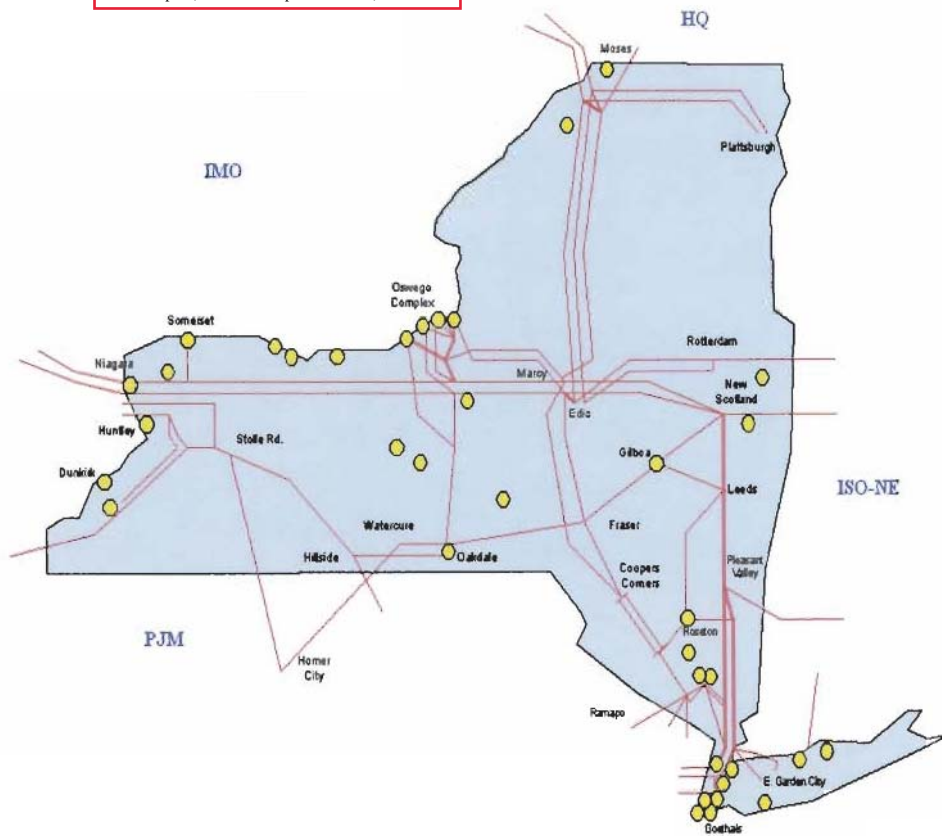


Initial Report
by the
New York State
Department of Public Service
on the
August 14, 2003
Blackout

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February 2004

Acknowledgements

Chairman William M. Flynn, acting at the request of Governor George E. Pataki, initiated a Formal Inquiry into the events surrounding the August 14, 2003 blackout. This Initial Report was prepared for Chairman Flynn and provided to the Chairman and Commissioners Thomas Dunleavy, James Bennett, Leonard Weiss, and Neal Galvin. The Formal Inquiry was performed under the direction of Howard Tarler, the management of Thomas Coonan, with the counsel of Penny Rubin, and by Department Staff from the Offices of Electricity and Environment, Telecommunications, Gas and Water, Security, Consumer Services, Retail Market Development, and General Counsel. Comments on this report can be sent to Howard Tarler at howard_tarler@dps.state.ny.us.

New York State Blackout Inquiry

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EXECUTIVE SUMMARY

On August 14, 2003, New York State was engulfed in a cascading blackout that resulted in the loss of electricity to 6.3 million customers, representing approximately 15.9 million of New York State's 19.2 million residents. Extensive research and analysis, including consideration of reports from the United States-Canada Power Outage Task Force (Task Force) and the NYISO (New York Independent System Operator), has shown that in the hours before the blackout the New York State electric system was operating normally, within existing reliability policies and standards established by NERC (North American Electric Reliability Council), NPCC (Northeast Power Coordinating Council), and NYSRC (New York State Reliability Council). As determined by the Task Force Interim Report and the NYISO, the blackout originated in Ohio. The Task Force cited First Energy and MidWest ISO (MISO) for six violations of NERC reliability standards; that same report did not demonstrate any violations in New York. Further, although the power surges from Ohio cascaded through Pennsylvania, New York, and Ontario into Michigan, and then reversed back into New York, there is no evidence of any significant failures in the way New York's electric system operated.

Based upon the initial findings of the Task Force, the NERC identified six critical areas for reliable operations and sent a letter to each of the NERC Regions (including NPCC) requesting a report on near term actions to assure reliability. These six areas closely tracked the causes of the events in Ohio. The New York response demonstrated how NPCC, and New York, already comply with applicable standards for the handling of voltage control, communications, system monitoring and control, emergency action plans, training, and vegetation

management. Our review of the responses from the NYISO and the New York transmission owners concluded that any problems in those six critical areas, in Ohio and elsewhere, did not exist in New York.

Contrary to public statements suggesting that the industry has not learned from past blackouts, New York has aggressively applied lessons learned from previous blackouts. Nearly 100 recommendations from the 1977 blackout were implemented by the New York utilities based on the New York Public Service Commission's (Commission) direction in 1982. New York operates under mandatory, and more stringent, reliability rules and higher reliability standards than those required by NERC and NPCC. Unfortunately, even after the August 14 blackout, attempts to influence national reliability legislation, if successful, could force New York to reduce its reliability requirements. Mandatory reliability standards are essential, but they must be a floor, not a ceiling.

This initial report is not able to answer several significant questions for which we seek answers:

- Why did the events in Ohio, Michigan and elsewhere so seriously affect New York State?
- Why did transmission lines between New York and Pennsylvania, New Jersey, and New England open and separate us from the rest of the interconnected grid?
- Why did transmission lines in New Jersey and Connecticut open and leave their customers connected to New York City and Long Island?
- What could be done to prevent a similar external event from causing a blackout in New York?

To answer those questions, electric industry experts, such as those on the Task Force, need to complete computer

simulations of what actually happened on August 14. Once those simulations are completed, additional studies can be performed to determine what measures need to be put in place to protect against future blackouts. In addition, vital technical information has not been provided to us, or to New York utilities, by neighboring state electric entities or by the Task Force. We continue to wait for those studies to be completed and the necessary information to be shared. It is clear that numerous transmission outages in surrounding states and in Ontario preceded the blackout in New York State. While we need to consider what, if anything, could and should be done to further protect the New York electric system, we cannot evaluate those potential actions without knowing the cause, the magnitude, and potential fixes for the external events whose consequences spilled over the state borders into New York.

Despite the impacts of the blackout on New York, it was determined that, under the circumstances, telecommunications, gas, and water systems generally performed well. The electric blackout, however, caused the total interruption of steam service in New York City. This report includes findings and recommendations for improvements in the provision of utility services based on our review of the events of August 14. Likewise, this report examines physical and cyber security, customer communications, and electric generator performance, and makes recommendations for improvement.

Five of the most important conclusions in this report include:

1. The New York electric system did not cause or contribute to the cascading blackout of August 14, 2003.
2. The New York electric system is designed and operated pursuant to enhanced reliability rules, including implementation of recommendations made as the result of the 1965 and 1977 blackouts.

3. The total restoration of electric service in New York was accomplished in 30 hours. However, the NYISO, the transmission owners, and the generation owners must review, update, and possibly modify restoration plans based on lessons learned from the blackout.

4. The nuclear and non-nuclear generators in New York performed as designed in response to the events of August 14, and substantially avoided significant damage.

5. Con Edison did not have a plan in place for the restoration of the steam system under conditions of a total shutdown.

Individual recommendations are included throughout the Report. Appendix A is a complete list. Selected recommendations of particular interest are summarized below.

1. Each electric utility, the NYISO, and Verizon should consider the need for back-up power for electronic devices used in protecting physical security, improved communications capabilities for security personnel, enhanced computer-based identification systems, and the need for prompt patch management on its cyber systems.

2. Telecommunications providers should re-assess their needs for back-up power, and the maintenance of back-up power equipment.

3. Wireless providers should examine what could be done to improve call completions (during periods of heavy calling).

4. Con Edison should conduct studies and develop procedures to avoid a steam system shutdown or implement measures to facilitate a more rapid return to normal steam system operations as the result of an electric blackout.

5. Nuclear plant licensees, together with the affected counties, should perform an analysis of whether to provide back-up power for certain alarm sirens.

6. All electric utilities should review their procedures for communicating with life support equipment (LSE) customers based on lessons learned from the blackout.

A final report, to be released in the coming months, will review the electric service restoration process, the measures needed to help protect New York from similar events in the future, and additional studies that will be necessary.

INTRODUCTION

During the afternoon of August 14, 2003, a series of events occurred in Ohio and other surrounding states that had a profound impact on the electric systems and people of New York State. The November 19, 2003 report of the Task Force states that, as a result of: 1) various human, mechanical and computer deficiencies, 2) inadequate training, 3) inadequate tree trimming, and 4) six violations of reliability standards in and around Ohio, an otherwise avoidable blackout progressed into a cascading power outage that overwhelmed parts of Ohio, Michigan, New York, New Jersey, Connecticut and Ontario. By 4:20 p.m. approximately 80% of New York's electric load (electric energy use) was blacked out, including virtually all customers in New York City, Long Island, and surrounding areas. Only portions of upstate New York were spared a total blackout.

Within hours, many public officials placed blame for the blackout on everything from the lack of new transmission lines and power plants in New York State to deregulation of the energy industry. Some even suggested that the blackout was caused by events in New York City, Utica, or Niagara Falls. This report will address the issues of the source of the blackout, the impacts on various utility operations, and the timeline for the restoration of service throughout New York.

As soon as the blackout occurred, governmental officials, under the direction of Governor George E. Pataki, took steps to identify the emergency needs of the State and, through the Department of Public Service, monitor utility efforts to restore services. Credit for the rapid and orderly restoration of power should be given to the NYISO, the New York utilities and generators, and to the people of New York who not only showed great spirit and resourcefulness in coping with the

difficulties, but continued to cooperate by conserving their use of electricity until the system could be fully restored.

While the restoration effort was still underway, Chairman William M. Flynn was asked by Governor Pataki to lead the State's examination of the causes and effects of the blackout and to take steps to reduce the likelihood of a similar event from reoccurring. Chairman Flynn directed Staff of the Department of Public Service to conduct a formal inquiry into the blackout of August 14 by gathering the relevant information, conducting technical analyses, and reporting back on:

1. The circumstances of the outage;
2. The effect of events that occurred outside New York State on electric service operations within the State;
3. Recommendations for actions or procedures to prevent, to the maximum extent possible, a similar outage from reoccurring; and
4. Any other issues relevant to this inquiry.

This Initial Report by Department Staff examines the pre-blackout condition of the New York electric system, including the extensive actions taken by New York State utilities after the 1965 and 1977 blackouts, the effect of the power surges from the Midwest on New York's electric transmission and generation, and the timing of the restoration effort by each of the electric utilities. Also included are reports on the return to service of nuclear generators, physical and cyber security issues, communications with electric customers during the blackout, and reports on the impacts on, and performance of, telecommunications, steam, gas, and water providers in New York State. The approximately 100 companies that participated in this Inquiry are shown in Appendix B.

The Formal Inquiry began with a compilation of relevant information through site visits to, and interviews

with, New York operators and owners of electric, steam, telecommunications, gas, and water facilities, a review of thousands of documents obtained from the companies, and discussions with regional and national groups examining the causes, effects, and prevention of blackouts. Our Inquiry is focused on the causes and effects of the power surge on New York State, and we rely on the efforts of the Task Force for an explanation regarding the design and operation of systems in surrounding states and Canada that ultimately affected the New York electric system. That Task Force has not yet shared this necessary information which is a critical part of any decisions that New York may make to protect itself in the future.

A final report, to be released in coming months, will contain a review of the electric restoration process, an analysis of electric system separations in New Jersey, Connecticut, and Ontario on the ability of New York to withstand the external power surges, and the studies and measures needed to help protect New York from similar events in the future.

Electric

I.a. Introduction

The Eastern Interconnection

As the events leading to the widespread blackout of August 14, 2003 demonstrate, New York State's electric system is not an island. It is instead one segment of an interconnected electric grid that stretches from the Dakotas to Florida, from Louisiana to Maine, and includes most of Canada as well. This electric grid, referred to as the Eastern Interconnection, is a machine made up of hundreds of thousands of mechanical and electronic parts that must operate together.

Like every machine, the Eastern Interconnection sometimes fails to operate properly; 100% reliability is not practicable or possible. In acknowledgement of this mechanical limitation, reliability criteria have been devised that enable the Eastern Interconnection to withstand disruptions arising from equipment breakdowns that occur during routine operating circumstances, to prevent the spread of local problems to wider areas.

New York State was affected by the cascading blackout because, according to the Interim Report of the Task Force, reliability criteria were not met in portions of the Midwest. Consequently, enforcement of the criteria, and the adequacy of the criteria's current specifications, are under close scrutiny, not only in the Midwest, but nationwide.

Evaluating the August 14 Blackout

A multi-step process was needed to properly evaluate circumstances that led to the blackout. First, it was necessary to establish exactly what happened on that day in order to ascertain how electric equipment functioned and how the system

operators performed. Second, it must be determined if the equipment and operators functioned in accordance with the existing reliability criteria, and if restoration efforts were conducted in conformance with procedures established for that purpose. Third, while the blackout could have been avoided if entities in the Midwest complied with existing reliability rules, the reliability criteria must be re-examined to decide whether additional or more stringent criteria are needed to minimize the likelihood of future cascading blackouts. Fourth, the need for modifications, if any, to the electrical system's physical equipment and its operating procedures must be evaluated.

The first step of this multi-phase process commenced with an analysis of three considerations:

1. Overview of The August 14 Events: While the Task Force Interim Report addresses blackout causes and chronology across the entire affected region, an analysis was needed that focused specifically on the New York control area, and its reaction to the events outside the State's borders that adversely affected the in-State high-voltage, or bulk, electric system. An examination of the NYISO's New York-specific chronology assisted in arriving at a better understanding of the blackout.
2. Reliability Standards and Right of Way Management: A description of the reliability criteria, including those for controlling vegetation growth within transmission rights of way, that were in place in New York at the time of the blackout was needed. With the description in place, some preliminary conclusions were reached on compliance with the criteria at the time of the blackout.
3. The Task Force: In its Interim Report, the Task Force found that the blackout commenced following Midwestern violations of the reliability criteria in six broad categories. An examination of the procedures in place in New York to prevent these same mis-steps was appropriate.

The second step of the multi-phase process is considered in the Nuclear Generation, Non-Nuclear Generation, and Customer Impact and Restoration sections of this Report, which contribute to the analysis of whether the system was operating within the parameters of the existing reliability criteria when the blackout commenced and detail restoration efforts. Additional analysis, however, may be needed to assess the performance of electric utilities in restoring service to retail customers and addressing additional system operational and restoration issues.

The third and fourth steps of the multi-phase analysis are beyond the scope of this initial report. Because New York is not an electrical island, the detailed analysis of blackout events within New York, and the formulation of remedial actions is dependent on coordination with neighboring control areas. The process is sequential. The national studies must be performed first, followed by regional studies.¹ Only after the completion of those analyses may the New York-specific analysis be undertaken.

Given the regional impacts flowing from any action a single control area, such as the NYISO, might take, any changes to reliability criteria, and any implementation of better operational or outage mitigation strategies must be coordinated at least at the regional level. Therefore, recommendations for those changes must be developed through a process that accommodates regional coordination and cooperation. Moreover, given the high cost of making modifications to the electric grid, care must be taken to ensure that any new operational or outage mitigation strategies dependent upon equipment

¹ It is anticipated that the national studies will be available during the fourth quarter of 2004.

modifications are cost-effective and are the best solution to prevent similar outages.

While the analytical studies of the electrical system progress, other issues arising out of the blackout can be pursued. New York-specific information has been gathered on system operator staffing levels, electric system and control room back-up resources, communications protocols, breaker and relay operation, restoration procedures, and other operational areas of concern. The evaluation of this information is ongoing, and, to the extent necessary, will be the subject of future reporting efforts in the coming months.

Electric

I.b. Overview of the Events of August 14, 2003

Executive Summary

Prior to the start of the August 14 blackout, NYISO System Operators were experiencing a typical summer day. Transmission system outages in Ohio, however, were creating a disturbance that would soon spread across much of the Northeastern and Midwestern United States and Canada.

NYISO Operators had virtually no warning of the cascading outage prior to its spread into New York. Most of New York had plunged into a blackout by 16:11:45 EDT, even though the first surge of electricity did not pass through the State until 16:10:38 EDT. New York effectively separated from the Eastern Interconnection within seconds thereafter.

NYISO operators, however, reacted promptly to prevent damage to transmission equipment, and began the process of restoring the bulk transmission system. The transmission system was reconnected to all areas outside of New York at approximately 01:53 EDT on August 15.

New York System Conditions on August 14

A. Resource Supply

On August 14, 2003, the NYISO projected a peak load for the day of 28,500 MW, well below the peak of 31,340 MW projected for the Summer. An operating reserve of 1,800 MW was in place, adequate to meet the largest contingency, i.e., an outage, that could credibly affect the New York grid system. An additional 2,992 MW of excess generation was available for service. New York was well-equipped to serve control area load and meet foreseeable contingencies for the day.

Con Edison forecast a load of 11,700 MW, including local NYPA customer loads. This was somewhat less than the summer peak load forecast of 12,650 MW. The LIPA area load was approximately 4,900 MW, below the projected peak load for the summer of 4,967 MW. The remaining Transmission Owners (TOs) were predicting a moderate electric demand, typical for a summer day.

Surrounding regions did not report any unusual events or circumstances. The NPCC morning report contained nothing extraordinary. All indications were that August 14 would be a typical summer day.

B. Transmission Outages

The NYISO-coordinated schedule of transmission line outages for August 14 shows that the number of lines scheduled for an outage was normal for a summer day. Con Edison's line from Linden, New Jersey was undergoing a long-term outage and was expected to remain out-of-service for several weeks. The remaining out-of-service transmission lines had been scheduled for outages by the NYISO coordinator prior to August 14 for outages of periods of less than one day. These lines were: one of the Moses-Willis-Plattsburg 230 kV lines; one of the Moses-Adirondack 230 kV lines; and the Edic-Porter 230 kV line. All were anticipated to return to service by the end of the day. All of the circuits scheduled for short-term outages returned to full service by 4:00 p.m. Consequently, the only bulk transmission line out-of-service at the time of the blackout was the New Jersey to Con Edison "A" line inter-tie. No unscheduled

outages affected bulk transmission lines before the blackout on August 14.²

The Midwest Situation on August 14

The Task Force Interim Report describes the events that occurred in the Midwest on August 14 in detail. To summarize, the Task Force concluded that the events leading to the blackout began when First Energy Company (First Energy) experienced transmission facility outages within its control area. Its system operators, however, were largely unaware of the outages, apparently because equipment malfunctions prevented them from timely observing the events that were occurring on their system. During the hour preceding the commencement of the blackout, the Midwest Independent System Operator (MISO) inquired into the transmission line outages First Energy was experiencing, and the Pennsylvania-Jersey-Maryland Independent System Operator (PJM ISO) contacted both MISO and First Energy concerning overloads it had detected on the First Energy system. None of these operators appeared to grasp that the likely consequence of these outages and overloads was to portend an imminent emergency.

Until shortly before the blackout cascaded out of its control area, the impact of First Energy's system failures did not extend beyond the local area. After its Canton Central-Tidd 345 kV line tripped at 15:45 EDT, however, First Energy's system reached the point where it could no longer withstand an additional outage, while its system operators remained mostly unaware of the circumstances that were threatening system reliability. When the utility's Sammis-Star 345 kV line tripped

² Other lower-voltage transmission facilities were scheduled out-of-service that day, but that class of lines does not transfer power cross-state, and so had no substantial impact on the functioning of the bulk system; that class also did not experience any unscheduled outages on August 14.

at 16:06 EDT because voltage was severely depressed, transmission lines began to fail across the MISO and a significant number of generation units began to trip off-line. Following the Sammis-Star line failure, the blackout spread rapidly.

The Sammis-Star line connects northern Ohio with southeastern Ohio. The outages that followed its loss constrained other facilities, which overloaded and tripped off-line. These outages reduced the supply of electricity flowing into northeastern Ohio. With the Sammis-Star line gone, only two paths were left for electricity to flow into northern Ohio; from northwestern Pennsylvania through Lake Erie loop lines, and from eastern Michigan and Ontario, again through Lake Erie loop lines. Ultimately, those two paths also overloaded and blackouts began in Ohio and Michigan.

The Outages Reach New York

Even as the outages began to spread, New York operators had not been informed of the events in Ohio. At 16:09 EDT, New York system operators first observed unexplained power flows from Pennsylvania through New York into Ontario (it was discovered later that the flows continued into Michigan). The NYISO operator evaluating the rapidly increasing flows - initially peaking at about 400 MW of additional deliveries into Ontario -- could have logically concluded that a large unit in Ontario must have shut down. About a minute later, before the NYISO operator could analyze the emergency support the NYISO could supply to Ontario if needed, the outage had overwhelmed New York and only a few areas within the State were still energized.

New York facilities began to trip off-line at approximately 16:11 EDT, and by 16:12 EDT, the spread of the blackout was substantially complete. Immediately prior to the

disturbances, the NYISO was serving load of approximately 28,000 MW; immediately afterward, load fell to about 5,700 MW. The NYISO Control Center map indicated outages across the State. The NYISO operators communicated to the TOs, over the emergency hotline, that they should secure their systems and begin to prepare for the restoration of the bulk transmission grid. The following depicts the extreme swings of power flow at the New York control area borders and the extremely short period of time in which much of the system collapsed.

The New York Outage Chronology

- The NYISO operator observed the first increase of power flowing to Ontario at 16:09:06. A sudden surge of power from Pennsylvania through New York and into Ontario occurred a short time later, at 16:10:38. As noted below, this power surge was so great that it tripped lines between Pennsylvania and New York and New York and New England.
- At 16:10:39, lines connecting Pennsylvania to New York tripped. The outage then moved to the east where the Branchburg-Ramapo 500 kV line connects to Con Edison. Next, northern New Jersey separated from the rest of New Jersey, while remaining tied to New York.
- At 16:10:47, New York and New England separated, with the exception that southwest Connecticut remained connected to New York. New York then separated into two islands, upstate and downstate.
- At 16:11:22 EDT, the Long Mountain-Plum Tree section of the Pleasant Valley-Frost Bridge 345 kV line in southern Connecticut tripped, leaving southwest Connecticut tied to LIPA through its 138 kV tie. At 16:11:23 EDT, the connections from upstate New York to LIPA tripped leaving southwest Connecticut and LIPA as an island. At 16:11:45 EDT, the 138 kV cable between southwest Connecticut and LIPA tripped.
- Within seconds, eastern New York and Con Edison's service territory were blacked out. Con Edison had automatically shed 50% of its load, but northern New

Jersey, with substantial load, was still connected to it, and system frequency quickly degraded until it reached the point where the system crashed.

- Approximately 300 MW of power deliveries from the Ramapo Station continued to flow into the Walldwick, New Jersey area following the blackout. Only this New York-supplied island remained on-line in northern New Jersey.
- At 16:14 EDT, NYISO and local system operators determined, after discussions and examination of Supervisory Control and Data Acquisition (SCADA) system data, that the New York control area was islanded from most of the outside grid. Almost all of the generation in New York State had tripped off line, except for a few generators in Niagara Falls, the St. Lawrence region, and a small portion of Ontario. One exception was the retention of the 765 kV line between Quebec and New York, which remained in service throughout.
- The western portion of New York remained connected to Ontario until 16:20:50 EDT, when nine 230 kV lines within Ontario tripped. These trips left Ontario's Beck and Saunders hydro stations, and some of Ontario's load, connected to an island formed with portions of western New York.

System Performance During and Immediately Following the Blackout

The relays protected the transmission lines and interties between New York and other control areas, and within New York, from the low voltages and high currents attending the disturbance, which the relays interpreted as groundfaults. In response to the frequency decline, the load shedding relays in each of the local TOs' control areas operated as designed, with only a few exceptions that were insignificant to overall performance. The abnormally high 63 Hz frequency in western New York caused generation there to trip. Conversely, frequency dropped in southeastern New York, causing most of the generation in that area to trip.

Significant frequency and voltage deviations persisted during the period when the State was islanded, because, in the post-disturbance period, it was difficult for operators to match load and generation while still controlling voltage. The 345 kV lines from Niagara Falls to Utica remained intact after the disturbance, and the Utica to Albany portion was re-established soon after the blackout occurred. A second path of 230 kV and 345 kV lines connected Niagara Falls to Binghamton at the Oakdale substation, through to the Coopers Corners substation at Ramapo in the lower Hudson Valley. The 765 kV line from Quebec to Massena to Utica remained energized, because direct current ties isolated the disturbance from the rest of the Quebec system. Through the tie, Quebec continued to provide power, assisting greatly in the restart of the New York system.

Transmission Restoration

Restoration efforts began one minute following the event. The NYISO operators immediately directed utilities to secure their systems, a procedure intended to protect electrical equipment from damage. Local transmission operators promptly opened breakers and disconnected any remaining electric circuits where abnormal voltages fell outside acceptable parameters. The NYISO could then commence restoration procedures. These procedures are the operating protocols for restarting the New York control area upon widespread generation and transmission outages.

The NYISO restoration procedures include the operation of the Niagara and St. Lawrence projects and the restart of other generators, including the Gilboa Pump Storage project, as the generation sources for restarting the cross-state transmission system. During the restoration, the NYISO System Operators worked closely with all transmission operators including Con Edison, NYPA, and the PJM ISO to match frequency

so that New York could be reconnected to the Eastern Interconnection. The transmission restoration chronology follows.

The Restoration Chronology

- Closing a breaker to the 500 kV PJM system at Ramapo was critical to the restoration effort. PJM and Con Edison had to closely match generation and load, requiring cooperation, full communications and some changes to generator operations. One important first step was the start-up of the Gilboa generation at 17:51 EDT. The initial effort to close the connection at 18:02 EDT was unsuccessful because differences in frequency were too great.
- At 19:07 EDT, the NYISO transmission system was fully synchronized with the PJM 500 kV transmission system at Ramapo, restoring normal frequency and adding stability to the New York system.
- By 19:56 EDT, transmission lines from the Ramapo 345 kV Station to Buchanan to Eastview and finally to Sprainbrook were restored, establishing interconnections to the Con Edison system. Through the tie to the north at Sprainbrook, Con Edison could begin to re-establish its in-city transmission system.
- At 21:50 EDT, the NYISO was able to restore an additional transmission path to PJM on a 230 kV cable between Con Edison and PSE&G. This intertie connected Farragut, Gowanus, Goethals, and, finally, Linden. Once a connection was made to Linden, start-up power could be supplied to bring up the generation at that site. At 00:11 EDT, August 15, Con Edison connected its southeast and northeast transmission systems together at Sprainbrook, establishing a complete loop through New York City.
- On Friday, August 15, at 01:53 EDT, the transmission system was extended from the New Scotland 345kv substation into ISO-New England by energizing the Alps to Berkshire to Northfield substation. The actual connection of New England to New York took place when frequency was matched at Northfield. Rapid

restoration of the ties to New England was needed to bring the system within its operational design criteria; the New Scotland Substation experiences high voltage conditions unless the New England tie lines are in service.

The transmission systems in New York State were fully interconnected by approximately 05:00 EDT on August 15, 2003. As described in a following section, full restoration of customer load was achieved by the end of the day on August 15, approximately 30 hours after the initiation of the blackout. Throughout the weekend, the NYISO and market participants worked to fully normalize operations. On Monday morning, August 18, the New York electric markets resumed normal operation.

Electric

I.c. The United States-Canada Task Force Findings

Executive Summary

According to the Task Force, violations of the NERC standards caused, at least in part, the blackout events of August 14. The NYISO and New York's transmission owners (TOs) have measures in place to prevent similar violations from arising in New York. Neither the design nor the operation of the New York State system was responsible for, or contributed to, the August 14, 2003 blackout.

Introduction

The Task Force cited six violations of NERC standards that, at least in part, precipitated the blackout events of August 14.³ Violations were related to:

1. First Energy's failure to return the system to a safe operating state within 30 minutes of an outage;
2. First Energy's failure to notify other systems of an impending system emergency;
3. First Energy's failure to use contingency analysis to assess system conditions;
4. First Energy's failure to adequately train operators;
5. MISO's failure to notify other reliability coordinators of potential problems; and
6. MISO's failure to have adequate monitoring capability.

³ United States-Canada Power System Outage Task Force, Interim Report, (November 2003), pp. 25-26.

The report also finds inadequate tree trimming⁴ as a major cause of line outages and sagging voltages/low reactive resources is a recurring theme throughout the report.⁵

The NYISO and New York TO operating procedures and practices generally prevent similar violations from occurring in New York. Moreover, the NYISO has implemented measures to further minimize the possibility of violations such as those that led to the August 14 blackout. On December 15, 2003, it reported those measures, through NPCC, to NERC.

Neither the Task Force Interim Report nor this New York Blackout Inquiry found any violations in New York of NERC Operating Policies or Planning Standards. While compliance with reliability criteria is mandatory for NPCC members, lack of mandatory compliance with reliability policies (standards, requirements, guides) in certain other regions was at the heart of the August 14, 2003 blackout. The need for mandatory compliance with reliability policies is essential throughout the NERC regions.

Discussion

A. Voltage and Reactive Management

The NYISO plans for and coordinates the operation of the bulk transmission system. It has established a profile of operating voltage limits for the key substations sited throughout the system, including those involved in inter-control area power transfers. Day-ahead and real-time studies are conducted to ensure voltage levels can be maintained both pre-contingency and post-contingency. Prior to every capability

⁴ Report at pp. 23, 34-35.

⁵ Report at pp. 22-23 for first discussion of voltages related to the blackout.

period,⁶ the NYISO conducts studies to review the operation of the bulk transmission system under peak conditions. Those studies focus on transfer limits and consider stability, voltage level, and thermal limitations that would arise upon the loss of major components in the system. Studies specifically address reactive power resource sufficiency. Major transmission line outages are modeled and the impact of an outage on the remaining circuits is evaluated. If a modeled outage causes a significant impact, such as a thermal overload or a voltage collapse, the modeling is documented and provided to the NYISO dispatchers for their use in responding to such an outage.

In order to operate the bulk transmission system within security limits, the NYISO must not violate any post-contingency voltage limits. Generators are required to test and verify reactive power capability twice a year as a condition of receiving voltage support payments⁷ from the NYISO. The NYISO requires all generators sized at more than 40 MW to operate with automatic voltage regulation at all times. If, at any time, the automatic voltage regulator is out of service, the generator is required to notify the NYISO dispatcher. On days when load is heavy, the NYISO reactive power sources are scheduled to ensure availability during peak times.

The NYISO coordinates with neighboring utility control areas in scheduling voltage to effectuate the transfers of electric power among ISOs and RTOs. Written agreements and NPCC

⁶ There are two capability periods per year in the New York control area. The summer capability period stretches from April through September, and the winter capability period runs from October through March.

⁷ Payments made to maintain transmission voltages within acceptable limits.

policies govern interactions among ISOs and RTOs, including the requirements for voltage control.

B. Reliability Communications

NYISO internal operating procedures require it to communicate with market participants, generators, and transmission owners on a weekly and daily basis, and more frequently as required. Communications take place more often during emergency situations. Under written agreements, neighboring ISOs and RTOs share information about key facilities on their systems with one another through SCADA systems that scan information every four to six seconds. By scanning portions of the surrounding systems for significant outages, the NYISO can adjust operations, if necessary, for the next contingency that might affect the New York system. Information about system emergencies, weather advisories, and critical facilities is required to be communicated immediately through pre-programmed hot lines with adjacent control areas.

The NYISO communicates with neighboring ISOs and RTOs on a regular basis regarding system conditions. Most importantly, communications protocols and the reasons for insisting upon timely communications are critical elements emphasized during ongoing operator training.

C. Preparations for Potential Failures of the System Monitoring Equipment

Whenever SCADA or EMS systems experience a communications failure or yield erroneous information, the system operator is alerted and required to acknowledge an alarm. When data cannot be transferred to the NYISO, again, the system operator is notified and must acknowledge its receipt. NYISO algorithms that process data from other surrounding SCADA inputs can compensate for the loss of some SCADA data, so that operators can continue NYISO system management. If the primary

NYISO computer system fails and the back-up dispatch center has to take over, inputs are transferred to the back-up system where the necessary software already resides. Should an operator confront a situation where the dispatch computer provides questionable results, the NYISO operators are authorized to re-dispatch the system so that it returns to a secured state. Operators are trained to develop ad hoc system limits to meet unanticipated system conditions.

D. Emergency Action Plan

The NYISO publishes an emergency action plan in its Emergency Operating Manual. That manual prescribes the actions the operators can take and implement to safeguard the system. The operators can direct changes to transactions, request outside assistance, and compel generators to bring units into or out of service to resolve an emergency situation before it develops into a larger problem. If these measures fail to secure the system, NYISO operators have the full authority to order both control area-wide or area-specific load shedding to avert a problem that may cause cascading outages.

E. Training for Emergencies

Every year, TOs and the NYISO practice the restart of the system from a blackout condition. Training is held at the NYISO with the utility transmission operators and the NYISO operators working together. In addition, a system restart drill is conducted every year before the summer; the most recent drill was held on June 5, 2003. During the drill, which proceeds from the assumption that the entire state is black, all necessary TO personnel and NYISO operators must be at their respective work locations. Each TO incorporates its blackstart procedure into the drill. Finally, NYISO system operator training, for normal operations and emergencies, exceeds 20 days per year.

F. Right of Way Vegetation Management

The Task Force reported that overgrown trees in electric transmission rights of way (ROW) in Ohio played a significant role in initiating the blackout by causing transmission line outages. The commencement and spread of the August 14 blackout, however, was not caused by overgrown vegetation in New York.

New York TOs have adequately managed transmission ROWs, consisting of over 190,000 acres of floor space and 15,000 line miles,⁸ maintaining a clear buffer between electric conductors and vegetation growing on or along ROWs. These ROW management programs have been conducted under the Commission's regulations at 16 NYCRR Part 84, which require the TOs to detail ROW management activities and develop and revise plans for the control of unwanted vegetation growth.⁹ Under these regulations, the Commission has overseen this aspect of TO operations since 1980. Appendix C describes in more detail ROW management requirements and the key factors underlying effective ROW management programs.

⁸ This includes voltage classes from 34.5 kV to 765 kV.

⁹ LIPA and NYPA are not generally subject to Commission jurisdiction. NYPA has voluntarily provided ROW information to Department of Public Service Staff over the last several years. LIPA cooperated fully in this Inquiry.

Electric

I.d. The Reliability Standards

Executive Summary

To date, no evidence has been found of bulk-system reliability standards violations in New York on August 14. It appears from all available evidence that New York system dispatch and system reserve requirements were well within established operations and reliability criteria just before the blackout commenced. In response to the blackout, protection systems functioned properly, limiting damage to generation, transmission, distribution and transformer equipment upon the system shutdown. Whether the existing reliability criteria and reliability standards need to be strengthened in light of the blackout could be topics of further analysis by international, national, and state organizations.

Introduction

Reliability standards in place at New York's utilities and NYISO at the time of the August 14, 2003 blackout are addressed below. These standards include general standards, and those initiated due to the 1965 and 1977 blackouts that affected all or a portion of New York State. Standards relating to the terrorist attack of September 11, 2001 and New York's utilities' compliance with all reliability standards are also addressed.

Discussion

A. Reliability Standards in General

The purpose of establishing reliability standards¹⁰ for the bulk power system is to assure that the system is designed and operated to withstand applicable categories of disturbances, known as "contingencies," such as faults on the system, and

¹⁰ The standards discussed herein are included within NERC, NPCC, NYSRC, and NYISO published documents.

generator and line outages.¹¹ The standards require that a system be designed to withstand specified contingencies; the grid must be able to absorb fault currents and system swings while the fault is on the system and the ability to return to stable system operation after the fault is cleared. In the post-contingency condition, the system must still continue to operate within permissible equipment loading limits and voltage levels, while delivering the necessary power to its loads.

In designing the system to meet reliability standards, power flow simulations and stability analyses are performed for forecast loads. The simulations are designed to model power transfers, loads, and generation conditions that stress the electric system, in order to assess the potential for cascading outages due to overload conditions, the potential for instability, and voltage collapse.

The characteristics of a reliable bulk power system include adequate generation supply resources, voltage control, and transmission capability to reliably meet projected customer demand. One resource adequacy criterion for the design of such a system specifies that the probability of the loss of load should not exceed a certain specified number of hours per year. Evaluations of resource adequacy reflect demand uncertainty, scheduled outages and de-ratings of generators, and forced outages. Assistance available from neighboring areas is included in the analysis. In recent years, application of a 0.1 day per year loss of load standard has resulted in establishment

¹¹ A "fault," as used in this Report, is the creation of an unintended path for a power flow. This is also known as a "short-circuit." Faults can occur when equipment fails, when trees make contact with a line, when animals and birds invade system equipment, upon lightning strikes, and under other similar circumstances.

of an installed reserve margin of 18%¹² within the New York control area.

When operating, the bulk system is subject to regular contingency analysis about every five minutes. The contingencies for which the system is tested are usually limited to sudden outages of lines and generators, under the conditions that represent the actual real-time operations of the system. NYISO maintains the required of operating reserves necessary to survive the outage of the largest single generation source, or the loss of the most significant transmission lines.

B. The 1965 Blackout Standards

The November 9, 1965 blackout began in Ontario at the Niagara frontier and cascaded through New York's transmission system. Much of eastern Ontario, New York, including New York City, and New England lost power. As a result of the 1965 blackout, representatives of New York, Ontario, and New England utilities signed a Memorandum of Agreement on January 19, 1966 establishing the Northeast Power Coordinating Council (NPCC). NPCC was the first organization of its kind in North America. Hydro Quebec and the Canadian Maritime Provinces later joined NPCC.

After the NPCC was formed, other reliability councils were created throughout the United States. All the reliability councils banded together in 1968, into the North American Electric Reliability Council (NERC), which now consists of ten

¹² The amount of transmission capacity, location and type of load, and number and size of generators on the system all impact calculation of the reserve margin. The New York State Reliability Council annually runs a probability-based computer simulation of the electric system and determines the appropriate reserve margin that must be maintained over the coming year for the New York control area. Barring major system changes, this reserve margin requirement will remain relatively stable from year-to-year.

regional councils that cover electric systems in the United States, Canada and a small portion of Mexico.

In 1966, the New York utilities formed the New York Power Pool (NYPP) and established a separate control center housing system monitoring and control tools that improved the security of electric operations across the entire footprint of the Pool. System planning was coordinated through NYPP committees and working groups. Real-time operations were improved through the installation of Automatic Generation Control (AGC) at the Pool Control Center (PCC), the performance of contingency evaluations on a NYPP-wide basis, and the monitoring of generation reserves across the entire Pool. The 1965 blackout provided the impetus for the subsequent development and implementation of the Security Constrained Dispatch (SCD) software program. SCD tests whether a particular generation dispatch configuration will result in reliable operations for the electric system, with no equipment overloads under either normal or outage conditions.

In 1967, the NPCC members adopted a Memorandum entitled "Basic Criteria for Design and Operation of Interconnected Power Systems" (NPCC Document A-2). The memorandum has been revised a number of times since 1967, but represents a minimum standard that all members must satisfy (the latest approved NPCC A-2 document is dated August 9, 1995). More rigid criteria than those contained in NPCC document A-2 may be applied by each council member if local considerations warrant.

C. The 1977 Blackout Standards

On July 13, 1977, a series of lightning strikes, subsequent electrical faults, and protective relay malfunctions islanded the Con Edison system from the rest of the grid. Because the island lacked sufficient generation supply, a

blackout spread throughout the Con Edison area. As a result, the New York State Department of Public Service (DPS) recommended additional criteria for planning and operations that would minimize the frequency of major interruptions. The analytical work on the criteria commenced in 1979 and was completed in 1981. All of the recommendations, almost 100 in number, were approved by the Commission and subsequently implemented by New York utilities and the NYPP.

When the NYPP was transformed into the stakeholder-inclusive, market-oriented New York Independent System Operator, the NYSRC was formed and the body of the reliability rules were applied to the new organization. Since the NYSRC formation, the reliability rules have been supplemented, but not substantially changed. A summary of the standards applicable to New York companies can be found in Appendix D.

D. Standards Related to 9/11

No changes were made in the reliability standards because of the September 11, 2001 terrorist attack on New York City. The NYISO follows threat communications protocols established in conjunction with NERC and federal authorities. The NYISO forwards all threats it receives to all New York Control Area Transmission Owners, who, in turn, transmit them to the owners of generation plants. Moreover, the NYISO and Transmission Owners no longer make security-sensitive information available to the public.

E. Compliance with Reliability Standards

All recommendations made in conjunction with the two previous major blackout events, in 1965 and 1977, have been implemented. To date, no evidence has been found of bulk-system reliability standards violations in New York on August 14 (the New York-specific standards are attached as Appendix D). It appears from all available evidence that system dispatch and

system reserve requirements were well within established criteria just before the blackout commenced. In response to the blackout, protection systems functioned properly, limiting damage to generation, transmission, distribution and transformer equipment upon the system shutdown.

Previous planning studies indicate that the design and operation of the system on August 14 appear to satisfy applicable planning and reliability criteria. The existing planning criteria did not require a study of a cascading event of the August 14 magnitude. NPCC studies were limited to events less threatening to New York than the August 14 event. NERC, NPCC, and NYSRC are evaluating the reliability standards and rules based on the August 14 events to determine if changes are necessary. International, NPCC and New York-specific studies and investigations are proceeding and must be completed before sufficient information will be available to form policies that could lead to changes in the standards. Any changes to those standards or rules will form the basis for new planning studies and operations procedures that can help to reinforce the electric system and allow it to survive similar events in the future.

Electric

I.e. Non-Nuclear Generation

Executive Summary

On August 14, 155 generating units were in service in New York State when the blackout commenced. None of the generation facilities reported abnormal operating conditions just prior to the event.

As electrical disturbances on the grid were detected on August 14, automatic relay protection devices or unit operators reacted, and nearly all of those generating units tripped off-line. Only NYPA's Niagara and St. Lawrence hydroelectric facilities and RG&E's Russell Station continued to operate and remain connected to the grid throughout the blackout event. Overall, the units that were shut down operated as designed, and damage to facilities was minor. Two generating units, however, experienced significant damage and substantial repairs were required prior to their return to service.

A variety of relay protection methods are in use at generation facilities located throughout New York. While the generator protection systems apparently operated as designed, the blackout experience provides a valuable opportunity for generation companies to evaluate the adequacy of those systems in coordination with the NPCC guidelines currently under review.

Introduction

New York State depends on in-state generation facilities to produce the vast majority of the power required to meet its electric demand. Market forces, environmental responsibilities, and unit availability all influence the daily operation of these generation facilities. On August 14, generation facilities were operating in a typical manner with no indication of the impending blackout.

For the 2003 summer capability period, the NYISO reported 37,094 MW of generation capacity in New York State, with 5,078 MW attributed to nuclear reactors. The non-nuclear generators therefore comprise approximately 32,000 MW of the in-state generation capacity, and include fossil steam turbine, combustion turbine, and hydroelectric units, and other methods of generation. The immediate effects of the blackout on the non-nuclear generating units are discussed below. The restoration of these generation facilities to service will be addressed in a future report.

The review of the effect of the blackout on non-nuclear generation considered 233 generating units, which comprise approximately 27,500 MW of summer capability or 86% of the non-nuclear generation capacity in the State. Most of these units are significant in size, at 80 MW or larger, although the analysis also extends to many gas turbine facilities somewhat smaller than 80 MW that are commonly used in the New York City and Long Island areas. Since these units account for 86% of the non-nuclear generation in the State, it was not necessary to analyze smaller units in order to arrive at an accurate picture of the impact of the blackout on non-nuclear facilities.¹³

Discussion

A. Pre-Existing Conditions

The generation facilities in New York were not exposed to abnormal grid conditions until the blackout occurred at approximately 4:11 p.m. Generating units that were in service on August 14, 2003 were providing power and voltage support in response to NYISO directives. Besides the 155 units that were in service at the time of the blackout, another 70 units were in

¹³ The companies operating the units reviewed are listed in Appendix B.

reserve or on standby,¹⁴ including one unit was that ramping up in preparation for synchronization to the grid. The remaining eight units of the 233 analyzed were listed as unavailable for dispatch prior to the blackout.

B. Immediate Effects Of the Blackout

Although the generating units located in New York vary as to type, fuel, and cooling method, each unit employs protective relay and other control systems that safeguard equipment and personnel. These systems are designed to automatically disconnect or trip the unit in reaction to abnormal electrical or mechanical events. Additionally, plant operators can manually trip a unit off-line if warranted.

NYPA's Niagara and St. Lawrence hydroelectric facilities remained in service during the event in part because of their physical characteristics and they are less dependent on auxiliary equipment than fossil-fueled generating units. RG&E's Russell Generating Station was the only other facility to stay on-line throughout the blackout, albeit one of its generating units disconnected from the grid.¹⁵ These three facilities were able to supply generation to a limited portion of upstate New York.¹⁶

The majority of the units tripped as a result of automatic relay protection systems responding to the grid

¹⁴ These generating units were capable of generating, but the NYISO had not requested that they commence operations to meet demand in the day ahead or real-time markets.

¹⁵ While Russell Station Unit 4 tripped in response to boiler water problems, the other units at the Station were able to withstand the disturbance.

¹⁶ While a few other generating units remained in operation and continued to serve local demand, these facilities are categorized as "tripped," since they disconnected from the state-wide grid in response to the blackout.

disturbances. In 12 instances, operators reacted to instrumentation alarms or boiler controls, and manually tripped generating units to protect the equipment. These actions were taken without the knowledge that a wide-scale blackout was emerging.

There were no instances where a generating unit disconnected from the grid inappropriately. While it is essential that generation facilities properly protect their equipment, relay protection systems should conform to common protocols that accommodate the individual needs and requirements of a generation facility. The generator protection systems appear to have operated as designed, in that they prevented most generating units from suffering significant damage. NPCC is reviewing protection guidelines, and it is recommended that generators review existing protection schemes in light of the events on August 14 and to ensure conformance to NPCC guidelines.

C. Equipment Damage

It is reasonable to expect that the circumstances of August 14 would result in some damage to generation equipment, and some equipment failures were experienced. The damage, however, was generally limited to that normally attending the proper operation of expendable protective devices, such as blown fuses at two of the units. As noted earlier, two generating units did experience significant damage that could not be repaired for two days in one case and weeks in the other.

Much of the damage reported was to steam turbine facilities. The inability to maintain cooling operations caused overheating and excessive pressures in the steam systems, leading to tube leaks and other boiler problems. Seven units reported that rupture discs opened to mitigate excess pressure

conditions.¹⁷ Although the operation of these discs is classified as damage in that they must be replaced, they are a protective measure that operated as designed.

Exposure to the abnormal conditions on the grid also resulted in damage to certain electrical equipment. Some circuit cards, control panels, and some instrumentation equipment, were rendered inoperable by the fluctuating voltages and current levels. Several facilities also reported damage to electric motors on auxiliary pumps.

Of the two significant plant failures, the first resulted when unstable grid conditions caused an electrical surge at a steam generation facility. The battery bank supplying back-up power to the unit was damaged, preventing some of its protective systems from operating. As a result, a circuit breaker failed to open while the facility was experiencing over-current conditions. A turbine oil pump motor was exposed to the electrical surges and caught fire. Operating personnel were able to quickly extinguish the fire, preventing more extensive damage to the plant. No personnel or any of the firefighters responding to the incident were injured. Because of the fire damage, that unit remained out of service until August 18.

The second major incident was an internal failure in a step-up transformer at another steam generation unit. That unit also suffered damage to its air compressor controllers and a drum safety valve. After the transformer was replaced and repairs to the other systems were made, the unit was able to return to service at the end of August.

¹⁷ A rupture disc is a device that relieves steam pressure should it exceed operating limits; unlike relief valves, the discs are designed to open once and then be replaced.

Most generating units, however, disconnected from the grid and, as designed, shut down safely on August 14. Of the 233 units examined, 187 units did not report any damage to their equipment as a result of the blackout. The actual damage experienced is not unreasonable considering the abnormal grid conditions of August 14. A total of 46 units experienced damage which delayed their return to service and affected the restoration time of electric service. This will be addressed in our next report on the restoration effort.

Recommendation

- Generators should review their conformance with protection system guidelines. The review should reflect potential revisions to those guidelines and address topics such as threshold limits and trip schemes.

Electric

I.f. Nuclear Generation

Executive Summary

As the events of August 14 commenced, the six nuclear plants located in New York State were operating normally. In response to the event, each unit tripped off-line as the protective equipment built into the design of the plants properly performed their functions.

At the time of the blackout, the six New York nuclear plants were generating slightly over 5,000 MW of power. As the Task Force concluded, there is "no evidence that the shutdown of the U.S. nuclear power plants triggered the outage, or inappropriately contributed to its spread." The return to service of the nuclear plants was conducted in a satisfactory manner. While delays from the initial time projections for return to service were experienced at some plants, the overall average outage time was less than would have been predicted in advance of the blackout, given past experience with returning individual nuclear units to service after outages.

Introduction

The Task Force Report on the causes of the August 14 blackout contained a detailed assessment of the performance of the nuclear power plants affected by the blackout. That Report concluded that the nine United States and eleven Canadian nuclear plants that shut down on August 14 responded automatically to grid conditions, and did so in a manner that was consistent with the plants' designs. Nuclear plants responded as anticipated in order to protect electrical equipment and systems from the disturbances on the grid. The nuclear plants did not trigger the power system outage or inappropriately contribute to its spread. Moreover, safety

functions at the nuclear plants were effective and the plants remained in a safe shutdown mode until their restart.

The Task Force Report did not delve into the restart of the nuclear plants. This Report builds on the Task Force Report's findings and conclusions, and focuses on the restart of the nuclear plants located in New York State.

Discussion

A. Nuclear Plants in New York State

Nuclear power is an integral component of the generation mix in New York State, accounting for 20% of the electricity generated in the State. It makes a valuable contribution to generation fuel diversity, reducing over-reliance on fossil fuels or any other single source of generation, and assists in keeping electricity prices stable and affordable.

The six nuclear plants in New York are owned and operated by three companies, as shown on Table 1 below. RG&E is fully regulated by the New York Public Service Commission,¹⁸ while Entergy and Constellation are subject to lightened regulation, under the Public Service Law.

Table 1 - Nuclear Plant Ownership

Plant	Owner Operator	Rating MW	Location
Ginna	RG&E	485	Rochester
FitzPatrick	Entergy	838	Oswego
Nine Mile 1	Constellation	613	Oswego
Nine Mile 2	Constellation	1149	Oswego
Indian Point 2	Entergy	985	Buchanan
Indian Point 3	Entergy	990	Buchanan

¹⁸ RG&E has signed a contract for the sale of its Ginna nuclear facility, and is seeking state and federal regulatory approvals of the sale.

On August 14, all six nuclear plants in New York State were operating at full power and were supplying approximately 5,000 MW. All the plants were experiencing normal operations, accompanied by the typical maintenance and testing that may normally take place on any given day.

B. Plant Response to Grid Conditions

Nuclear plants are designed to protect themselves from problems on the electric grid and to respond to any grid disturbance that may be experienced. The electric conditions on the grid are constantly monitored, and automatic circuit breakers will isolate the plant from the grid if pre-set conditions are experienced. Protective relays are designed to protect the electrical output equipment of the plant, its main generator and turbine, as well as the reactor, and its pumps and motors from excess pressure and temperature parameters. Activation of protective features from either the turbine/generator or the reactor will cause an automatic shutdown of the other.

C. The Response to the Commencement of the Blackout

On August 14, 2003, at approximately 4:11 p.m., electrical disturbances on the grid, and problems with incoming power quality, were observed at all six nuclear plants. Protective relay equipment, including the communication signals amongst protective features, responded properly. Multiple protective equipment redundancies assured that the plants would function as designed.¹⁹

Emergencies were declared at each of the plants upon the loss of off-site power. An emergency occurs when a loss of the ability to supply power from off-site circuits continues for

¹⁹ United States-Canada Power System Outage Task Force Interim Report: Causes of the August 14th Blackout in the United States and Canada (November 2003).

more than 15 minutes. The Notice of Unusual Event declarations, the lowest NRC emergency classification level, remained in effect until off-site power was restored. Since the cause of the plant's shutdown was due to outside power loss and not internal plant operations, which could affect public safety, operators at each of the plants properly classified and declared the emergency at the lowest level. Timely notifications were made to State and local officials and to the NRC in accordance with applicable requirements. At no time did the circumstances at any of the six nuclear units warrant emergency notifications to the public.

The plant and county emergency plans identify requirements for alerting the public of an emergency through the sounding of sirens. The responsibility for activating the sirens rests with the counties. The sounding of the sirens would alert residents to tune to prescribed radio stations for news about an emergency event and directions on any actions they are expected to take. Sounding of the sirens is not required until an emergency event reaches a level of severity sufficient to require that residents take action.

On August 14, many of the emergency sirens proved unavailable due to the loss of power. Had an emergency at any of the plants occurred during this time when power to the sirens was not available, notification of the emergency to the public would have been accomplished in accordance with the provisions in the county plans. Alternatives for notification under the plans include the use of emergency vehicles that make loud speaker announcements while driven about local roadways. While this and other notification alternatives were in place on August 14, at no time did circumstances at any of the six nuclear facilities warrant their implementation. The loss of

the sirens did not justify the declaration of an emergency that would have triggered notification of local residents.

Installing emergency sources of electric power to activate and supply the sirens is feasible in some instances. Sirens are located within the emergency planning zones that extend to a ten-mile radius from around each plant. The sirens closer to the plant, such as those within a two-mile radius, or sited within selected population areas, may be candidates for the installation of a back-up power source, such as distributed generation. It may be more practicable to install back-up generation at only selected sirens, instead of a wholesale installation at all sirens regardless of need.

D. Restoration of Service

1. Startup Considerations

Before a nuclear generating station can be brought into service, equipment and system alignments must be checked and verified. System alignments include assuring that valve positions and control circuits, both electric and pneumatic, are properly arranged. Plant technical specifications, identified in each plant's NRC license, must be satisfied. An analysis of the conditions causing the shutdown must be evaluated and approved by station management and an operations review board.

Before restart of a generating unit, work related to a plant's out-of-service condition must be safely accomplished, and any work that emerged as a result of a component or system anomaly during the shutdown, or was identified during restart, must be completed. This last category of emergency work can pose significant challenges to plant management and technical personnel as they seek to meet a restart schedule.

2. Plant Restart Times

Nuclear power plants do not start up as rapidly as other generators. Restart is accomplished only after all the

start-up conditions, including management reviews and paperwork approvals, are completed. The restart of the six nuclear units in New York State was accomplished in a deliberate and satisfactory manner consistent with criteria prescribed by the NRC in each plant license and in other plant documents.

Table 2 shows the restart times for each of the six nuclear plants as they returned to service following the blackout.

Table 2. Nuclear Restart Times and Estimates

Plant	Ratings	Sync to Grid Actual	August 15 Estimated Reconnection to Grid
Indian Point 2	985 MW	8/17 00:52	8/16 Noon - 16:00
Nine Mile 2	1149 MW	8/17 19:34	8/17 No time given
Ginna	485 MW	8/17 20:38	8/16 Around 06:00
FitzPatrick	838 MW	8/18 06:10	8/17 PM
Nine Mile 1	613 MW	8/19 02:08	8/16 Late PM
Indian Point 3	990 MW	8/22 05:03	8/16 Noon - 16:00

Table 2 shows that four of the six plants predicted they would be reconnected to the grid on August 16, with the remaining two estimating they would be back in service on August 17. Nine Mile 2, Indian Point 2, and FitzPatrick all returned to service within approximately 12 hours of the projected return times. Ginna returned a day and a half later, while the Nine Mile 1 unit returned two days later than initially predicted. Indian Point 3 experienced problems that necessitated repairs, keeping the plant out-of-service for over five days beyond the initial projection. It is noted that the plant's managers made their initial predictions before all of the issues confronting a restart could be fully known.

An indication that recovery from an outage has been successful may be found in the operational record achieved

following the outage. To date, each of the six nuclear plants has operated without any further forced shutdowns since their restart following the August 14 event.

In consideration of the forced shutdown, the plants did not experience any equipment problems that prevented a typical restart of the units. The exception was at Indian Point 3 where control and rod drive cable repairs delayed the restart. The plants managed the myriad of issues that arose, working in accordance with applicable procedural requirements and within the scope of prior training given to station personnel. Technical requirements and safety criteria, for both nuclear material and personnel, were met, while the plants were expeditiously returned to service.

3. Comparison to Canadian Units

Of the 11 Canadian nuclear plants that tripped, four were back in operation on August 14.²⁰ But the remaining Canadian units returned to service many days later, bringing the average outage time for all 11 Canadian units to over seven days. United States units, on the other hand, returned to service in an average of 4.5 days. This average reflects the six units located within New York, and the three units located outside of New York that shut down because of the outage -- Oyster Creek in New Jersey (three days), Perry in Ohio (seven days), and Fermi in Michigan (six days).

4. Comparison to Prior Forced Outages

A review of forced outages over the last three years at the six New York nuclear units shows that there were 18 outages ranging in duration from less than two days to 19 days,

²⁰ Canadian nuclear plants are designed so that the reactor can remain on-line while the turbine/generator is disconnected from the steam path. The unused steam is either ejected to the atmosphere or sent to a condenser.

and averaging six days.²¹ While the duration of a forced outage does not, by itself, demonstrate how well or how poorly that outage was managed, it does suggest that the August 14 New York nuclear plant outages, in the aggregate, were resolved in a reasonable amount of time. Moreover, the New York nuclear units returned to service more quickly than the average experienced in recent years.

E. Equipment Failures

When the nuclear plants shut down on August 14, they experienced an abrupt change in operational mode, and some equipment failed or did not respond as it should have. This, however, did not prevent the safe shutdown of the units.

At Indian Point 2, the two rupture discs on the low-pressure turbine failed. Rupture discs are designed to fail in order to prevent damage to other equipment in the turbine and condenser.²² At roughly the same time, the sheet metal on the lower turbine casing bowed slightly where it meets the turbine deck (the floor). No adverse conditions affecting the operation of the turbine were experienced as a result. Service water system piping expansion joints to emergency diesel generators leaked as a result of water hammers experienced during their start-up. The leaks did not cause the generators to fail.

At FitzPatrick, uninterruptible power supplies (UPS) failed, causing temporary loss of some communications functions, the emergency response data system computer, the meteorological

²¹ Refueling outage durations were not reflected in this review, as they are a planned outage.

²² Rupture disc failures were also reported at other plants; when a plant shuts down, it cannot maintain vacuum on the condenser and turbine and a gradual heat-up will then pressurize the condenser; when the pressure reaches a pre-set point, the rupture discs fail, relieving the pressure.

data acquisition system computer, and the plant information server. A similar failure of uninterruptible power supplies affected the Emergency Operations Facility at Indian Point.²³ The UPS failures are not attributable to the blackout itself, and occurred because the licensee, Entergy, did not properly maintain these devices.

The back-up generators for the Technical Support Centers (TSC) at both Indian Point units failed to operate properly. A TSC is normally activated during an emergency, and is a source for technical support that may be relied upon in making operations decisions. Each TSC is connected to an emergency source of back-up electric power from a dedicated emergency generator, separate from the emergency generators that supply back-up power to vital plant equipment. Preliminary information on the failure was documented in Condition Reports prepared for each plant.²⁴ In investigating these failures, the NRC issued two "green" findings,²⁵ which adhere to events of very low significance that do not present an immediate safety concern.

The Indian Point uninterruptible power supply failures did not prevent successful operation of Indian Point's Emergency Operations Facility (EOF). Moreover, all nuclear plants maintain an Alternate Emergency Operations facility (AEOF) with the complete capability to manage any emergency that might occur. The AEOF for Indian Point is sited in a building where Entergy maintains offices. Emergency generators were operable

²³ The NRC documented these failures in NRC Inspection Report 05000247/2003013 and 05000286/2003010 (December 23, 2003).

²⁴ Condition Reports CR-IP2-2003-05199 and CR-IP3-2003-04706 (August 15, 2003).

²⁵ NRC Inspection Report 05000247/2003013 and 05000286/2003010 dated December 22, 2003.

at the AEOF site and that facility was capable of meeting all AEOF functions.

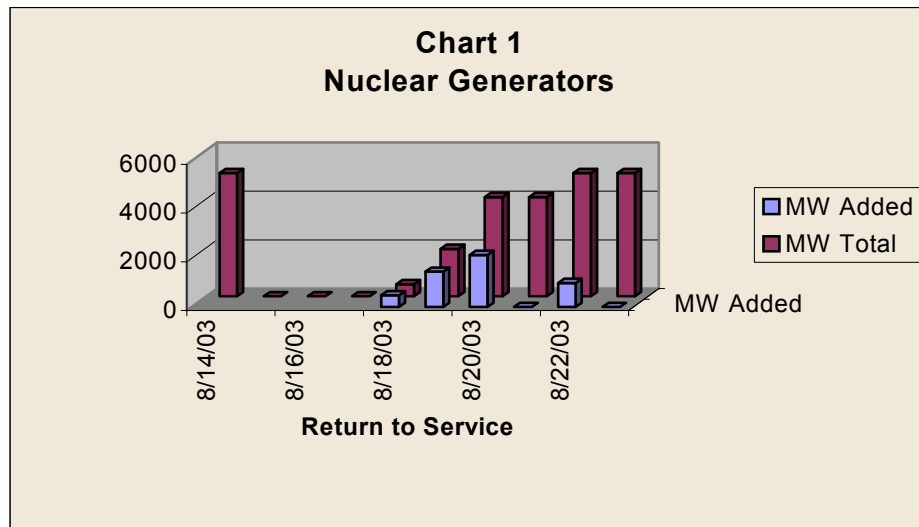
F. Restart - Full Power

Following the August 14 blackout, no nuclear units were available until the three units, indicated on Table 2 above, returned to service on August 17. When nuclear plants are initially reconnected to the grid, it is at low power levels, generally at less than 25% of capability. Nuclear plants ascension to full power is a very deliberate process, and, like all other aspects of nuclear operation, is carefully prescribed in regulations and operating license procedures. Plants will hold production at certain power levels to allow for testing and chemistry stabilization. Power ascension also must be closely monitored. Each unit's return to full power is detailed in Table 3 below; at Nine Mile 2, power ascension was slower than elsewhere, attributable to the condition of that Unit's nuclear fuel at that point in time.

Table 3. Full Power Operation

Nuclear Units at Full Power			
Plant	Ratings	100% Power	
Indian Point 2	985 MW	8/20	22:35
Nine Mile 2	1149 MW	8/20	17:14
Ginna	485 MW	8/18	21:40
FitzPatrick	838 MW	8/19	05:15
Nine Mile 1	613 MW	8/19	23:15
Indian Point 3	990 MW	8/22	22:00

The chart below depicts the total output from the New York nuclear units as they achieved full power.



G. Corrective Action Programs

The NRC requires corrective action programs at all nuclear plants. Plant personnel document items, such as equipment anomalies, procedures, and personnel actions, that do not perform as expected and enter them into a system for subsequent review.²⁶ These reviews encompass input from a broad spectrum of employee disciplines and are intended to yield an evaluation of a circumstance that leads to its correction by changes to plant equipment, revisions to procedures, enhancements to training, or other actions.

The number of reports generated during the August 14 outage reflects a reasonable capturing of the issues that arose at the plants. Review of the issues reported into the corrective action programs at each plant, and submitted in response to document requests, demonstrates that plant personnel have documented the issues that arose during the outage. Specific lessons learned at each plant are addressed in the

²⁶ The programs and the initiating documents are denominated differently at the various plants, as follows: Ginna - Action Reports; Nine Mile 1 and 2 - Deviation/Event Reports; FitzPatrick and Indian Point 2 and 3 - Condition Reports.

final disposition of the corrective action documents as appropriate, after review and approval by plant management.

Recommendations

- The nuclear plant owners, together with the affected counties, should perform an analysis regarding the installation of certain back-up power for alarm sirens.
- The nuclear plant owners should review their arrangements for ensuring that back-up and uninterruptible power supply is adequate during outages.

Electric

I.g. Customer Impacts and Restoration

Executive Summary

The blackout resulted in the loss of electric service to 6.3 million electric customers in New York State, representing approximately 15.9 million of the State's 19.2 million residents. Electric utilities located downstate faced the most widespread outages, with Con Edison, LIPA, and O&R interrupting service to all customers. At Con Edison and LIPA, full restoration of service took approximately 30 hours, the longest period required by any of New York's electric utilities.

The electric utilities relied upon customer restoration priorities that were consistent with well-established emergency restoration guidelines. In many respects, the progress of customer restoration following the blackout was based on the TOs' decisions and was limited by transmission and generation supply considerations. These issues will be examined in a subsequent report.

Introduction

The impact of the blackout on electric utility customers and the timeline for the customer restoration process are evaluated below. Historical data are presented on the number of customers affected and the progress of restoration of service to them, recapitulated on an hourly basis. Not addressed are the restoration of the transmission system or the re-establishment and reconnection of generation supply. Those events will be analyzed in a subsequent report.

Discussion

A. Immediate Effects

No significant electric utility customer interruptions were in progress at the time the blackout commenced on August 14.

Soon after the blackout commenced, but before the utilities could ascertain from SCADA systems what circuits, with their attendant customers, were out of service, the utilities roughly estimated the customers affected based on the amount of load lost. These projections culminated in an estimate that 6.7 million out of 7.5 million New York utility customers lost power as a result of the blackout.²⁷ Load loss estimates are a commonly-used predictive technique employed when major load shedding occurs before utilities can assemble more accurate outage data. It is expected that adjustments will be made to these rough estimates.

For Con Edison, LIPA, and O&R, the initial estimation process was simplified because each of these electric service providers lost all of their customers. Other utilities appropriately adjusted their data. Niagara Mohawk and NYSEG lost substantially fewer customers than initially estimated, and RG&E lost substantially more.

Following the initial estimations, each of the electric utilities analyzed their SCADA data in conducting a thorough evaluation of which customers were interrupted. Evaluating this data generally took several days to weeks, depending on the level of automation available for processing the data. In reviewing the evaluations performed by the

²⁷ The impacts on municipal electric utility customers were not reflected in these preliminary estimates.

utilities, samples of the SCADA data were selected and the circuit restoration process over time was considered.

The final assessment of the impact on customers is shown in the following Table 1. Impacts on municipal electric utility customers have been reflected, increasing the overall number of customers served on a state-wide basis. The final tabulation shows that 6.3 million of the State's 7.6 million electric customers lost service during the blackout. This represents approximately 15.9 million of the State's 19.2 residents.

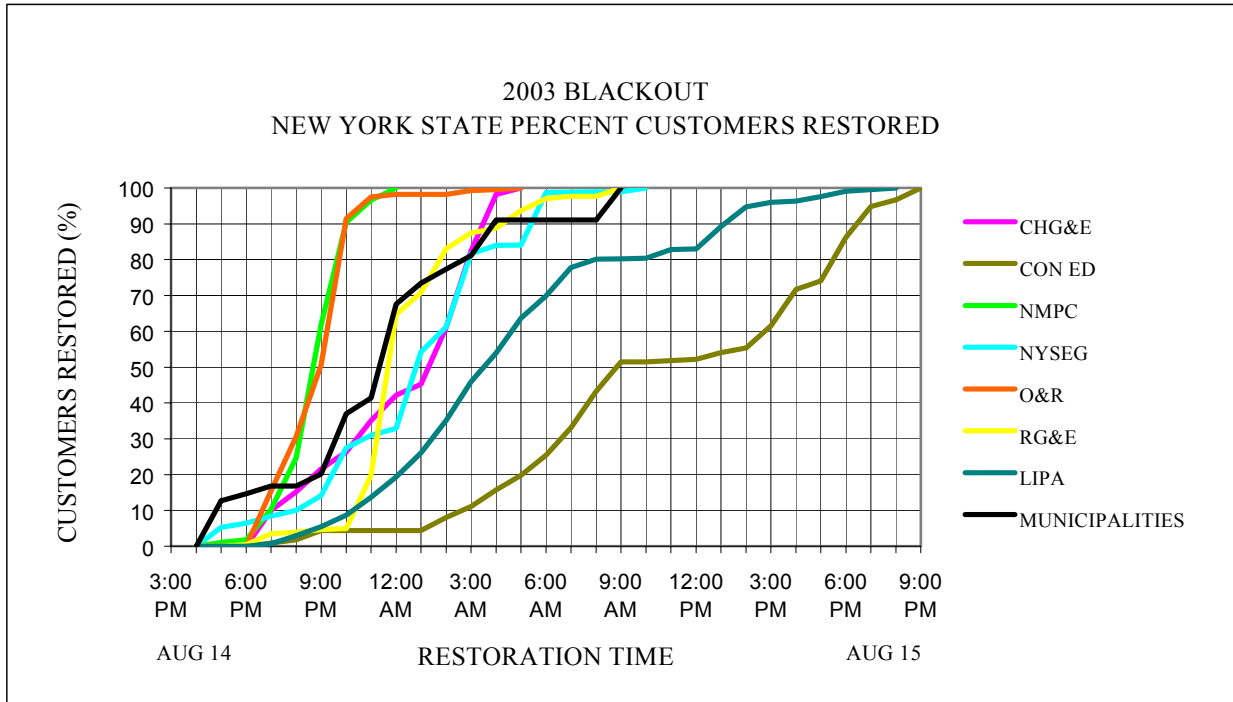
Table 1

COMPANY	CUSTOMERS SERVED	CUSTOMERS AFFECTED	% CUSTOMERS AFFECTED
Central Hudson	282,814	255,438	90.3%
Con Edison	3,087,350	3,087,350	100.0%
Niagara Mohawk	1,580,395	840,137	53.2%
NYSEG	844,912	470,267	55.7%
O&R	210,235	210,235	100.0%
RG&E	362,975	287,256	79.1%
LIPA	1,084,196	1,084,196	100.0% ²⁸
MUNICIPALITIES	169,270	101,408	59.9%
TOTAL	7,622,147	6,336,287	83.1%

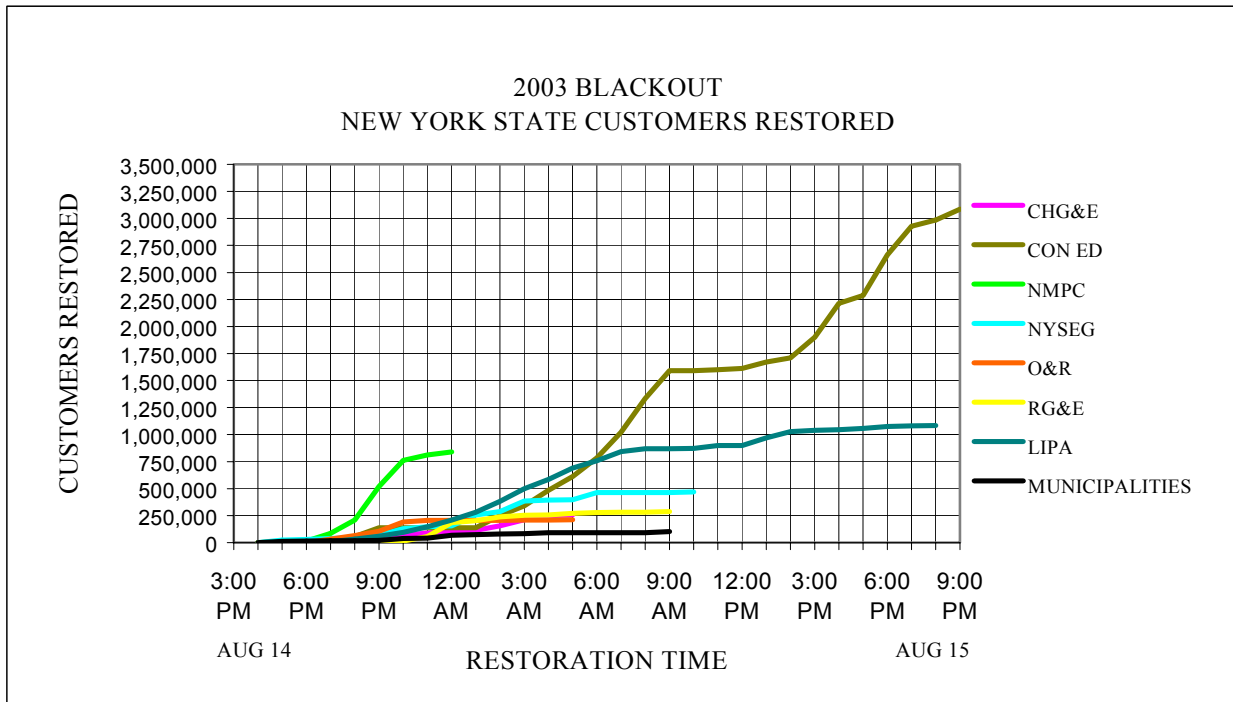
B. The Restoration

Graphs 1 - 3 show the progression of electric customer restoration by percentage and number of customers restored.

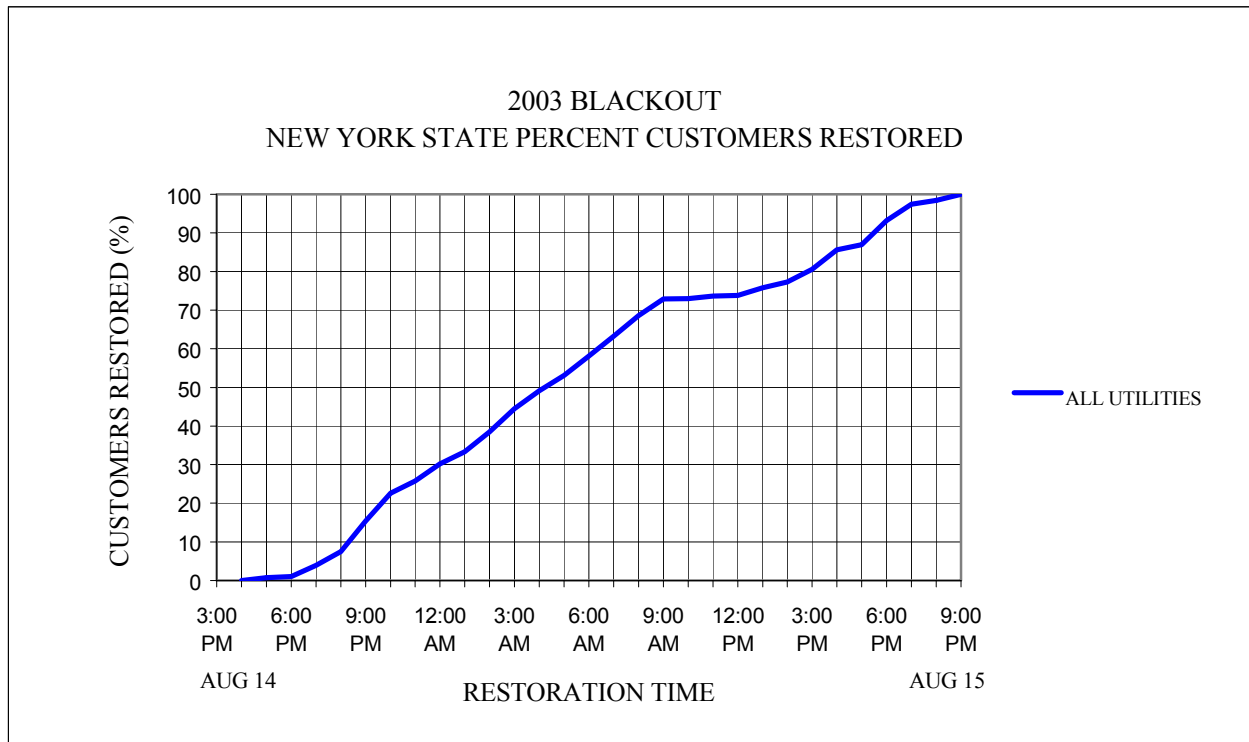
²⁸ 56 LIPA commercial customers did not lose service, because they were switched over to an alternative source of supply available from a cogeneration facility.



Graph 1



Graph 2



Graph 3

As the Graphs show, Con Edison and LIPA took the longest to restore service. These providers lost their entire systems. In comparison, significant segments of the upstate grid remained intact and customers continued to receive service.²⁹

Two special conditions are not reflected in the graphs. Three municipal utilities on Long Island (Rockville Center, Freeport, and Greenport) were able to serve only part of their load on August 15. These municipalities had to impose

²⁹ O&R also lost service to all customers, but its electric system is smaller than Con Edison's or LIPA's and did not take as long to restore.

rolling blackouts³⁰ on approximately 20% of their customer base until the LIPA system was fully stabilized. For the purpose of Graphs 1 - 3, at the time these municipal customers were first restored, that municipal electric utility was considered fully restored.

The other condition not reflected in the Graphs is the number of customers interrupted on August 15 when the NYISO directed utilities to shed load.³¹ During the morning of August 15, the NYISO directed that utilities needed to reduce load by 300 MW. The NYISO determined that generation returning to service was falling behind the growth of the load demanded. In Graph 3, the restoration progression curve flattens to correspond with the data from the load shedding period.

The NYISO's Emergency Demand Response Program (EDRP) and the State Agency Load Curtailment Program were both implemented on August 15 and 16, to assist the utilities in balancing the load demanded against generation and transmission capabilities. Even though all customers had been restored by August 15, supply capabilities and demand remained delicately balanced. The demand response programs proved invaluable in maintaining that balance.

The electric utilities restored service to customers to the extent that the NYISO authorized load restoration based

³⁰ Rolling blackouts are interruptions to customers that utilities intentionally implement for the purpose of reducing electric demand. Rolling blackouts are typically implemented by turning off blocks of circuits for a time, and then switching the outage to another group of circuits or customers, so that the impact is spread among customers without any one customer group bearing the burden of the entire outage.

³¹ Manual load shedding is the intentional disconnection of utility service an electric utility implements in order to maintain system stability.

on the progress made in restoring transmission and generation systems. It was necessary to carefully balance customer load with both generation and transmission capabilities.

Few problems were encountered in the electric utilities' sub-transmission and distribution systems as a result of the blackout. The problems that were seen were typical of the events expected when an entire distribution substation loses supply. In particular, difficulties were experienced with fuse operations due to cold load pickup.³² These fuse operations affected only a small portion of the customers on any particular circuit. None of these problems caused a substantial delay in the return of customers to service.

³² Cold load pickup is a power surge that occurs when electric devices left on during an outage simultaneously commence drawing electric demand upon restoration of service. This power surge may cause fuses to trip inadvertently.

Electric

I.h. Communications with Customers and the Public

Executive Summary

Following the onset of the blackout, customers flooded electric utilities with hundreds of thousands of calls to report that their service was out, to inquire into the cause of the outage, and to request information on restoration times. During the first hours of the blackout, callers often encountered busy signals due to high call volumes. Customers, however, soon learned that the outage was widespread through the extensive media coverage of the event.

To meet the demands on their call centers, the companies extended the shifts of their call center representatives and assigned additional representatives. The utilities promptly updated the voice response units (VRU) on their phone lines to provide customers with general information on the widespread nature of the outage.

Because the blackout was a national news event, affected utilities received numerous media requests for information and interviews. The companies worked with the media, held press conferences, conducted radio and television interviews, fielded hundreds of media calls, and issued numerous press releases to keep the public informed on the status of the blackout, restoration efforts and the need to conserve energy.

Except for RG&E's and Central Hudson's communications with LSE customers, the electric utilities responded in accordance with their emergency plans for communicating with customers during a major outage. All registered LSE customers that were affected by the blackout were called within 24 hours as required by Commission regulations.

While efforts were made to contact local and elected officials, most government offices were closed when utilities initiated calls to them around 4:30 pm on August 14. Utilities also communicated with emergency management agencies, and in some cases dispatched personnel to these agencies in accordance with their emergency plans. Critical care facilities and large-use customers received information from the utilities regarding utility expectations affecting the customer's operations, and utility service restoration times. As described below, utilities should revise their procedures for communications with critical care facilities to update contact information.

The Department of Public Service call center did not receive any complaints or inquiries on the blackout until after it ended. In subsequent weeks, fewer than twenty calls were received inquiring into food loss claims and credit for lost service.

Introduction

Communicating to customers and the public on the causes of electric outages and anticipated restoration times is a major component of the emergency plans electric utilities file in compliance with 16 NYCRR Part 105. In the plans, the utilities describe procedures and facilities for handling the large volume of customer calls that are normally placed during emergency events. Procedures are also delineated for establishing and maintaining communications with the media, human service agencies, governmental offices, emergency management services, critical care and large customers, and life support and other special needs customers.

A review was conducted of the electric utilities' emergency plans, and the actions the utilities took to implement their plans for communications with customers, government officials, and the public. The utilities provided the lessons

learned during implementation of their emergency plans for communications, and noted whether any new or revised emergency procedures for contacting governmental officials, emergency management agencies, critical care facilities and large-use customers were needed.

Discussion

In general, the companies implemented their emergency procedures in a timely fashion. The companies contacted emergency management offices and attempted to contact local and elected officials promptly. Calls were made to all LSE customers. Most of the companies issued multiple press releases and updated VRU messages to provide information about the blackout to customers.

A. Call Center Operations

Each electric utility operates a call center that is expected to handle the anticipated surge in calls from customers upon a major outage. The call centers all employ voice response unit automatic message technology, to ensure that a customer can at least obtain information on an outage even if reaching a customer representative is difficult. The call center operations of each of the utilities during the August 14 outage are described below.

Central Hudson promptly updated its VRU message following the inception of the blackout to alert customers to the status of the blackout, announce estimated restoration times and advise customers on the need to conserve energy. During the first three hours of the outage, the message was frequently updated, and periodic updates followed thereafter as new information became available. Copies of the VRU messages, however, were not available for review because the utility records over entire messages in performing its updates.

Central Hudson's call center received over 32,000 calls on August 14. Central Hudson customer access to the VRU messages was unconstrained, in that no customer call was answered with a busy signal, because the utility arranges for excess VRU capacity during an emergency. Central Hudson was able to commence announcement of estimated restoration times, through the VRU message and its customer service representatives, beginning at 7:30 p.m.

Responding promptly to the outage, Con Edison, at 4:25 p.m. on August 14, installed a VRU message informing customers calling its center of the outage and the service restoration process. The message was periodically updated to reflect press release information.

Con Edison received over 170,000 calls during the 30-hour extent of the outage in its service territory. Over the first few hours of the outage, calls were placed at a rate of over 20,000 per hour. To respond to these calls, Con Edison adjusted its call center staffing in accordance with its emergency plan. At peak times, 248 customer service representatives were available to respond to calls and all 644 call center phone lines were open. The customer service representatives responded to over 20,000 calls, with most of the remainder answered through the VRU. The utility does not contract for excess VRU capacity to take excess calls when all phone lines are in use.

Within minutes after the inception of the blackout, Niagara Mohawk posted a VRU message informing customers that electric outages were widespread through the utility's service territory and in New York State. While the message was updated, estimated restoration times were not provided. Customer service representatives, however, could furnish information regarding the company's restoration efforts. Moreover, the utility

updated its web site by inserting a link on its home page to an outage information page.

During the first hour of the outage, Niagara Mohawk received over 350,000 calls, with the majority of callers getting a busy signal. By midnight on August 14, call volume reached 470,000, with over 55,000 calls reaching the VRU message. Customer service representative staffing during the outage was boosted from 66 to 118 personnel, with 310 phone lines available for calls. An additional 118 phone lines could have been added if the outage had been prolonged. Customer service representatives responded to 8,595 calls.

In keeping its customers informed during the blackout, NYSEG updated its VRU message to announce that widespread outages were occurring throughout the Northeast. The message also advised customers that a loss of power could be reported, or the status of the existing interruption could be checked, by staying on the line for connection to an automated response unit. Subsequent VRU updates announced that 75% of NYSEG's customers were affected.

During the first two hours of the blackout, NYSEG received over 160,000 calls, with most receiving a busy signal. Call volume over the duration of the outage reached 220,000 calls, of which 60,000 were answered by VRU or a customer representative. Customer service representatives worked overtime and additional representatives were assigned. Approximately 297 phone lines were available for customer calls.

The power outage forced O&R's VRU system offline, but the utility relied on its Sprint network service that is normally used only to respond to overflow calls. The capacity on this network was unconstrained, and O&R was able to promulgate a message informing all callers that the outage was

widespread. The message did not include estimates of restoration times.

O&R received almost 10,000 calls between 4:00 p.m. and midnight on August 14. Call center coverage was enhanced by extending the tour of duty for day shift customer service representatives, and a supplemental shift was alerted for assignment, if necessary. O&R was unable to access its web site until early on August 15. At that time, it posted messages requesting customers to voluntarily curtail energy use.

RG&E updated VRU messages approximately one to two times per hour during the initial stages of the blackout. Further updates followed as more information became available. Restoration times, however, were not included in the VRU messages, and the messages were not preserved for later review.

RG&E did not retain data it had collected on the number of calls received or the number of callers that received a busy signal. On August 14, however, it answered 6,918 calls through the VRU or customer service representatives, with an additional 3,742 calls responded to on August 15. To staff its call center, the utility extended customer service representatives' shifts and assigned additional representatives.

LIPA's VRU message was updated to advise customers that the outage was widespread and that it was making every effort to restore service. Over the course of the outage, LIPA customer service representatives answered over 25,000 calls and its VRU responded to 51,942 calls. At the inception of the outage, approximately 75 representatives were on duty, but staffing was augmented within an hour to 130 representatives as shifts were extended and personnel from other departments were redeployed. The company augmented its 350 phone lines by activating its high-volume call center, with 1,800 ports available for VRU calls.

LIPA relied upon its website as a prime communication vehicle during the blackout. It replaced its website home page with a map illustrating the progress of restoration of service, updated hourly. LIPA reports that the home page was viewed a record 36,735 times during the outage, compared to an average daily view rate of 1,334.

Recommendations

- Each electric utility should evaluate call volumes experienced, and number of calls answered by busy signals, VRUs or call centers, to determine if arrangements for responding to high call volumes during emergencies are adequate.
- Central Hudson and RG&E should preserve VRU messages, and RG&E should retain call volume data, for a reasonable time period after an unusual event affecting a substantial number of customers occurs.

B. Media Contacts

Under their emergency plans, electric utilities informed the public of unusual events through contacts with the news media. The electric utilities were in regular contact with the media during the course of the August 14 blackout.

Central Hudson conducted more than 100 media interviews during the initial 24 hours of the outage and issued two press releases to all local media outlets announcing restoration efforts and asking customers to conserve electricity until system stability was restored.

Con Edison received over 1,000 calls from the media during the blackout. It issued its first press release at 6:15 p.m. on August 14, followed by a press briefing and subsequent press releases detailing the outage and service restoration efforts. In addition, it reinforced the need for energy conservation efforts through the press releases, and

requested that TV stations carry a conservation message in all news reports.

Niagara Mohawk was confronted with numerous calls from the media when some news outlets initially reported that the outage commenced on its system. The utility issued seven press releases, held two international press conferences, one of which was carried live on national TV affiliates. It conducted over 25 live television and radio interviews, reporting on the progress of restoration, urging conservation efforts and reminding customers to observe safety precautions.

NYSEG issued five press releases during the course of the blackout, and contacted media in cities throughout its service territory and the Northeast. The utility did not update its web site, given the relatively quick restoration of service.

While O&R did not issue any press releases, its media relations personnel fielded over 60 calls and made outbound calls to local media. On the morning of August 15, the utility contacted media to advise that load shedding might be needed. O&R also notified the media when load shedding ended.

RG&E's Chief Operating Officer participated in four joint press releases with Monroe County, at events attended by major media outlets, and the utility issued five other press releases. RG&E did not update its website to furnish information on the blackout because it did not believe communication over that vehicle would be useful to customers that lacked the electric service needed to operate computers.

In cooperation with KeySpan, LIPA actively communicated with the public on the restoration process. On August 14, the LIPA Chairman and KeySpan Chairman briefed the media on the status of restoration efforts, and subsequently updated the media with additional briefings and news conferences on both August 14 and August 15. Governor Pataki joined in an

11:30 a.m. briefing on August 15 to announce steps the State had taken to assist with the restoration of power on Long Island.

C. Life Support Equipment (LSE) Customers

Under the Commission's regulations (16 NYCRR Part 105), electric utilities must include in their emergency plans procedures for meeting the requirements of customers who rely upon electrically-operated machinery to sustain basic life functions, and other special needs customers, such as the elderly, blind or disabled.³³ After the blackout commenced, utilities were required to implement these emergency plan procedures. 16 NYCRR requires electric utilities to contact these LSE customers within 24 hours during an electric emergency.

Beginning at 6:00 p.m. on August 14, Central Hudson's customer service representatives attempted to contact all 460 of its registered LSE customers at 6 p.m. on August 14. The customers reached were advised of the extent of the outage, restoration efforts and, if assistance was needed, to seek help at rescue organizations or hospitals. Customers not reached on the first effort were called one additional time. Central Hudson did not keep records on the number of customers contacted or missed. It also did not make the follow-up phone calls described in its emergency procedures after electricity was restored, because it believed the outage was distinguishable from the storm-related outages the requirement was intended to address.

Con Edison's representatives commenced contacting its LSE customers at 5:50 p.m. on August 14. Of the utility's 2,144 LSE customers, 961 could not be contacted initially. Of the 540

³³ See, Case 00-E-0811, Electric Utility Emergency Plan Procedures, Order on Electric Service to Life Support Equipment and Special Needs Customers (issued October 5, 2000).

customers residing in Westchester County, the utility contacted 399 on the initial effort.

In New York City, the names of customers not contacted were referred to the City's Office of Emergency Management and the Police Department. In Westchester, the utility's representatives were to notify Westchester Fire Control of those LSE customers that could not be contacted. The utility, however, did not record the success of their referral efforts, and was unable to provide Westchester Fire Control with data by fax or e-mail because those services were affected by the blackout.

In a second effort to reach LSE customers, Con Edison, on August 15, used automated call-out messaging to dial the complete list of LSE customers. A message was left with 2,080 of the customers advising them to seek assistance from the nearest hospital, if needed, and listing a Con Edison telephone number for requesting assistance.

The blackout did not affect all of Niagara Mohawk's 496 LSE customers, and those unaffected were not called. Utility representatives commenced contacting the 274 affected LSE customers at 4:30 p.m. on August 14, and 208 were reached either directly or with a message. The customers were advised to arrange for electric service alternatives if needed. The utility noted that many LSE customers contacted informed the utility representative that service had already been restored.

NYSEG attempted to reach all of its 648 LSE customers and contacted 414. Where contact could not be made, NYSEG referred the name, address, and phone numbers of LSE customers to 911 call centers and local fire departments. The customers reached were read NYSEG's media releases and provided with the utility's 800 emergency number for LSE customers.

Approximately one hour after the blackout began, O&R called all of its 320 LSE customers and were able to contact approximately 290. Two phone calls were made to each customer, who were informed that the time for restoration was unknown, and that arrangements for a night without service should be made. Another effort was made to contact LSE customers on August 15.

RG&E, at approximately 7:30 a.m. on August 15, began contacting all 1,334 of its LSE customers affected by the outage. At least two contact efforts were made for each customer. Moreover, utility personnel visited all 57 LSE customers it could not contact directly. Of those customers, 35 were reached and 22 notices were left at vacant premises. While electrical power was restored to RG&E's LSE customers within 24 hours, RG&E did not notify such customers within its own standard of 12 hours identified in its emergency plan.

Using an automated system, LIPA made one call to each of its 3,332 LSE customers, contacting 1,160 of them, informing them that it was experiencing a widespread outage. The LSE customers were reminded of the LIPA phone line dedicated to their needs and advised that they should contact local police or fire authorities if necessary.

All electric utilities attempted to contact their LSE customers within the 24-hour period following the onset of the blackout. More uniformity and specificity, however, is needed to guide utility communication efforts with LSE customers during emergencies.

Recommendation

- All electric utilities should review their policies and procedures for treatment of customers with life support equipment during major outages. Such a review should include, but not be limited to, the methods and timing of contact efforts, options for follow-up if customers cannot be directly contacted during the

first 24 hours after an outage, and the efficacy of keeping logs detailing LSE customer contact efforts.

D. Other Contacts With Customers and the Public

Under their emergency plans, utilities contact local and elected officials, emergency management agencies, critical care facilities and large-use customers to inform them about an outage. The utilities' contact efforts are detailed below.

Central Hudson contacted 73 community aid and emergency service management agencies, 223 critical and commercial/industrial customers, and 144 municipal and elected officials in Albany, Columbia, Dutchess, Greene, Orange, Putnam, Sullivan and Ulster Counties, commencing approximately two hours after the initiation of the blackout. An appeal to conserve electricity was made to large-use customers on August 15, and NYISO emergency demand response customers were asked to curtail loads. Central Hudson did not prepare written statements for dissemination to customers.

Emergency management agencies and critical care facilities indicated that Central Hudson's restoration estimates were accurate and helpful, and reported no problems with communications from the utility. Large-use customers also found the utility's communications helpful, and some closed down second-shift operations in response. Because government buildings were closing just as the blackout commenced, most government officials obtained information about the blackout from sources other than the utility.

Con Edison furnished over 245 critical care facilities and nearly 1,000 large-use customers with information on the outage and asked them to assist with restoration efforts by controlling their load. While only a few elected officials could be reached, repeated efforts were made. The utility also provided personnel to support staffing at the New York City and

Westchester Offices of Emergency Management. The utility's customers generally found its efforts satisfactory.

O&R implemented communications outreach through its Commercial Operations/Emergency Services Group (COESG), which was charged with handling calls from county emergency offices, critical care facilities and other sensitive load and large customers. O&R coordinated the re-energizing of large customers with onsite generation to assure a smooth transition to utility power. Finally, on August 15, local officials were informed of the temporary loadshedding needed to facilitate the restoration efforts. The O&R customers contacted found O&R responsive and proactive.

Niagara Mohawk implemented its emergency plan procedures for contacting appropriate categories of customers and the public. Most customers were satisfied with the utility's contact efforts, but one county emergency service center would have preferred that outage data be categorized by locality rather than by region.

NYSEG's governmental affairs representatives initiated contact with elected officials, while its marketing and sales department reached out to critical care and large customers. The latter customers were advised if curtailments were needed. The utility experienced some difficulties in contacting customers due to telephone service outages. While customer evaluations of NYSEG's communications were generally positive, two hospitals noted that NYSEG failed to properly contact them, and complained that NYSEG's communications efforts had also failed in past outages.

RG&E's government affairs representative initiated contacts with local elected officials. The utility believes communications with large customers went well, despite some initial difficulties posed by phone service outages, and that

arrangements with these and other business customers for voluntary curtailments and rolling blackouts could be made. In evaluating its performance, however, the utility realized that the only critical care facilities contacted were those that participated in the NYISO emergency demand response programs.

LIPA and KeySpan acted together to establish liaisons with governmental agencies and county emergency operations centers. Critical care facilities and large customers were contacted, albeit some loss of phone service required LIPA to exercise flexibility in implementing its emergency procedures. Large customers were provided with pertinent information enabling them to make business decisions on staffing and operations. Few criticisms of LIPA's performance emerged when customers were contacted.

Recommendations

- Electric utilities should implement lessons learned as a result of their evaluations of their customer contact and public information efforts.
- Electric utilities should ensure that they have properly identified, and obtained appropriate contact information for, governmental and elected officials, critical care facilities, and large use customers, including information for non-business hours.
- Electric utilities should review their use of websites, and consider, to the extent appropriate, upgrades that would afford better outage and service restoration information.

II. Security

Executive Summary

The responses of Verizon, the NYISO and electric utilities to the security issues raised by the blackout were generally well executed. Established procedures were generally followed and worked effectively. A few deficiencies, however, were found.

Some information system software was out of date. There were shortcomings affecting the functionality of the infrastructures supporting communications and the supply of back-up power to both information system and security equipment. At two utilities, security technology used to limit access to restricted company facilities was inadequate.

Introduction

The Task Force Interim Report addresses whether a malicious cyber event could have caused the outage or exacerbated its impact. Consideration of physical security issues in the Task Force Report, however, was limited to a brief acknowledgment that physical security shortcomings could have been contributing factors to the potential for a significant compromise of computer systems and cyber operations.

This review is broader in scope. Given the possibility that any blackout could be instigated or exploited by malicious action, security vulnerabilities that might impede the response to, or recovery from, a blackout should be identified, whether of a cyber or physical nature. Also of concern are physical security inadequacies that may have made computer systems more vulnerable, and that may have diminished, or could have hampered, post-event security command and control, contingency operations, and service restoration. Moreover, this review is directed towards a better understanding of the

adequacy of security systems that could prove useful in preventing or thwarting an attempted malicious act against the power grid -- cyber or physical.

Focusing on the eight TOs, the NYISO, and Verizon, conformance to, and the adequacy of, existing security procedures are discussed below. Security infrastructure or equipment problems exposed by the blackout are also analyzed. Utility responses to data requests and other inquiries identified shortcomings that can be categorized into the five areas addressed below.

Discussion

Security operations at the onset of the blackout were well coordinated and consistent with prearranged contingency plans. The importance of quickly determining if the blackout had been instigated by malicious activity was universally understood. There was a rapid and coherent flow of information between company and government operations centers in the effort to identify evidence of a possible terrorist event. That information exchange was somewhat impaired by technical communications failures, as discussed below.

Recognizing the possibility of a widely coordinated attack or malicious exploitation of the blackout, most of the companies immediately deployed additional security personnel to assist in protecting their critical facilities. Company security personnel integrated well with state and local law enforcement agencies to both exchange information and to augment guard force and other physical protective measures. The blackout clearly showed the importance of prior joint preparedness planning and briefings between companies and state or local law enforcement regarding assistance during emergencies. All of the companies had adequately addressed this need.

A. Back-up Power for Physical Security Systems

New York's utility companies have been upgrading their physical security countermeasures at both core and remote facilities independent of the lessons learned from the blackout. Typically, these upgrades include the installation of security lighting, closed circuit video surveillance cameras and motion sensing detectors on perimeter fencing or within sensitive spaces.

The blackout exposed the limitations of short-term battery back-up for this security equipment. Functionality of security devices was lost in many instances because the batteries powering these devices failed before electricity was restored to the grid. With the exception of two companies, all reported that video surveillance, security lighting and motion sensor equipment was rendered inoperable after battery back-up power for these system was depleted. In contrast, the two companies that supported their security system equipment with back-up generators maintained this equipment in service.

Without adequate back-up power, security system equipment is rendered useless in an extended blackout. The August 14 outage revealed that arrangements for the supply of back-up power to physical security systems should be improved.

Recommendation

- More robust battery back-up capacity should be installed by the electric utilities, the NYISO and Verizon to power electronic security hardware. For more sensitive and critical facilities and equipment, back-up power should be augmented with standby emergency generators or fuel cells capable of supporting security systems operations for a reasonable time period.

B. Security of Communications

Communications technology has improved dramatically in recent years, with the acceptance of the cellular telephone as a

standard means for communication between utility executives, operations, emergency response, and security personnel. The portability, convenience, relatively low cost, service coverage and voice quality of wireless telephone offer advantages over other forms of mobile voice communication, such as the mobile radio.

Cellular telephone, because of its inherent advantages, has displaced mobile radio for many day-to-day operational and security communications functions. Five of the evaluated utilities relied on cellular phone service as a primary means of communications for their security staff personnel. These companies experienced losses of service ranging from intermittent to significant when cellular system operations degraded during the blackout.

Mobile radio equipment continues to function as an important back-up communications alternative in responding to emergency circumstances. Unlike wireless telephone, mobile radio does not fall prey to service shortcomings that can afflict wireless networks when call volume congestion is experienced. Radio is also immune from the loss of service that would occur if the wireless network infrastructure were disabled by cyber or physical attack -- a less likely, but nevertheless real, contingency. Moreover, battery-operated mobile radio equipment is not immediately affected by an electric power outage.

Two of the utilities no longer avail themselves of mobile radio as a communications alternative. While the other utilities maintain a strong mobile radio capability, only three of them report deploying substantial mobile radio capacity in their security operations. Four companies indicated that they have limited mobile radio capability and it is only marginally useful in their security operations.

Another avenue of communications, Wireless Priority Service (WPS), is now available to senior emergency preparedness officials, including those employed by energy and telecommunications utilities. This service routes cellular calls made from designated numbers and assigns those calls a higher priority, to better ensure that calls made from those numbers will be completed during periods of call congestion. An application to the National Communications System (NCS) is a prerequisite to obtaining WPS. Upon approval of the application by NCS, a WPS service account may be opened with a wireless carrier authorized to provide the WPS service. Currently, only one wireless carrier in the United States is authorized to provide the WPS service. This wireless carrier offers the service in all of the larger cities of New York State. One of the TOs indicated that it had obtained WPS service for the use of its security personnel.

Satellite telephone service is a unique means of emergency communications back-up. A satellite phone connection to another satellite phone is made with minimal dependence on terrestrial telephone network functionality. A satellite phone may be the only technology capable of immediately enabling a telephone connection from or into an area experiencing a total electric service outage. Moreover, satellite phone capability might provide the only means available for long distance communication following a debilitating compromise of the telecommunications infrastructure.

Three companies reported use of satellite telephone service as an alternative means of communications. The five companies without this service advise that they do not currently intend to acquire satellite phone service for their security personnel.

The availability of reliable communications is of paramount importance in the management of any crisis. Ever-increasing reliance on new technologies has, however, led to new problems when personnel were forced to do without them.

Consequently, mobile radio capability should be retained, at least for emergency response and security personnel working at company operations centers or at outlying company facilities, including those personnel assigned to patrolling at those outlying locations. In a terrorism-generated or other crisis, mobile radio may be the only means to obtain information on the situation from field response personnel at dispersed utility facilities.

This basic mode of communications capacity could be critical to an effective security response. Priority cellular and satellite phone system capability for senior security managers can also provide effective communications support in times of crisis.

Recommendations

- The electric utilities with limited or no mobile radio capability should implement and reinforce, as necessary, emergency mobile radio capacity to present a viable back-up communications system. Mobile radio back-up should provide consistent transmission/reception coverage at key company facilities and undergo regular reliability testing and battery charging.
- The electric utilities, the NYISO, and Verizon should explore the feasibility of acquiring Wireless Priority Service and satellite telephone service for security purposes.

C. Central Identification Database

Many of the companies have updated their central identification databases used to verify personal identity upon a

request for access to restricted utility facilities. Two companies, however, reported they lack such a centralized capability.

A central identification database that enables a company to verify the identity of persons desiring entry into a restricted utility facility is a crucial security measure. Daily updating of, and prompt modifications to, levels of security authorization are capabilities essential to the successful operation of these systems.

Recommendation

- The electric utilities, the NYISO, and Verizon should implement, if they have not done so already, a centralized identification and access system. Databases should be updated daily and programmed to sound an alarm at security offices if unauthorized access is attempted.

D. Patch Management

Five of the companies failed to promptly deploy newly-released cyber security patches in the period preceding the blackout. Factors contributing to this failure included a desire to analyze the severity of the vulnerability the patch was intended to fix and to test the patch within the network environment. Four companies promised prompt improvements in the efficiency of their patch management practices, and only one company stated that all necessary patches were in place at the time of the blackout.

Most New York utility providers realize prompt patch installation is an important cyber security measure and plan to improve upon their existing patch management programs. Some of the companies, however, consider their practices adequate and are not planning to change their approach to newly-discovered cyber vulnerabilities.

A company may be operating a variety of network platforms, including SCADA systems, each of which pose different requirements for protection against vulnerabilities, making a structured patch management program crucial. Regular updating of protection against new cyber viruses is vital in any corporate environment, and is especially significant for utility companies managing critical infrastructure.

The dependence upon availability of information technology (IT) systems affecting all aspects of day-to-day utility operations is greater than ever before. To avoid the potential for exploitation, system vulnerabilities must be controlled and mitigated in a judicious manner. Testing and review of security patches in the network environment may take time and resources, but this work is integral to avoiding possible cyber attacks, which could result in potential loss of operating capabilities and degradation of services.

Recommendation

- Each electric utility, the NYISO, and Verizon should review the adequacy of its patch management program and implement necessary improvements.

E. Network Power Back-up

Many of the companies indicated that the Uninterruptible Power Supply (UPS) units supporting IT systems operated as intended, allowing IT systems to shut down without damage. Three companies stated that additional back-up power generation for selected IT systems was available, but with limitations. Most of the companies recognize the limitations of their current back-up power capabilities for their IT systems, and plan to review their alternate power resources. Four of the companies consider their back-up power resources for their IT systems adequate, and have no plans for improvement.

In the event of power loss, dependence upon UPS units for back-up power is adequate to perform an orderly shutdown of most IT systems. The prolonged operation of critical IT systems upon a power outage, however, can be sustained only if reliable forms of back-up power generation are available.

It is no longer possible to forgo IT functions instead of installing adequate back-up power. For example, most companies consider e-mail an elemental facet of internal communications. If e-mail is rendered undeliverable upon a server outage, the consequences may be detrimental. Increasing dependence upon hand-held e-mail devices, such as the Blackberry, as a common form of daily communication, even in a crisis, renders the ability to sustain e-mail system operations ever more important.

Recommendation

- The electric utilities, the NYISO, and Verizon should thoroughly review their back-up power requirements for sustaining operation of essential IT network components.

III. Telecommunications

Executive Summary

The August 14 blackout negatively affected telecommunications because so many telephone and cable devices rely on electric service to operate. Telephone customers with hard-wired telephones, however, fared well because most of the landline telephone network remained in service during the blackout.

Approximately 346,000 customers -- fewer than 5% of telephone subscribers in New York State -- lost "dial tone" at some point during the blackout event. The majority of the landline customers who lost service connect to the telephone network through two Verizon central offices in Manhattan that lost back-up power.

Communications between Verizon and competitive carriers regarding service problems, critical to the operation of Competitive Local Exchange Carrier (CLEC) networks, was inconsistent and should be improved. The smaller independent telephone companies were largely unaffected by the blackout, experiencing only minor problems.

Wireless networks confronted a twofold impact: the inability to handle the call surge at the time of the blackout, and loss of coverage and capacity as cell sites went out-of-service when back-up batteries failed. Cable networks also went out of service, but, as with cordless telephones, the impact was derivative since cable customers lost electricity needed to power the devices that access cable service.

Introduction

An investigation of telephone service impacts was conducted through a review of the performance of Verizon New York, which serves over 80% of the access lines in New York

State; CLECs, such as AT&T, MCI, and Time Warner; smaller independent telephone companies (the independents), which collectively serve the rural and upstate New York regions, and the major wireless carriers.³⁴ Telecommunications companies responded to information requests and their personnel were interviewed. In addition, the impact of the loss of electric power on cable television companies was evaluated.³⁵

Discussion

Except for the malfunctions discussed in the body of this report, the companies' back up power systems worked well during the blackout. Over ninety percent of the telecommunications facilities (e.g., telephone central office switching facilities, cable television head ends) which had emergency power generators in place worked exactly as intended. Approximately half of the sites that initially had difficulty with emergency back-up power systems, had those problems resolved before customers were impacted. Those telecommunications services that were disrupted were mainly facilities where the emergency back-up power systems actually failed, or smaller or localized facilities where there was inadequate or no emergency back-up power available.

This inquiry also observed that the companies' participation in New York City's Mutual Aid Restoration Consortium provided a valuable tool for sharing information and aiding in recovery.

³⁴ Wireless carriers cooperated with the inquiry, although the Commission does not have jurisdiction over such entities.

³⁵ A list of companies contacted is attached as Appendix B and a glossary of terms is attached as Appendix E.

A. Pre-existing Conditions

The Commission's telephone service standards (16 NYCRR Part 603) require service providers, to the extent practical and reasonable, to maintain networks that continue to operate and serve customers in the event of a loss of power supply from the electric grid.³⁶ Moreover, under the terms of its original Performance Regulatory Plan (PRP)³⁷ and its current Incentive Plan (VIP),³⁸ Verizon New York, the largest provider of telecommunications services in the State, periodically attests to its conformance with best practices established by the National Reliability and Interoperability Council (NRIC). NRIC has certified 98 Best Practices addressing the relationship between electric power and telecommunications services.

Evaluating the circumstances just prior to the blackout, the majority of companies reported no unusual events or pre-existing conditions, projects or other circumstances that could have aggravated a telephone service outage. In general, staffing levels were normal, and were adequate to deal with emergency situations. Several companies, however, noted that additional personnel were brought in during the blackout period.

³⁶ 16 NYCRR §603.5(a).

³⁷ Case 92-C-0665, Order Approving Performance Regulatory Plan Subject to Modification (issued June 16, 1995).

³⁸ Cases 00-C-1945 and 98-C-1357, Order Instituting Verizon Incentive Plan (issued February 27, 2002).

B. Effects of Blackout

1. Impact on the Telecommunications Network

a. Verizon

Verizon operates 540 telephone switches in New York State, sited in more than 500 buildings. The power outage lasted from 6 to 24 hours at the various Verizon locations.

During the blackout, back-up generators at 21 locations, or 4% of the company's sites, either did not start automatically or experienced difficulty in remaining on line. In the New York City area, two switches were lost at one midtown Manhattan location and three switches were lost at a second midtown Manhattan location when on-site back-up generators started but later failed and battery power became depleted, thus resulting in a loss of electric back-up power services. Telephone service outages followed the complete loss of back-up power.

At both locations, the back-up generators were successfully started, and the building and equipment loads were transferred to back-up power, but several factors led to generator failures after start-up. At the first midtown Manhattan location, high temperatures in the generator rooms, along with a fuel transfer system failure, caused the generator to stop operating within the first hour of the power outage.

At the second midtown Manhattan location, the main generator failed. Three additional back-up generators at that location also failed after four hours, with the last ceasing operations at approximately 8:45 p.m. A portable generator was not on hand.³⁹ Although one was sent, traffic problems prevented

³⁹ As discussed below, some competitive carriers with collocation also lost power at this location, while some did not.

the generator from arriving in sufficient time to install it before power from the grid returned to the location at 2:00 p.m. on August 15. Services dependent on the operations at that location were not restored until that time.

The generator failures at the second midtown Manhattan location resulted mostly from overheating caused by excessive load, lack of air conditioning, poor air circulation due to placement of the generator, or internal malfunction. A full load test of the back-up generators at this location was last performed in April, 2003.⁴⁰ This test may not have been rigorous enough to equal the load actually realized on August 14 when the excessive heat in the building taxed the machine's ability to provide power for adequate cooling.

In addition to the Manhattan central office failures, an office in Brooklyn lost Signaling System 7 (SS7) connectivity four separate times,⁴¹ in outages of no more than 20 minutes in length, affecting nearly 70,000 additional customers.⁴² These sporadic outages occurred when excessive heat built up upon temporary loss of air conditioning systems. A small number of Telecommunication Service Priority (TSP) circuits,⁴³ special services, and Enhanced 911 services were affected at the New

⁴⁰ A full load test simulates the loss of grid electric service to the equipment it is powering. It does not, however, mimic actual conditions that might be experienced during a blackout.

⁴¹ SS7 is a signaling protocol used to set up call paths between central offices. If SS7 is inoperable, calls can only be made within the boundaries of a customer's central office area. 911 calling is not affected.

⁴² A separate analysis of the SS7 outage was conducted under the Verizon Incentive Plan (VIP) requirements.

⁴³ The TSP program identifies and prioritizes telecommunications services that support national security or emergency preparedness missions.

York City locations dependent upon the failed central offices. Verizon's switches outside New York City generally operated as designed.

Verizon tests all back-up generators monthly, and the results of the tests are documented in logs that are maintained on site. While the back-up generator failures under actual load it experienced in Manhattan were not necessarily predictable, Verizon's failure to perform a full load test that simulates a peak load during summer months, similar to the conditions experienced during the blackout, may have camouflaged the generators' shortcomings. Moreover, some of Verizon's technical assistance personnel called to duty during the outage were not fully trained on building layout or power sub-systems, which contributed to the duration of the back-up power outages.

Consequently, Verizon's testing and maintenance procedures may not be sufficient to uncover back-up generation equipment deficiencies, prevent their failure, and return them to service swiftly. Moreover, although some back-up batteries did last as long as expected, that form of electric back-up service is inherently limited in capacity and would not sustain service during an outage such as was encountered in many locations on August 14-15.

Recommendations

- Verizon should do a full power load test of back-up generators in all of its offices during peak months to determine if back-up generators can support

- equipment load during the hottest and coldest months of the year.⁴⁴
- Verizon should certify additional technicians in building power system operations.⁴⁵

b. Independent Companies

Generally, central office switching equipment at the Independent Companies was largely unaffected; exceptions were minor and of limited duration. Alarms functioned properly and were logged and reported.

Four companies reported fixed generators that failed to start automatically when commercial power was lost. These incidents did not adversely affect service; no customer lost dialtone. Five companies reported that service was affected by battery failures at remote locations during the power outage.

There were no impacts on TSP circuits, special services, enhanced 911 circuits and systems or most SS7 circuits and systems. Some companies noted that the loss of power at customer locations may have affected the customers' ability to use their telephone equipment.

Testing and maintenance schedules for power systems, including generators and batteries, vary by company and local

⁴⁴ All major telecommunications facility back-up installations should comply with the "National Electric Code" (NEC) "Article 700 Emergency Systems," which covers the design and testing of emergency power systems. Test and maintenance practices should also meet common industry practice, applicable recommended standards and manufacturer's recommendations, such as the "2002 NEC Handbook," referencing the National Fire Protection Association (NFPA) standards 110, "Standard for Emergency and Standby Power Systems" and 111, "Standard on Stored Electrical Energy and Emergency and Standby Power Systems."

⁴⁵ "Less Power Expertise Identified in NRIC VI December 2002 Report as an 'Area for Attention'" - NRIC Review of Power Blackout (September 15, 2003 Meeting) (NRIC Report), p. 4.

conditions, and may not be adequate to reveal deficiencies that might affect the back-up equipment's operation. Batteries at remote locations do not always outlast power outages of long duration. Due to travel time, sending out portable generators to isolated, rural locations may create logistical difficulties, which may lead to extended telephone service outages.

Recommendations

- The Independent Telephone Companies should evaluate their testing and maintenance schedules for power systems in light of NRIC recommendations.⁴⁶
- The Independent Telephone Companies should consider replacing batteries in remote locations more frequently, in order to enhance back-up power reliability.

c. CLECs

Loss of commercial power can affect CLEC service in two different ways: they may experience loss of their own switching or other facilities, or they may lose facilities or services that are physically collocated at Verizon's premises or that Verizon otherwise provides. In fact, most CLECs rely on Verizon facilities to provide at least a portion of the service they offer to their customers.

Twelve of the 21 CLECs reported no issues affecting service and no loss of dialtone to their customers attributable to the blackout. Some of their customers did lose service, however, when power surges damaged their equipment or due to the lack of back-up power sources at the customers' premises. Companies which subscribe to Unbundled Network Element -

⁴⁶ In particular, companies should consider the generator testing protocols set forth as NRIC Recommendation 6-5-0662.

Platform (UNE-P) services from Verizon reported no Operations & Support Services (OSS) systems failures.⁴⁷

The remaining CLECs reported various outage-related issues, including switch failure, due to loss of battery or generator power. Outages lasted between 5 and 42 hours.⁴⁸

The significant back-up power failure at Verizon's second midtown Manhattan central office affected many competing carriers collocated at that site. Back-up power was lost at CLEC collocation cages for periods of between 11.5 and 42 hours. The back-up power failure affected high-capacity circuits used by large businesses, as well as interconnection and 911 circuits serving that area of New York City.

A number of CLECs collocated at this central office did not lose service because Verizon was able to serve their facilities with battery back-up power. The explanation as to why some carriers lost collocated facilities at this central office while others did not may be rooted in the variety of generator and battery power back-up arrangements at that location. It is not clear that Verizon knows specifically which carriers are drawing back-up power from which sources.

Many CLECs' collocation facilities are sited at Manhattan locations other than the two that lost back-up power, but only one CLEC reported back-up power failures at any other location. In addition, one CLEC reported several of its customers were affected, for varying periods of time, by the

⁴⁷ A UNE-P permits competitive carriers to serve residential and small business customers by purchasing unbundled network elements from Verizon. The OSS system is the process for handling the change of service orders needed to move customers among Verizon and the competitive carriers.

⁴⁸ In some cases, telephone-related outages extended beyond the return of commercial power as sensitive electric equipment needed to be reset and coordination with Verizon was needed.

loss of power at the first midtown Manhattan central office location.

A number of CLECs that own switches noted that back-up generators, particularly downstate, are often located offsite, and some carriers have stored them at locations outside New York City, making it difficult to import this equipment during the emergency due to street and bridge closures. Other CLECs also expressed the belief that they should receive priority restoration from electric providers, specifically from Con Edison.

Overall, the CLECs, particularly in the upstate region, were not significantly affected by the power outage. Verizon's power failures and associated service outages at its second midtown Manhattan central office compromised the CLEC networks and facilities in the New York City area. The failure of several carriers with major switches to have truck-mounted or other portable generators in the metropolitan area may have added to the length of time their customers were without service.

Recommendations

- The Competitive Local Exchange Carriers should test back up power generators at peak periods under full-load conditions to determine if the back-up generators can support the batteries in the hottest and coldest months.
- The Competitive Local Exchange Carriers should rigorously maintain back-up batteries and generators.
- The Competitive Local Exchange Carriers should make every effort to have a back-up power source (i.e., portable back-up generators) readily available.
- The Competitive Local Exchange Carriers should encourage their business customers to provide and maintain a back-up power source at their locations in

order to ensure continuous service in an emergency situation.

- The Competitive Local Exchange Carriers in New York City are encouraged to open a dialogue with Con Edison to discuss the potential for priority restoration of services within areas that are known to contain a concentration of key telecommunications facilities.

d. Wireless Carriers

Although a number of wireless carriers lost commercial power at switching offices, the impact did not adversely affect service. Back-up power sources allowed the wireless switches, known as Mobile Telephone Switching Offices or MTSOs, to function properly.

Wireless carriers operate over 6,500 cell sites in New York State, with over 3,400 sited in the New York City area. Generally, back-up power worked as designed at most locations, but sites that lost commercial power, and were without a back-up generator, lost service. Fixed generator placement varies by company. In Manhattan, landlord restrictions and city zoning ordinances were cited as reasons for preventing placement of such equipment. Batteries were depleted during the event because they are not capable of supporting service over the duration of long-term outages. In some cases, cell sites continued to function on back-up power but were inoperable as the backhaul circuits provided by landline carriers failed.⁴⁹

During the first three hours after the onset of the blackout, call volumes exceeded a normal busy hour by 150% to 500%. Within four hours, approximately 20% of cell sites lost service as back-up power failed. Within 12 hours, approximately

⁴⁹ Backhaul circuits are physical paths that connect the cell site to the MTSO. These circuits provide signaling and the voice path for communications.

30% of cell sites lost service.⁵⁰ After the 12-hour mark, cell sites began to return as grid power returned, or back-up power sources were put into place. Nationwide, nearly all cell sites were back in service at the 36-hour mark.

Wireless carriers acknowledged that the extraordinary demand for cell phone service overburdened the network, but note that customers who were persistent were able to make calls. Wireless networks are not designed to withstand a long-term power outage, and New York City represents a unique challenge to the wireless industry because lease and zoning restrictions narrowly constrain locations where a back-up generator may be placed. Even with adequate power, the capacity of a wireless network is not designed to accommodate the calling surge which accompanies a widespread and unusual emergency event.

Recommendations

- Wireless carriers should examine all forms of back-up power sources for their cell sites, such as use of fuel cell technologies.⁵¹
- Wireless carriers should work with New York City and its other interested stakeholders to develop a plan for ready availability of back-up power sources for use at critical times.
- Wireless carriers should examine what can be done to improve call completions (choke incoming calls, improving call-handling capacity generally, etc.) to wireline networks during emergency/unusual events.

⁵⁰ With two exceptions cell carriers chose not to furnish specific information and referred to the aggregate totals provided by the Cellular Telephone and Internet Association (CTIA).

⁵¹ NRIC also recommended use of fuel cell technology. NRIC Report at p. 5.

- Wireless carriers and their backhaul circuit providers, should examine the feasibility of sharing valuable back-up power sources.

e. Cable TV Companies

Generally where power was lost, the ability to use cable services was lost due to lack of power to operate televisions, computers and cable terminal equipment at customer locations. Loss of power to local neighborhoods also meant loss of electricity to pole or pedestal-mounted cable equipment and fiber-optic nodes within those neighborhoods. Cable service continued in areas that still had power, as nearly all of the larger central cable facilities throughout the State have installed emergency back-up generator systems.

The cable television infrastructure constitutes a portion of the FCC-mandated Emergency Alert System (EAS), which provides emergency information to the public through local broadcast radio, television and cable television. Because consumers dependent on electricity were not able to use their televisions, radios and other equipment upon the loss of that power, only those with battery-powered radios or televisions were able to receive EAS messages as well as other local information and news.

The length and scope of the blackout exceeded the ability of cable TV companies to deploy adequate back-up power to field node and power supply locations. The cable companies' outages were, however, generally not noticeable to customers because there was no electricity available to power televisions and similar equipment at customer locations.

2. Consumer Impacts

a. Verizon

During the blackout, the 911 system in New York City became overloaded but the system did not fail.⁵² New York City's Emergency Medical System (EMS) dispatch center, however, lost service for short periods of time. The EMS dispatch center is served by a Verizon central office in Brooklyn and depends entirely on the public telephone network switched through that location. The EMS dispatch center is not part of the dedicated 911 system,⁵³ and the Brooklyn office could not be bypassed within the telephone system so that calls could be routed to it. Therefore, calls could not be forwarded directly to the EMS dispatch center during the four brief times Verizon's SS7 service was down. The outages occurred between the hours of 10:10 p.m. and 2:44 a.m. when 911 calls, including medical emergency calls, are generally lighter. Moreover, the 911 calls could be processed, and the EMS call center bypassed outside the telephone system, via mobile radio communications directly with EMS personnel.

A small number of customers lost power when battery power in electronic field equipment was depleted. The total number of customers out of service for this reason, however, was within the normal daily outage rate.⁵⁴

⁵² 911 call volumes are discussed in Enhancing New York City's Emergency Preparedness - A Report to Mayor Michael R. Bloomberg (October 28, 2003).

⁵³ The 911 system uses non-switched, dedicated trunks and its circuits are redundant at most locations.

⁵⁴ The number of customers who called Verizon to report a service-affecting or out-of-service condition rose only marginally on August 15.

With the exception of the three New York City central offices, Verizon's network generally performed well. Less than 5% of their customers statewide were adversely affected by the blackout, primarily in the New York metropolitan area; 50% of the affected lines were served by the second midtown Manhattan central office. Interruption of calls to the City's EMS dispatch center could be avoided if the City were to subscribe to redundant services from another central office, or if the EMS dispatch center was served from the 911 system.

Recommendation

- Verizon should approach the City of New York to establish alternate routing for EMS calls to eliminate single points of failure.

b. The Independent Companies

For the most part, the independent companies were minimally affected by the blackout. Approximately 19,000 lines were out of service due to the blackout, with durations ranging from 15 to 60 minutes. No particular problems with 911 systems were reported.

In general, the independent companies' emergency plans provide for deployment of temporary pay telephone banks or cell phones. Only one company, however, provided cell phone service to a local hospital, for use in emergencies.

Many companies were unaware whether they provided critical circuits to local electric, gas and water utilities. The independent companies' lack of awareness of important services provided to other utilities requires correction.

Recommendation

- Critical service locations and customers should be identified by the Independent Telephone Companies, and reasonable alternative forms of telephone service should be provided during emergencies.

c. CLECs

Of the 21 CLECs reporting, 13, primarily from the upstate area, indicated there were no significant customer impacts. Of these 13, five carriers had no service-affecting outages at all. Another eight carriers reported no network failures, but noted some customers lost service because on-premises equipment failed.

Two CLECs reported outages affecting long distance service only. The remaining six carriers, most of whom serve the New York metropolitan area, restored local service over periods of between 5 and 43 hours, although some carriers indicated some customers did not clear all of their blackout-related troubles for several days after the event. Two of these CLECs experienced switch failures, causing 714 New York City business customers to lose service for some period of time.

In total, nearly 14,000 customers served by CLECs were without service for some period of time after the blackout. Of these, approximately 13,200 were dependent on the Verizon facilities that failed, primarily at Verizon's second midtown Manhattan location. Of the reporting carriers, three offered to provide cell phones or other accommodations to their customers who were without phone service.

For the most part, the CLEC facilities performed well during the blackout and back-up power sources performed as expected. In general, CLECs affected by the blackout took all reasonable steps to mitigate the effect of the outage on their customer base, including providing cell phone coverage and facilitating aid to each other where requested.

Recommendation

- Competitive Local Exchange Carriers that experienced major switch outages should take steps to arrange alternate accommodations for their customers.

d. Wireless Carriers

Approximately 8.8 million cell phones are in use in New York State. A substantial majority of these customers use their phones in New York City. As previously discussed, some customers were unable to place a call on the first attempt due to extremely high call volumes at the onset of the blackout.⁵⁵ New York City area customers also saw service degradation when cell transmission sites lost back-up power several hours into the blackout. The reliability of cell phones can be compromised during a crisis, and multiple call attempts may be necessary before completion.

e. Cable Television

The loss of power at residential locations results in the inability of consumers to operate the televisions, VCRs, computers and other equipment that enable them to utilize cable services. In addition, terminal equipment located within homes or apartment buildings, requires power to operate.

The effects of the blackout for the cable systems and their subscribers were not unlike those experienced upon a major storm or equipment failure, but on a much larger geographic scale. Consumer equipment in most cases returned to normal operation within minutes of the restoration of power. Some consumer equipment may have required a "reset" or, in some rare cases, the operating settings may have required

⁵⁵ Trunk blockages involving wireless carriers were raised as a concern in a report entitled Network Reliability After 9/11 - A Staff White Paper on Local Telephone Exchange Network Reliability (dated November 2, 2003). The report was made in Case 03-C-0922, Proceeding on Motion of the Commission to Examine Telephone Network Reliability.

reconfiguration.⁵⁶ Generally, loss of power caused by the blackout rendered cable television or cable modem service unusable due to lack of power at customer premises.

Recommendation

- Cable companies should review their back-up power arrangements for outside plant and major cable facilities in light of the increasing reliance of cable facilities for voice telephone.

C. Intercarrier Coordination with Verizon

Because of their reliance on Verizon's network, CLECs must promptly and effectively coordinate restoration activities with Verizon. Of the 21 CLECs filing reports, eight had no contact with Verizon during the blackout period. Of the 13 reporting contact, five were satisfied with their interaction, and found it productive. In fact, several companies characterized their interaction with Verizon as "excellent," reporting that they were "satisfied and appreciative" and that "repair tickets closed in a reasonable period of time."

Two companies gave a somewhat less enthusiastic response, calling the escalation process "difficult,"⁵⁷ and the hold times "excessive," but perhaps to be expected given the circumstances. Another CLEC stated that trouble tickets took 30-60 minutes to open with the New York City Carrier Account Team Center (CATC) but once Verizon rolled the calls over to the Boston CATC, hold times decreased to 15-30 minutes.

⁵⁶ Consumers increasingly rely on the cable broadband for telephone services; its operation during power outages is becoming more of a concern. This is especially true where broadband may support Voice over IP telephony and other services of importance.

⁵⁷ Companies that cannot resolve their service issues through normal channels may escalate their trouble reports to progressively higher levels of Verizon management until the situation is resolved.

The CLECs that were not entirely satisfied with their contacts with Verizon raised several specific complaints. They maintain that: 1) trouble resolution and hold times were excessive; 2) communications were inconsistent, disorganized and untimely; 3) critical information was unavailable; and, 4) escalation, particularly above the third level, was unresponsive, impossible, or ended at voice mail. Further, some CLECS indicated that information provided on-site at central offices contradicted information from status desk personnel, supervisors and other off-site sources, and several complained that post-blackout repairs were not timely.

The CLECs differ on whether communication with Verizon improved after power was restored. One CLEC said communications returned to normal shortly after power was restored; others state that communication did not significantly improve for several days. One company indicated that the backlog of maintenance and provisioning issues required escalation within Verizon that lasted several weeks, while another indicated that even though it escalated 30 situations to the vice-presidential level, Verizon was extremely responsive and worked diligently to restore priority customer circuits.

There are significant differences between and among CLECs in perceptions of the ability to communicate with Verizon during the blackout period, and the differences extend to the restoration period as well. Difficulty in escalation to higher levels within the Verizon organization seems a significant factor in some competitive carriers' ability to restore customer service in a timely manner.

Verizon's perspective on communication, escalation and restoration issues differs significantly from that expressed by various competitive carriers. It maintains its performance was more than satisfactory, given the circumstances.

Recommendations

- Verizon should review its intercarrier communications procedures, including, but not limited to, making a minimum number of lines and/or personnel available for intercarrier calls during any major emergency situation. This should include the availability of live account representatives rather than recorded voicemail drops, as well as a timely rollover of incoming calls to its Massachusetts or other CATC.
- Verizon escalation personnel who can access the information necessary to facilitate critical restoration efforts should be readily available at all times in emergency situations, such as the blackout.
- Verizon's feedback to carriers on their individual situations should be timely, pertinent, consistent and accurate. Verizon should work with competitive carriers to address their concerns.

D. Reports to the Commission

All local exchange carriers in New York State are required to report major services outages, which include a central office failure or toll center failure lasting more than five minutes, under the terms of the Department's Office of Telecommunications Emergency Plan. For long distance carriers, only major companies like AT&T, MCI and Sprint are required to report outages. Other carriers are not required to file reports.

During the blackout, Verizon reported its outages, as required. None of the smaller independents reported major service interruptions, even though some experienced events that met the threshold for reporting. MCI reported failures immediately; AT&T reported the outages over a period of days, and Time Warner did not report until 5:00 p.m. on August 15.

The remaining companies did not report any major service interruptions.

Wireless carriers are not regulated by the Public Service Commission and therefore are not required to report outages to the PSC. Wireless carriers have voluntarily agreed to report major outages under a federal program that relies upon the FCC reporting thresholds as criteria. None were reported as the result of the blackout event.

Cable television companies are required in the Department's Emergency Plan to report large scale cable outages exceeding 1,000 subscribers for 24 hours or more. In a number of areas of the state, cable outages did not meet this criteria so no reporting was required. In other areas, cable service disruptions did meet the criteria and some, but not all, cable systems reported the outages.

Recommendation

- All telephone and cable companies should strictly adhere to the Department's Office of Telecommunications Emergency Plan pertaining to the reporting of service-affecting conditions in their networks; reports should be timely and accurate.

E. The Mutual Aid and Restoration Consortium

Approximately ten years ago, New York City established the Mutual Aid and Restoration Consortium (MARC) to act as a clearinghouse facilitating the restoration of critical telecommunications facilities in the City after a major outage. Of the reporting landline carriers that operate in the City, seven participated in calls MARC arranged to assist in coordinating the response to the blackout; seven did not. One CLEC was critical of Verizon's participation, maintaining that its crucial role as a service provider required it to furnish essential information more expeditiously. Other carriers simply

noted that they were on the calls. Wireless carriers and some cable companies also participated on MARC calls.

Generally, carriers noted that MARC was able to assist in gaining access to cell sites and buildings and disseminated useful information about on the status of electric service restoration efforts. It also assisted in the routing of emergency equipment and fuel supply deliveries through the City's congested streets.

Recommendations

- All facilities-based Competitive Local Exchange Carriers providing service in the NYC metro area should be encouraged to participate on MARC calls. Participation should entail full disclosure of information pertaining to conditions that affect service within each carriers' networks, particularly if the condition affects other telecommunications carriers, or critical communications for key city or state agencies.
- Through the MARC process, Competitive Local Exchange Carriers are encouraged to discuss with the City prioritizing routes for the travel of the telecommunications emergency services vehicles necessary to deliver equipment or essential personnel to facility sites.

F. Restoration of Power

Restoration of commercial power did not guarantee full restoration of telephone service as, in many cases, consumer premises visits were required, and a backlog of repair calls, particularly in the New York City area, took several days, or longer in some instances, to clear. Cable company personnel reported no lasting impact on cable service upon restoration of power, and only a relatively few cases of adverse impacts on equipment were noted upon the restoration of power.

G. Lessons Learned

Many carriers suggested changes to either their own processes, or communication with other entities that, in their view, would serve to mitigate the effects of future precipitous situations such as the blackout.

Recommendation

- The telecommunications carriers should implement lessons learned identified during the blackout.

IV. Con Edison Steam Service

Executive Summary

As a result of the August 14 blackout, the Con Edison steam system shut down and all steam customers lost service. Because none of Con Edison's steam generation plants is capable of a blackstart without electric supply from an outside source, the utility could not commence restoration of steam service by using those units until after electric service was restored. However, Brooklyn Navy Yard Cogeneration Plant (BNYCP), an independent power producer under contract to supply both electric and steam to Con Edison, is equipped with blackstart capability. Consequently, BNYCP was capable of producing a limited supply of steam for Con Edison's use soon after the blackout commenced, but Con Edison did not immediately request that service.

Notwithstanding its efforts to restore steam service following the outage, Con Edison had not, prior to the outage, developed a plan or set of detailed written procedures outlining the steps necessary to re-energize the steam system following the complete loss of steam pressure. The absence of a written plan, the failure to timely ask BYNCP to blackstart and resume supplying steam, and the decision to await energizing the steam system until after electric service was restored to customers, in all likelihood delayed the full restoration of steam service.

Introduction

Con Edison furnishes steam service in Manhattan to nearly 2,000 customers. It is the only steam utility fully regulated under the Public Service Law. A description of the system is attached as Appendix F.

A review conducted into the impact of the August 14, 2003 blackout on Con Edison's steam system examined the

following: the conditions existing prior to the electric blackout, the effects of the blackout on steam service, steam production capability, and steam service restoration.

Discussion

The loss of electric power supply during the blackout caused the entire Con Edison steam system to shut down. The shutdown was accomplished without causing a major component failure at the steam production plants and without damage to the distribution system. Immediately following the blackout, the utility's steam personnel devised a procedure to re-energize the distribution system. Con Edison was able to systematically and methodically re-start their steam generation plants and re-energize the entire steam system while preserving public health and safety.

A. Pre-Existing Conditions

Just prior to the inception of the blackout on August 14, Con Edison was sending out steam at a rate of approximately 5,200 thousand pounds per hour (mlb/hr), and steam pressures in the system ranged from 152 to 165 pounds per square inch gauge (psig). Con Edison had forecast a 2003 summer peak load of 6,640 mlb/hr. All but one of the nine steam plants the utility owns was supplying steam, at varying levels of production, and BNYCP was operating at full production.

The utility's East River facility, which is capable of generating electricity as well as producing steam, was operating in an electric-only mode.⁵⁸ The Hudson Avenue facility was producing steam from boilers, while a combined electric and steam unit at that location was unavailable. There were no

⁵⁸ When operating only to generate electricity, the steam and electric capable facilities use steam to run turbines that drive generators, but do not inject steam into the steam delivery system.

significant construction or maintenance projects in progress, nor were there any unusual conditions that would have exacerbated the effects of the blackout.

Once electric power was lost on August 14, the steam generation plants quickly tripped off-line. These facilities rely on electric supply to operate auxiliary equipment such as lights, motors, fans and pumps. Steam generation facilities can draw substantial electric load for these purposes, and may require five to eight MW for those purposes. Once steam supply was lost, the pressure in the system decayed to zero in two hours, interrupting steam service to 1,394 customers. The 421 winter-seasonal customers that were isolated from the system for the summer were not directly affected.

B. The System Shut Down

The steam system shut down without damage to equipment, either in the transmission or distribution systems, or in the steam production plants. All equipment operated as designed when the loss of power was sensed.

Telemetry equipment used to monitor pressures in the system at appropriate locations, including the transition points where the steam transmission and steam distribution systems are tied together, ceased to operate once electric power was lost. The three remotely-operated, electrically-powered butterfly valves, used by the steam dispatcher to direct steam flow where needed, operated as designed, remaining in their positions, full open, immediately following the blackout.

No reports of damage to customer-owned piping or equipment were received. Generally, steam equipment and components installed within customer premises automatically stop functioning without experiencing damage when steam pressure falls below a system design value. Usually, 125 psig is needed

to power air-conditioning equipment, while 40 psig is sufficient to operate heating systems.

Communications disruptions did not affect Con Edison personnel's response to the outage or the restoration effort. Although Con Edison experienced sporadic degradation of landline and cellular telephone service, its personnel relied on the utility's mobile radio system to communicate effectively.

C. Steam Production Unit Capabilities

None of Con Edison's nine steam plants can blackstart, and back-up power is not available to operate the auxiliary equipment required for continued steam production in the event of an electric outage. The East River and Hudson Avenue plants, by design, can bypass the electric generating turbines and continue supplying steam even when not generating electricity. However, approximately 24 hours is needed to reconfigure one of the two East River combined electric and steam units to bypass the turbine, and 72 hours is required to reconfigure the other unit for that purpose. Consequently, even if the East River combined electric and steam units had been capable of a blackstart, steam production at the facility could not have resumed until well after the two hours it took for steam system pressure to be lost.

Depending on the electric load, the combined electric and steam units at the Hudson Avenue plant can be reconfigured for steam bypass of the turbine within one hour or less. But, the Hudson Avenue unit was out-of-service and unavailable at the time of the blackout.

Moreover, the auxiliary power requirements at the combined steam and electric plants are much greater than at the steam boiler plants. The steam and electric stations require pure water of high quality to avoid chemical reactions and corrosion that would otherwise attend their operations at high

pressures and temperatures. The treatment processes that purify the water draw a large electrical demand. Consequently, auxiliary electric load at the steam only stations require 5 MW on average, against the 7 MW to 8 MW needed at combined steam and electric stations.

Like the Con Edison-owned units, BNYCP was able to shut down its operations without incurring damage. After the shut down, BNYCP brought its emergency back-up diesel generators on-line and re-established power supply to its facility. It could have commenced supplying Con Edison with steam as early as two hours following the blackout, had the utility requested it. Although the steam send-out from BNYCP under these conditions would have been at approximately 30 mlb/hr, a reduced capacity insufficient to maintain supply to any part of the system, the steam could have been used to warm up and maintain pressures within the steam main connecting Brooklyn and Manhattan. This approach could have played a role in expediting the restoration of the steam system. As events transpired, Con Edison did not commence warm up of the this main until 4:50 p.m. on August 15, a full day after the blackout had commenced.

Another potential source for quickly reviving steam production is Con Edison's Ravenswood facility.⁵⁹ The steam boilers at the Ravenswood plant require only 150 kW of back-up electrical power because the majority of its auxiliary equipment is steam-driven. If a back-up supply of electricity had been in place, Ravenswood would have been capable of self-sustaining steam production by extracting from its steam output the steam needed to operate its auxiliary equipment.

⁵⁹ While Con Edison owns the steam boilers at Ravenswood, it contracts out operation and maintenance of the equipment to KeySpan Energy, which owns and operates an electric generation plant adjacent to, but independent of, the steam boilers.

As a result, if sufficiently equipped with back-up power, Ravenswood could have continued steam production notwithstanding the loss of electricity in the outage. If the facility had been shut down at the time of an outage, start-up would have required an alternative source of steam, such as a portable steam generator.

D. System Restoration Planning

Following the outage, Con Edison's steam personnel drafted a plan for the re-energization of the steam system. The utility had no existing plans or written procedures in place outlining the steps necessary to restore the entire steam system to service once pressure had decayed to zero. The utility initially considered isolating the steam system into hundreds of sections and then implementing existing procedures to restore the various sections individually. This approach to restoration of individual sections is commonplace for routine operations, including maintenance activities.

That plan, however, was abandoned when utility personnel decided they could isolate the system into twenty sections, and proceed with the restoration of those segments. Utility crews were dispatched to manually close the valves that would accomplish such an isolation. The work on implementing this plan continued into the early morning hours of August 15.

Reacting to the actual system conditions observed on August 15, Con Edison modified its restoration plan. Instead of breaking the system into twenty segments, it decided to divide it into two large sections -- an uptown loop and a downtown loop. The Upper West Side along Central Park was designated as a separate zone within the uptown loop. This approach, Con Edison personnel believed, would accelerate the restoration effort without increasing safety risks. A detailed procedure was drafted to effectuate this strategy, with the uptown loop

energized first, followed by the downtown loop, and finally by the Central Park West zone.

Con Edison crews spent the remainder of August 15 closing the valves that would isolate the uptown and downtown loops. Crews also traveled to and repositioned or checked numerous other mainline valves, service valves, bypass valves, blow-off valves, and station outlet valves. In some cases, valves which had been visited under the prior restoration plan were revisited and repositioned to accommodate the new restoration plan.

Moreover, prior to reintroducing steam into the system, crews had to inspect and assess the operability of pumps installed in manholes used to drain water at low points in the system. These pumps are designed to remove any water that condenses out of the steam. Water not removed prior to the introduction of steam could be forced through the system at increasing velocity until arriving at an obstruction, such as a steam fitting or a sharp elbow joint. The resulting effect, known as a water hammer, could result in a rupture of the system that could endanger health and safety.

E. System Restoration Operations

Once Con Edison was satisfied that the system was ready for the safe reintroduction of steam, it proceeded to commence pressurization of the system. At the initial stages of system restoration, it relied extensively on steam production from the Waterside combined steam and electric plant, which returned to service at about 11:35 p.m. on August 15, after electric supply from the grid was re-established. Steam production from this facility was gradually introduced into the uptown loop. At 1:35 a.m. on August 16, steam flows were observed in the loop when steam emanated from a blow-off valve located several blocks from the Waterside plant. Soon

afterwards, other steam production plants re-entered service, as seen in Table 1 below.

Table 1 - Steam Send-out in mlb/hr

Plant	8/15 11:00 PM	8/16 1:30 AM	8/16 7:00 AM	8/16 12:00 PM	8/17 3:00 AM	8/17 12:00 PM	8/18 1:45 AM
59 th St.	0	0	188	154	122	255	449
74 th St.	0	0	0	0	0	113	240
Ravenswood	0	0	0	0	0	0	71
60 th St.	0	0	200	180	155	300	500
Waterside	0	44.5	n/a	n/a	407	472	757
East River	0	0	0	0	0	194	217
Hudson Ave.	0	0	0	0	0	0	151
BNYCP	*	*	*	*	*	130	380

* Production from BNYCP during these periods ranged from 50 to 100 mlb/hr, as needed.

BNYCP returned to electric service at 6:21 a.m. on August 15. Its steam turbines subsequently returned to service and, at 11:00 a.m., the four-hour process of warming its steam export line -- a 24-inch diameter pipe of 0.6 miles in length -- commenced. The export line interconnects BNYCP to Con Edison's main in Manhattan. By approximately 3:00 p.m., the warm-up process was complete and BNYCP was then capable of sending 550 mlb/hr of steam to Con Edison.

With BNYCP available to supply steam at full capacity, Con Edison began to warm up the main between Brooklyn and Manhattan. This main feeds lower Manhattan. The main valve connecting BNYCP's export line to this main needed to be opened slowly so that pressure on either side of the valve was equalized before it was opened completely. The warm-up process relied upon steam production from BNYCP introduced into the main through bypasses of the main valve, with the utility carefully checking the fifteen steam traps within the Tunnel to ensure that condensate was draining.

Warm-up of the main connecting Brooklyn and Manhattan was initiated by Con Edison at approximately 4:50 p.m., and the main valve to BNYCP was fully opened at 10:46 p.m. on August 15 upon completion of the warm-up process. The main was pressurized to 100 psig, with flows of 50 to 100 mlb/hr from BNYCP. Steam was now available from BNYCP's Brooklyn location to the first valve in lower Manhattan.

The restoration of steam service continued with the cautious build-up of pressure in the uptown loop. The company chose to restore the uptown loop first since most of the steam production plants and steam customers are located uptown. Pressures were maintained between 15 and 35 psig during a four-hour soak period. Soaking is the introduction of steam into a main up to a certain pressure, which is then held constant for a set time period until pressure is stepped-up to the next level. Throughout this process, Con Edison's crews checked low points on the system to assure adequate drainage of condensate, and otherwise proceeded in conformance with the system restoration procedure it developed after the blackout. Over 120 personnel, working in 12-hour shifts, were assigned to the steam system restoration.

Re-energizing the uptown loop continued throughout the day and into the night of August 16. During this time, Con Edison also restored service to a main located in lower Manhattan. The main was used to redirect steam supply from BNYCP to the uptown loop, supplementing the steam supply available for its restoration. Pressure in the uptown loop was gradually increased until it reached 90 psig at 4:00 a.m. on August 17, and the uptown loop operated at that level while drainage was monitored.

While this approach to the uptown loop was consistent with the steam restoration plan Con Edison developed after the

blackout commenced, the steam from BNYCP potentially could have been used to initiate restoration of the downtown loop instead. This would have enabled the utility to proceed with the restoration of both loops simultaneously.

At 11:00 a.m. on August 17, restoration of the downtown loop commenced, with a repetition of the soaking procedure and the checking of low points for proper drainage. Pressure reached 90 psig in the downtown loop at 9:00 p.m. At midnight on August 18, the remaining valves on the steam system were opened and the uptown and downtown loops were equalized to 100 psig. Central Park West was fully energized at 2:45 a.m.

According to Con Edison, restoration of the steam system was slowed not because steam supply was inadequate but because of concern over the safe introduction of steam to the premises of those customers that require electric power in order to take steam service. Those customers rely on electric pumps to remove condensate from steam traps, and, absent pump operation, Con Edison feared that a destructive or dangerous water hammer could be created when steam returned to the customers' premises. The number of customers relying on electric pumps, however, could not be verified, and the utility admits that most steam traps on customer premises rely on steam pressure mechanisms to remove condensate. Such customers consequently require no special preparation to make ready for the return of steam service.

F. Conclusion

Under the Commission's regulations governing the distribution of steam, 16 NYCRR Part 420, a steam utility must develop a written plan for safely restoring any main or service outage. While Con Edison had developed plans for addressing some contingencies that could affect steam operations, prior to the August 14 blackout, it had not developed plans for

responding to a widespread electric outage or for restoring the system if it had to shut down entirely. The absence of such plans contributed to a delay in restoring the steam system.

The development of emergency plans for steam system restoration upon a complete shut down of the steam, and for other steam system contingencies Con Edison might experience, is needed. Better procedures might enable the utility to avoid a system shut-down by shedding steam load or otherwise reducing demand on the steam system, or by maintaining a back-up level of supply. These approaches also might facilitate a quicker return to full normal operations than occurred following the blackout.

Once Con Edison arrived at a restoration plan, however, the steam restoration process proceeded carefully in order to protect the public health and safety. A conservative approach to restoration was appropriate because the blackout had an unprecedented effect on the steam system, which, according to Con Edison personnel, had never shut down in its entirety before.

Lessons Learned

- In retrospect, based on system conditions experienced during the restoration effort, Con Edison believes the system could have been reenergized as a whole instead of requiring segregation into two loops.
- An analysis of the minimum steam pressure adequate to sustain system operations is needed. With BNYCP production available after a blackstart, it may be feasible to install sufficient back-up power at some other steam production sites that, when combined with blackstart production from BNYCP, would raise overall production to a level that could be used to sustain the system.

Recommendations

- Con Edison should develop formal written procedures detailing the steps and actions necessary to restore the steam system in the event of a complete system-

wide outage or other major disruption. The procedures should address other scenarios that may occur at different times of the year under varying system conditions. Customers that depend on an electric-driven condensate pump within their premises should be identified, and if necessary, procedures should be written for restoration of service to them, including their isolation prior to the introduction of steam into the system.

- Con Edison should make arrangements to access steam supply that may be available from plants it does not own, like the Brooklyn Navy Yard Cogeneration Plant, under emergency or outage circumstances. Specific notification and emergency procedures may be needed to facilitate cooperation with these providers following an event such as a widespread or total loss of system pressure.
- Con Edison should study the feasibility and efficacy of installing emergency back-up power systems at steam generating plants. The study should include a cost benefit analysis, establish a minimum pressure for sustaining system operation, and identify the production plants that must operate in order to maintain that minimum steam pressure.

Natural Gas

V.a. Local Distribution Companies

Executive Summary

The impact of the blackout on New York's natural gas local distribution companies (LDCs) was minimal. Their back-up systems and procedures worked as intended. No customers lost natural gas delivery service as a result of the blackout. Although some LDCs experienced pressure increases within their distribution pipe systems, the increases remained within safety code limits. No hazardous conditions arose as a result of the blackout.

Operational and equipment failures were minor. The most important problems were deficiencies in back-up power arrangements and damage to electronic components. Several LDCs are considering enhancements to their back-up power capabilities at critical facilities.

Several LDCs operate "peak-shaving" plants, which are used to supplement gas supplies with propane or liquefied natural gas. These plants operate during times of high demand, usually during very cold weather. Because the weather was warm, none of these peak-shaving plants was supporting gas service at the time of the blackout. The impact on these plants was generally minimal, with the exception of one facility where back-up batteries for the gas and fire detection systems depleted much sooner than expected.

Several LDCs reported that their communication abilities were adversely affected, with landline and cell phone service quality degraded at times. No LDC, however, lost the ability to maintain necessary communications. To facilitate internal communication among their personnel, LDCs furnish them with a variety of communications devices in addition to cell and

landline telephones, including mobile radios and satellite phones. The LDCs reported that these alternative means of communication functioned adequately during the blackout.

Introduction

A review was conducted into the impact of the August 14, 2003 blackout on the ten major LDCs. The affected companies are shown in Appendix B. We inquired into the conditions pre-existing the blackout, effects of the blackout on ability to monitor and control the gas system, safety issues, continuation of service, corrective actions and lessons learned.

Discussion

The companies promptly evaluated the situation to determine what actions were necessary to maintain safe operations. Since the primary impact of the loss of electric power was the inability to receive gas pressure and flow data from remote telemetry locations, personnel were dispatched to critical locations to manually retrieve data and perform any necessary operations. All equipment and facilities used to maintain system pressures within code limits functioned as expected. The LDC's and pipelines promptly established communications between themselves to discuss operational and gas supply issues. Gas flow rates were adjusted where needed. Gas supply issues were resolved by diverting extra gas to storage or line pack.

A. LDC Service Reliability

The first priority in operating a natural gas system is safety -- protection of life and property. During a blackout, the LDCs are expected to prevent over-pressurizing of the system by maintaining pipeline pressures within the safety code limitations specified in 16 NYCRR Part 255. They are also expected to react promptly to abnormal situations, by remaining available to receive reports of, and respond to, emergencies

like pipeline failures or gas leaks. Reliable service is also a priority and is expected unless over-riding safety considerations require interruption of service.

Gas distribution pipeline systems operate pneumatically, and therefore do not rely on electricity from the grid to maintain system pressures and deliver service. While the LDCs do depend on the grid for power to remotely monitor and control system pressures and flows, critically-important equipment is supported with back-up power from batteries or on-site generators. The LDCs can also dispatch personnel to critical sites, where necessary operations and monitoring can be performed manually.

LDCs depend to a limited extent on electric power for the control and monitoring of gate and flow stations. To operate these facilities, SCADA systems monitor pressures and flows and transmit data via telemetric equipment to a central gas system control location. SCADA systems at critical locations are supported with back-up power and LDC personnel can be dispatched to these locations to manually monitor the data. As a result, gas pipeline systems can continue to operate during an interruption of electric supply from the grid.

A blackout can affect the operations of the propane-air and liquefied natural gas (LNG) peak-shaving gas supply plants that are used to supplement gas supply during peak periods. Because large quantities of fuels are stored at these facilities, extensive leak and fire detection and fire suppression systems have been installed. Even where plants lack comprehensive back-up power systems, LDCs are still expected to maintain these safety functions during a blackout.

While the LDCs all have written emergency procedures, the level of detail and specificity of those procedures varies. Some LDCs do not address large scale interruption of electric

power from the grid, although generalized procedures are in place for responding to "unusual events." Some LDCs have procedures addressing the effect of loss of grid power on alarms and on the monitoring of, and communication with, control points. Some have promulgated business continuity and crisis management plans, which can be triggered by any crisis, including terrorism, civil disturbance, catastrophic accident, severe weather, and the like.

Regardless of the initiating event, the emergency responses would be similar in most cases -- mobilizing personnel (including mutual aid if necessary); making hazardous conditions safe; implementing special considerations for nursing homes, hospitals, life-support and other similar customers; restoring service in the event of outages; maintaining liaison with government officials and media; and, taking similar steps to alleviate the impact of the emergency. No matter the level of detail in the written procedures, some level of judgment will always be required in determining whether activation of an emergency plan is warranted and which specific components of the plan should be implemented.

B. Pre-Existing Conditions

The LDCs report that their gas systems were operating at typical summer loads just prior to the blackout. Interstate pipelines had not implemented any curtailments. No unusual events were occurring.

Only two major assets were out-of-service, a gas transmission line owned by Central Hudson and a Niagara Mohawk gate station, which was out-of-service for maintenance. As the blackout commenced, Central Hudson was reducing pressure on one of its gas transmission lines in preparation for a pipe replacement project the following day. This work was postponed for several days as a result of the blackout. Niagara Mohawk

met its gas supply needs by adjusting flows at another gate station.

C. Effects of the Blackout

1. The Pipeline Distribution System

The loss of electric power did not lead to loss of gas service from the LDCs. Two buildings in Con Edison's service territory, however, lost gas supply because the loss of power caused customer-installed electric valves, located downstream of Con Edison's service valve, to close.

The blackout caused some damage to LDC system components. Con Edison's Hunts Point compressor shut down and a damaged computer control board prevented it from restarting.⁶⁰ The compressor station returned to service on August 19 after repairs.

The blackout caused a reduction in gas demand on the LDC systems, as large-volume users, like industrial customers and electric generation stations, went off-line. This loss of demand, in turn, could have increased system pressures on the LDC pipelines. Mechanically-operated relief valves and over-pressure protection systems, however, are designed to prevent pressures from reaching unsafe levels.

O&R reported that when low demand caused its Pearl River gate station to shut down, some excess gas continued to pass into the downstream pipeline distribution system because second stage regulators did not lock as intended.⁶¹ A relief

⁶⁰ Operation of this compressor station is not integral to gas system integrity because it moves gas volumes from an interstate pipeline to electric generation stations. While gas delivery to the generators can be rescheduled through other pipelines when the compressor is out-of-service, rescheduling was not necessary because the blackout prevented the generators from operating.

⁶¹ These second stage regulators had previously been targeted for replacement and that work has now been completed.

valve activated intermittently in response,⁶² and downstream pressures remained within safety code limits. O&R crews responded to monitor the situation. Although some of the other LDCs experienced pressure increases in their systems, none were above the limits specified in the safety regulations.

In addition to the potential for pressure increases in pipelines, the reduction of gas demand can create an imbalance between the delivery nominations LDCs make with interstate pipelines and the LDCs' actual usage. Several LDCs reported these imbalances arose on their systems. This excess gas problem was mitigated. Line packing -- allowing pipeline pressure to increase within safe limits -- absorbed some of the excess. Gas was also diverted to storage.

2. Monitoring Equipment

Con Edison reported that six remote telemetry units (RTU) experienced circuit board damage, either during the loss of power or upon the repowering of the RTU unit.⁶³ Repairs included replacement of an isolated circuit board or complete replacement of the RTU. Con Edison's pumps for dewatering several company tunnels that contain gas, electric, and steam pipeline facilities ceased operating when the blackout commenced, but back-up generators were promptly installed to restore electric service to the pumps. RG&E reported that two RTUs required repair or replacement due to circuit board damage.

⁶² The valve vents gas to the atmosphere. O&R estimates that venting continued intermittently over approximately one hour. The valve closed after the excess pressure was relieved.

⁶³ Damage to one RTU at a transfer station, where the direction of flow could vary depending on downstream pressures, prevented remote monitoring of gas flows. Utility personnel were dispatched to manually control the flows. At other damaged RTU locations, mechanical overrides remained operable.

Notwithstanding this damage, the loss of power did not adversely affect the LDCs' ability to monitor and control their gas systems. RTUs switched to battery or back-up generation and continued to send data to the SCADA systems. While several LDCs reported that back-up batteries were eventually depleted, some installed portable generators at locations where they were needed. Personnel were also dispatched to critical locations to manually monitor system pressures. Niagara Mohawk reported that a back-up generator failed to start at a RTU location in Utica, and monitoring capability was consequently lost at several sites in the Utica/Rome area. Gas personnel were dispatched to the affected sites to monitor safety operations until power was restored. The generator was subsequently repaired and returned to stand-by service.

Other than Niagara Mohawk, the LDCs note that the back-up power systems supporting gas monitoring and control functioned as expected. In any event, even if these remotely-controlled systems experienced electrical problems, mechanical controls that do not rely on electric power remained operable. Where manual operation of the system was necessary, it was limited to the monitoring of gas pressure and odorant injection systems, and on-site visual checks of meters, dials, and gauges.

3. Peak-Shaving Plants

a. Propane-Air Plants

The propane air peak-shaving plants operate infrequently, and generally lack extensive or comprehensive back-up power systems. Moreover, natural gas demand would likely decline during a large-scale blackout, rendering the peak-shaving function unnecessary. As a result of these combined factors, it may not be cost-effective or beneficial to maintain back-up power generation at these locations.

O&R's propane-air plant operates only on unusually cold winter days and, thus, was not operating on August 14. When needed to supplement gas supply, the liquid propane at the plant is vaporized, mixed with air, and injected into the natural gas pipeline system where it blends with natural gas supplies. Batteries supply back-up power to the gas and fire detection systems at the facility. The fire suppression system is manually operated, even under normal circumstances. Valves are opened by hand, allowing water to flow to fixed spray nozzles directed at the propane tanks.

Central Hudson's two propane plants were also out of operation at the time of the blackout. One lost its gas detection and communication systems when the blackout commenced. The fire detection system at that location, however, is operated by a municipal Fire Department, which supports the service with battery back-up that was unaffected by the blackout. The fire suppression system is not dependent on electric power and was unaffected by the loss of power.

Central Hudson's other propane plant experienced a loss of gas detection and fire alarm detection. No fire suppression system is installed or needed at this facility because the propane tanks are underground. The RTU controlling station communications is equipped with battery back-up and therefore communications were not affected.

Subsequent to the blackout, Central Hudson instituted procedures for the assignment of employees to the plants in the event communications are interrupted or detection systems are disrupted. The employees will periodically inspect the plants and their equipment, both visually and with a battery-operated gas detector, and report any abnormal findings.

b. LNG Plants

When needed to support gas system operations, LNG plants vaporize gas stored as a liquid and inject it into the pipeline system. Con Edison's one LNG plant was in standby mode at the time of the blackout. In the event of a blackout, the plant depends upon a blackstart generator. The generator is sited at an adjacent gas turbine site owned by an independent generator, and had been damaged beyond repair prior to August 14, 2003. A new back-up generator, which Con Edison will own and operate itself, has been delivered to its site and is scheduled for installation by July 2004.

Other back-up generators installed at this LNG plant served communications, gas detection, fire detection and suppression systems, and emergency lights. Although power was lost to those systems when the blackout commenced, it was restored once the back-up generators were started.

At the time of the blackout, one of KeySpan's LNG plants was engaged in liquefaction, cooling gas for storage as a liquid, using power drawn from on-site generation. Liquefaction continued normally until about five hours after onset of the blackout when the generators were shut down to ensure they would be available for other purposes if needed.⁶⁴ Had vaporization of LNG been required during the blackout, it would have been available but at reduced capacity. Gas detection capabilities were lost momentarily, but were quickly restored upon switching to back-up generator power. Fire suppression capability was never lost.

⁶⁴ These back-up generators support other functions, such as gas detection and fire protection. The duration of the blackout was uncertain and liquefaction could be postponed, rendering it prudent to preserve the generators for use in performing the more important functions.

KeySpan's other LNG plant was operating normally at the time of the blackout, but was neither liquefying nor vaporizing gas. Back-up battery power to the gas and fire detection systems failed 36 minutes after the onset of the blackout. The power was restored to the facility within 77 minutes after the blackout commenced using a KeySpan-owned generator located on an adjacent property. During the loss of power, plant operators controlled LNG tank pressure by sending boil-off gas to burn at a flare and by venting through a manually-operated valve.⁶⁵ Fire suppression systems were available at all times. KeySpan plans to install increased battery capacity, with a two-hour run time, to avoid rapid battery depletion in the future.

3. Communications

After onset of the blackout, the LDCs maintained contacts with their suppliers, gas marketers and major customers. For example, Niagara Mohawk and Central Hudson contacted gas-fired generators and upstream transmission pipelines regarding operational issues. O&R spoke with each of its upstream transmission pipelines and advised that it might reach out for assistance if necessary.

In addition, Con Edison contacted its transmission pipelines to ensure that they were capable of supplying gas and controlling their systems. When unable to communicate with Pipeline Electronic Bulletin Boards, the utility asked two transmission pipelines to make the nominations necessary to divert to storage the supplies that were scheduled for delivery to the New York City gate. KeySpan conversed with its

⁶⁵ Inside the tanks, LNG constantly boils off as it absorbs heat. Under normal conditions, the boil-off is injected into the distribution system. To keep pressure at safe limits when power is unavailable, back-up safety systems flare or vent the gas.

transmission pipelines over reductions to system flows and pressures. Communications were also maintained with generators to ensure coordination with plant restarts.

Con Edison and KeySpan were the only LDCs to report significant communications with local and state authorities,⁶⁶ and were also the only LDCs to implement their gas emergency plans. Con Edison activated its Corporate Emergency Response Center (CERC) and Incident Command System (ICS). The CERC coordinated all communications with municipal and state agencies. Con Edison declared an emergency condition immediately after the blackout. The ICS was activated by Con Edison Gas Operations to coordinate all communications with the utility's field personnel.

Consistent with its gas emergency plan guidelines, KeySpan made frequent contact with the New York City Office of Emergency Management, Nassau County Office of Emergency Management, Suffolk County Fire, Rescue and Emergency Services and the New York State Emergency Management Offices (Region 1). KeySpan also contacted a number of Town Supervisors and Village Mayors, as well as the Nassau and Suffolk County Executives.

Describing the operation of communication systems, several LDCs reported that telephone service was intermittent in some locations, for both cellular and landline service. LDCs, however, operate a variety of additional internal communication systems, including private radios and satellite phones. KeySpan noted that the mobile radio remained the most reliable means of communication, while other LDCs reported that, overall, their communications systems functioned adequately during the blackout.

⁶⁶ The LDCs either contacted, or were contacted by, our Safety Section Staff to discuss impacts on their systems.

Most LDCs retained the ability to receive incoming calls from the public, such as reports of gas leaks or emergencies. Two LDCs reported difficulties. Central Hudson reported that some customers using the landline network heard an "all circuits busy" message from the landline company during the first two hours of the blackout, due to congestion on the landline system. Central Hudson connects with the various County 911 centers through direct lines that were not affected by the blackout and remained available for reports of emergencies.

KeySpan reported that loss of power at a central office adversely affected local telephone service in one area. KeySpan, however, remained in direct communication with landline emergency dispatchers through alternative arrangements. Customers in Brooklyn, Queens and Staten Island were advised through public radio announcements to contact an alternate number if attempts to reach the regular number were unsuccessful. KeySpan also assigned personnel to the local Fire Department stations to take reports of gas leaks or odors from customers unable to make outgoing telephone calls.

D. Gas Emergency Procedures

The LDCs written emergency plans vary as to whether the widespread interruption of electric power is considered a gas emergency. Many list examples of events that would trigger a gas emergency, such as pressure problems (high or low), explosions, interruptions, or natural disasters. Generic language is also relied upon. For example, one utility describes a triggering event as "any unusual or abnormal condition which could affect the normal operation of the gas system, pose a threat to the safety of customers or the public, cause damage to buildings or property, or result in a disruption

to gas supply.”⁶⁷ KeySpan, however, specifically lists “electric rolling blackouts” as a triggering event. The decision to activate an emergency plan is therefore somewhat subjective.

Most of the LDC’s did not consider the blackout a gas “emergency.” There were no interruptions of gas service; no fires, explosions or property damage; no deaths or injuries, and no evacuations. Even if there had been interruptions of service, the health and safety impacts would have been less critical than if the event had occurred during cold weather.

As noted above, only the New York City LDCs, Con Edison and KeySpan, implemented their emergency plans. Con Edison advised that it declared a gas emergency because, once it triggered emergency procedures for its electric and steam systems, gas personnel would have been called upon for assistance in any event. The utility was also concerned that its tunnels were prone to flooding, which could affect gas as well as electric and steam service. The potential that SCADA system data might be unavailable also warranted moving to a gas emergency mode of operation.

KeySpan stated that concerns over the nature of the event, questions about its ability to communicate with the public, and the need to properly deploy its personnel led it to implement its emergency plan. The utility also advised that preparations in recent years for terrorist incidents might have influenced its decisions, and that its urban environment raises the sensitivity to disruptions of service. It prefers to implement an emergency plan and then stand down, instead of failing to declare an emergency when it should have.

⁶⁷ The language is quoted from Niagara Mohawk’s gas emergency procedures but is representative of a typical LDC emergency procedure.

The degree to which the LDCs write their plans into a procedure varies. The LDCs' emergency plans address issues such as making notifications, both within the LDC and to outside entities, such as DPS Staff, local emergency responders, and the media; establishing command centers; mobilizing personnel; and responding to the location of the emergency. Because it would be difficult, if not impossible, to foresee every type of emergency that might arise, the plans contain generalized language providing for responses such as dispatching personnel to the affected location to evaluate the situation and take appropriate actions. These appropriate actions might include evacuating the area, controlling the flow of gas, calling for additional personnel, and coordinating with police and fire departments. As to determining which step-by-step actions must be undertaken to respond to a specific situation, LDCs rely upon the experience and training of their personnel, and their knowledge of their facilities and systems.

Lessons Learned

- Several LDCs indicated they would review their emergency or contingency plans in light of the blackout, and determine if updates or revisions are appropriate. Several LDCs also indicated that they will consider increasing back-up battery or emergency generator capacity at flow stations.
- One LDC noted it would review fleet fueling and security issues, as fuel pumps and many types of security equipment are dependent on electricity supply. Although the company did not experience any fleet fueling or security problems, improvements in back-up power arrangements serving those needs might be feasible and useful if a longer or more severe electric outage were experienced.
- One LDC stated that if this type of event had occurred during a period of high gas usage, it would have had to take precautions to properly sequence the return of gas-fired power generation, with some gas-fired

generators perhaps asked to switch to fuel oil supply after start-up on natural gas fuel.

Recommendations

- All LDCs should review their emergency plans and procedures to determine if improvements could be made in light of their experiences in dealing with the August 14 blackout. Consideration should be given to the circumstances that might propel a similar event to the level of "emergency;" for example, if an outage were to occur during cold weather.
- The LDCs should evaluate if actions taken in response to a blackout might be better described in written Operating & Maintenance (O&M) procedures instead of in emergency plans or procedures. For example, O&M procedures might be written to govern responses to smaller-scale, localized blackouts that do not rise to the level of an emergency. The Emergency Plans could be cross-referenced to O&M procedures, which could be deployed on a broader scale when an electric outage rises to the level of an emergency.

Natural Gas

V.b. Interstate Gas Pipelines

Executive Summary

Interstate natural gas pipelines serving New York (the pipelines) rely on electric power to remotely monitor and control system pressures and flows. While the control centers for the operation of these pipeline systems are located outside of New York State, the pipeline operators also employ local maintenance personnel that can be dispatched to critical sites to manually perform the necessary monitoring and operation functions. Moreover, local facilities that are critical to pipeline operations can be supplied with power from back-up batteries or on-site generators that have been installed where necessary.

The pipelines' back-up systems and procedures for responding to emergency events like the August 14 blackout worked as intended. Natural gas deliveries were not interrupted, pipeline system pressures were maintained within safe limits, and no hazardous conditions arose.

Introduction

Major interstate natural gas pipelines operate long-distance, large-diameter, high-pressure pipelines that supply natural gas to New York's LDCs. A review of the blackout's impact on those companies serving New York was conducted. The companies are identified in Appendix B. The inquiry addressed the effects of the blackout on the ability to monitor and control the gas system, safety issues, the continuation of service, any remedial actions taken and lessons learned.

Discussion

A. Standards for Reliable Service

The first priority in operating a natural gas pipeline system is safety -- the protection of life and property. During the blackout, the pipelines are expected to prevent over-pressurizing of the system and maintain pipeline pressures within safety-code limitations. They are also expected to react promptly to abnormal situations, by remaining available to receive reports of, and respond, to emergencies like pipeline failures or gas leaks.

Natural gas pipeline systems depend upon the electric grid to power equipment that monitors and controls the operations of their systems. Equipment critical to operations are supported with a back-up supply from batteries or emergency generators located on-site. In addition, local personnel can be dispatched to these locations to manually monitor and retrieve data.

Like the gas LDCs, the interstate transmission pipelines rely on pressure differentials to move the gas through the pipelines. The transmission pipelines also depend upon compressor stations, a type of facility generally not found on the LDC systems.⁶⁸ These compressor stations, which boost downstream pressures, draw electricity from the grid, but are also supported with on-site back-up power systems.

B. The Response to the Blackout

The interstate pipeline systems were operating at typical summer loads prior to the August 14 blackout. No unusual conditions were noted.

⁶⁸ Con Edison is the only LDC in New York State that operates a compressor station. Its Hunts Point compressor moves gas volumes from the interstate pipeline system to electric generation plants.

The interstate pipeline system operators first became aware that an unusual event was occurring at approximately 4:10 EDT. Columbia Gas Transmission System (Columbia) reported that, at approximately 4:10 p.m., a First Energy generation plant had tripped off-line. Soon thereafter, the pipeline lost communications to the northeastern segment of its system, which includes southern New York. At about the same time, Iroquois Gas Transmission System (IGTS) saw that power generators were dropping off the gas system, causing pressure to build up.⁶⁹ Transcontinental Gas Pipeline Corporation (TRANSCO) also noticed that delivery rates through meters serving the New York City area were falling rapidly, while Dominion Transmission, Inc.'s (DTI) data communications were interrupted across their system. Alarms began to sound on Texas Eastern/Duke/Algonquin Transmission's (Duke) SCADA system, warning of power failures at various locations. Duke personnel received a call from KeySpan reporting a decline in demand, and asking that flow rates into New York be adjusted accordingly. Tennessee Gas Transmission (TGT) received a similar request from Con Edison.

After electric service was lost at the inception of the blackout, the pipelines' back-up power systems at critical facilities functioned as intended, with a few exceptions. Duke reported that a generator at a microwave tower in New York did not start automatically as it should have. For a few hours, Houston could not retrieve data affecting New York and parts of New Jersey, so local personnel were sent to retrieve data manually.

⁶⁹ The interstate pipelines that connect directly to generators typically install remote telemetry meters that monitor the gas flows to these customers in real time. LDCs may monitor and meter generator usage differently.

IGTS reported that two metering stations depleted back-up battery power, with the consequence that a small amount of gas went unmetered. Moreover, a power surge damaged unit control circuits at an IGTS compressor station in New York, causing the unit to shut down. However, this station was not needed for gas supply purposes because gas load had declined as gas-fired generators ceased operating in response to the blackout. Repairs were completed within one day.

DTI's underground gas storage compressor station in Woodhull lost power. Its emergency back-up generator was unavailable because it was undergoing work unrelated to the blackout. The loss of the station did not affect the flow of gas to any transportation or storage customer.

Columbia, TRANSCO and TGT reported that all their back-up power systems functioned as expected. As a precautionary measure, personnel were also dispatched to critical stations to standby in the event they were needed.

Several of the pipeline operators reported drops in demand. Although pressures in their pipelines increased as a result, none experienced pressures high enough to affect safety. Gas scheduled for delivery, but not taken, was absorbed by line pack, diverted to storage, or dispatched to other locations on their systems.

C. Communications

A few of the pipeline operators reported localized difficulties with landline or cellular phones. But one form of telephone service was always available and communications functions were never lost entirely. Shippers, operators of interstate pipelines that do not serve New York, and the pipelines that do serve New York communicated fully with each other to address gas delivery issues. Similar communications also took place with the LDCs, in addition to discussions over

operational issues like dispatching personnel to critical facilities. None of the interstate pipelines reported communications with local government authorities.

D. Conclusion

The interstate pipelines reported that their procedures and processes worked as intended. A few mentioned that their implementation of procedures and systems in preparation for the Year 2000 computer event proved beneficial. TGT found its response to the blackout proceeded almost as if it were an emergency drill, highlighting the importance of preparing for emergencies through mock drills and the drafting of sound emergency plans. None of the pipelines discovered that changes in plans or procedures were needed as a result of the blackout.

VI. Water

Executive Summary

Overall, the major investor-owned public water utilities subject to regulation by the Public Service Commission were generally well prepared for, and reacted promptly to, the unforeseen and widespread electrical outage of August 14, 2003. Their actions were consistent with the approaches detailed in their individual Emergency Plan and Procedures (EPP). The provisions of the EPPs generally demonstrated considerable foresight, and properly guided utilities and their employees as they reacted to the loss of electric service. As a result of their experiences during this event, however, each of the large water companies plans further refinements, including adjustments to the EPPs and augmentation of emergency response equipment. With the exception of one company, Long Island Water Company (LIWC), water service to customers of the six major water companies in New York State was unaffected by the blackout.

Introduction

The response of the major investor-owned public water utilities (the major water companies) to the August 14, 2003 blackout was evaluated by focusing on the reactions and steps taken by the six major water companies that serve substantial numbers of customers. These water companies, all located in downstate New York, are shown in Appendix B. The inquiry addressed the water companies' preparations for, and response to, the blackout, and lessons learned.

Discussion

A. Operational Status Prior to the Blackout

The six major water companies report that they operate their systems according to the guidelines detailed in the "Ten

States Standards" Report,⁷⁰ applicable municipal, county and New York State Department of Health (DOH) requirements, Public Service Commission tariffs and regulations and, under emergency conditions, their individual EPPs. These companies had updated their EPPs after the terrorist attacks of September 11, 2001. These plans are subject to further refinement after the federal government and the New York DOH finish their evaluation of Vulnerability Assessment (VA) studies the utilities recently completed and submitted.

Immediately prior to the August 14 outage, each of the six major water companies were at, or near, normal conditions in supply, demand, storage and operating pressures. There were no major construction projects underway and no signs of impending system irregularities. Each of the major water companies had sufficient back-up engines or generation facilities, either diesel or natural gas-fired, to operate their systems at near-normal levels for at least 24 hours, once manually-operated equipment was placed into service.⁷¹ These back-up systems and equipment are tested either monthly, at a minimum, or regularly in accordance with the manufacturer's recommendations.

Each major water company is interconnected between two to 16 points with neighboring water systems, which are typically operated by municipalities. Some of these interconnections are normally used for water supply on a daily basis, while others are opened only in an emergency. Of these emergency

⁷⁰ Recommended Standards For Water Works, The Great Lakes - Upper Mississippi River Board of Public Health and Environmental Managers (1992).

⁷¹ As discussed below, all companies except LIWC were able to maintain water pressure because their systems were either gravity-fed or sufficient back-up generation, with manual or automatic start capability, was available.

interconnections, one was activated by United Water New York, Inc. (UWNY) to assist the Village of Nyack, a municipal system experiencing a temporary pressure drop as a result of the loss of normal electrical power on August 14.

B. The Impact of the Loss of Power

Damage to equipment of major water companies stemming from the electric outage was minimal. The most extensive damage was suffered at a water treatment plant owned by UWNY, where power surges damaged electrical equipment. The affected equipment was shielded with surge protectors designed to protect against sudden voltage spikes, of the type seen in an event like a lightning strike. Those surge protectors did not respond adequately to the sustained high voltages, at 25% to 30% above the normal range, experienced when the blackout commenced.

The major water companies reported, and confirmed through supporting back-up generator maintenance logs, that all back-up generators had been tested and maintained according to manufacturer's specifications. The back-up generators generally operated as expected. At New York Water Service Corporation (NYWS), one generator overheated and a battery was weak at another unit, but these deficiencies were corrected in less than one hour. At UWNY's West Nyack complex, one generator's cooling belt failed, but a portable unit was utilized, and power was restored by 7:30 p.m. on August 14. The generator unit that had failed was repaired the next day.

At Aquarion Water Company of New York's (AQNY) pump station, individual diesel generator fuel tanks were refilled manually on a regular basis because water infiltration had recently contaminated the company's main diesel fuel storage tank. The tank had been previously scheduled for repair or replacement. Customers did not experience any adverse impacts

as a result of the back-up power difficulties the water companies encountered and resolved.

LIWC lacked Automatic Transfer Switching gear (ATS) to start its back-up generators and its main diesel pumps were temporarily out-of-service. Because LIWC has little or no elevated storage and, therefore, does not operate in a gravity-fed mode, system pressure dropped to below 20 psi in some parts of its system for periods of up to one hour and 20 minutes. Once back-up generators or engines were manually started, the low pressure circumstance was reversed and system pressures rose to over 35 psi within one hour and 30 minutes. Consequently, it did not entirely lose water pressure at any time.

New York DOH regulations require the company to issue a "boil water notice" if pressures fall below 20 psi. LIWC complied with a notice broadcast via radio at approximately 8:00 p.m. on August 14. In accordance with Nassau County DOH requirements, once LIWC drew from its water distribution system satisfactory water quality samples showing adequate chlorine residuals, the boil water notice was lifted at approximately 5:00 p.m. on Saturday August 16. Notice of the "low pressure event" was made to Department of Public Service Staff and local DOH and Department of Environmental Conservation (DEC) offices.

Four major water companies experienced temporary disruptions in the operation of their SCADA systems, until back-up power came on-line. Depending on the utility's system protocols, and means of SCADA communications, this necessitated manual operation of some equipment located in the field, with operational status updates transmitted from the field via mobile radio. Manual operations generally consisted of operating and monitoring pumps and, in some instances, relaying information to SCADA control centers during the early phases of the electric

outage. No negative customer impacts were experienced as result of these field operations.

During the first two hours of the blackout event, the Rockland County area surrounding UWNYS service territory experienced some cell phone service outages that disrupted communications. This affected UWNYS ability to effectively communicate with the County's emergency management personnel. Following the initial assessment of the outage's impact, however, UWNYS personnel were able to leave voice-mail messages with the County's designated Emergency Management Team personnel at approximately 5:15 p.m. Two-way communications with the County's DOH were in place by 6:15 p.m., enabling UWNYS personnel to furnish a full status report and to establish a protocol for subsequent hourly updates.

C. System Restoration

The major water companies are largely dependent upon back-up generation and engine units for continuing operations following a loss of normal electrical power. As previously noted, LIWC lacked ATS and as a result relied on manual operation to start its back-up generators and engines.

The major water companies generally followed the procedures outlined in their individual EPPs, which delineate specific operational tasks and responsibilities, staffing assignments (including those at critical facilities), and public official notification protocols. Four companies, LIWC, Aquarion Water Company of Sea Cliff, NYWS and UWNYS, disseminated general radio announcements asking customers to curtail unnecessary water use. The systems of these four companies are not gravity-fed, and are, therefore, dependent upon continuous pumping of groundwater for supply. Appeals for water conservation during periods when water companies are relying upon back-up generation

is an appropriate step to avoid imposing unnecessary burdens on the back-up equipment.

Lessons Learned

- Major water companies that experienced problems with back-up sources of electric supply are considering the installation of additional back-up generation capacity. The upgrade of fixed placement back-up generator units and engines, conversion from manual to automatic transfer switching start capability, and the enlargement or repair of storage capacity for the generator's diesel fuel have also been identified as issues to be corrected.
- Some major water companies will conduct "table top" exercises to better familiarize personnel with emergency operations and streamline the response to future events, or will develop an emergency response team.
- UWNY will determine if the installation of additional electric protective relay devices to prevent electrical equipment failures at its water treatment facility is feasible and cost-effective.

Recommendation

- Each major investor-owned public water utility should implement its proposed system and procedural improvements to its equipment, EPP or other aspect of its emergency response plan to ensure the best feasible mitigation of the impacts arising out of any emergency event in the future.

List of Recommendations

1. Generators should review their conformance with protection system guidelines. The review should reflect potential revisions to those guidelines and address topics such as threshold limits and trip schemes.

2. The nuclear plant owners, together with the affected counties, should perform an analysis regarding installation of back-up power for alarm sirens.

3. The nuclear plant owners should review their arrangements for ensuring that back-up and uninterruptible power supply is adequate during outages.

4. Each electric utility should evaluate call volumes experienced, and number of calls answered by busy signals, voice response units (VRUs) or call centers, to determine if arrangements for responding to high call volumes during emergencies are adequate.

5. Central Hudson and Rochester Gas and Electric (RG&E) should preserve VRU messages, and RG&E should retain call volume data for a reasonable time period after an unusual event affecting a substantial number of customers occurs.

6. All electric utilities should review their policies and procedures for treatment of customers with life-support equipment (LSE) during major outages. Such a review should include, but not be limited to, the methods and timing of contact efforts, options for follow-up if customers cannot be directly contacted during the first 24 hours after an outage, and the efficacy of keeping logs detailing LSE customer contact efforts.

7. Electric utilities should implement lessons learned as a result of their evaluations of their customer contact and public information efforts.

8. Electric utilities should ensure that they have properly identified and obtained appropriate contact information for governmental and elected officials, critical care facilities, and large use customers, including information for non-business hours.

9. The electric utilities should review their use of websites, and consider, to the extent appropriate, upgrades that would afford better outage and service restoration information.

10. More robust battery back-up capacity should be installed by the electric utilities, the NYISO, and Verizon to power electronic security hardware. For more sensitive and critical facilities and equipment, back-up power should be augmented with standby emergency generators or fuel cells capable of supporting security systems operations for a reasonable time period.

11. The electric utilities, the NYISO, and Verizon should reinforce emergency mobile radio capacity to present a viable back-up communications system. Mobile radio back-up should provide consistent transmission/reception coverage at key company facilities and undergo regular reliability testing and battery charging.

12. The electric utilities, the NYISO, and Verizon should explore the feasibility of acquiring Wireless Priority Service and satellite telephone service for security purposes.

13. The electric utilities, the NYISO, and Verizon should implement, if they have not done so already, a centralized identification and access system. Databases should be updated daily and programmed to sound an alarm at security offices if unauthorized access is attempted.

14. The electric utilities, the NYISO, and Verizon should review the adequacy of its patch management program and implement necessary improvements.

15. The electric utilities, the NYISO, and Verizon should thoroughly review their back-up power requirements for sustaining operation of essential information technology (IT) network components.

16. Verizon should do a full power load test of back-up generators in all of its offices during peak months to determine if back-up generators can support equipment load during the hottest and coldest months of the year.

17. Verizon should certify additional technicians in building power system operations.

18. The Independent Telephone Companies should evaluate their testing and maintenance schedules for power systems in light of NRIC recommendations.

19. The Independent Telephone Companies should consider replacing batteries in remote locations more frequently, in order to enhance back-up power reliability.

20. Competitive Local Exchange Carriers should test back up power generators at peak periods under full-load conditions

to determine if the back-up generators can support the batteries in the hottest and coldest months.

21. Competitive Local Exchange Carriers should rigorously maintain back-up batteries and generators.

22. Competitive Local Exchange Carriers should make every effort to have a back-up power source (i.e., portable back-up generators) readily available.

23. Competitive Local Exchange Carriers should encourage their business customers to provide and maintain a back-up power source at their locations in order to ensure continuous service in an emergency situation.

24. Competitive Local Exchange Carriers in New York City are encouraged to open a dialogue with Con Edison to discuss the potential for priority restoration of services within areas that are known to contain a concentration of key telecommunications facilities.

25. Wireless carriers should examine all forms of back-up power sources for their cell sites, such as use of fuel cell technologies.

26. Wireless carriers should work with New York City and its other interested stakeholders to develop a plan for ready availability of back-up power sources for use at critical times.

27. Wireless carriers should examine what can be done to improve call completions (choke incoming calls, improving call-handling capacity generally, etc.) to wireline networks during emergency/unusual events.

28. Wireless carriers and their backhaul circuit providers should examine the feasibility of sharing valuable back-up power sources.

29. Verizon should approach the City of New York to establish alternate routing for Emergency Medical Service calls to eliminate single points of failure.

30. Critical service locations and customers should be identified by the Independent telephone companies, and reasonable alternative forms of telephone service should be provided during emergencies.

31. Competitive Local Exchange Carriers should take steps to arrange alternate accommodations for their customers.

32. Cable companies should review their back-up power arrangements for outside plant and major cable facilities in light of the increasing reliance cable facilities for voice telephone.

33. Verizon should review its intercarrier communications procedures, including, but not limited to, making a minimum number of lines and/or personnel available for intercarrier calls during any major emergency situation. This should include the availability of live account representatives rather than recorded voicemail drops, as well as a timely rollover of incoming calls to its Massachusetts or other customer assistance telephone center.

34. Verizon escalation personnel who can access information necessary to facilitate critical restoration efforts should be readily available at all times in emergency situations, such as the blackout.

35. Verizon's feedback to competitive carriers on their individual situations should be timely, pertinent, consistent and accurate; Verizon should work with competitive carriers to address their concerns.

36. All telephone and cable companies should strictly adhere to the Department's Office of Telecommunications Emergency Plan pertaining to the reporting of service-affecting conditions in their networks; reports should be timely and accurate.

37. All facilities-based Competitive Local Exchange carriers providing service in the New York City metro area should be encouraged to participate on Mutual Aid Restoration Consortium (MARC) calls. Participation should entail full disclosure of information pertaining to conditions that affect service within each carriers' networks, particularly if the condition affects other telecommunications carriers, or critical communications for key city or state agencies.

38. Through the MARC process, Competitive Local Exchange carriers are encouraged to discuss with the City prioritizing routes for the travel of the telecommunications emergency services vehicles necessary to deliver equipment or essential personnel to facility sites.

39. The Telecommunications carriers should implement lessons learned identified during the blackout.

40. Con Edison should develop formal written procedures detailing the steps and actions necessary to restore the steam system in the event of a complete system-wide outage or other major disruption. The procedures should address other scenarios that may occur at different times of the year under varying system conditions. Customers that depend on an electric-driven condensate pump within their premises should be identified, and if necessary, procedures should be written for restoration of

service to them, including their isolation prior to the introduction of steam into the system.

41. Con Edison should make arrangements to access steam supply that may be available from plants it does not own, like the Brooklyn Navy Yard Co-generation Plant (BNYCP), under emergency or outage circumstances. Specific notification and emergency procedures may be needed to facilitate cooperation with these providers following an event such as a widespread or total loss of system pressure.

42. Con Edison should study the feasibility and efficacy of installing emergency back-up power systems at steam generating plants. The study should include a cost benefit analysis, establish a minimum pressure for sustaining system operation, and identify the production plants that must operate in order to maintain that minimum steam pressure.

43. All gas local distribution companies (LDCs) should review their emergency plans and procedures to determine if improvements could be made, in light of their experiences in dealing with the August 14 blackout. Consideration should be given to the circumstances that might propel a similar event to the level of "emergency," for example, if an outage were to occur during cold weather.

44. The LDCs should evaluate if actions taken in response to a blackout might be better described in written Operating & Maintenance (O&M) procedures instead of in emergency plans or procedures. For example, O&M procedures might be written to govern responses to smaller-scale, localized blackouts that do not rise to the level of an emergency. The Emergency Plans could be cross-referenced to O&M procedures, which could be deployed on a broader scale when an electric outage rises to the level of an emergency.

45. Each major investor-owned public water utility should implement its proposed system and procedural improvements to its equipment, Emergency Plans and Procedures (EPP) or other aspect of its emergency response plan to ensure the best feasible mitigation of the impacts arising out of any emergency event in the future.

List of Companies that Participated in the Inquiry

Electric Companies

Central Hudson Gas & Electric Corporation
Consolidated Edison of New York, Inc.
Long Island Power Authority
New York Power Authority
New York State Electric & Gas Corporation
Niagara Mohawk Power Corporation
Orange & Rockland Utilities, Inc.
Rochester Gas and Electric Corporation

New York Independent System Operator

Generating Companies - Non-Nuclear

AES Corporation
Brooklyn Navy Yard Cogeneration Partners
Calpine Energy Service, LP
Consolidated Edison of New York, Inc.
Dynegy Power Inc.
Florida Power & Light
KeySpan Energy
El-Paso Merchant Energy, LP
Mirant Corporation
NRG Power Inc.
New York Power Authority
Pennsylvania Power & Light EnergyPlus Co.
PSEG Power, LLC
Reliant Energy
Rochester Gas and Electric Corporation
Sithe Energies, Inc.

Generating Companies - Nuclear

Constellation Generation
Entergy Nuclear
Rochester Gas & Electric Corporation

Gas Local Distribution Companies

Central Hudson Gas & Electric Corporation
Consolidated Edison of New York, Inc.

Corning Natural Gas Corporation
KeySpan Energy
National Fuel Gas Distribution Corporation
New York State Electric & Gas Corporation
Niagara Mohawk Power Corporation
Orange & Rockland Utilities, Inc.
Rochester Gas & Electric Corporation
St. Lawrence Gas

Gas Interstate Pipeline Companies

Columbia Gas Transmission System
Dominion Transmission, Inc.
Iroquois Gas Transmission System
Tennessee Gas Transmission
Texas Eastern/Duke/Algonquin Transmission
Transcontinental Gas Pipeline Corporation

Steam Companies

Consolidated Edison of New York, Inc.

Water Companies

Aquarion Water Company of New York
Aquarion Water Company of Sea Cliff
Long Island Water Corporation
New York Water Service Corporation
United Water New Rochelle, Inc.
United Water New York, Inc.

Independent Telephone Companies

Alltel New York, Inc.
Armstrong Telephone Company - New York
Berkshire Telephone Corporation
Cassadaga Telephone Corporation
The Champlain Telephone Company
Chautauqua & Erie Telephone Company
Chazy & Westport Telephone Corp.
Citizens Communications Company of New York, Inc.
Citizens Telephone Company of Hammond NY, Inc.
Crown Point Telephone Corporation
Delhi Telephone Company
Deposit Telephone Company, Inc.
Dunkirk & Fredonia Telephone Company
Edwards Telephone Company, Inc.

Empire Telecommunications Corporation
Fishers Island Telephone Corp.
Frontier Communications of AuSable Valley, Inc.
Frontier Communications of New York, Inc.
Frontier Communications of Seneca-Gorham, Inc.
Frontier Communications of Sylvan Lake, Inc.
Frontier Telephone of Rochester, Inc.
Germantown Telephone Co., Inc
Hancock Telephone Company
Margaretville Telephone Company, Inc.
The Middleburgh Telephone Company
Newport Telephone Company, Inc.
Nicholville Telephone Company, Inc.
Ogden Telephone Company
Oneida County Rural Telephone
Ontario Telephone Company, Inc.
Oriskany Falls Telephone Corp.
Pattersonville Telephone Company
Port Byron Telephone Company
State Telephone Company
Taconic Telephone Corp.
Township Telephone Company, Inc.
Trumansburg Telephone Company, Inc.
Vernon Telephone Company
Warwick Valley Telephone Company

Verizon New York Inc.

Competitive Local Exchange Companies

Adelphia Business Solutions, Inc.
Allegiance Telecom of New York, Inc.
AT&T Communications of New York, Inc.
BridgeCom International, Inc.
Cablevision Lightpath
Choice One Communications of New York, Inc.
CTC Communications Corp.
Focal Communications Corporation of New York
Global Crossing
Global NAPS, Inc.
Level 3 Communications, LLC
MCI Worldcom Communications, Inc.
Metrocom NY
Paetec Communications, Inc.
RCN Telecom Services, Inc.
SBC Telecom, Inc.
Talk America, Inc.

TDS Metrocom, Inc.
Tech Valley Communications, Inc.
Time Warner Telecom - NY
XO New York, Inc.
Z-Tel Communications, Inc.

Wireless Companies

AT&T Wireless
Cingular Wireless
Dobson Cellular
Metrocall Wireless
Nextel Communications, Inc.
Sprint PCS
T-Mobile USA, Inc.
Verizon Wireless

Right-of-Way Management

Introduction

Continuous control of vegetation capable of growing into, or near to, overhead electric transmission and distribution lines is critical to public safety and electrical system reliability. Certain tree species are capable of growing as much as 15 feet per year after cutting. Absent an adequate program to control vegetation growth, reliability can suffer.

Each Transmission Owner (TO) files a Long Range Management Plan (LRMP) for electric transmission ROWs with the Commission, subject to its approval.⁷² In its LRMP, each TO addresses its procedures and activities for the management of its ROWs.

ROW Programs

The ROW maintenance program of each TO subject to the jurisdiction of the Commission is reviewed and assessed annually. This review includes a field inspection of a portion of each company's ROW system, a tree-caused outage assessment, and a trends analysis. Annual ROW management expenditures, ROW management staffing levels, ROW acres treated per year, danger tree work, herbicide use and complaint handling are also analyzed.

Danger Trees

In the last five years, few transmission outages in New York can be traced to trees or other tall vegetation growing directly under transmission wires. Over 90% of the tree-caused outages on transmission ROWs occurred when a tree growing along

⁷² The Long Island Power Authority (LIPA) and the New York Power Authority (NYPA) are outside the Commission's jurisdiction for this purpose.

the edge or outside of the ROW fell. Many of these outages are tied to various types of storm events, including wind, rain, and snow.

Since edge or danger trees present the greatest risk of causing an outage on a transmission line, all TOs need to direct resources to the control of these trees. Each LRMP contains criteria for horizontal as well as vertical wire clearance from vegetation along the sides of the ROW or wire zone⁷³, and a corresponding timeframe for the treatment of vegetation when it reaches into those zones.

ROW Cycles

TOs remove undesirable vegetation from each ROW on a prescribed regular basis, or "cycle."⁷⁴ While cycle lengths are not dictated by 16 NYCRR Part 84, that regulation requires each TO to include the cycle length, and the rationale for that length, in its LRMP. Selection of the appropriate cycle length is important to ensure reliability. In New York, transmission cycle lengths range from four to eight years.

Criteria for determining cycle lengths include site conditions that affect the rate of tree and vegetation growth like soil quality and wire to ground clearance. In general, the lower the minimum clearance of the transmission wire above the ground, the more often tall growing trees must be treated to prevent growth into the wire zone and contact with the wire.

Selection of a longer cycle length, such as eight years, sometimes lead to reliance on costly "hot spot" work to maintain reliability. Hot spot work is the treatment of only some vegetation along an ROW between cycles, usually at the four

⁷³ The wire zone is the area of the ROW that lies underneath and alongside transmission wires.

⁷⁴ Undesirable vegetation is that capable of growing into the wires or wire security zones.

to six year mark, to remove vegetation that may reach the wires before the next scheduled full treatment of all vegetation. Companies that perform significant quantities of hot spot work are able to stretch out their cycle lengths. At the same time, they run a greater risk of a tree-to-wire contact unless they regularly patrol ROWs and perform all the work needed to keep lines clear until the next cycle.

Budgets and Staffing

Adequate, well-qualified staffing and sufficient budgets are key ingredients for a successful ROW management program. ROW management professionals are needed to maintain a prudent cyclic ROW treatment program administered both year after year and cycle after cycle. Qualified personnel ensure proper program implementation, management, scheduling, and work completion. They adequately supervise the ROW vegetation control companies specialized in the application of herbicides and working near energized wires, that, under contract with the TOs, perform most of the vegetation management work.

Summary of Selected Reliability Standards for New York Companies

State-Wide Standards

New York is subject to the NPCC A-2 and New York State Reliability Council standards.⁷⁵ The objective of the standards is to assure that the bulk system is designed and operated so that the loss of a major portion of the bulk system, or the unintentional separation of a major portion of the bulk system, should not result from any design contingencies. The bulk system should, therefore, be designed and operated such that it can withstand certain specified contingencies. The conclusion of an analysis of the system subjected to these contingencies should be that they will not result in widespread cascading outages due to overloads, instability, or voltage collapse.

Resource Adequacy - Design Criterion: Sufficient resources should be available so that the probability of disconnecting any firm load, on average, should be no more than once in ten years. The evaluation should include load forecast errors, scheduled outages and de-ratings, forced outages, assistance over interconnections with neighboring areas, transmission transfer capabilities, and load relief from available operating procedures.

Resource Adequacy - Operating Criteria: Sufficient resources should be available to adequately meet the forecasted load and reserve requirements. The New York Control Area (NYCA) reserve requirements are as follows: a ten minute spinning reserve of 600 MW; a ten minute total reserve of 1200 MW; and a thirty minute total reserve, including the ten minute total, of 1800 MW.

Inter-Area Operation: Coordination among areas within NPCC is vital to the reliability of interconnected operations. Timely information concerning bulk system conditions shall be transmitted to all areas of NPCC. Where inter-area reliability is affected, each area of NPCC shall establish limits and

⁷⁵ The New York State Reliability Council (NYSRC) was established when the wholesale electric market and the NYISO were installed in New York. The NYSRC develops, through an open process, reliability rules specific to the New York bulk electric system and monitors compliance with those rules.

operate so that the contingencies listed below can be withstood without causing a significant adverse impact on other Areas within NPCC. Two categories of transmission transfer capabilities, normal and emergency, are utilized. Scheduled outages of facilities that affect inter-area operations shall be coordinated, in order for the areas to operate reliably. Any forced outages that are experienced by one area, and which may impact other areas of NPCC, have to be communicated to the other areas of NPCC.

System Analysis and Modeling Data Exchange Requirements: All areas of NPCC shall share and coordinate forecast system information as well as real time information to enable the correct modeling of the interconnected bulk system for planning and operations to take place. All data required for interconnected planning and operations analysis shall be developed and maintained, including data for fault level analysis.

Transmission Design Criteria: The bulk transmission system of each member of NPCC should be designed with sufficient capability to serve the forecasted loads under the contingency conditions listed under "Stability Assessment" below. The same criteria also apply to the loss of a generator, transmission circuit, transformer, series or shunt compensating device, or high voltage DC pole, assuming the area generation and power flows are adjusted between outages by the use of the ten minute reserve. Anticipated inter-area transfers shall be considered in the design of the transmission system.

Transmission Operating Criteria: The bulk transmission system of each member of NPCC should be operated in a manner such that the contingencies listed under "Stability Assessment" below can be tolerated without adversely affecting other areas. Note that these criteria are tested out in an Operations Planning environment and not in real time. In real time, the outage of a single element of the bulk system is considered at dispatch intervals.

Stability Assessment: Pre-contingency line and equipment loadings in a planning and an operating environment shall be within normal limits, and within applicable emergency limits in the post-contingency condition. Stability of the bulk system shall be maintained during and following the most severe of the following contingencies with breaker re-closing considered:

- a. A permanent three phase fault on any generator, transmission circuit, transformer or bus section with normal fault clearing.
- b. Simultaneous permanent phase to ground faults on different phases of each of two adjacent transmission circuits on a multiple circuit tower, cleared in normal time. These faults can be excluded in the event that multiple circuit towers are used only for station entrance and exit purposes, and if they do not exceed five towers at each station.
- c. A permanent phase to ground fault on any transmission circuit, transformer, or bus section with delayed fault clearing.
- d. Loss of any element without a fault.
- e. A permanent phase to ground fault on a circuit breaker with normal fault clearing (normal fault clearing time for this condition may not always be high speed).
- f. Simultaneous permanent loss of both poles of a direct current bipolar facility without an ac fault.
- g. The failure of a circuit breaker to operate when initiated by a Special Protection System (SPS) following either by the loss of any element without a fault, or a permanent phase to ground fault, with normal fault clearing, on any transmission circuit, transformer, or bus section. A Special Protection System, per NPCC document A-7, is defined to be a protection system designed to detect abnormal system conditions, and one that takes corrective action other than the isolation of faulted elements. Such action may include changes in load, generation, or system configuration, to maintain system stability, acceptable voltages, and power flows.

Adequate reactive resources shall exist in the bulk system to maintain voltages within normal limits under pre-contingency conditions, and within emergency limits for post-contingency conditions.

Emergency Limits: Two Emergency Limits are specified for all equipment and transmission lines in New York: a Short term Emergency Limit (STE) and a Long Term Emergency Limit (LTE). A

short term limit only allows power flows up to that level for fifteen minutes before the flows have to be lowered. The Long Term Emergency Limit can be maintained up to four hours.

Post-contingency Operation: Following the occurrence of a contingency, transfer levels throughout the bulk system have to be adjusted within thirty minutes to prepare for the next contingency. If those readjustments are inadequate to restore the system to a secure state, other measures, such as voltage reduction and shedding of firm load, may be required. System readjustments have to be made within thirty minutes following the occurrence of the contingency.

Emergency Transfers: When firm load cannot be supplied in an area of NPCC within normal limits, the transfers of power between areas of NPCC can be increased where pre-contingency voltages and line and equipment limits are within emergency limits. Stability shall be maintained following one of the more severe contingencies (a) or (d), itemized under Stability Assessment above. Voltages, line and equipment loadings must be within applicable emergency limits in the post-contingency condition.

Operation under High Risk Conditions: High Risk Conditions considered to be temporary, such as unusual weather conditions or the expectations of severe contingencies, require that operations be conducted in a more conservative manner. Under those conditions, operations are conducted such that two outages under non-fault conditions (N-2) should be able to be tolerated.

Extreme System Conditions: Steady State and Dynamic Simulation Studies should be performed by each area of NPCC under conditions which are more severe than those that were outlined above. Consideration of more extreme conditions determines the ability of the bulk system to withstand conditions such as peak load, combined with extreme weather conditions, fuel shortages, etc.

Extreme Contingency Assessment: The effects of extreme contingencies should likewise be evaluated by each member of NPCC. This evaluation, in terms of simulation studies, is necessary to determine the performance of the bulk system in the case of widespread bulk system disturbances. These include stability, cascading and voltage collapse, and post-contingency conditions. Extreme contingencies extend beyond those listed above, and it is up to each area of NPCC to identify additional extreme contingencies to be assessed. Analytical studies shall

be conducted to determine the effect of the following extreme contingencies:

- a. Loss of the entire capability of a generating station.
- b. Loss of all transmission circuits emanating from a generating station, switching station, DC terminal or substation.
- c. Loss of all transmission circuits on a common right-of-way.
- d. Permanent three phase fault on any generator, transmission circuit, transformer, or bus section, with delayed fault clearing and with due regard to re-closing.
- e. The sudden loss of a large load or major load center.
- f. The effect of severe power swings arising from disturbances outside the NPCC's interconnected system.
- g. Failure of a special protection system to operate when required following the normal contingencies listed earlier.
- h. The operation or partial operation of a special protection system for an event or condition for which it not intended to operate.
- i. Sudden loss of fuel delivery system to multiple plants.

Measures should be taken to reduce the likelihood of such extreme contingencies, and measures determined which would mitigate the consequences of these contingencies.

New York City (NYC) Specific Standards

The contingencies listed under Stability Assessment apply, with the exception that instead of contingency 'd', which calls for the loss of any element without a fault, the loss of two elements without a fault (N-2) are considered in planning as well as in committing units in the Day Ahead Market to ensure that sufficient capacity is available. Under storm watch or severe weather conditions, the two contingencies are extended to

the adjacent overhead transmission system directly to the north of the city which connects to the cable system of Con Ed. The Con Ed operators continually monitor the system in real time operations, to ensure that a second contingency can be tolerated in various load pockets of Con Ed, as well as throughout the Con Edison system.

Telecommunications Glossary

Backhaul - A connection between a wireless service antenna site (cell site) and its associated switching location.

Blocking (of calls) - An uncontrolled occurrence of more calls to be completed than available trunks or telephone channels available to complete such calls.

Broadband - A generic term referring to a telecommunications service that can transmit information that can't be carried by a typical telephone line. A broadband line or connection can carry multiple telephone or single/multiple television channels. A broadband line is also capable of data transmission rates in excess of 128 kilobits per second.

Brownout - A term referring to low voltage from the supplying electric distribution company. Low voltages can lead to improper operation or destruction of electric devices.

CATV - Community Antenna (or Access) Television. Also referred to as Cable or Cable Television service.

Call ID - A telephone company service that displays the name and telephone number of a calling party. This service relies on the SS7 signaling network and on commercial power at the customer's premises.

CATC - Carrier Account Team Center. A Verizon business office that provides contacts for Competitive Local Exchange Carriers.

Cell Site - A wireless service provider's location that has the tower, antennas, transmitters, and receivers needed to provide service in a limited geographic area.

Central Office - A telephone company building that serves as a hub for telephone cables serving a given territory. It also includes switching equipment, used to place telephone calls, and multiplexing equipment, to make efficient use of copper wire and fiber-optic cables.

Choking (of calls) - A controlled occurrence of more calls to be completed than available trunks or telephone channels. Telephone calls are deliberately discarded in order to maintain the overall functions of the network.

CLEC - Competitive Local Exchange Company - Any local telephone company, other than the former Bell System Companies (Verizon) and the Independent Telephone Companies. (These latter companies are known as Incumbent Local Exchange Companies or ILECs). CLECs require interconnection with ILECs, or need to make use of Unbundled Network Elements supplied by ILECs.

Collocation - The provision space in buildings and other structures to CLECs. Collocation is typically provided for the purpose of providing access to Verizon's network and Unbundled Network Elements.

Collocation hotel - A building housing multiple telephone companies for the purposes of interconnection.

CTIA - Cellular Telecommunications and Internet Association. A trade group that represents wireless companies.

Dedicated Services - See Special Services below.

Dial Tone - A phrase used to indicate that switched telephone service is operational and available.

Digital Loop Carrier - A multiplexing system used to provide service in a given area. Digital Loop Carrier systems allow the use of smaller copper wire cables or fiber-optic cables between the Central Office switch and the service area.

DS1 - Digital Signal Level 1. A form of multiplexing used with copper wire. Used to derive 24 channels or voice paths over two copper wire pairs.

DS3 - Digital Signal Level 3. A form of multiplexing used with copper wire and fiber-optic cables. Used to derive 672 telephone channels over two copper wire pairs or two fibers.

EMS - Emergency Medical Services.

Fiber-optic communication - Communication by the transmission of light through a glass fiber.

Hard-wired telephones - Telephone sets directly connected to telephone lines. This equipment is powered from telephone lines, and will continue to work during blackouts. Cordless telephones and computer modems are powered from commercial power, and will not work during blackouts.

Independent Telephone Companies - Long established local telephone companies that serve defined territories, and that were not part of the former Bell System.

Load - A use for generated and delivered electrical energy. In telecommunications, typical loads are Central Office switches, multiplexing equipment, head-end cable television equipment, computers, radio transmitters and receivers, lights, elevators, and air conditioning.

Load test - A test where commercial power is interrupted, and the ability of the back-up power system to support all the necessary loads in a telecommunications facility is determined.

MARC - Mutual Aid and Recovery Consortium. A New York City-sponsored clearing house for telecommunications companies to request support during emergency situations.

Multiplexing - A technology used to derive multiple communications channels from a single transmission medium. The typical number of derived channels from copper wire and fiber-optic cables range from 24 to over 32,000.

NRIC - Network Reliability and Interconnection Council. A joint Federal Communications Commission and industry forum charged with addressing cyber security, physical security, disaster recovery, business continuity, network security and reliability issues.

OC-48 - Optical Carrier Level 48. A form of multiplexing used with fiber-optic cable. Used to derive 32,256 telephone channels over two fibers.

OSS - Operations and Support Systems. Computer-based systems used to maintain customer account records, place orders for services to be installed or repaired, to dispatch equipment and personnel on specific work orders, and to perform billing.

Outside Plant - The various components of a local distribution system located outside of a telephone company central office or cable television head end building. These components include poles, ducts, conduits, pedestals, splice cases, distribution boxes, copper wire cables and fiber-optic cables, amplifiers, and digital loop carrier systems.

Run test - In this report refers to an attempt to determine if a generator will start and run. It does not necessarily include a test of the generators ability to supply electricity.

Special Services - Telephone services that meet specific customer requirements, such as data transmission, protective alarms, corporate networks that cover multiple locations. Also referred to as Dedicated Services.

SS7 - Signaling System 7. A telephone industry control system used to set-up calls between telephone company Central Office switches. It is also used to look-up databases for call destinations (800/888 service telephone numbers, local number portability) and to implement some functions such as Caller ID.

Switched services - Telephone services that allow customers to place telephone calls.

Switch - Telephone company Central Office equipment used to place and complete telephone calls.

Telecommunications - In this report, refers to telephone, wireless and cable television services.

Trunk blockage - An uncontrolled occurrence of more calls to be completed than available trunks or telephone channels.

TSP Service - Telecommunications Service Priority Service. A federal program administered by the National Communications System that establishes priorities for installation and restoration of telephone service.

Wireline service - A term used to refer to conventional telephone service, in contrast to the wireless services.

Wireless services - A term that includes various publicly available services, including cellular radio telephone service and personal communications service.

Unbundled Network Element (UNE) - A functional part of a telephone network available for use by competitors. Examples of UNEs include links (connections from a customer location to a telephone company Central Office), switching (placing and routing of calls) and transport (carrying of calls and communications channels between Central Office locations).

Steam System Overview

Steam is produced from: 1) utility-owned electric generation facilities where the steam is first used to run turbines and is then injected into the system, and 2) cogeneration facilities where waste heat from gas combustion turbines is captured to produce steam that can then be used to generate electricity or to supply the steam system.

The Con Edison system extends from the southern tip of Manhattan north to 96th Street on the West Side, and to 89th Street on the East Side. This distribution system provides steam to approximately 1,370 commercial and 445 residential customers, for a total of 1,815 customers. The steam system is comprised of 75 miles of distribution main and 12 miles of transmission main, with insulated steel pipe diameters ranging from 2 inches through 30 inches and 24 inches through 30 inches, respectively. The major uses of steam include space heating, air conditioning, and domestic hot water.

The distribution system operates at pressures between 150 - 200 pounds per square inch (psig) with a maximum temperature of 413° F. The transmission mains operate at pressures between 150 - 400 psig, with a maximum temperature of 475° F. Due to the total loss of electric power on August 14, all ten steam generation plants tripped off line and steam system pressure decayed to 0 psig in about two hours,⁷⁶

⁷⁶ Con Edison owns three combined steam and electric plants and contracts with one independent power producer that owns a cogeneration facility, where steam is produced as a by-product of electric generation. Con Edison also owns six steam-only plants, consisting of stand-alone steam production boilers.

effectively eliminating all steam supply to 1394 active customers.⁷⁷

In order to maintain or re-establish steam supply, electric power is required either directly from the grid or blackstart via an alternate power source (such as natural gas or other fossil fuel generator). The electric power requirement, in the range of 5 to 8 MW, is utilized for start up of auxiliary equipment and is required by the steam generation plants before steam can be produced.

⁷⁷ Not included in this figure are 421 seasonal customers that were isolated from the system for the summer.