failure no. 7 *supra*)
From contact with this feeder;

9. Feeder cable 1M18
Tuesday, July 6, 1999, 7:20 p.m.
Failure due to heat at cable joint splice where
insulation was weakened by water intrusion;

10. Feeder cable 1M07;
Tuesday, July 6, 1999, 9:50 p.m.:
Failure due to heat at point where paper cable insulation
was exposed to water following mechanical damage
to the lead sheath covering the cable;

11. Feeder cable 1M06 fails again as it is being returned to service;
Tuesday, July 6, 1999, 10:04 p.m.:
Short circuit and fire caused by
loose connections in through-bushing at substation.

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[76] *Cf. Id.*, p. 4-11 (Recommendation 18 - Refurbished Transformers).

12. Feeder cable 1M02
Tuesday, July 6, 1999, 10:07 p.m.
Failure due to solder in cable splice melted by heat;

13. Feeder cable 1M14
Tuesday, July 6, 1999, 10:08 p.m.
Following fire resulting from failure no. 11,
Con Edison shuts down feeder manually to reduce
danger to personnel and to avoid further damage
to the Washington Heights-Inwood network.[77]

1. Feeder Cable Failures Attributable To Heat

What is most striking about the Washington Heights-Inwood network feeder cable failures is that eight out of the thirteen failures (failure nos.1, 2, 3, 5, 7, 9, 10, and 12) were attributable to short circuits in the feeders even though, at the time of each of these feeder cable failures, the network as a whole was carrying less electric power than it was designed to carry. In seven out of eight of these feeder cable failures it appears that the insulation on the failed feeder cables or on equipment connecting cable sections contained weak spots that lost their insulating ability at a temperature below the temperature the cable or equipment was built to withstand.[78] In the other feeder (failure no. 7, 1M03), it appears that Con Edison had installed a cable section with a carrying capacity too small for the load the feeder as a whole was carrying.[79]

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[77] Feeder cable no. 1M14 was functioning properly when Con Edison shut it down. *CRC Report*, p. 2-47. The company shut down this feeder for safety reasons and to prevent further network damage. *City Council Hearing,*, pp. 34-36, Testimony of Eugene McGrath, CEO, Con Edison.

[78] Interview with CRC, January 24, 1999.

[79] *CRC Report*, pp. 2-27.

Con Edison acknowledges that distribution cable and other components installed underground must be able to function at temperatures above that of the outside air.[80] Summer heat exacerbates local heat stress in underground equipment. Hot weather stimulates demand for electricity for cooling, which in turn causes distribution cable and equipment to generate more heat as it carries load. The heat generated by higher loads raises the temperature in conduits and manholes and, especially when sustained over time, heats up the ground around the equipment. All of this heat build-up occurs at a time when the aboveground temperature is also high, thus making it more difficult to get rid of the heat built up in undergrounded distribution equipment.

As heat builds up around underground distribution cable and equipment, the temperature of the insulation can rise to the point that the insulation loses its ability to prevent the electrical current in the cable or equipment from "going to ground,"rather than continuing to flow in the cable. At that point a short circuit occurs.[81] Such short circuits tend to occur where insulation is weakest, such as where the insulation has been damaged (feeder failure no. 1, 1M06), where water gets into the insulation (feeder failure no. 5, 1M01), or where the equipment installed is asked to carry more load than it is capable of carrying (failure no. 7, 1M07).[82]

2. Feeder Cable Failures Not Directly Attributable to Heat

Five of the thirteen feeder cable failures (feeder failures nos. 4, 6, 8, 11 and 13) may not have been directly caused by the temperature of the cable or other equipment at the time of the

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[80] *Id.*, pp. 3-8 - 3-10.

[81] *Id.*, pp. 3- 8 through 3-9. How higher temperatures cause insulation to fail short of its ignition temperature is highly technical and beyond the scope of this report.

[82] Interview with CRC, January 24, 1999.

failure. For example, one failure is attributed to a loose connection in a Sherman Creek Substation "through-bushing" (failure no. 11, 1M06), and another is attributable to the fire ignited by that short circuit (failure no. 13, 1M14).[83]

Following feeder 1M06's initial failure on July 2, 1999, Con Edison unplugged the feeder at the Sherman Creek Substation in order to make the feeder safe to work on. When the company completed its repair work on 1M06 and attempted to plug the feeder back in at Sherman Creek on July 6, 1999, the through-bushing in the socket for 1M06 was loose and shorted out. This short circuit caused a fire in the substation section that housed the "sockets" for 1M06, 1M14 and two other feeder cables.[84]

When it became aware of the fire the 1M06 short caused, Con Edison followed pre-established company policy and shut down power to the entire section of the substation in which the fire was burning.[85] This put out of service every feeder connected to Sherman Creek through "sockets" in this building. It is not clear whether heat played a role in creating the initial short circuit.

The other three Washington Heights-Inwood distribution feeder cable failures for which it is unclear that heat had a direct role include two distribution transformer failures (failures nos. 4,

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[83] *CRC Report,* pp. 2-42 and 2-47. Just as a person plugs an electrical cord into a wall socket to connect an appliance to electrical current and unplugs the cord before trying to repair the appliance, Con Edison plugs feeder cables into "sockets" at substations and unplugs the feeders to work on them. The feeder cable sockets at the Sherman Creek substation included as part of their structure a copper "through-bushing," which performs the same function as the copper contacts enclosed inside a household wall socket.

[84] Of the two other feeders connected to the Sherman Creek substation in the same section as 1M06, one had already failed and the other supplied power to the Riverdale network.

[85] *CRC Report,* p. 2-47.

1M11; and 6, 1M04) and a protective relay that did not disengage a failed feeder cable (feeder failure no. 8, 1M05).

V. CON EDISON'S PREPAREDNESS FOR SUMMER 1999

A. Inadequacies in Con Edison's Preparation for the Summer of 1999

Given the role of heat in the distribution failures leading to the Washington Heights-Inwood blackout, we examined Con Edison's actions preceding the summer of 1999 to prepare its systems for the demands of the "summer cooling season." In the summer, the stress on Con Edison's systems is usually at its yearly high, due to air conditioner use and the effects of heat on the system.

As part of its obligations under the New York Public Service Law ("PSL"), Con Edison has a duty to take reasonable steps to assure that its electric service is reliable.[86] This duty encompasses both the company's day-to-day operations and the research, planning, design, construction and maintenance of its electrical system. Con Edison's duty to provide reliable electric service requires it to take reasonable steps to assure that the company can deliver electricity to its customers during the summer cooling season. Every year, Con Edison has to plan for the upcoming summer's weather and electricity demand, assess the ability of its distribution system to carry load, inspect the physical state of its distribution equipment, and repair and upgrade that equipment as needed.

We found that Con Edison carried out extensive efforts in all these areas, but that its efforts were not adequate to prevent the distribution system equipment failures that resulted in

[86] Every electric utility "shall provide such service ... as shall be safe and adequate and in all respects just and reasonable." PSL § 64(1).

the July 6, 1999 Washington Heights-Inwood blackout. Con Edison's preparation of its distribution system was inadequate in at least three ways. First, Con Edison did not identify and repair or replace underground distribution system components that could not withstand a reasonable level of heat. Second, the company ignored the fact that, after three summers in a row with below normal temperatures, its underground distribution system likely contained a significant number of unidentified components that would not be able to withstand the heat of a hot summer.[87] Third, the company failed to remove a known load bottleneck from the Washington Heights-Inwood network.

B. Distribution Equipment Condition

Electric distribution equipment wears out and gets damaged like any other equipment. To prepare for the summer, Con Edison has to identify distribution equipment weakened by age, wear, or damage and has to repair or replace it. Otherwise, the weakened distribution system components may break down under the summer load.

1. Con Edison's Testing of Distribution Equipment

Con Edison indicates that it inspects and tests its distribution systems in preparation for each summer. A major part of this preparation is the "high potential" or "Hi-Pot" tests the company applies in the spring of each year to selected feeder cables.[88] A Hi-Pot test consists of

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[87] Con Edison gauges the relative level of summer weather severity by comparing "cooling degree days," which it derives by ascertaining the number of average daily temperature degrees above 57.5°. Con Edison determined that there was an annual average of 1,157 cooling degree days in the thirty years 1969-1998. In the years 1996, 1997, and 1998, the number of cooling degree days were, respectively, 3.3%, 8.3% and 0.4% below normal. The summer of 1999 was 13.1% above normal. Con Edison, Response to AG IR No. 130.

[88] "High-Potential" refers to the voltage going through the equipment. "Hi-Pot" testing is a generally accepted procedure used by many electric utilities to test whether a distribution feeder

disconnecting a feeder from its load area and then subjecting it for a short time to voltages more than twice the strength the feeder is designed to carry. The purpose of voltage-stressing the feeder is to cause defective or weakened components susceptible to failure because of voltage surges to fail so that they can be identified and replaced before summer. However, the Hi-Pot test does not involve sending very much electricity through a feeder; that is, Hi-Pot test currents are at low amperages.[89]

Con Edison indicates that, in preparing for the summer of 1999, it applied Hi-Pot tests to about 250 of its approximately 891 network feeder cables to ascertain the feeders' reliability.[90] Included in this group were the feeders identified based on the previous year's performance as among the 5% least reliable feeder cables in each borough and in Westchester County.[91] In addition, the company tested over 200 other network feeders selected using a three-factor

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cable contains components susceptible to failure from excessive voltage. *CRC Report*, p. 11.

[89] An ampere is a measure of current flow.

[90] Con Edison periodically reviews the design of its load areas and may decrease or increase the number of feeder cables depending on the results of such reviews. Currently the company has 87 network and 75 non-network feeder cables in the Bronx, 155 network and 117 non-network feeder cables in Brooklyn, 518 network feeder cables in Manhattan, 131 network and 200 non-network feeder cables in Queens, 163 non-network feeder cables in Staten Island and 620 non-network feeder cables in Westchester County. Con Edison, *Annual Report on 1997 Electric Service and Power Quality* (March 31, 1999), *passim.*

[91] Con Edison identifies and tests the 5% worst performing network feeder cables as part of a reporting requirement imposed by the PSC. Con Edison indicates that it tests additional feeders as a means of managing its operations. *Id.*, pp. 1-6, 3-3.

analysis that looks at each feeder's components,[92] each feeder's performance during the previous year, and the importance of the feeder cable to the network it supplies.[93]

Con Edison indicates it administered Hi-Pot tests to eight of the fourteen Washington Heights-Inwood network distribution feeder cables at some point between January 1, 1998 and June 30, 1999,[94] including performing Hi-Pot tests of feeders 1M05, 1M07 and 1M09 in its spring 1999 Hi-Pot testing of the 5% worst performing feeders.[95] All these feeders passed that test.[96] Nonetheless, six Washington Heights-Inwood distribution feeders which had passed the Hi-Pot test sometime in the previous eighteen months failed between July 2, 1999 and July 6, 1999.[97]

2. Inadequacies of Existing Testing Methods

Con Edison indicates that a Hi-Pot test is not designed to identify the kind of failure that occurred in seven out of the thirteen feeder cables that failed in the Washington Heights-Inwood

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[92] "Component" factors are such things as the number, type and age of cable sections in a feeder cable and the number, type and age of the distribution transformers attached to a feeder. Con Edison indicates that feeder cables that have a larger number of components, that have had breakdowns recently and that supply power to a crucial part of a network are more likely to be included among the cables given Hi-Pot tests. Interview with CRC, January 25, 2000.

[93] For various technical reasons, each feeder cable is not of the same importance to maintaining a network in service.

[94] Con Edison, Response to AG IR No. 126.

[95] Con Edison, *Annual Report on 1998 Electric Service and Power Quality*, March 31, 1999, pp. 6-5 - 6-10.

[96] Con Edison test distribution feeder cables 1M02, 1M05, 1M06, 1M07, 1M09, 1M11, and 1M14, and all passed. *Ibid.*

[97] Distribution feeder cables 1M02, 1M04, 1M05, 1M07, 1M09 and 1M11. *CRC Report*, Section 2, *passim*.

network in early July 1999.[98] In fact, six of those seven cables had been given the Hi-Pot test prior to the summer of 1999 and all passed.[99] Con Edison's explanation for this result is that the Hi-Pot test identifies only those distribution equipment components whose insulation is so deteriorated at the time of the test that the high voltage current administered will overwhelm the insulation's resistance to electricity and create a short circuit in the weakened or defective component.[100] The Hi-Pot test is pass-fail and provides no indication as to how close a component that passes is to failing.[101]

A further deficiency of the Hi-Pot test is that it does not in any way measure how much heat a cable or other distribution component can withstand.[102] Consequently, a feeder cable or other distribution component can pass a Hi-Pot test and then fail in operation when a component vulnerable to heat[103] has a short circuit at a temperature it was manufactured to tolerate. For

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[98] Interview with IRB member Lionel O. Barthold and CRC members Peter Zarakas and Charles Durkin, January 25, 2000; Con Edison, Response to AG IR No. 126.

[99] Con Edison, Response to AG IR No. 126.

[100] *Ibid.*

[101] The IRB notes that there is a body of opinion which suggests that the Hi-Pot test actually contributes to the failure of distribution equipment. However, the IRB is of the opinion that whatever injury the Hi-Pot test may cause, such testing identifies enough defective components to make tested distribution equipment more reliable than untested equipment. *Ibid.*

[102] Distribution system components are manufactured to operate within a certain range of temperatures. *See, e.g.*, CRC's discussing of the highest temperature at which Con Edison can reasonably expect paper-insulated lead sheathed cable to function. *CRC Report*, pp. 3-10 - 3-11.

[103] In any discussion of "heat" in the context of electric utility distribution cable or equipment, the reference is generally to the temperature of the cable or the equipment itself, or to the temperature in the immediate environment, such as inside a manhole or a cable conduit. For the purpose of determining whether such heat is likely to cause a cable or other equipment to fail, the source of the heat is not relevant. A vulnerable cable section or piece of equipment will fail if it exceeds the temperature it can withstand.

example, Con Edison indicates that it designs and operates its distribution system with the expectation that paper-insulated lead-sheathed cable[104] can function at up to 212˚ F.[105] However, damage to the lead sheath can permit water to enter the paper insulation at the point of the damage. When wet, paper insulation deteriorates over time and loses some of its ability to withstand heat. The result is that a cable otherwise able to withstand 212˚ F. can have a short circuit at a lower temperature in a portion of the cable with deteriorated insulation.

Con Edison indicates that water intrusion and subsequent degradation of thermal insulation capacity is also a problem with certain types of "stop joints," which are pieces of equipment used to connect paper-insulated lead-sheathed cable to cable covered with another insulating material.[106] The company indicates that the extent of the problem with stop joints is not clear, but proposes to discontinue using at least one particular type[107] and to reduce the

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[104] Con Edison indicates that approximately half of the cable in its underground distribution system is insulated with oil-impregnated paper that is covered with a lead sheath to keep out moisture. The company's position is that paper-insulated lead-sheathed cable is reliable as long as it is protected from moisture and is not subjected to temperatures above its thermal limits. *CRC Report*, pp. 3-10 - 3-11. Moisture over time can enter paper insulation at points where a cable's lead sheathing is broken, such as by mechanical damage by a contractor digging up the street, metal fatigue caused by repeated heating and cooling of the lead sheath or corrosion. *See, e.g.*, Washington Heights-Inwood feeder cable failures no. 1 (1M06) and no. 3 (1M07).

[105] *CRC Report*, pp. 3-10 - 3-11.

[106] *See, e.g., CRC Report*, pp. 3-12 ("Stop Joint") and 3-13 (Moisture Intrusion"). Con Edison describes the insulating materials on the cable it currently installs in its distribution system as "solid dialectic," that is, one or another plastic.

[107] Con Edison identifies the suspect equipment as a "modified premolded 2 way/1 way stop joints." *Id.*, p. 4-6 (Recommendation 9 - Cable Stop features).

number of joints at which paper-insulated lead-sheathed cable is connected to cable insulated with another material.[108]

Con Edison and the IRB indicate that there is no means of testing an electric utility company distribution system to determine if any of its components will likely fail because of the heat that the components can reasonably be expected to be exposed to during the summer.[109] In its Action Plan, Con Edison indicates that the company is currently preparing to research the possibility of developing such a test for distribution system thermal reliability.[110]

The success of research is not guaranteed, much less the speed with which research will produce practical results. Con Edison indicated that it could not be more precise about its efforts to develop a test for distribution system component susceptibility to heat because the company is breaking new ground in its effort.[111]

C. Accumulation of Unreliable Distribution System Components

The summer of 1999 was considerably hotter than the three previous summers. During the summer months of June, July and August, 1999, there were maximum temperatures of 89˚ F.

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[108] *Action Plan*, p. 6 (action item No. 7 - Reduce the number of stop joints that have demonstrated a greater susceptibility to failure than comparable components. Review methods of improving splice conditions.) (Recommendations CRC-9, CRC-14, IRB 3.5, IRB 3.6, IRB-3.13).

[109] *Ibid.*

[110] *Action Plan*, p. 8-9. DOE also expresses concerns about the Hi-Pot test, agrees that buried equipment is exposed to threats such as heat and salt, and is concerned about deficiencies in current methods of predicting the local temperatures in which equipment underground operates and the lack of direct data about such conditions. *DOE Report*, pp. 1-12 - 1-13.

[111] Interview with IRB member Lionel O. Barthold and CRC members Peter Zarakas and Charles Durkin, January 25, 2000.

or above on twenty-seven days. In the previous three summers of 1998, 1997 and 1996, the number of days with maximum temperatures of 89˚ F. or above were seven, twelve and one, respectively.[112] According to the IRB:

> incipient weaknesses in cables are...quite often precipitated by a prolonged period of hot weather accompanied by heavy system loading and higher than normal heat release in ducts and manholes....But the Con Edison system had not seen prolonged hot spells for the past several summers, so it is likely that cables, splices and related equipment that would have failed in those years due to excessive operating temperatures remained intact. The severe hot period of July 1999, caused this backlog of weaknesses to manifest themselves as faults.[113]

The pattern of failures in Con Edison's entire distribution system in July 1999 is consistent with what would be expected to happen in a distribution system in which equipment vulnerable to heat has accumulated. In preparing for the summer of 1999, Con Edison failed to take account of the fact that, after three successive summers without sustained hot weather, the underground distribution system was likely to contain a significant number of components that would fail during the next heat wave.

D. Distribution System Upgrades To Take Account of Load

To determine before each summer whether its distribution system components are able to handle the load that they will be called upon to carry,[114] Con Edison takes each year's projected

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[112] "Monthly Local Climatological Data, Central Park Observatory," 1996, 1997, 1998, 1999, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climate Data Center.

[113] *IRB Report*, p. 4.

[114] The demand for electricity is not uniform everywhere within an electric utility's distribution system. For example, on a ten-mile-long feeder cable the cable section closest to the substation has to carry much more electricity than the last few cable sections of the feeder. Each section of feeder cable, distribution transformer, distribution wire or other distribution system component may carry different amounts of electricity, *i.e.*, may carry a different "load," at any

summer peak demand, *i.e.*, projected summer peak load,[115] and analyzes how that projected summer peak load would be carried by each component in its distribution system. If this analysis indicates that the projected summer load on a component would be such that the component could not carry the load with the required safety margin, Con Edison's procedures provide that each such component is to be strengthened by replacing existing equipment with new equipment that can carry more electricity or by rerouting the flow of electricity so that the existing equipment will have less electricity to carry. Con Edison's term for this annual process of upgrading its distribution system components to match component capacity with expected load is "load relief."[116]

If Con Edison's load relief process does not upgrade a distribution system component that no longer has the capacity to carry the load likely to be placed on it, that component becomes a "load bottleneck" and may fail even under normal load. Since the load on Con Edison's electric system peaks in the summer, such load bottlenecks are most likely to fail in the summer.

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given time, and the load a piece of distribution equipment may have to carry changes over time.

[115] Each summer, Con Edison prepares a prediction of peak demand for the forthcoming summer. The two primary factors the company considers in forecasting its summer peak demand forecast are historical demand patterns and reasonably foreseeable weather and economic conditions during the coming summer. For the summer of 1999, Con Edison forecast a peak demand of 11,650 megawatts. Con Edison, Press Release, "Con Edison Projects Record Demand for Power This Summer," June 2, 1999. Con Edison's actual system peak electricity demand during 1999 was 11,830 MW, achieved at 1:00 p.m. on Tuesday, July 6. *CRC Report*, p. 2-25; Con Edison, Press Release, "Con Edison Hits a New Peak in Energy Usage," July 6, 1999, 1:10 p.m.

[116] *See, e.g.*, Con Edison, *Annual Report on 1998 Electric Service and Power Quality*, (March 31, 1999), p. 1-7.

Con Edison indicates that, in Manhattan, it used 1997 summer load data rather than 1998 data in its initial calculations to identify distribution load bottlenecks in preparing for the summer of 1999. Con Edison explained that using the older load data enabled it to issue work orders to begin removing such load bottlenecks while the 1998 summer load data was still being collected and put in a form usable in the company's load prediction calculations.[117]

Con Edison states that the company completed collecting and organizing Manhattan load distribution data for 1998 in April 1999, and that the company then re-ran its load flow calculations to ascertain whether the use of the 1998 load distribution data would indicate that additional distribution feeder sections required work to ensure that they would be able to carry the amount of electricity the calculations indicated might be called for in the summer of 1999.[118] According to Con Edison, the load flow calculation re-run identified an additional 105 feeder sections on 33 feeders that needed improvement in order to be certain that the sections would have the current-carrying capacity that Con Edison predicted each section would need in the summer of 1999.[119]

Before July 1999, Con Edison did not complete all the distribution feeder section load relief work the company's re-run load flow calculations indicated was needed before the summer of 1999. In at least one instance Con Edison's failure to remove a known load bottleneck caused a feeder cable failure in the Washington Heights-Inwood network. This failed feeder cable,

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[117] Interview with CRC, January 24, 2000.

[118] Con Edison, Response to AG IR No. 115.

[119] *Ibid.*

1M03, figured in the Washington Heights-Inwood blackout.[120] Moreover, the failure of 1M03 at 10:29 a.m. on July 6, 1999 led to the failure of feeder cable 1M05, the last feeder supplying power directly to the Inwood section of the Washington Heights-Inwood network.[121] The failure of 1M05 produced the distribution wiring failures that put 15,000 Inwood customers out of service by 10:40 a.m. on July 6, 1999,[122] and 1M05 was one of the feeder cables out of service when Con Edison shut down the entire Washington Heights-Inwood network at 10:11 p.m. that day.[123]

VI. CON EDISON'S ACTIONS DURING THE JULY 1999 HEAT WAVE

In addition to examining Con Ed's preparedness for the 1999 summer season, we also discerned two ways in which Con Edison's actions immediately leading up to the blackout in Washington Heights-Inwood contributed to the blackout.

A. Feeder Cable 1M04

Washington Heights-Inwood network feeder cable 1M04 failed on Tuesday, July 6, because water entered a transformer through a hole created by corrosion of the transformer's casing, causing a short circuit in the transformer. Con Edison had sprayed this transformer with water on July 2 and once before in the summer of 1999 in order to cool it and keep it functioning.

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[120] *CRC Report*, p. 2-27.

[121] *Id.*, p. 2-28.

[122] Con Edison, February 8, 2000 Response to AG IR.

[123] *CRC Report*, p. 2-49.

[124] However, Con Edison indicates that it was not aware of the hole in the transformer's case at the time it sprayed the transformer.[125]

B. Feeder Cable 1M06

Con Edison took an exceptionally long time, 108½ hours, or over four and a half days, to bring feeder cable 1M06 back to service after it failed on July 2 at 9:30 a.m.[126] Con Edison indicates that in 1998, the last year for which complete data is available, the company on average took 46 hours and 46 minutes to repair a feeder cable in Manhattan.[127]

Con Edison's explanation for the length of time it took to repair feeder cable 1M06 is that the company had to dig an extensive trench to reach the damaged feeder section and that it did not dig at night to avoid disturbing the immediate neighborhood. Whether this was an appropriate response by Con Edison, given the serious danger to its network, is questionable.

VII. CON EDISON'S ELECTRIC SERVICE IN EARLY JULY 1999 OUTSIDE WASHINGTON HEIGHTS-INWOOD

In addition to examining the causes of the early July 1999 blackout in Washington Heights-Inwood, we also looked at what happened in early July 1999 in other parts of Con

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[124] *CRC Report*, p. 2-11. Con Edison indicates that spraying transformers with water to cool them is an accepted electrical industry practice.

[125] Interview with CRC members Peter Zarakas, Charles Durkin and John Tully, January 24, 2000. *See also*, *CRC Report*, p. 2-11.

[126] *CRC Report*, pp. 2-2, 2-42.

[127] Con Edison, *A chart showing 1998 average feeder restoration time by restoration step and total time,* (February 9, 2000), Response to AG IR. Con Edison indicates that repairing any feeder cable requires extensive pre-repair precautions to isolate a feeder to ensure worker safety and post-repair preparation to coordinate the reconnection of the feeder, and that repair of underground feeders such as those in Washington Heights-Inwood requires additional time to locate and gain access to the equipment needing repair.

Edison's service territory to determine whether load areas other than Washington Heights-Inwood experienced distribution system problems.

Three other networks in particular, Long Island City in Queens, Williamsburg in Brooklyn, and the East Village and the Lower East Side in Manhattan, all suffered multiple feeder cable failures such that they operated above the second contingency for substantial periods of time. Although these three networks continued to supply power to most of their customers, outages occurred and customers there were at serious risk of sharing Washington Heights-Inwood's fate in early July 1999.

A. Long Island City

The Long Island City network has 22 feeder cables, is designed to carry up to 775 megawatts of load[128] and is classified by Con Edison as a commercial network.[129] During 1999, the Long Island City network experienced its peak load of 357 megawatts on July 19, 1999, not during the early July heat wave.[130] At 1:53 a.m., Wednesday, July 7, 1999, the Long Island City network had seven feeder cables out of service, but did not suffer a network blackout.[131] For the seven Long Island City feeder failures between July 2, 1999 and July 6, 1999, Con Edison attributes three to transformer faults, two to insulation breakdown and one to an "inherent" problem in a feeder cable joint.[132] (Con Edison indicates that it was unable to find a cause for

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[128] Con Edison, Response to AG IR No. 3a.

[129] *Briefing Book*, Tab B.

[130] Con Edison, Response to AG IR No. 3a.

[131] Con Edison, Response to AG IR dated July 19, 1999.

[132] Con Edison, Response to AG IR No. 110.

the seventh Long Island City feeder failure during this period.[133]) Thus, it appears that the failures in this network had causes similar to those involved in Washington Heights-Inwood.

B. Williamsburg

The Williamsburg network has 18 feeder cables, is designed to carry up to 410 megawatts of load and experienced its 1999 peak load of 181 megawatts on Tuesday, July 6, 1999.[134] Despite operating at well under half of its designed load capacity at the time, the Williamsburg network had six feeder cables inoperable at 12:37 a.m. on Tuesday, July 6, 1999.[135] Like the Long Island City network, the Williamsburg network did not experience a blackout in July. For the six Williamsburg feeder failures between July 2, 1999 and July 6, 1999, all of which occurred on July 6, the company attributes two to moisture, one to insulation breakdown, one to "general corrosion." and one to a cable joint problem.[136] (Con Edison indicates that it was unable to find a cause for the other Williamsburg network feeder failure on July 6, 1999.[137]) Thus, it appears the distribution system failures in this network had causes similar to those which led to the failures in Washington Heights-Inwood.

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[133] *Ibid.*

[134] Con Edison, Response to AG IR No. 3a.

[135] Con Edison, Response to AG IR dated July 19, 1999.

[136] Con Edison, Response to AG IR No. 110.

[137] *Ibid*.

C. East Village and Lower East Side

The Cooper Square network, which supplies electricity to the East Village and the Lower East Side in Manhattan through 24 feeder cables, is classified by Con Edison as a commercial network. It is designed to carry up to 363 megawatts of load, and experienced a 1999 peak load of 233 megawatts on July 6, 1999.[138] Although the 1999 peak was well within its design limit, the Cooper Square network nonetheless had five feeders out of service as of 8:37 a.m. on July 7, 1999. It experienced a total of eight feeder cable failures between Friday, July 1, and Thursday, July 8. Con Edison's Cooper Square network experienced 758 electric power outages on July 6, 7 and 8, affecting 64,066 customers.[139] For the four Cooper Square network feeder failures between July 2 and July 6 for which the company provided any detailed information, Con Edison attributes one to insulation breakdown, two to problems with feeder cable joints and one to a fire in a subway station.[140] Thus, it appears that the failures in the distribution system in this network are similar to those which occurred in the Washington Heights-Inwood network.

The feeder cable failures for the Cooper Square network are especially notable because four of the cables that failed supplied service to the New York City Transit Authority electrical substation at Stanton and Essex Streets. A fire occurred at around the time of the outage of these feeder cables on July 7. The information available to us does not make it clear whether the fire caused the feeder outages, whether the outages and the fire had the same cause, or whether the relationship between the fire and the outages was more complex.

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[138] Con Edison, Response to AG IR No. 3a.

[139] Con Edison, February 14, 1999 Response to AG IR.

[140] Con Edison, Response to AG IR No. 110.

D. New York City Housing Authority

The New York City Housing Authority ("NYCHA") is one of the largest Con Edison electricity delivery customers in New York City.[141] According to Con Edison, the company asked all of its larger customers, including the NYCHA, to conserve energy during the early July 1999 heat wave, but did not specify how any particular customer should comply with this request.[142] According to the New York City Office of Emergency Management ("OEM"), the NYCHA received Con Edison's request for energy conservation, analyzed its electrical system, and decided to turn off the water boiler circulating pumps in its facilities beginning at about 2:00 p.m. on Wednesday, July 7, 1999, thereby terminating hot water service to about 600,000 residents, rather than risk shutting down elevator and hall lighting service.[143] The NYCHA may also have lost service to some of its residential facilities as part of the more widespread outages. The NYCHA has commenced litigation against Con Edison in connection with the July 1999 blackouts. The parties have declined to release information regarding the NYCHA pump shut downs, and this office has not been able to form any conclusions or recommendations regarding them.

E. Westchester County

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[141] Testimony Jerry Hauer, Director of the City of New York Office of Emergency Management ("OEM"), *Assembly Hearing*, p. 144.

[142] Testimony of Eugene McGrath, CEO, Con Edison, *Assembly Hearing*, pp. 119-122.

[143] Testimony Jerry Hauer, Director, OEM, *Assembly Hearing*, pp. 144-145.

In addition to the outages in New York City, approximately 937 outages in Westchester County caused over 49,000 Con Edison customers to experience a loss of electrical service.[144] The outages in Westchester County were scattered, but had serious consequences. In at least one Westchester municipality, the Town of Harrison, the police department and its radio communications equipment experienced a total outage.[145]

As in New York City, Con Edison's Westchester customers suffered outages attributable to identifiable equipment failures in the company's distribution system. It does not appear that Con Edison sought to maintain service to some customers by withholding service from others.

Con Edison's service area in Westchester is designed as a radial distribution system, as opposed to the network distribution system design employed by Con Edison in most areas of New York City. One of the key differences between a radial system and a network system is that there are fewer redundancies in a radial system to compensate for component failures. A failure of any component in the radial line distributing power from the substation to the customer will more likely result in an outage.

Another characteristic of a radial system is that customers across the street from each other may be on different radials, so that one customer could experience an outage while the neighbor across the street still has electrical service. The fact that one side of a street lost service while the other side did not is a product of Con Edison's system design in Westchester County and is not the result of disparate treatment of neighboring customers.

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[144] Con Edison, Response to AG IR No. 141.

[145] New York Journal News, August 21, 1999, quoting Harrison Town Attorney Marc Tolchin.

In Westchester County, most of the feeder cables that failed were located above ground.[146] An analysis of the causes given by Con Edison for the 937 outages in the first ten days of July indicates that the vast majority of them resulted from one of two causes: either what Con Edison terms a "defective connection" (472 outages), or what Con Edison describes as an "overload" (246 outages).[147] A comparison between the first ten days of July and the remaining 21 days shows that the number of outages fell dramatically for the rest of the month and that the causes of such outages changed.[148] The inescapable conclusion is that the outages in Westchester County in early July 1999 were heat-related.

VIII. CON EDISON'S TREATMENT OF THE WASHINGTON HEIGHTS-INWOOD NETWORK

Because questions were raised publicly in the aftermath of the Washington Heights-Inwood blackout as to whether that neighborhood was singled out by Con Edison for a shutdown of service, or was otherwise treated in a discriminatory manner by Con Edison, we sought to determine whether Con Edison treated Washington Heights-Inwood differently from other load areas in the company's service territory.

A. Electricity Allocation

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[146] Con Edison, Response to AG IR No. 141, pp. 55-92.

[147] *Ibid.*

[148] In contrast to the dominant role of defective connections and overloads during the first ten days of July 1999, Con Edison ascribed these causes to only 32 of the 191 outages that occurred in Westchester County during the last 21 days of July 1999. Indeed, during those 21 days, Con Edison ascribed outages to 17 different causes and none dominated in the way defective connections and overload had during the first ten days of the month.

As discussed earlier, Con Edison had no problem with receiving power to its systems in early July 1999. Power was flowing from generation sources through the high-voltage transmission systems to the substations in its load areas at all times. Thus, the Washington Heights-Inwood blackout was not a result of a desire to favor other networks, in the allocation of the power supply available, nor did the shutting down of Washington Heights-Inwood have an effect on other networks' power allocation.

B. Network Attributes

We looked at the technical attributes of the Washington Heights-Inwood network compared to other Con Edison networks to analyze whether the Washington Heights-Inwood network was unusual in any respect. In this regard, we found no significant disparities between that network and the other Con Edison networks.

Appendix G consists of five Tables, based on information provided by Con Edison, ranking the 55 networks according to a variety of attributes, namely: number of customers served; maximum design load; geographic area served; number of feeder cables per network; and average length of feeder cables per network.

1. Customers Served

Con Edison characterizes 25 of its 55 networks as commercial, that is, as primarily serving businesses, institutions or government, and 30 as residential.[149] The company's commercial networks include Long Island City in Queens, Borough Hall in Brooklyn, and West

[149] *See,* Appendix F.

Bronx in the Bronx, and all 22 networks south of 62d Street in Manhattan.[150] Washington Heights-Inwood and Williamsburg are among the 30 networks classified as residential.[151]

The number of customers a Con Edison network serves varies from 120,000 (Long Island City) to six (World Trade Center in Manhattan).[152] With more than 68,880 customers, Washington Heights-Inwood is the sixteenth largest network out of the fifty-five networks in the number of customers served.[153]

2. Maximum Design Load

The maximum design load ranges from 775 megawatts (Long Island City) to 91 (Battery Park in Manhattan).[154] The Washington Heights-Inwood network has a design load of 277 megawatts, making it the thirty-first largest network with respect to load.[155]

3. Geographic Area

The geographic area of networks ranges from 9.8 square miles (Flushing in Queens) to 0.04 square miles (World Trade Center in Manhattan).[156] The Washington Heights-Inwood

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[150] *Briefing Book,* Tab D.

[151] *Ibid.*

[152] Con Edison, Response to AG IR No. 3a. As noted earlier, the number of customers is not synonymous with the number of persons served by a network.

[153] *Ibid. See also,* Appendix G, Table 1.

[154] Con Edison, Response to AG IR No. 3a. A "megawatt" is a million watts.

[155] *Ibid. See also,* Appendix G, Table 2.

[156] Con Edison, Response to AG IR No. 3a.

Network serves an area 2.79 square miles, which makes it the twenty-first largest network out of the fifty-five networks in Con Edison's service territory.[157]

4. Number of Feeder Cables

The number of feeder cables that connect a network to the substation from which it gets power ranges from 28 (Jamaica in Queens and Yorkville in Manhattan) to eight (Battery Park City, Greenwich and World Trade Center, all in Manhattan).[158] Washington Heights-Inwood is connected to its substation (Sherman Creek in Manhattan) by 14 feeder cables, making Washington Heights-Inwood the thirty-second largest network in terms of number of feeder cables.[159]

5. Length of Feeder Cables

With respect to the length of feeder cables, the longest feeder cable is 16.21 miles (Flatbush in Brooklyn) and the shortest 0.10 miles (World Trade Center).[160] In the Washington Heights-Inwood network, the 14 feeder cables vary in length from 9.25 miles to 4.05 miles, with an average length of 6.65 miles, making Washington Heights-Inwood the network with the twenty-fourth longest average feeder cable length.[161]

6. Feeder Cable Failures

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[157] *Ibid. See also*, Appendix G, Table 3.

[158] Con Edison, Response to AG IR No. 4a.

[159] *Ibid. See also*, Appendix G, Table 4.

[160] Con Edison, Response to AG IR No. 4.

[161] *Ibid. See also,* Appendix G, Table 5.

Appendix H consists of two tables, based on information provided by Con Edison, showing the number of feeder cable failures in each Manhattan network having feeder cables appearing among the worst performing 5% of feeder cables during, respectively, 1998 and 1997. In 1998, there were sixteen failures in eight feeder cables in the Washington Heights-Inwood network. A number of other Manhattan networks, in many different parts of the borough, both residential and commercial, were in the top 5% of worst-performing feeder cables in 1998.

The annual number of feeder cable failures in Washington Heights-Inwood varied during the four years prior to 1999. In 1998, the Washington Heights-Inwood network had three among the twenty-six feeder cables that comprise the 5% worst performing feeder cables in Manhattan.[162] In 1997, none of the 5% worst-performing Manhattan feeder cables were located in the Washington Heights network.[163] In 1996, one Washington Heights-Inwood feeder cable ranked among the 5% worst-performing feeder cables,[164] and in 1995, none did.[165] The performance of the feeder cables in the Washington Heights-Inwood network during the four years prior to 1999 is not dissimilar from that of many other Manhattan networks in many different neighborhoods.

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[162] Con Edison, *Annual Report on 1998 Electric Service*, March 31, 1999, p. 6-26. In the spring, Con Edison tests each feeder cable it identifies in the previous year as among the 5% worst-performing. Thus, networks with the worst feeder cables receive special attention in preparation for the summer cooling season.

[163] Con Edison, *Annual Report of 1997 Electric Service*, March 31, 1998, after p. 6-27.

[164] Con Edison, *Annual Report on 1996 Electric Service*, March 31, 1997, p. 6-11.

[165] Con Edison, *Annual Report on 1995 Electric Service*, June 30, 1996, p. 6-13.

The apparent lack of any technical attribute significantly distinguishing the Washington Heights-Inwood network from other networks further heightens our concern that the network outages in Washington Heights-Inwood resulted from systemic issues affecting many of Con Edison's distribution networks, and not from any localized treatment of Washington Heights-Inwood.

C. Capital Improvements and Maintenance

We sought information on how much Con Edison spent on individual networks for capital improvements and repairs in the five years from 1994-1998. Con Edison indicated that it did not compile such information by network, but only by borough and county, and that information on individual networks would have to be abstracted by hand from voluminous engineering records at considerable expense.[166] We thus have no direct information to establish what Con Edison's expenditures have been for the Washington Heights-Inwood network and how they compare to other networks.

We reviewed Con Edison's published annual reports of capital expenditures and maintenance expenditures for the years 1995 through 1998. This data is aggregated by borough and county, rather than by network. The data available to us did not reveal expenditure patterns by which we could conclude that Con Edison gave preference to some areas over others. Appendix I consists of four tables reproducing the pages of the annual Con Edison reports showing capital and maintenance expenditures in each of these four years.

We conclude that Con Edison should go back over the record of its capital and maintenance expenditures during the four years prior to 1999, aggregate the relevant data by load

[166] Con Edison, Response to AG IR No. 3a.

area and make the result publicly available. Going forward, the company should aggregate this information by network in a readily retrievable form and publish it annually.

D. Emergency Work Crews

We asked Con Edison to provide information regarding the dispatch of emergency work crews during the early July 1999 power outages. The company indicated that emergency work crews and equipment are dispatched out of four Control Centers (Manhattan, Brooklyn-Queens, Bronx-Westchester and Staten Island) and that each Control Center keeps records showing when, where and what was dispatched to emergencies. According to Con Edison, the failure locating, grounding, repairing, and service restoration functions are performed by different work crews that may be dispatched from different offices. Con Edison indicated that the emergency work crew and equipment dispatch records exist only as paper documents, that there is no report or other compiled source of information about how many emergency work crews or what equipment are sent to a given network or radial load area, and that preparing a comparison of how many emergency work crews and what equipment was sent to individual networks or radial load areas in early July 1999 would involve examining and abstracting voluminous paper records.[167]

We have no independent information indicating that during early July 1999 Con Edison did not dispatch emergency work crews and equipment to Washington Heights-Inwood as needed. However, in the absence of relevant dispatch data, it cannot be determined whether Con Edison sent a proportionate share of emergency work crews and equipment to Washington Heights-Inwood in early July 1999.

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[167] Con Edison, Response to AG IR No. 27b.

We conclude that Con Edison should aggregate the data regarding the dispatch of work crews during the first week of July 1999 by network and release that information publicly. Going forward, Con Edison should aggregate this information by network in readily retrievable formats so that the information is readily available.

IX. CON EDISON'S COMMUNICATIONS WITH THE PUBLIC BEFORE THE BLACKOUT

During the July 1999 crisis, Con Edison did not take all the steps appropriate to the situation to inform public officials, critical care facilities, and the general public of the danger of outage faced by the Washington Heights-Inwood network. As of 8:49 a.m. on Monday, July 5, the Washington Heights-Inwood network had two of its fourteen feeder cables out of service.[168]

On Monday, July 5, the National Weather Service issued an Excessive Heat Warning, the highest level alert.[169] Between the morning of July 5, and 10:11 pm on Tuesday July 6, when the Washington Heights-Inwood network was shut down, a total of eleven out of the fourteen feeder cables in the network had failed at some time.[170]

Statements by Con Edison and government officials are somewhat contradictory regarding Con Edison's communications to public officials, critical care facilities, and the public during this time. For example, Con Edison asserted that it contacted the OEM on Friday, July 2; that over the weekend Con Ed was in contact with OEM; and that on Tuesday morning, July 6, at 6:40 a.m., the company told OEM that the voltage in the Washington Heights-Inwood network

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[168] Testimony of Eugene McGrath, CEO, Con Edison, *City Council Hearing*, p. 32; *CRC Report*, p. 2-6.

[169] Testimony of Jerry Hauer, Director, OEM, *City Council Hearing*, p. 127.

[170] *CRC Report*, Section 2, *passim*.

had been reduced by eight percent.[171] However, OEM stated that, in its communications with city officials, Con Edison failed to indicate the gravity of the situation in Washington Heights. OEM also states that Con Edison provided inconsistent information to OEM's staff as to the seriousness of the deterioration in the Washington Heights-Inwood network.[172]

Columbia New York Presbyterian Hospital ("CNYPH") was adversely affected, with 7200 patient visits to doctors, 500 surgeries, and another 800 procedures canceled due to load shedding and the network power outage.[173] Officials at CNYPH indicated that as early as Friday, July 2, Con Edison contacted CNYPH and requested that CNYPH use its emergency generation to assist Con Edison in shedding load in the Washington Heights-Inwood area, which CNYPH did.[174] Even though Con Edison was in regular contact with CNYPH beginning on Friday, July 2, four days prior to the full network shutdown, CNYPH officials assert that the actual network shutdown and the need for CNYPH to switch to full emergency generation came "without warning."[175] According to CNYPH, its systems did work the way they were supposed to and patients were protected from potential danger.[176] However, questions remain as to whether Con Edison could have done more to notify CNYPH of the very real possibility of a complete

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[171] Testimony of Eugene McGrath, CEO, Con Edison, *City Council Hearing*, p. 31.

[172] Testimony of Jerry Hauer, Director, OEM, *City Council Hearing*, p. 132.

[173] Testimony, Marvin O'Quinn, Vice President for Business Development, New York Presbyterian Hospital, *Assembly Hearing*, p. 247.

[174] *Id.*, p. 240.

[175] *Id.*, p. 241.

[176] *Id.*, p. 247.

network shutdown at a time when the distribution network that served the hospital had exceeded its design parameters.

Additional complaints were made by public officials and community service providers that Con Edison's failure properly to inform officials and the general public of the deterioration of the Washington Heights-Inwood network left many senior centers and critical care facilities unprepared for the blackout crisis. There are approximately nine senior centers in the Washington Heights community area. Apparently none of them was forewarned of the possibility of a network blackout.[177] Many seniors live in apartment buildings dependent on elevator service. The frail elderly on the upper floors were the most vulnerable.[178] If the agencies serving seniors in Washington Heights-Inwood had been notified of the very real possibility of a network shutdown, those agencies could have mobilized more effectively.

X. CON EDISON'S REIMBURSEMENT TO CUSTOMERS

Con Edison's July, 1999 outages imposed a severe burden on its customers in New York City and Westchester County. The Attorney General examined the adequacy of Con Edison's compensation to customers for damages suffered as a result of the outages and the adequacy of the notice to customers about the availability of compensation.

A. Con Edison's Legal Obligation To Provide Compensation

[177] Testimony of Ruth Rossini, Washington Heights Inwood Council on the Aging, *City Council Hearing*, p. 17.

[178] *Id.*, p. 19.

Under the New York Public Service Law the PSC has the power to require that electric and gas utilities such as Con Edison file with the PSC a document, called "tariff," detailing rates and liability provisions for the utility.[179] Rather than have each utility customer in its service territory execute a separate contract with Con Edison, these tariffs create legally binding terms and conditions of service between Con Edison and different categories of customers. For example, Con Edison files tariffs detailing the terms for service for residential, business, and religious customers. The PSC is charged by state law to review the tariffs upon filing[180] and to enforce the tariff in the event of a violation by the utility.[181] The tariffs approved by the PSC are available for public inspection.

Currently, P.S.C. No.9-Electricity tariff regulates the terms and conditions of Con Edison's service to its residential and commercial retail customers.[182] The tariff provisions, including the compensation amounts, in effect today have not changed since they were instituted in July 1973. At that time, the PSC ordered Con Edison to file a tariff creating specified liability provisions for Con Edison to compensate customers for losses resulting from power failures

[179] PSL §66(12)(a).

[180] *Ibid.*

[181] PSL §26.

[182] *Tariff*, Con Edison, PSC No.-9 - Electricity.

attributable to Con Edison's distribution system.[183] Con Edison is the only New York utility with liability provisions for customer service interruptions in its tariff.

The 1973 Con Edison tariff approved by the PSC specifies that Con Edison's liability to residential customers for service interruptions is limited to "$100 for any one Customer for any one incident, as a result of intentional disconnection of service of an individual Customer made in error lasting more that 12 hours, when such losses consist of spoilage of food or medicine for lack of refrigeration."[184] The tariff also specifies that Con Edison's liability to commercial customers for service interruptions is limited to "$2,000 for any one Customer for any one incident, as a result of intentional disconnection of service of an individual Customer made in error lasting more that 12 hours, when such losses consist of spoilage of perishable merchandise for lack of refrigeration."[185] The tariff also limits Con Edison's total liability for intentional service interruptions to $1,000,000.[186] If claims totaling more than $1,000,000 are filed, Con Edison may pro-rate the claims among eligible customers. The tariff further provides customers with ninety days from the date of interruption to file a claim with Con Edison.[187]

B. Con Edison's Post-July 1999 Compensation Program

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[183] *See, Consolidated Edison Company of New York, Inc.* (Case 3729), 13 NY PSC 1038 (1973). These compensation provisions also apply to tenants in residential buildings who are not separately metered for electrical service, and thus are not direct "customers" of Con Edison, but whose electricity is paid by their landlord and reflected in the rent.

[184] *Tariff*, Con Edison, PSC No-9 - Electricity, Leaf No. 64.

[185] *Ibid.*

[186] *Id.*, Leaf No. 63.

[187] *Id.*, Leaf No.64.

1. Adequacy of Con Edison's Customer Compensation

The $100 limitation often failed to compensate residential customers for reasonable actual damages incurred as a result of Con Edison's July 1999 power outages.[188] As of February 23, 2000, Con Edison had received 61,636 claims from residential customers of which 58,333 customers were paid up to $100 each for a total of $5,804,576.[189] Con Edison determined to exceed the tariff liability cap of $1,000,000, which was appropriate under the circumstances. Nevertheless, Con Edison still denied 1,849, or 2.99%, of residential claims because they did not evidence service interruption for at least twelve hours *and* food or medicine spoilage.[190] Commercial customers filed 2,236 claims, of which 1,266 have been paid up to $2000 each for a total of $1, 645,868, with eight claims still pending. Again, Con Edison appropriately determined to exceed the $1,000,000 tariff liability cap. But 43%, or 964, commercial claims were denied by Con Edison because they did not seek compensation for food or medicine spoilage.[191]

Con Edison's tariff limiting reimbursement to food spoilage and medicine losses fails to recognize other losses sustained by customers whose service is interrupted. For example, the YM-YWHA located at 58 Nagle Avenue in Washington Heights sustained damage to its air conditioning system as a result of the Con Edison service interruption. Martin Englisher, the Executive Director of the YM-YWHA testified at the PSC's public statement hearing that the claim he had filed on behalf of the YM-YWHA was denied and that, "they told me, no, it has to

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[188] Testimony of Stanley Michels, PSC Public Statement Hearing, August 31, 1999, p. 24.

[189] Con Edison, March 7, 2000 Updated Response to AG IR.

[190] *Ibid.*

[191] *Ibid.*

be for food, so you're out the money."[192] The financial damage to businesses was widespread across Con Edison's service territory and in many cases exceeded $2000 because businesses closed during or for a time after the blackout. For example, on Ludlow Street in the Lower East Side, "El Nuevo Amanecer Restaurant, El Castillo de Jagua Restaurant, H & H Hardware, Grace's Unisex and the Essex Beauty Salon were forced to close due to lost electrical power."[193]

2. Application Process

In implementing its compensation program after the July outages, Con Edison failed to establish set procedures for customers to make claims for compensation. Customers relied on unofficial information and rumor throughout the compensation process. For example, some small business customers erroneously believed that acceptance of compensation from Con Edison would serve as a bar to any future private legal action, and delayed making claims, until this misconception was finally dispelled in a meeting with Con Edison officials two days before the initial deadline for filing a claim.[194] In fact, the lack of procedures forced Con Edison to extend the period to file a claim until December 31, 1999.

Con Edison customers across its service territory were not provided forms for making compensation claims. Indeed, no forms existed. Many Con Edison customers contacted their

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[192] Testimony of Martin Englisher, PSC Public Statement Hearing, August 31, 1999, p. 8.

[193] Testimony of Marcia Lemmon, PSC Public Statement Hearing, September 2, 1999, p. 197.

[194] Testimony of Jose Fernandez, of the Store Owners Association of Washington Heights, PSC Public Statement Hearing, August 31, 1999, p. 17.

public officials for guidance in securing compensation for their service interruption. A number of legislators created their own forms to facilitate the filing of claim forms by constituents.[195]

At the series of public statement hearings conducted by the Commission regarding the July, 1999 outages, public officials from various regions within Con Edison's service territory uniformly lamented the lack of information provided by Con Edison to community leaders. The Attorney General's Office also received numerous inquiries from Con Edison's customers regarding the procedures for filing a claim form.

C. Proposed Tariff Changes

Con Edison retains the power to change its tariff voluntarily. The PSC also has the authority to require changes.[196] Con Edison should increase the maximum amounts it makes available for compensation, $100 for residential customers and $2,000 for commercial customers, to reflect the current value of money. Con Edison should also increase its total liability from the 1973 level of $1,000,000.

Additionally, the limitation of compensation to "spoilage of food or medicine" serves to deny customer compensation for other actual losses. Con Edison should amend its tariff to include compensation for damage to air conditioning units, computers, electronic equipment, and other electrical appliances, which are commonplace today.

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[195] Testimony of Stanley Michels, PSC Public Statement Hearing, August 31, 1999, p. 24.

[196] PSL §§ 66(5) and 72.

One way to determine compensation would be to have a minimum amount to which each customer is automatically entitled and then to provide a mechanism for customers who believe that their damages are greater to claim an additional amount for repairs to damaged equipment.

Con Edison should also file a standard "Service Interruption Claim Form" as part of its published tariff. This form should clearly indicate an address for the customer to mail the form and a toll-free number for customer inquiries regarding service interruption reimbursement. Con Edison should make this form readily available, including posting it on its web-site, and forwarding a hard copy of the form to elected officials, police departments, and consumer protection agencies in Con Edison's service territory.

D. Additional Reimbursement To Customers

Con Edison's liabilities for service interruption were established a generation ago and as illustrated above do not properly compensate customers for actual losses, particularly in regard to computers and other electronic equipment and appliances. Con Edison should therefore immediately review customer compensation claims filed after the July outages and establish a program to upwardly supplement those refunds to reflect actual harm.

XI. CON EDISON'S RESPONSE TO THE JULY 1999 OUTAGES

Con Edison's two reports on the July 1999 outages, one by the company's Corporate Review Committee and the other by an Independent Review Board the company selected, [197] identified inadequacies in the company's preparation for the summer of 1999 and made 35 recommendations as to efforts Con Edison could undertake to address those inadequacies. On

[197] The conclusions and recommendations of the CRC and the IRB are summarized in Appendix B, below.

January 15, 2000, Con Edison issued an Action Plan that the company asserted responded to all of the recommendations the CRC and the IRB made in their reports.[198] By and large, Con Edison's Action Plan does respond to the CRC and IRB recommendations and, so far as we can judge, the efforts to which Con Edison commits should increase the reliability of the company's distribution system.

Con Edison indicates that it is undertaking concrete steps to remove from its distribution system components that in the summer of 1999 proved to be vulnerable to heat.[199] The company indicates that, system-wide, it is focusing on the removal of paper-insulated lead-sheath cable and replacing it with plastic-insulated cable less susceptible to heat stress. Changing the feeder sections to plastic-insulated cable has the additional benefit of eliminating two types of "stop joints" used to connect sections of paper-insulated cable.[200] Con Edison indicates that it suspects these types of "stop joints" are more prone to failure than the types of joints used to connect plastic cable.[201] Con Edison indicates that it is committed to giving first priority to removing such components from the eight networks that experienced multiple feeder cables failures in July 1999.[202]

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[198] Con Edison's Action Plan is summarized in Appendix C, below.

[199] Con Edison, Letter to Attorney General's Office, February 26, 2000.

[200] *Ibid.*

[201] *CRC Interview*, January 24, 2000.

[202] Con Edison identified the networks slated to receive priority equipments replacement as Washington Heights-Inwood, Cooper Square, Long Island City, Williamsburg, Richmond Hill, Fordham, Harrison, and Granite Hill. Con Edison, Letter to Attorney General's Office, February 26, 2000.

Con Edison further indicates that it used the most recent load data, from the summer of 1999, in planning its summer 2000 load relief, that it has replaced the faulty through-bushings at the Sherman Creek Substation, and that it has ensured that this type of through-bushing is not used at any other of its substations.[203]

Despite these indications of Con Edison's efforts, which we commend, we have concerns about some aspects of its plan of response to the outages of 1999. In particular, key components of Con Edison's Action Plan are couched in contingent terms, such as "investigating," "reviewing," or "evaluating." Thus, it is not clear that Con Edison has committed to carrying through to completion all of the efforts listed in its Action Plan.

We are concerned about the IRB's conclusion that, as currently designed, the company's underground distribution system crowds so many components into a limited space that the cumulative heat from the massed components may exceed the component's thermal tolerance when the distribution system is under high load.[204] Con Edison's Action Plan does not commit to carrying out a program to address the distribution system's design to prevent further potential overheating or to remove the thermal vulnerabilities that currently exist.[205]

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[203] Interview with John Miksad, Chief Engineer, Distribution Engineering Department, Con Edison, and William Longhi, currently Vice President of Operations, Orange & Rockland Utilities, Inc., and, from 1997 until December 1999, Chief Engineer, Distribution Engineering Department, Con Edison, January 25, 2000.

[204] *IRB Report*, pp. 6-8.

[205] We are concerned to note that Con Edison's peak load forecast for summer 2000 is 11,825 MW, which is 25 MW lower than the actual peak load at 1 p.m., July 6, 1999, which was 11,850 MW. Con Edison, Response to AG IR No. 26b.

We are also concerned that Con Edison has not committed to carrying out the IRB's recommendation that the company examine the feasibility of improving the reliability of service in Washington Heights-Inwood by breaking that network into two independent networks. [206]

XII. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

Last summer, many Con Edison customers lost electric power, and many more were put in jeopardy of losing service, because various components of its distribution system failed. Con Edison had enough power on hand and the means to transmit that power to each of its load areas. Con Edison did not withhold power from any neighborhood in order to supply another neighborhood. The equipment breakdowns, including the breakdowns that put all of Washington Heights-Inwood in the dark, occurred within geographical load areas: in the feeder cables, the distribution transformers to which they connect, the grid or loop that connects transformers to the customer, and, in at least one instance in Washington Heights-Inwood, in the connection between the substation and a feeder cable.

Con Edison entered the 1999 summer cooling season, the time of year when demand on the system is highest and the effects of heat on the system are most pronounced, with a distribution system containing numerous defective or inadequate components. When the weather got very hot in early July, components susceptible to failure were unable to withstand the high temperatures to which they were subjected by the combination of the hot weather itself and the heat generated by the large volume of electric current demanded by customers. As a result, many customers lost their electric power.

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[206] *IRB Report*, p. 14.

In preparation for the 1999 cooling season, Con Edison appears to have undertaken the usual weather forecasting, load prediction, Hi-Pot testing, feeder repair, load relief and distribution service quality reporting that it had undertaken in previous years. That preparation, while necessary, proved to be inadequate to prevent the blackout and outages which occurred.

Con Edison's distribution system had such an accumulation of components susceptible to failing in early July 1999 because:

* In designing its distribution system, Con Edison did not take sufficient account of or seek to minimize the effects of heat on underground components of the system, and did not adequately ensure that equipment was not placed too close together and was not otherwise exposed to excessive heat.

* In maintaining its distribution system, Con Edison did not take into account the fact that as a result of three summers in a row in which the overall temperatures were not as hot as usual, there were a greater number of components with weakened ability to withstand heat in the system, and Con Edison did not take adequate steps to identify, repair or replace such components.

* In maintaining its distribution system, Con Edison did not have adequate means to identify components that would be susceptible to failing when heated to the levels their immediate environment would reach during a heat wave.

* In maintaining its distribution system, Con Edison did not undertake an effort to develop a means to identify components most likely to fail and to replace such components.

* In maintaining its distribution system in Manhattan, Con Edison failed to use the most recent data, 1998, when planning load relief for 1999, and as a result, failed to adjust more than one hundred portions of the system to eliminate load bottlenecks.

* In repairing its distribution system, at least in the Washington Heights-Inwood neighborhood, Con Edison took too long to restore a failed feeder cable at a time when the network serving that neighborhood was at serious risk of a blackout.

The Washington Heights-Inwood blackout, as well as the other outages experienced by Con Edison customers in July 1999, appear to be the result of these design and maintenance

deficiencies. Based upon the information at hand, we are not able to conclude that the Washington Heights-Inwood network is unique or different from other Con Edison networks with regard to these deficiencies. The fact that design and maintenance problems endemic to Con Edison's distribution system led to a total blackout of this network only heightens the urgency for Con Edison to address these problems in Washington Heights-Inwood and elsewhere in its service territory. Con Edison's customers cannot be put in jeopardy, in the 21st century, of a reoccurrence of the events of July 1999.

B. Con Edison's Action Plan

Con Edison's January 15, 2000 Action Plan, based on the recommendations of the Corporate Review Committee and the Independent Review Board, while commendable, is deficient in important respects.

(1) Despite the importance of Con Edison's developing a test to identify distribution equipment that is vulnerable to heat, the Action Plan only commits the company to "research" the development of such a test without a target date for reporting results.

(2) Con Edison also lacks knowledge of the specific thermal conditions in much of its underground system. According to the IRB, Con Edison stated that it believes that Con Edison has the technology and most of the data it needs to create a computer model that would enable it to determine how hot undergrounded components are under different weather, load and other variable factors. Despite the prominence of this issue in both the CRC and the IRB reports, Con Edison has committed only "to investigate improvements to thermal modeling techniques."

(3) The Action Plan does not provide for a review of the Washington Heights-Inwood network to determine whether reorganizing that network into two free-standing networks would increase its reliability, a review suggested by the IRB**.**

(4) Con Edison has not committed to improving its policies, procedures and means of alerting and communicating with its customers, government, institutions or the public during power emergencies.

(5) Con Edison has made no commitment to increasing the amount of compensation for customer losses caused by the company's power outages or to enhancing the procedures for notifying customers about the opportunity of compensation and for processing such claims.

C. Recommendations

Based on our findings, we urge Con Edison to do the following:

* Con Edison should fully implement its Action Plan of January 15, 2000, which commits Con Edison to carrying out sixteen specific efforts to improve the reliability of its distribution system.[207]

* If Con Edison determines that any of the efforts proposed in its Action Plan cannot be accomplished or are impractical, it should publicly disclose its determination and propose an alternative means to achieve the same goal.

* Con Edison should redesign its distribution system to ensure that underground components are not overcrowded into limited space, creating greater susceptibility to heat; to ensure that components are not otherwise subject to excessive heat; and to ensure that all portions of its system can carry the load to which they will be subject during a summer heat wave.

* Con Edison should develop a test to identify distribution equipment with impaired heat resistance. If Con Edison determines that a practical test is not readily achievable in the near future, it should state so publicly and propose an alternative means to ensure that such defective equipment is identified and removed from its distribution system.

[207] The Action Plan is summarized in Appendix C.

* Con Edison should determine whether splitting the Washington Heights-Inwood network into two independent networks would improve the reliability of service in that neighborhood, and should report publicly the reasons for its decision.

* Con Edison should ensure that equipment repairs are carried out as quickly as possible whenever there is any indication that a network or any appreciable number of customers are at risk of losing service.

* Con Edison should aggregate by network, in a readily retrievable form, its records on capital improvements and maintenance expenditures for the four years prior to 1999 and make them publicly available. Going forward, Con Edison should aggregate its records on capital improvements and maintenance expenditures by network in a readily retrievable form and make them publicly available on an annual basis.

* Con Edison should aggregate its data regarding the dispatch of work crews during early July 1999 by network, in a readily retrievable form, and make that information publicly available. Going forward, Con Edison should aggregate such records by network in a readily retrievable format so that the information is readily accessible.

* Con Edison should report periodically to the communities affected by last July's blackouts and other outages on its progress in implementing the Action Plan and its other efforts to ensure and improve service reliability.

* Con Edison should improve its policies and procedures for alerting and informing its customers, government, institutions and the public during actual outages and when there is a serious risk of an outage.

* Con Edison should amend its tariff to increase the amount of compensation a customer can receive for losses due to a power outage, expand the definition of "losses" for which compensation can be provided, and improve its policies and practices for submission of claims by customers who suffer losses attributable to a power outage.

* With such a tariff revision in mind, Con Edison should review customer compensation claims filed after the July 1999 outages and upwardly supplement its refunds to reflect a revised tariff's compensation levels and loss definition.

* The PSC should review its distribution service quality standards for Con Edison to determine whether amending those standards would improve the reliability of Con Edison's electric service.

Every person, household, business, and institution that suffered through an outage during last July's heat wave, knows firsthand the hardship it caused. When outages assumed large-scale proportions, covering entire neighborhoods, and lasting for many hours, or even days, that hardship only increased. The outages of early July 1999 underscore the fact that the loss of electricity can cause physical and emotional distress, create significant financial losses, especially for small businesses, and, when widespread, threaten the public safety and welfare. In the twenty-first century, the millions of residents of New York City and Westchester depend upon electricity to light our streets; to power our homes, businesses, and hospitals; and to provide relief from oppressive and sometimes unhealthy heat. While some outages cannot be avoided, Con Edison must not run the risk of another major outage such as occurred last July. To do so is unacceptable. We urge Con Edison to heed the warning of the summer of 1999, and to ensure that this summer, everywhere in its service territory, the power stays on.

APPENDIX A

APPENDIX A

DOCUMENTS REVIEWED BY THE ATTORNEY GENERAL IN THE PREPARATION OF THIS REPORT

DOCUMENTS ISSUED OR PROVIDED BY CON EDISON

Corporate Documents

Action Plan For Washington Heights Network Shutdown Reports (January 15, 2000).

Annual Report to Stockholders, 1994-1999.

Annual Report of Consolidated Edison Company of New York, Inc. to the State of New York Public Service Commission, 1994-1999.

Annual Report on 1995 Electric Service (June 30, 1996).

Annual Report on 1996 Electric Service (March 31, 1997).

Annual Report on 1997 Electric Service (March 31, 1998).

Annual Report on 1998 Electric Service and Power Quality (March 31, 1999).

Substation Operations 1999-2003 Business Plan (December 11, 1998).

The Washington Heights Network Shutdown July 6, 1999, Report By The Corporate Review Committee (December 10, 1999).

Washington Heights Network Shutdown Of July 1999, Independent Review Board Report (December 10, 1999).

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Bill Insert, "To Our Customers," August 1999.

Brochure, "Con Edison's Manhattan Customer Service Control Center."

"Cable and Joint Failure Analysis," Operation and Maintenance of Cable Manual No. 2, EO-2088-2, April 10, 1984.

Customer Service Procedures:

Credit and Collections, Active Accounts, 3-1-8, April 14, 1995.

Electric Operations, General, 5-0-2, April 1, 1999.

"Design Criteria For Low Tension Network Splits And Transfers," Application and Design Manual No. 4, EO -5416 May 3, 1989).

Feeder Cable Data, 9/3/99.

Load Areas Maps, Plates I-VII, 1999

"Network Feeder Contingency Design," Application and Design Manual No. 4, EO-2073-2 (June 24, 1992).

1999 Summer Load Management Program (50% Automatic Load Shedding Priority Order, April 11, 1999.

Results of cable and joint autopsies conducted by Cable Technology Laboratories, Inc. September 28-29, 1999 and October 25-26, 1999, transformer tests by Con Edison on September 30 and October 1, 1999 and by General electric on November 1-4, 1999, together with miscellaneous documents produced by Con Edison and others concerning examination of cable, joint and transformer failures during July 1999.

System Operations Computer Control System Extension ("SOCCS-X") 1999 Summer Load Management Program, (50% Automatic Load Shedding Priority Order), July 30, 1999.

System Operation Department Procedures:

SO5-5-4, Criteria for Shutting Down an Area Substation, March 4, 1998.

SO5-9-7, Emergency Outage Requests, April 1, 1998.

SO5-12-6, Guide for Action in a Major Emergency, August 24, 1998.

SO5-13-7, Load Management Emergency Procedure, August 20, 1998.

SO5-14-3, Operating Reserve Deficiency Procedure, January 31,1995.

SO5-30-0, Radial Load Shedding, June 6, 1997.

SO16-1-4, Voltage Control, Bulk Power System, December 31, 1992.

System Operation Department Procedures: (continued)

SO5-17-5, Load Restoration after a Station Shutdown, January 1997.

CG2-2-9, CIG Notification for Possible Load Interruptions and/or Voltage Reduction, June 26, 1998.

CT2-4-11, CIG Notifications for Customer Outages & Voltage Reductions, January 12, 1999.

CG2-8-5, Notification for Bulk Power System Emergencies, March 1997.

"Testing of AC Feeders Operating at 2.4kV to 33kV, Revision 27," Distribution Engineering Department, Specification EO-4019, December 1998.

Selected Documents Prepared By Con Edison At The Attorney General's Request

Chart showing average feeder repair times in 1998 Con Edison wide and by division (February 9, 2000).

Chart showing customer outages by hour for the Cooper Square network on July 6 through 8, 1999 (February 14, 2000).

Chart showing network characteristics, including maximum designed load.

Chart showing Washington Heights network peak loads July 2 through 7, 1999 (February 14, 2000).

Chronologies for feeder outages on the Washington Heights, Cooper Square, Long Island City and Williamsburg networks

Discussion and chronology of the outages in Inwood and Washington Heights on July 6, 1999.

Letter to the Attorney General re: Con Edison preparation for summer 2000, February 26, 2000

List of distribution substation annual peak loads from 1995 through 1999.

List of feeder cable outages, January 1, 1999 - July 31, 1999.

List of feeder cables, with characteristics.

List of network annual peak loads from 1995 through 1999.

List showing number of feeders in each network.

List of system-wide annual peak loads from 1995 through 1999.

List of system-wide, distribution substation and network projected year 2000 peak loads.

List, Area Station Peak Loads (1995-1999).

New York State Attorney General Briefing Book (November 10, 1999).

Con Edison Press Releases

"Con Edison Projects Record Demand for Power This Summer; Increase Electric Use Driven by Healthy Economy," June 2, 1999.

"Con Edison Urges Washington Heights and Sections of Brooklyn and Queens to Reduce Their Use of Electricity," July 6, 1999, 11:00 a.m.

"Con Edison Hits a New Peak in Energy Usage," July 6, 1999, 1:10 p.m.

"Con Edison Reduces Voltage System-Wide," July 6, 1999, 3:00 p.m.

"Con Edison Urges Customers to Reduce Their Use of Electricity," July 6, 1999, 8:40 p.m.

"Con Edison to Brief Media on Washington Heights Outage," July 7, 1999, 8:15 a.m.

"Con Edison Creates Independent Board to Review Outage," July 9, 1999, 8:15 a.m.

"Statement Concerning July 6th Power Outages," July 14, 1999,10:55 a.m.

"Con Edison to Outline Preparations for Projected Weekend Heat Wave," July 16, 1999.

"Con Edison Advises Fordham Residents of System Status," July 18, 1999.

"Con Edison Notifica a los Residentes de Fordham Sobre el Estado del Sistema de Electricidad," July 18, 1999.

"Con Edison Asks Customers to Reduce Electricity Use," July 19, 1999.

"Claims Extension," July 21, 1999.

"Con Edison Releases Results Of review of July 1999 Outage In Washington Heights," December 10, 1999.

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Public Hearing, New York City Power Blackout Of July 6 And July 7, 1999, New York State Assembly Speaker Sheldon Silver, Assembly Standing Committee on Energy, Assembly Standing Committee on Corporations, Authorities & Commissions, Assembly Standing Committee on Ways and Means, and Assemblymember Adriano Espaillat, New York State Assembly, July 15, 1999 (New York, New York), 328 pages.

Public Statement Hearings, New York State Public Service Commission ("NYSPSC") Case No. 99-E-0930, Consolidated Edison Electric Service Interruptions:

1. Washington Heights, New York, New York, August 31, 1999, 3:00 p.m., 46 pages.

2. Washington Heights, New York, New York, August 31, 1999, 8:30 p.m., 97 pages.

3. 515 Audubon Avenue, New York, New York, September 1, 1999, 1:00 p.m., 36 pages.

4. Columbia Medical Center, New York, New York, September 1, 1999, 8:30 p.m., 11 pages.

5. One Penn Plaza, New York, New York, September 2, 1999, 8:30 p.m., 23 pages.

6. Queens Borough Hall, New York, New York, October, 12, 1999, 1:00 p.m., 13 pages.

7. Yonkers, New York, October, 13, 1999, 1:18 p.m., 48 pages.

Public Hearing, Committee on Consumer Affairs, City Counsel, City of New York, New York, New York, July 14, 1999, 193 pages.

LEGISLATIVE REPORTS

Oversight Hearings: Con Edison - The Heat Wave Blackout: What went Wrong?, Report of the Legal and Government Affairs Division to the Committee on Consumer Affairs, City Council, City of New York (July 14, 1999)`, 18 pages.

COURT AND ADMINISTRATIVE OPINIONS AND ORDERS

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Court of Appeals

Koch v. *Consolidated Edison Co. Of New York, Inc.*, 62 NY2d 548 (1984).

New York State Supreme Court

Food Pageant, Inc. v. *Con Edison*, 54 NY2d 167 (1st Dept 1981).

New York City Civil Court

Higgins v. *New York City Housing Authority et al.*, New York Law Journal, October 26, 1999, 31 (Civ. Ct. N.Y.).

Administrative Opinions And Orders

Opinion and Order Directing the Filing of Tariff Provisions by Consolidated Edison Company of New York, Inc. to Provide Compensation For Losses Due to Distribution System Interruptions, Opinion No. 73-20, NYSPSC Case No. 3729 - Consolidated Edison Company of New York, Inc. (issued July 10, 1973).

Opinion And Order Directing Refund Of Excessive Fuel Adjustment Charges, Opinion No. 82-2, NYSPSC Case 27869 - Consolidated Edison Company of New York, Inc. - Proceeding on motion of the Commission to investigate the outage of the Indian Point No. 2 Nuclear Generating Plant (issued January 21, 1982).

Opinion And Order Allowing Recovery Of Replacement Power Costs But Denying Other Expenses Related To The Outage, Opinion No. 84-23, NYSPSC Case 28166 - Proceeding on motion of the Commission to investigate the outage of Rochester Gas and Electric Corporation's Ginna Nuclear Plant (issued August 29, 1984).

Order Adopting Standards On Reliability And Quality Of Service, NYSPSC Case 90-E-1119 - Proceeding on Motion of the Commission as to consider establishing standards on Reliability and Quality of Electric Service (issued and effective July 2, 1991).

Order Adopting Changes To Standards On Reliability Of Service, NYSPSC Case 95-E-0165 - Proceeding on Motion of the Commission as to Proposed Changes to the Standards on Reliability and Quality of Electric Service filed in Case 90-E-1119 (issued and effective October 12, 1995).

Order Adopting Changes To Standards On Reliability And Quality Of Service, NYSPSC Case 96-E-0979 - Proceeding on Motion of the Commission as to Proposed Changes to the Standards on Reliability and Quality of Electric Service, filed in Case 90-E-1119 (issued and effective February 26, 1997).

Opinion And Order Adopting Terms Of Settlement Subject To Conditions And Understandings, Opinion No. 97-16, NYSPSC 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 PSL, Sections 70, 108 and 110, and Certain Related Transactions (and three consolidated cases) (issued and effective November 3, 1997).

Order Instituting Proceeding And Directing Staff Investigation, NYSPSC Case 99-E-0930 - Proceeding on Motion of the Commission to Investigate the July 6, 1999 Power Outage of Con Edison's Washington Heights Network (issued and effective July 16, 1999).

Tariffs

NYSPSC, Consolidated Edison Company of New York, Inc., Tariff P.S.C. No. 9 - Electricity:

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Original Leaf No. 63 (issued October 7, 1993 and effective January 1, 1994)

Original Leaf No. 64 (issued October 7, 1993 and effective January 1, 1994)

STATUTES

New York State Public Service Law § 25 - Penalties.

1884 New York Laws, Chapter 534, An Act in relation to telegraph and electric light companies in cities of this state.

1885 New York Laws, Chapter 499, An Act providing for placing electrical conductors underground in cities of this state and for commissioners of electrical sub-ways..

PROPOSED LEGISLATION

Assembly Bill 8981-A, An Act to amend the general municipal law, in relation to the recovery of damages by municipal corporations from public utility companies.

LEGAL PLEADINGS

"Complaint," *Rudolph W. Giuliani, as the Mayor of the City of New York, and the City of New York* v. *Consolidated Edison Company of New York, Inc.* (Sup. Ct., N.Y. Cty).

"Complaint," *Rudolph W. Giuliani, as the Mayor of the City of New York, the City of New York and the Board of Education of the City of New York* v. *Consolidated Edison Company of New York, Inc.* (Sup. Ct., N.Y. Cty).

"Answer," *Rudolph W. Giuliani, as the Mayor of the City of New York, the City of New York and the Board of Education of the City of New York* v. *Consolidated Edison Company of New York, Inc.* (Sup. Ct., N.Y. Cty).

"Complaint," *New York City Housing Authority* v. *Consolidated Edison Company of New York, Inc.* (Sup. Ct., N.Y. Cty).

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"State Accuses Con Edison of Polluting Waterways for 7 Years," The New York Times, July 21, 1994.

"Questions Linger About Cause of Blackout," The New York Times, July 8, 1999, p. B4.

"Thousands Lack Power, Mostly on Lower East Side," The New York Times, July 9, 1999, p. B5.

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APPENDIX B

APPENDIX B

CON EDISON'S REPORTS

After the events of early July 1999, Con Edison undertook an internal inquiry and also arranged for an outside review. On December 10, 1999, Con Edison issued the reports resulting from each of these inquiries. One report,[1] was produced by an internal Corporate Review Committee ("CRC") composed of retired Con Edison managers.[2] The other[3] was written by three outside experts (the "Independent Review Board" or "IRB") the company selected.[4] Con Edison has used these reports to develop an "Action Plan"[5] to eliminate or at least reduce the technical deficiencies that led to last summer' electric power outages in New York City and Westchester County. *See* Appendix C.

Report By The Corporate Review Committee

In *The Washington Heights Network Shutdown July 6, 1999, Report By The Corporate Review Committee* (December 10, 1999) ("*CRC Report*"), the CRC describes Con Edison's

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[1] Con Edison, *The Washington Heights Network Shutdown July 6, 1999, Report By The Corporate Review Committee* (December 10, 1999).

[2] The CRC members are Peter Zarakas and Charles Durkin, both former Vice Presidents of Con Edison and John Tully, formerly General Manager of Electric Operations in Manhattan for the company.

[3] *Washington Heights Network Shutdown Of July 1999* (December 10, 1999).

[4] The IRB members are: Dr. Allen Greenwood, professor of Electric Power Engineering, Rensselaer Polytechnic Institute, Troy, New York; Dr. Gerald L. Wilson, Vannevar Bush Professor of Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts; and Lionel O. Barthold, Chairman and Principal Consultant, Power Technologies, Schenectady, New York.

[5] Con Edison, *Action Plan for Washington Heights Network Shutdown Reports* January 15, 2000) ("*Action Plan*").

systems, sets out a narrative of the technical events in the Washington Heights-Inwood network from Sunday, July 4, 1999 through the network blackout at 10:11 p.m. on Tuesday, July 6,1999, makes an analysis of the blackout, and states conclusions and recommendations applicable to Con Edison's entire system. The CRC discusses the tools Con Edison's operators had for monitoring network conditions, the models the company uses to estimate the capabilities of its networks and their components, the defects in Con Edison's operation of its distribution system and the damage that occurred in that system last July.

Based on its analysis, the CRC included in its Report nine conclusions and eighteen recommendations.

The CRC's Conclusions. The CRC Report concluded that: (1) the Washington Heights-Inwood blackout was cause by "events ... uniquely combined,"[6] (2) the problems with the Washington Heights-Inwood network had no effect on any other Con Edison load area, (3) during the distribution feeder outages in early July 1999 Con Edison did everything it could at that time to avoid the blackout, and (4) Con Edison can reduce the likelihood of another blackout by improving its equipment and operations.

The CRC Recommendations. The CRC's major recommendation was that the lessons Con Edison learned at Washington Heights-Inwood should be applied to the company's entire operations. The CRC's specific recommendations included (1) use the most current data when preparing for summer, (2) improve Con Edison's ability to determine the suitability of cable and other equipment for actual network conditions, (3) improve protective relays to better protect functioning feeder cables from faults in other feeders, (4) shorten the time Con Edison takes to

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[6] *CRC Report*, p. ES-3.

put a malfunctioning feeder cable back into operation, (5) consider segmenting feeder cable so that portions can be shut down to protect the rest from a fault, (6) improve the company's ability to monitor and control networks, (7) eliminate the equipment whose lose connections caused the short circuit and fire that forced the shutdown of the Washington Heights-Inwood network, (8) make cables less susceptible to failures in splices, (9) improve network operators' ability to respond to emergencies, (10) consolidate and improve cable management programs, (11) look for cable testing and fault detection method that don't risk damaging equipment, and (12) improve testing of distribution transformers.

Report By The Independent Review Board

In the *Washington Heights Network Shutdown July 6, 1999* (December 10, 1999) ("*IRB Report*"), the IRB covered the same events and issues as the CRC, although in much less detail and mostly conclusory fashion.

The IRB's Conclusions. The IRB concluded that: (1) the blackout was not due to a shortage of electric power, (2) Con Edison designed and maintained the Washington Heights-Inwood network to the meet the same reliability criteria as the company's other networks, (3) like other residential networks, the Washington Heights-Inwood network is less amenable to dropping large blocks of demand as a means of maintaining service to the network, (4) network feeder outages caused the blackout, (5) the network feeder outages had several different causes, (6) not all of the network feeder outages were crucial to the blackout, and (7) avoiding certain feeder outages might have enabled Con Edison to avoid the Washington Heights-Inwood blackout.

The *IRB Report* addressed technical problems the authors found throughout Con Edison's distribution system and identified problems with (1) Con Edison's methods of predicting its

distribution system's ability to withstand heat, (2) the company's written guidelines for responding to conditions that might put a network out of service, (3) Con Edison's efforts to protect distribution equipment from moisture, and (4) the company's process for identifying and remedying potential load bottlenecks.

The IRB Report concluded that the Washington Heights-Inwood blackout was due to technical limitations and flaws in the network, rather than in Con Edison's immediate responses to the feeder cable crises that led to the blackout.

The IRB's Recommendations. The IRB urges that Con Edison:

(1) revise its methods for predicting local heat levels in its underground distribution system and consider monitoring actual temperatures in most of that system;

(2) evaluate "over-temperature" testing methods and undertake a program of testing the reliability of older cable and splices under high local temperatures;

(3) evaluate testing all of its distribution feeders periodically;

(4) research how moisture causes paper insulated cable and joints in such cable to fail, and evaluate the relative risk that Hi-Pot tests and high temperature pose for paper-insulated and all other types of cable;

(5) evaluate the cost-effectiveness of methods of reducing the number of faults caused by moisture intrusion in the splices in paper-insulated cable;

(6) minimize the number of joints connecting paper-insulated cable with other types of cable;

(7) install distribution cable, transformers and circuits with generous load carrying capacity so as to minimize local heat generation during hot weather;

(8) increase its inspecting of manholes;

(9) shorten the time it takes to repair a feeder cable;

(10) repair or replace protective relays that do not isolate functional feeder cables from faulted feeders;

(11) consider separating the Washington Heights-Inwood network into two independent networks or installing a means of separating the two portions to avoid complete blackouts;

(12) provide network operators with more specific guidelines for extreme situations, ensure that there is no potential overload under second contingency conditions, and add transformer capacity if a distribution transformer must be sprayed with water or submerged before there is a third contingency condition;

(13) make Washington Heights-Inwood the first recipient of any company effort to reduce the likelihood of a recurrence of the July 1999 outages; and

(14) complete by January 15, 2000 an action plan for reducing the likelihood of a repeat of July 1999 and take aggressive action to ensure that its distribution system is significantly more resilient by the summer of 2000.

The IRB also noted that:

(1) while implementation of the *IRB Report's* recommendations will reduce the likelihood of another network blackout, there is no way to totally guarantee that another blackout will not happen;

(2) given Con Edison's size, it will take years to realize a significant benefit system-wide from changing equipment;

(3) shorter-term benefits would be realized from Con Edison's improving its method of predicting heat conditions in its distribution system, elimination of potential bottlenecks in its distribution cables, and reviewing and revising operating procedures; and

(4) the shortest-term benefits would be realized from Con Edison's (i) developing and using a method that finds distribution system faults faster, more efficiently and in a manner less likely to damage equipment, (i) shortening the time it takes to repair distribution equipment, (iii) remedying certain protective relay flaws, and (iv) improving operating procedures.

APPENDIX C

APPENDIX C

Consolidated Edison Action Plan For Washington Heights Network Shutdown Reports

Con Edison indicated in its *Action Plan For Washington Heights Network Shutdown Reports* (January 15, 2000) ("*Action Plan*")[1] that the Plan would address all of the recommendations the Con Edison Corporate Review Committee ("CRC")[2] and the Independent Review Board ("IRB")[3] the company selected made in their reports.[4] Specifically, Con Edison company proposed to carry out sixteen efforts responsive to the CRC and IRB recommendations. In its *Action Plan*, Con Edison organizes these efforts under four headings - "Design" (seven action items), "Operations" (four action items), "Restoration" (two action items) and "Test" (three action items). The company characterized each action item as either short-term, long-term or both. "Short-term" means that Con Edison expects to complete the effort before summer 2000.[5] The *Action Plan* classified five action items as short-term, three as long-term and eight as a combination of short-term and long-term efforts.

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[1] *Action Plan*, p. 2.

[2] The CRC members are Peter Zarakas and Charles Durkin, both former Vice Presidents of Con Edison and John Tully, formerly General Manager of Electric Operations in Manhattan for the company

[3] The IRB members are: Dr. Allen Greenwood, professor of Electric Power Engineering, Rensselaer Polytechnic Institute, Troy, New York; Dr. Gerald L. Wilson, Vannevar Bush Professor of Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts; and Lionel O. Barthold, Chairman and Principal Consultant, Power Technologies, Schenectady, New York.

[4] Con Edison, *The Washington Heights Network Shutdown July 6, 1999, Report By The Corporate Review Committee* (December 10, 1999), and *Washington Heights Network Shutdown Of July 1999* (December 10, 1999).

[5] *Action Plan*, p. 2.

The *Action Plan* included efforts intended to eliminate from Con Edison's distribution system components that have caused or are suspected of causing power outages and to prevent installation of such components (action items 1, 4, 7, 11, 14 and 15), to improve methods of determining which distribution system components can function properly at temperatures likely to occur underground (action items 2, 3 and 13), to monitor what is happening in the distribution system underground (action items 6 and 10), to increase Con Edison's control of certain distribution feeders (action item 5), to improve the company ability to respond to distribution system emergencies (action items 8, first 9 and second 9)[6] and to shorten the time needed to repair a distribution feeder (action item 12). The action items range in complexity and level of effort from the simple and quick (action item 11: replacement of the Sherman Creek Substation through-bushings involved in the July 6, 1999, Washington Heights-Inwood blackout) to original research that may take years (action item 13: development of a means of testing the underground distribution system for components that may fail if subjected to temperatures likely to be encountered in actual operations).

During a half-day interview by this office on January 25, 2000, John Miksad,[7] the Con Edison manager responsible for implementing the *Action Plan*, and William Longhi, a Con Edison manager largely responsible for developing the *Action Plan*,[8] indicated that the company has completed two action items, (1) the use of the most recent load data when determining which distribution system components need to have their ability to carry current improved before next

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[6] *Action Plan*, pages 8 and 9.

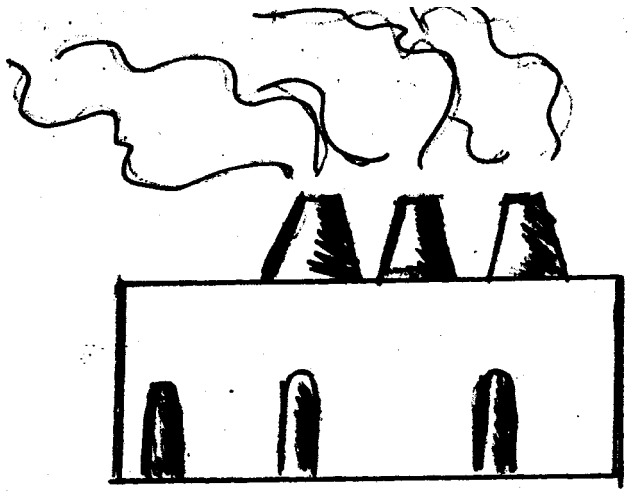
[7] Chief Engineer, Distribution Engineering Department, Con Edison.

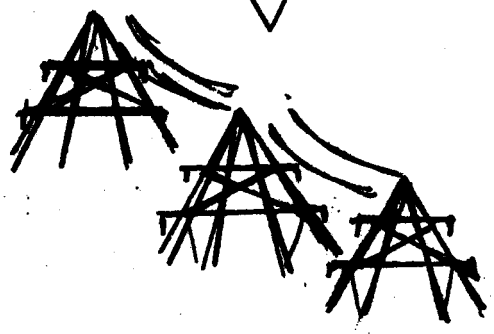
[8] Currently Vice President for Operations, Orange and Rockland Utilities, Inc., and from 1997 until December 1999, Chief Engineer, Distribution Engineering Department, Con Edison.

summer (action item 1) and (2) the replacement of the Sherman Creek Substation through-bushings and an inspection to assure that Con Edison does not use this equipment elsewhere (action item 11). Messrs. Miksad and Longhi further indicated that the company had taken significant steps toward implementing the other fourteen efforts included in the *Action Plan.*

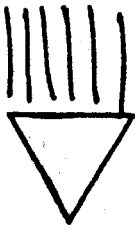
APPENDIX D

Electric Power Supply



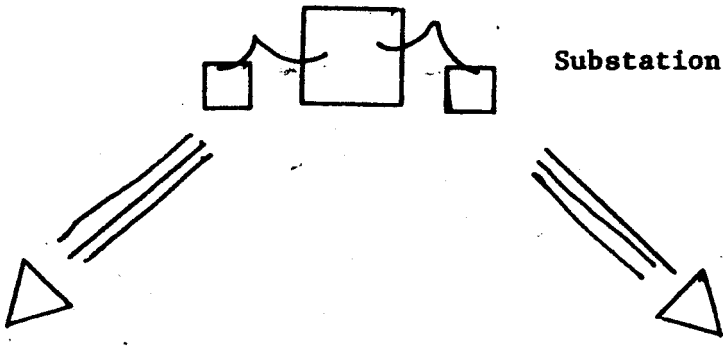


Transmission System



Load Area

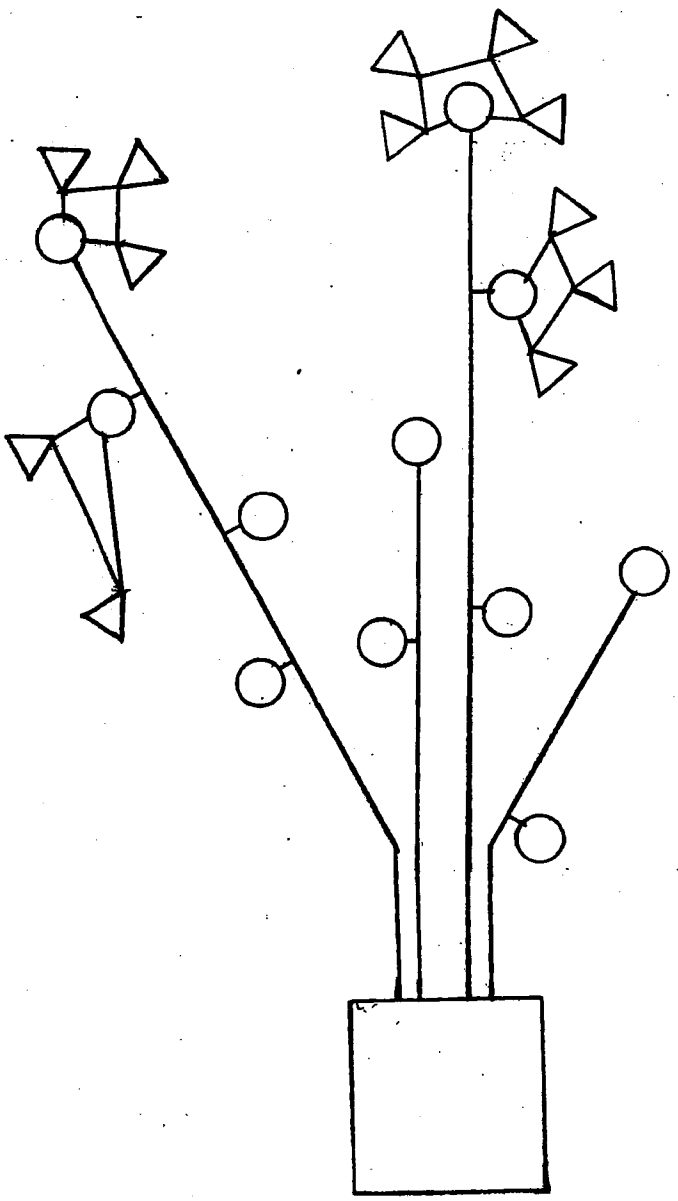
Distribution System



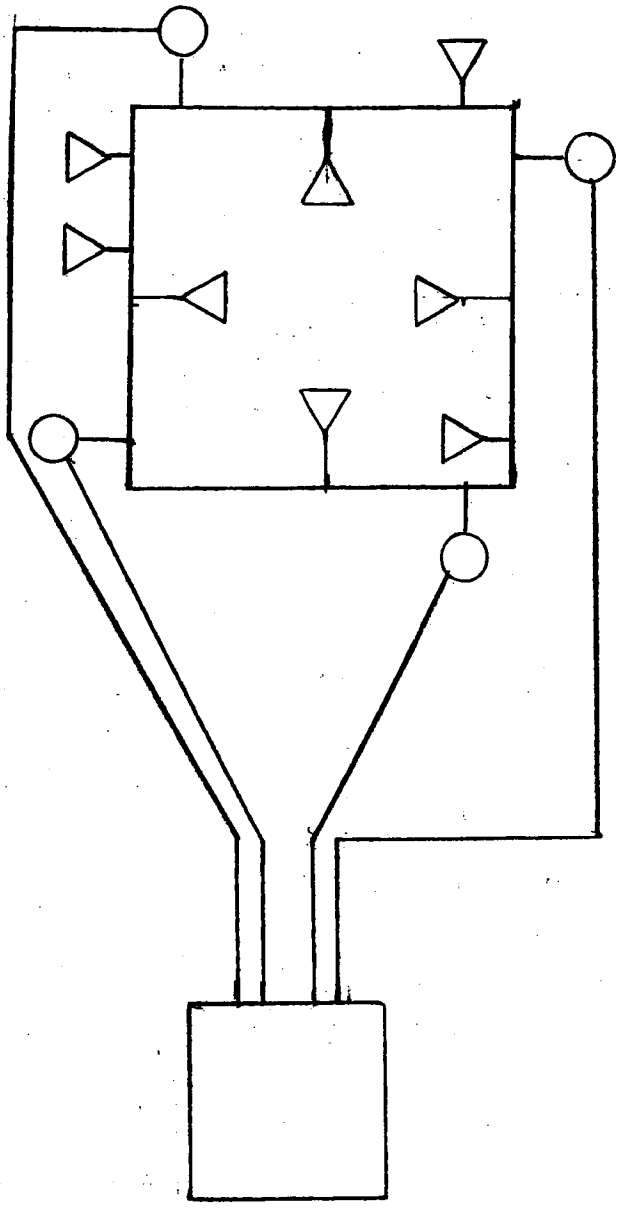
Substation

APPENDIX E

ELECTRIC DISTRIBUTION LOAD AREAS
DIAGRAMS - SIMPLIFIED



RADIAL LOAD AREA



NETWORK LOAD AREA

— Feeder Cables & Distribution Lines

△ Customers

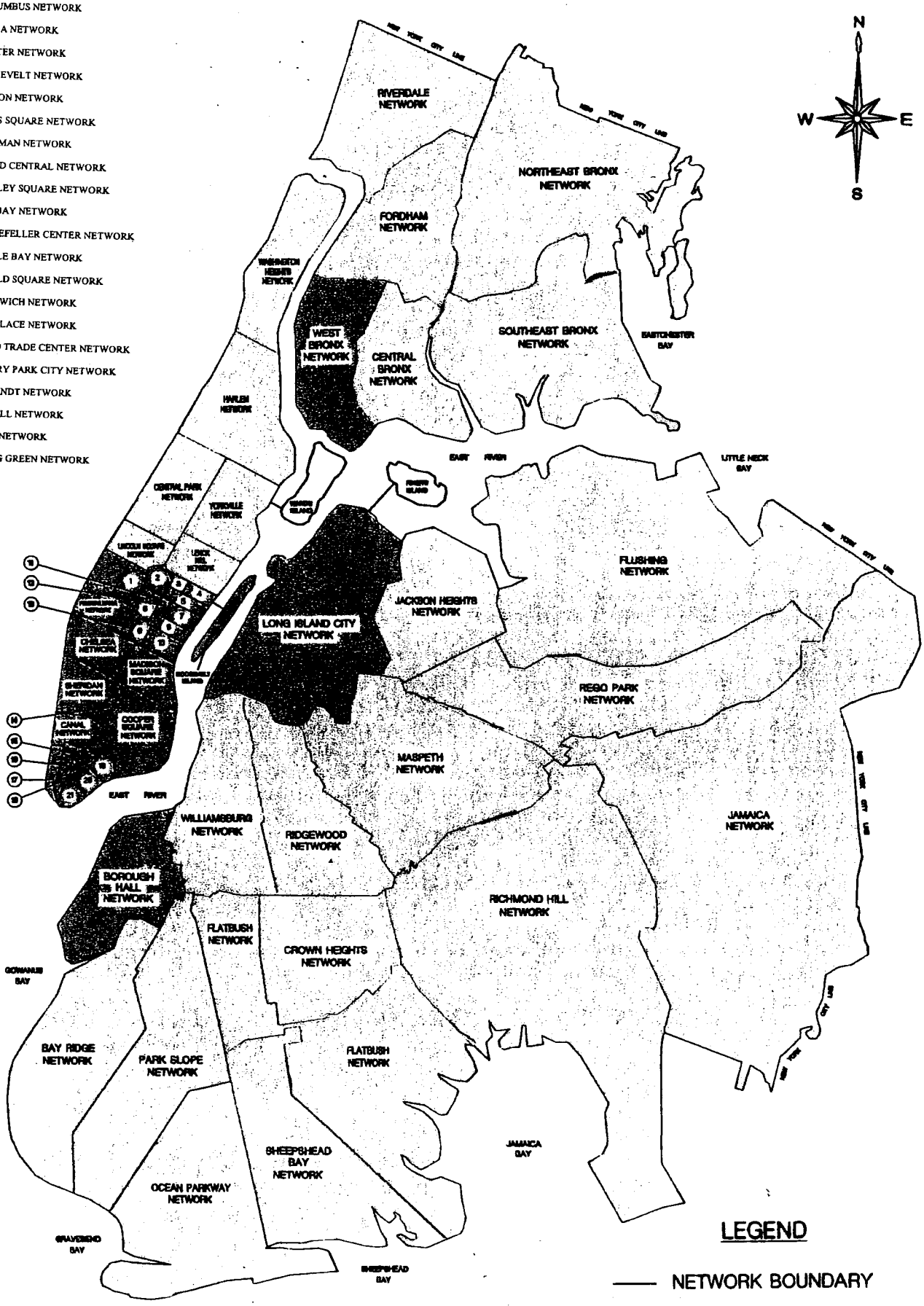
○ Transformers

□ Substations

APPENDIX F

ELECTRIC NETWORK DISTRIBUTION SYSTEM

1. COLUMBUS NETWORK
2. PLAZA NETWORK
3. HUNTER NETWORK
4. ROOSEVELT NETWORK
5. SUTTON NETWORK
6. TIMES SQUARE NETWORK
7. BEEKMAN NETWORK
8. GRAND CENTRAL NETWORK
9. GREELEY SQUARE NETWORK
10. KIPS BAY NETWORK
11. ROCKEFELLER CENTER NETWORK
12. TURTLE BAY NETWORK
13. HERALD SQUARE NETWORK
14. GREENWICH NETWORK
15. PARK PLACE NETWORK
16. WORLD TRADE CENTER NETWORK
17. BATTERY PARK CITY NETWORK
18. CORTLANDT NETWORK
19. CITY HALL NETWORK
20. FULTON NETWORK
21. BOWLING GREEN NETWORK



Source: Con Edison

APPENDIX G

Con Edison's Networks Ranked By Customers Served

Table 1

Network Name	Number Of Customers	Rank Of 55
Long Island City	119,935	1
Flushing	99,161	2
Boro Hall	98,956	3
Ocean Pkwy	97,037	4
Park Slope	90,576	5
Jamaica	87,888	6
Fordham	80,709	7
Williamsburg	80,579	8
Harlem	78,258	9
Central Park	76,712	10
Flatbush	76,641	11
Yorkville	75,941	12
Rego Park	74,398	13
Bay Ridge	73,307	14
Maspeth	70,495	15
Washington Hts	***68,888***	***16***
Richmond Hill	66,355	17
Ridgewood	65,939	18
Sheepshead Bay	64,926	19
West Bronx	64,533	20
Jackson Hts.	64,071	21
Cooper Sq.	64,066	22
Crown Hts	58,666	23
Lenox Hill	48,072	24
Central Bronx	44,271	25
SE Bronx	39,844	26
Sheridan Sq.	39,655	27
NE Bronx	31,500	28
Madison Sq.	28,501	29
Riverdale	26,937	30
Chelsea	25,810	31
Kips Bay	23,047	32
Columbus Cir.	20,912	33
Lincoln Sq.	18,396	34
Greenwich	10,393	35
Beekman	10,227	36
Sutton	9,774	37
Pennsylvania	8,269	38
Roosevelt	6,674	39
Plaza	6,213	40
Canal	6,114	41
Greeley Sq.	5,163	42
City Hall	3,921	43
Grand Central	3,819	44
Park Pl.	3,618	45
Battery Park	3,255	46
Times Square	2,703	47
Hunter	2,398	48
Fulton	1,747	49
Bowling Green	1,627	50
Turtle Bay	1,139	51
Cortlandt	1,127	52
Herald Sq.	860	53
Rockefeller Ctr.	223	54
World Trade Ctr.	6	55
Total	2,234,252	
Average	40,623	

Source: Con Edison Response to AG I.R. No. 3a

Con Edison's Networks Ranked By Design Load **Table 2**

Network Name	Design Max Load (MW)	Rank Of 55	Historic Peak Load (MW)
Long Island City	775	1	353
Boro Hall	584	2	258
Rego Park	520	3	298
Flushing	514	4	378
Harlem	488	5	255
Fordham	474	6	214
Madison Sq.	460	7	266
Yorkville	442	8	291
Jamaica	432	9	398
Ocean Pkwy	427	10	286
Pennsylvania	425	11	219
Williamsburg	410	12	181
Chelsea	407	13	224
Grand Central	387	14	218
West Bronx	379	15	158
Bay Ridge	375	16	207
Maspeth	371	17	199
Richmond Hill	369	18	288
Lenox Hill	365	19	251
Cooper Sq.	363	20	233
Park Slope	357	21	251
Bowling Green	343	22	141
Crown Hts	326	23	179
Fulton	324	24	133
Ridgewood	317	25	160
Plaza	315	26	174
Times Square	310	27	157
Sutton	304	28	161
Sheridan Sq.	288	29	153
City Hall	288	29	130
Washington Hts.	***277***	***31***	***155***
Flatbush	277	31	258
Central Park	275	33	214
Jackson Hts.	267	34	165
Central Bronx	260	35	112
Turtle Bay	259	36	132
Beekman	254	37	138
Sheepshead Bay	252	38	186
Columbus Cir.	243	39	138
SE Bronx	234	40	187
Cortlandt	232	41	93
Greeley Sq.	217	42	117
Herald Sq.	217	42	108
Kips Bay	212	44	112
NE Bronx	185	45	152
Rockefeller Ctr.	183	46	93
Roosevelt	161	47	58
Riverdale	158	48	78
Hunter	149	49	85
Park Pl.	144	50	67
Canal	135	51	87
Lincoln Sq.	127	52	127
Greenwich	111	53	54
Battery Park	91	54	62
World Trade Ctr.	n/a	55	87
Total	17,059		
Average	316		180

Source: Con Edison Response to AG I.R. No. 3a

Con Edison's Networks Ranked By Geographic Size

Table 3

Network Name	Area (Sq. Miles)	Rank 0f 55
Flushing	9.80	1
Richmond Hill	9.50	2
Maspeth	8.80	3
Jamaica	8.60	4
Long Island City	8.60	4
Rego Park	7.90	6
Flatbush	7.50	7
Ocean Pkwy	6.40	8
Park Slope	6.00	9
Fordham	5.87	10
Sheepshead Bay	5.10	11
Crown Hts	4.50	12
SE Bronx	4.42	13
Ridgewood	4.20	14
Bay Ridge	4.20	14
Central Bronx	4.09	16
Williamsburg	3.90	17
West Bronx	3.79	18
Jackson Hts.	3.70	19
Harlem	3.62	20
Washington Hts	***2.79***	***21***
Boro Hall	2.50	22
NE Bronx	2.17	23
Cooper Sq.	1.90	24
Yorkville	1.53	25
Riverdale	1.28	26
Central Park	1.23	27
Chelsea	0.99	28
Sheridan Sq.	0.88	29
Pennsylvania	0.87	30
Madison Sq.	0.82	31
Lenox Hill	0.68	32
Lincoln Sq.	0.52	33
Columbus Cir.	0.39	34
Roosevelt	0.39	34
Beekman	0.36	36
Canal	0.35	37
Greeley Sq.	0.25	38
City Hall	0.24	39
Kips Bay	0.24	39
Greenwich	0.20	41
Battery Park	0.18	42
Grand Central	0.18	42
Sutton	0.18	42
Times Square	0.17	45
Park Pl.	0.16	46
Plaza	0.15	47
Cortlandt	0.15	47
Fulton	0.14	49
Bowling Green	0.11	50
Herald Sq.	0.09	51
Hunter	0.09	51
Turtle Bay	0.08	53
Rockefeller Ctr.	0.04	54
World Trade Ctr.	0.04	54
Total	142.83	55
Average	2.60	

Source: Con Edison Response to AG I.R. No. 3a

Con Edison Number Of Feeder Cables In Each Network

Table 4

Newtwork Name	Number Of Cables	Rank Of 55
Yorkville	28	1
Jamaica	28	1
Madison Square	24	3
Fulton	24	3
Flushing	24	3
Cooper Square	24	3
Chelsea	24	3
Pennsylvania	23	8
Long Island City	22	9
Borough Hall	22	9
Lenox Hil	21	11
City Hall	21	11
Harlem	21	11
Grand Central	20	14
Fordham	20	14
Southeast Bronx	19	16
Wiliamsburg	18	17
Plaza	18	17
Crown Heights	16	19
Beekman	16	19
Park Slope	16	19
Times Square	16	19
Rego Park	16	19
Richmond Hill	16	19
Flatbush	16	19
Bowling Green	16	19
Central Park	16	19
Maspeth	15	28
Ocean Parkway	15	28
Central Bronx	15	28
Cortlandt	15	28
Washington Heights	***14***	***32***
Columbus Circle	14	32
West Bronx	12	34
Turtle Bay	12	34
Sutton	12	34
Rockefeller Center	12	34
Roosevelt	12	34
Sheepshead Bay	12	34
Ridgewood	12	34
Park Place	12	34
Bay Ridge	12	34
Canal	12	34
Greeley Square	12	34
Herald Square	12	34
Hunter	12	34
Kips Bay	12	34
Sheridan Square	12	34
Lincoln Square	11	49
Northeast Bronx	11	49
Jackson Heights	10	51
Riverdale	10	51
Battery Park City	8	53
Greenwich	8	53
World Trade Center	8	53
Total	879	55
Average	16.0	

Source: Con Edison Response to AG I.R. No. 4a

Con Edison's Networks Ranked By Average Feeder Cable Length

Table 5

Name	Avg.Miles/Feeder	Rank
Ridgewood	13.00	1
Ocean Pkwy	12.99	2
Rego Pk.	12.84	3
Long Island City	12.41	4
Flushing	12.35	5
Flatbush	12.18	6
Maspeth	11.96	7
Riverdale	11.38	8
Sheepshead Bay	10.73	9
Bay Ridge	10.64	10
Richmond Hill	10.64	11
6.9689473684211	10.64	12
Jackson Hts	10.46	13
Jamaica	10.12	14
Park Slope	9.77	15
Williamsburg	9.67	16
Central Bronx	9.28	17
Crown Hts.	8.80	18
Fordham	8.07	19
Harlem	7.20	20
SE Bronx	7.01	21
Yorkville	6.95	22
NE Bronx	6.87	23
Washington Hts.	***6.65***	***24***
Borough Hall	5.74	25
Sheridan Sq.	4.84	26
Central Pk.	4.40	27
Cooper Sq.	4.09	28
Greeley Sq.	3.46	29
Bowling Grn.	3.32	30
Turtle Bay	3.31	31
Rockefeller Ctr.	3.28	32
Sutton	3.28	33
Lennox Hill	3.26	34
Greenwich	3.08	35
Pennsylvania	2.95	36
Herald Sq.	2.93	37
Lincoln Sq.	2.82	38
Madison Sq.	2.73	39
Plaza	2.73	40
Times Sq.	2.70	41
Columbus Cir.	2.58	42
Kips Bay	2.55	43
Chelsea	2.52	44
Roosevelt	2.40	45
Grand Central	2.34	46
City Hall	2.22	47
Canal	1.88	48
Beekman	1.69	49
Cortlandt	1.59	50
Hunter	1.52	51
Fulton	1.28	52
Park Pl.	1.24	53
Battery Pk. City	1.14	54
World Trade Ctr.	1.12	55
Total	5,300.97	
Average	6.05	

Source: Con Edison Response to AG I.R. No. 4a

APPENDIX H

NETWORKS WITH FEEDER CABLES IN
THE WORST-PERFORMING 5%
MANHATTAN
1998[1]

Network	# of Feeder Cables in Network	# of Feeder Cable Failures	# of Feeder Cables That Failed[2]	# of Feeder Cables in Worst 5%
Yorkville	28	23	15	1
Chelsea	24	28	13	2
Madison Square	24	18	10	2
Pennsylvania	23	18	11	1
City Hall	21	19	10	2
Harlem	21	28	14	3
Grand Central	20	19	14	1
Plaza	18	18	12	3
Cortlandt	15	8	5	1
Washington Heights	14	16	8	3
Canal	12	12	7	1
Herald Square	12	10	7	1
Sheridan Square	12	9	6	1
Sutton	12	18	9	3
Lincoln Square	11	10	7	1

[1] Con Edison, *Annual Report on 1997 Electric Service,* March 31, 1999.

[2] There is a discrepancy in most networks between the number of feeder cable failures and the number of feeder cables that failed because one or more feeder cables in the network failed more than once.

NETWORKS WITH FEEDER CABLES IN
THE WORST-PERFORMING 5%
MANHATTAN
1997[1]

Network	# of Feeder Cables in Network	# of Feeder Cable Failures	# of Feeder Cables That Failed[2]	# of Feeder Cables in Worst 5%
Yorkville	28	24	16	2
Chelsea	24	20	14	1
Cooper Square	24	18	10	1
Fulton	24	9	7	1
Pennsylvania	23	15	11	2
City Hall	21	16	10	3
Harlem	21	25	15	2
Lenox Hill	21	19	9	1
Grand Central	20	19	11	1
Central Park	16	21	10	3
Times Square	16	8	6	1
Greeley Square	12	24	11	2
Herald Square	12	8	6	1
Hunter	12	10	9	1
Rockefeller Center	12	11	8	1
Sheridan Square	12	13	9	1
Sutton	12	9	5	1
Greenwich	8	7	4	1

[1] Con Edison, *Annual Report of 1997 Electric Service*, March 31, 1998.

[2] There is a discrepancy in most networks between the number of feeder cable failure failures and the number of feeder cables that failed because one or more feeder cables in the network failed more than once.

APPENDIX I

TABLE 1

(THOUSANDS OF DOLLARS)

SYSTEM REINFORCEMENT

1998 CAPITAL EXPENDITURES

	BRONX	BROOKLYN	MANHATTAN	QUEENS	STATEN ISLAND	WEST-CHESTER	TOTAL
RELIEF							
Area Substations	$0	$0	$0	$0	$0	$217	$217
Primary Feeders	$3,009	$1,203	$8,100	$299	$8	$702	$13,320
4KV Substations	$0	$0	$0	$0	$8	$2	$10
4KV Feeders	$2	$0	$0	$0	$0	$7	$9
Transformers & Sec	$1	$2,269	$6,232	$0	$0	$0	$8,502
<$100K Load Relief	$2,493	$1,616	$392	$4,021	$2,894	$3,861	$15,278
	$5,504	$5,088	$14,724	$4,320	$2,910	$4,790	$37,336
RELIABILITY							
Paper Cable	$202	$1,490	$224	$1,112	$0	$128	$3,156
Remote Monitoring [illegible]	$0	$128	$213	$0	$0	$0	$340
Multibank Retirement	$0	$0	$0	$0	$0	$1,894	$1,894
Substation Retirement	$0	$0	$0	$0	$0	$1,443	$1,443
Defective Aerial Cat	$0	$0	$0	$0	$0	$624	$624
Hi-Pot Program	$42	$2,182	$2,047	$151	$0	$0	$4,421
General Improvements	$33	$1,116	$567	$614	$242	$55	$2,628
	$277	$4,915	$3,051	$1,876	$242	$4,144	$14,506
Total	$5,781	$10,004	$17,775	$6,197	$3,152	$8,933	$51,842

1998 MAINTENANCE EXPENDITURES

	BRONX	BROOKLYN	MANHATTAN	QUEENS	STATEN ISLAND	WEST-CHESTER	TOTAL
Tree Trimming	$266	$454	$0	$870	$710	$4,658	$6,958
CINDE	$1,639	$1,286	$4,851	$1,629	$412	$725	$10,541
CIMOES	$41	$640	$1,110	$457	$51	$192	$2,490
OH Inspection & Maintenance	$107	$97	$0	$302	$459	$1,120	$2,085
	$2,053	$2,477	$5,961	$3,257	$1,632	$6,695	$22,074

Source: Con Edison, "Annual Report on 1998 Electric Service and Power Quality," March 31, 1999, p. 1-8.

TABLE 1

(THOUSANDS OF DOLLARS)

SYSTEM IMPROVEMENT

1997 CAPITAL EXPENDITURES

	BRONX	BROOKLYN	MANHATTAN	QUEENS	STATEN ISLAND	WEST-CHESTER	TOTAL
RELIEF							
Area Substations	$0	$0	$0	$0	$0	$0	$0
Primary Feeders	$768	$2,690	$4,771	$60	$1	$2,528	$10,818
4KV Substations	$0	$0	$0	$0	$1,191	$0	$1,191
4KV Feeders	$207	$0	$0	$0	$1	$287	$496
Net Transf & Sec Mains	$38	$4,124	$8,984	$5	$0	$0	$13,150
<$100K Relief & Other	$2,049	$1,866	$548	$3,303	$4,017	$3,350	$15,133
subtotal	$3,062	$8,680	$14,302	$3,368	$5,211	$6,166	$40,788
RELIABILITY							
Paper Cable	$3	$219	$1,032	$830	$0	$0	$2,085
Remote Monitoring NWP	$0	$400	$178	$0	$0	$0	$578
Multibank Retirement	$1	$74	$0	$0	$0	$42	$118
Obsolete NWP	$0	$0	$3	$0	$0	$0	$3
Special Projects	$989	$0	$949	$0	$5	$0	$1,944
Substation Retirement	$0	$0	$0	$0	$0	$1,298	$1,298
Defective Aerial Cable	$0	$0	$0	$0	$0	$455	$455
Hi-Pot Program	$264	$1,783	$2,858	$796	$0	$0	$5,702
General Improvements	$217	$196	$323	$124	$41	$155	$1,055
subtotal	$1,475	$2,672	$5,343	$1,750	$46	$1,949	$13,236
TOTAL	$4,537	$11,352	$19,645	$5,118	$5,257	$8,115	$54,024

1997 MAINTENANCE EXPENDITURES

	BRONX	BROOKLYN	MANHATTAN	QUEENS	STATEN ISLAND	WEST-CHESTER	TOTAL
Tree Trimming	$205	$386	$0	$740	$392	$3,170	$4,893
CINDE	$1,392	$477	$3,898	$1,612	$295	$503	$8,178
CIMOES	$97	$303	$862	$234	$29	$240	$1,765
OH Insp & Maintenance	$159	$68	$0	$211	$514	$516	$1,467
TOTAL	$1,853	$1,234	$4,760	$2,797	$1,230	$4,430	$16,303

Source: Con Edison, "Annual Report on 1997 Electric Service," March 31, 1998, p. 1-9

TABLE 1

(THOUSANDS OF DOLLARS)

SYSTEM IMPROVEMENT

1996 CAPITAL EXPENDITURES

	BRONX	BROOKLYN	MANHATTAN	QUEENS	STATEN ISLAND	WEST-CHESTER	TOTAL
RELIEF							
Area Substations	$0	$0	$2	$0	$2	$0	$4
Primary Feeders	$391	$0	$4,333	$0	$15	$1,104	$5,844
4KV Substations	$1	$0	$0	$0	$121	$523	$644
4KV Feeders	($10)	$0	$0	$0	$1	$0	($9)
Net Trans. & Sec Mains	$112	$33	$4,901	$133	$0	$0	$5,179
<$100K Relief & Other	$3,183	$11,950	$8,391	$3,090	$3,377	$1,886	$31,876
Subtotal	$3,676	$11,983	$17,628	$3,222	$3,517	$3,513	$43,539
RELIABILITY							
Paper Cable	$60	$345	($42)	$110	$0	$0	$473
Remote Monitoring NWP	$2	$92	$166	$28	$0	$0	$287
#4 #6 Wire 4KV Cable	$0	$0	$0	$2	$0	$5	$7
Multibank Retirement	($1)	$0	$0	$0	$0	$372	$372
Obs NWP	$0	$0	$54	$0	$0	$0	$54
Special Projects, Etc.	$238	$0	$1,566	$0	$106	$0	$1,911
Isolation Devices	$0	$0	$0	$31	$0	$0	$31
Defective Aerial Cable	$0	$0	$0	$0	$0	$564	$564
Jumbo Transformers	$0	$1	$0	$0	$0	$0	$1
Hi-Pot Program	$172	$1,032	$2,099	$337	$0	$0	$3,640
General Improvements	$1,086	$440	$46	$94	$242	$845	$2,753
Subtotal	$1,558	$1,910	$3,888	$602	$349	$1,786	$10,094
TOTAL	$5,234	$13,894	$21,516	$3,824	$3,867	$5,299	$53,633

1996 MAINTENANCE EXPENDITURES

	BRONX	BROOKLYN	MANHATTAN	QUEENS	STATEN ISLAND	WEST-CHESTER	TOTAL
Tree Trimming	$191	$393	$0	$703	$346	$3,883	$5,515
CINDE	$1,823	$80	$4,204	$1,727	$410	$430	$8,672
CIMOES	$130	$367	$541	$149	$21	$457	$1,666
OH Inspect. & Maint.	$294	$51	$0	$257	$405	$994	$2,001
TOTAL	$2,438	$891	$4,745	$2,836	$1,182	$5,764	$17,854

Source: Con Edison, "Annual Report on 1996 Electric Service," March 31, 1997, p. 1-10.

TABLE 1 - SYSTEM IMPROVEMENT 1995 CAPITAL EXPENDITURES
(THOUSANDS OF DOLLARS)

RELIEF:	BRONX	BROOK	MANH.	QUEENS	STATEN ISLAND	WESCH>	TOTAL
Area Substations	0	0	3,441	0	(1)	0	3,440
Primary Feeders	1,023	0	5,486	0	1,491	926	8,926
4 kV Substations	0	20	0	0	(20)	633	633
4 kV Feeders	781	0	0	0	841	239	1,861
Transf & Sec Mains	4	618	9,333	310	0	0	10,265
<$100K Relief	2,345	2,872	319	5,185	620	3,694	15,035
Subtotal	$4,153	$3,510	$18,579	$5,495	$2,931	$5,492	$40,160
RELIABILITY:							
Paper Cable	1,864	941	1,171	1,881	0	0	5,857
Remote Mon .NWP	4	123	80	21	0	0	228
Obsolete NWP	0	0	79	0	0	0	79
Multibank Retirement	1	3,500	0	0	0	325	3,826
Special Projects	240	0	954	0	1,170	0	2,364
Isolation Devices.	0	2	0	70	0	0	72
Defective Aerial Cable	0	0	0	0	0	2	2
Hi Pot Program.	259	1,210	1,568	739	0	0	3,776
General Imp.	325	4,504	118	0	910	415	6,272
Subtotal	2,693	10,280	3,970	2,711	2,080	742	22,476
TOTAL	$6,846	$13,790	$22,549	$8,206	$5,011	$6,234	$62,636

Source: Con Edison, "Annual Report on 1995 Electric Service," June 30, 1996, p. 1-9.