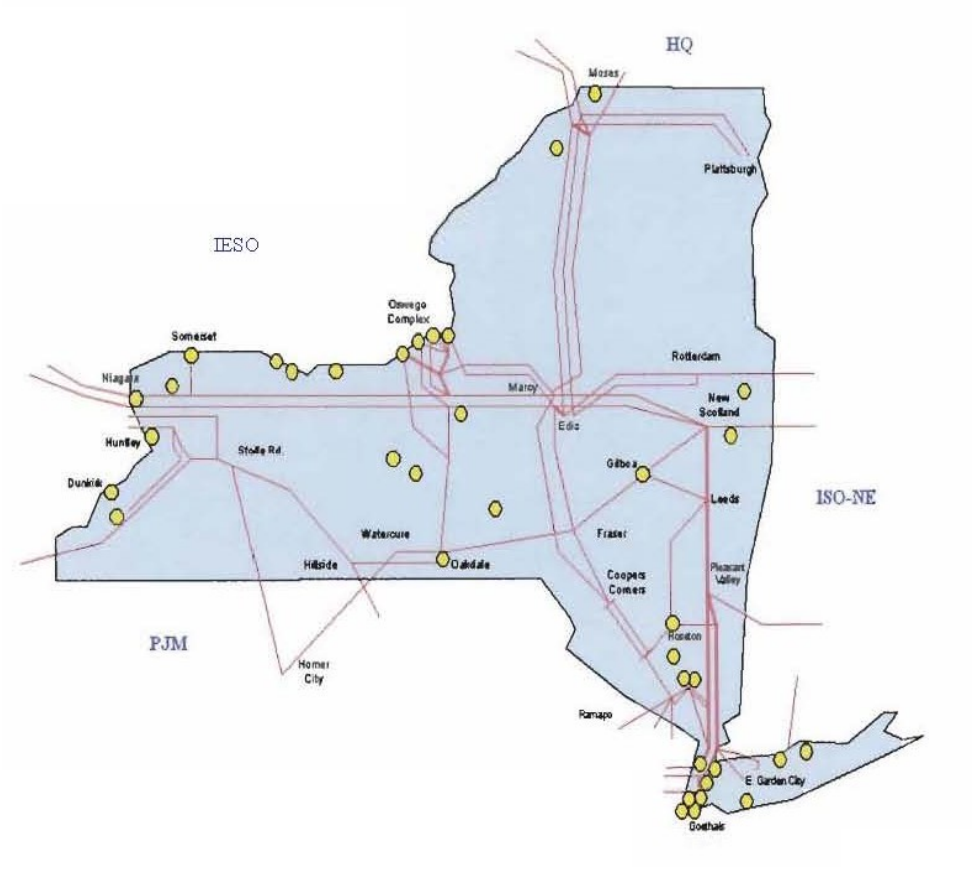
New York State
Department of Public Service
Second Report
on the
August 14, 2003 Blackout



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Preface

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. An Initial Report was prepared for Chairman Flynn and posted to the Department of Public Service website. This Second Report examines the restoration of power in New York State and makes recommendations for action by the appropriate entities. This report was prepared by the Department's Office of Electricity and Environment under the direction of James Gallagher. It was written by Howard Tarler with the assistance of Fred Carr, Leka Gjonaj, and Ed Schrom, and with the counsel of Penny Rubin.

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INTRODUCTION

The "Initial Report by the New York State Department of Public Service on the August 14, 2003 Blackout" (Initial DPS Report) was issued in February 2004. Numerous other reports have been written explaining the causes and impacts of the Blackout, offering recommendations for preventing future blackouts and describing further analyses to be performed. Unlike the previous reports, this Second DPS Report on the August, 2003 Blackout does not analyze the events in the Midwest where the blackout originated. Instead, after describing the various statewide and local procedures for restoring the transmission system and service to customers, this report examines the actual restoration of electric service in New York.

To prepare this report, DPS staff carefully analyzed the extensive data in thousands of documents collected from the New York State transmission and generation owners and the New York Independent System Operator (NYISO). This examination demonstrated that the majority of restoration process decisions and actions were appropriate for the circumstances. The examination showed, however, that restoration was delayed for a number of reasons. By examining the chronology of the restoration events and the problems that occurred during the restoration, this report arrives at conclusions and recommendations for improving the ability of the New York electric system to recover, should a future blackout occur.

In addition, this report reviews the communications among the NYISO, transmission owners (TOs), and generator owners, and in particular, the handling of the black start generation performance and readiness during the August 2003 blackout and since that time. Finally, this report acknowledges that it is necessary to continue ongoing studies both to analyze what happened and what might be done to protect against events such as those that happened on August 14, 2003.

BACKGROUND

The Initial DPS Report covers a wide range of Blackout events, including impacts on the electric, gas, steam, telecommunications, and water services in New York State. Additionally, the Initial DPS Report deals with related issues such as customer impact, customer communication, and security matters at the utilities. It contains 45 recommendations directed toward the applicable service providers. Since that time, those providers prepared implementation plans and submitted regular implementation progress reports for projects that respond to the recommendations. Department Staff have reviewed those plans and completion reports and are monitoring those projects in coordination with other periodic visits to the service providers' offices.

Since the Initial DPS Report was released, the Joint International Taskforce issued its "Final Report", the New York Independent System Operator Operating Committee released its "Report of the NYISO Restoration Working Group on the August 14, 2003 System Event" (RWG Report), the North American Electric Reliability Council (NERC) released its "Technical Analysis of the August 14, 2003 Blackout: What Happened, Why, and What Did We Learn?", the Northeast Power Coordinating Council (NPCC) issued its "Conclusions of the NPCC 2003 Blackout Investigative Team Assessing the Power System Collapse of August 14, 2003", the NPCC Inter-Control Area Restoration Coordination Working Group released its report "Restoration of the NPCC Areas Following the Power System Collapse of August 14, 2003," and the Department of Energy/Natural Resources Canada issued a report "The August 14, 2003 Blackout One Year Later: Actions Taken in the United States and Canada to Reduce Blackout Risk."

The Joint International Taskforce Report is particularly relevant because it described the events leading up to the August 14, 2003 Blackout, cited seven violations of NERC (North American Electric Reliability Council) reliability standards, and contained conclusions that identified specific and significant shortcomings in the way the Midwest systems were operated that day by First Energy, the Midwest ISO coordinator, and the PJM coordinator.

The NERC report reaches important conclusions about violations of NERC operating policies and planning standards, inadequate monitoring to ensure compliance with NERC standards and regional reliability standards, inaccurate modeling data, failure to share planning studies, design assumptions and facilities ratings, and inadequate tools to allow operators to visualize system conditions.

It is not the intent of this Second DPS Report to repeat the important analyses, conclusions, and recommendations of those other reports but instead to take the analysis a step further with respect to the electric system restoration activities in New York State. What follows in this background section is a description, consistent with the findings of the prior reports, of the status of the New York electric system immediately following the separation and subsequent blackout of a large part of the New York State electric system. Subsequent sections of this report describe the procedures and actions that were taken by the New York State transmission and generation operators and the NYISO, which coordinated the restoration of the New York transmission system.

The New York electric system separated from Pennsylvania, New Jersey, New England, and Ontario (except for limited amounts of load and generation isolated onto New York from other regions). The New York system then separated internally, with the downstate areas losing electric service, while areas of western and northern New York retained electric service to about 5,700 MW of load. Northern New Jersey separated from the rest of New Jersey, and those New Jersey customers were served from New York. Approximately 300 MW of power from the Ramapo Station in New York continued to flow into the Waldwick, New Jersey area following the start of the blackout.

Almost all of the generation in New York State tripped off line, except for generators in Niagara Falls, the St. Lawrence region, and a single generating station in Rochester. Ontario's Beck and Saunders hydro stations, and some of Ontario's load, remained connected with portions of western New York. Of particular importance was the retention of the 765 kV line connecting generation in Quebec with the upstate electric system near Utica, New York, which remained in service delivering power to upstate New York throughout the period of the blackout.

RESTORATION PROCEDURES

Statewide System Procedures

According to the NYISO Emergency Operations Manual (EO Manual), a system restoration state exists if a part of the New York Control area becomes islanded (i.e., a portion of the system continues to operate by balancing local generation and load but without any ties to the rest of the electric grid), or if customer load becomes interrupted, following a disturbance affecting the New York State bulk power system. Both of those conditions occurred as a result of the events leading to the August 14, 2003 blackout.

The first step in the restoration procedure is to stabilize the remaining energized portions of the NYS power system so that the stabilized system can be extended to blacked-out areas. The ultimate goal is to restore normal transmission system operations. The EO Manual details the highest restoration priorities as:

1) energizing the NYS Power System;

2) synchronizing the NYS Power System with the interconnection (i.e., to other states and Canada); and

3) restoring off-site power supplies to the nuclear power plants.

After these priorities, the next procedural priority is restoration of load (service to end-use customers).

In addition to the NYISO's requirements for the system in the State as a whole, each TO is required to have restoration procedures for meeting local system requirements. Restoration of transmission and load must be closely coordinated through communications between the NYISO and the local TOs.

To stabilize the transmission system, the NYISO and TOs must ascertain the status of all transmission and generation in the State. This requires confirming the status of the system as shown on NYISO instrumentation and computers with the reports from the operators of the transmission and generation in New York and with the operators of the adjacent power systems in neighboring states and provinces.

The NYISO and the TOs then need to call upon the operators of generators with "black start" capability[1] and other generators to ascertain their availability and readiness to operate. The restoration procedures need to be implemented based upon the actual readiness and availability of all the electric system components. The NYISO and TOs also need to be aware of the availability of assistance from surrounding states' power systems to assess the feasibility of using power from those areas to support the restoration of the transmission grid in New York.

To synchronize and re-close (reconnect) with power systems in adjacent areas, the frequency at each end of the tie line between the adjacent areas must be the same and the phase angles (the electric timing of the alternating current) very close; otherwise, it is not possible to re-close the circuit breakers that tie the systems together. The NYISO and the TOs must make sure that load and generation in the New York "island" are sufficiently balanced for the New York generators to maintain frequency at exactly 60 Hertz (cycles per second). At the same time, transmission line voltages must be controlled so that large voltage differences do not prevent re-closure of the circuit breakers.

In sum, the transmission system needs to be re-energized, line by line, adding generation, voltage control devices, and load as needed and as available to keep the frequency, voltage, and line flows within operating limits. The process must be careful and precise lest a mistake cause further tripping of lines, islanding, blackouts, or damage to equipment.

It is possible for individual TOs to begin implementing their own restoration plans while waiting for the NYISO to restore the bulk power system in New York State, as long as those efforts are communicated to and coordinated with the NYISO efforts. To the extent that individual TOs can prepare their systems for synchronizing with the rest of

[1] Black start capability is currently defined by the NYISO in the NYISO Ancillary Services Manual, Effective Date : 4/6/2004, as: "Black start capability represents the key generators that, following a system-wide blackout, can start without the availability of an outside electric supply and are available to participate in system restoration activities that are under the control of the NYISO or, in some cases, under local Transmission Owner control." Generators with such capabilities are called "black start generators".

the State and for providing energy supply and voltage control, the statewide effort can proceed faster than it otherwise would.

New York City Area Transmission Owner Procedures

Con Edison's restoration procedures include eight system restoration plans – seven of which use external sources to restore the Con Edison system. The eighth plan uses black start generators within the City to re-start the Con Edison system as an island. It is the responsibility of the Con Edison bulk power system operators to assess the status of the system equipment, the status of surrounding system operating conditions, and then decide which combination of the eight plans, including the black start plan, should be used to restore the transmission system.

The restoration of the Con Edison transmission system requires that adequate generation be available to serve some customer load at the same time as transmission lines are energized and that customer load is connected. This is because transmission lines, without sufficient customer load being served, could exceed allowable voltage limits. Generation can come from external or internal sources, but must be matched with sufficient customer loads to maintain transmission system voltages within allowable limits. Until the NYISO is able to commit adequate generation resources to supply load in New York City, or until adequate black start generation is available within New York City, the transmission in New York City cannot be restored.

Once the transmission grid is restored to and within New York City, Con Edison can attempt to use in-City generators to expedite the restoration process.

Long Island Transmission Owner Procedures

The procedures in place at the Long Island Power Authority (LIPA) on August 14 provided for the use of black start generation on Long Island to energize the bulk transmission system. This is done by coordinating the operation of pockets or "islands" of generation, transmission, and load so that a balance is achieved in each of those islands. Then, those islands are tied together to form larger islands until Long Island can be tied back (connected) to the interconnected grid. Putting the system together on Long

Island in this fashion requires a high level of skill on the part of the operators and good communication and coordination in order to keep the system stable.

Upstate Transmission Owner Procedures

The procedure for each of the upstate TOs is to use the statewide bulk transmission grid as the starting point for system restoration. Each TO has to work with the NYISO and neighboring TOs to restore the transmission grid and to restore service to customers. Each TO needs to assess and stabilize its own transmission system, consider the availability of local generation sources, and respond to NYISO directions to restore transmission lines and reconnect customer load.

NYISO Black Start vs. Transmission Owners' Black Start Plans

The NYISO identifies in its Emergency Operations Manual**,** the black start generating units and transmission lines that are critical for NY's statewide transmission system restoration. During transmission system restoration activities, the NYISO calls upon the NYISO black start capability, as needed, depending on the specific situation.

The NYISO may amend[2] its restoration plan and determine black start requirements to account for changes in transmission system configuration. If it determines that additional black start resources are needed to restore the transmission system, it has the flexibility to seek additional resources. Before the blackout, the NYISO's statewide bulk system restoration plan was designed to coordinate with the New York City and Long Island restoration plans. The RWG Report, however, recommends that the NYISO expand its restoration plan to extend the re-energization of the bulk transmission system all the way into New York City and Long Island. The RWG is working on a means to implement this recommendation.

In addition to the NYISO restoration plan, portions of the local TO control areas may require some additional black start generators, e.g., in New York City and on Long Island. The NYISO will collect from TOs and make payments for local area black start

[2] Such changes, if required, must be made based on prior studies and analyses and could not be changed during the course of a system restoration.

capability directly to the generating facilities designated by local TOs that provide that service pursuant to the NYISO Tariff.

Status of Black Start Negotiations Between
New York City Generators and Con Edison

Because of the national prominence of New York City, its many energy-sensitive customers, and the potential consequences of an extended blackout, Con Edison has the greatest need for generators that are able to black start in the event the transmission system is unavailable. These black start units would then be able to energize the transmission grid in New York City in advance of the reconnection of the New York City transmission grid with the New York or New Jersey transmission grids.

Prior to the divestiture of its generating units, Con Edison's restoration plans designated certain Con Edison generating units for black start duty. When the generating units were divested, however, the contracts for the sale of the generating assets that had previously provided black start capability did not include terms providing for continuation of this service. Although the NYISO, Con Edison, and the generation owners were working to develop such agreements during the period between divestiture and the blackout in 2003, there were no formal agreements for New York City black start services, or rapid restoration services, or for payments to the new owners of the former Con Edison generators for such services. Consequently, the units had not been tested, and the lack of testing of the units appears to have directly contributed to the poor performance of most of the New York City black start generators, as will be described later in this Report.

On September 14, 2001, the New York State Reliability Council approved a new rule which requires TOs to file with the NYISO their local restoration plans. On September 4, 2002, the NYISO sent letters to all owners of New York City black start and rapid restoration generation, notifying them that they had been identified in the Con Edison restoration plan, requesting cost information, and noting that annual testing is required. To facilitate the resolution of various black start issues statewide, the NYISO formed the Black Start Task force under the Market Structures Working Group in 2003,

not long before the August 14, 2003 blackout. Since the blackout, the NYISO, Con Edison, and the former Con Edison generators capable of black start, have renewed their efforts to reach agreement on black start issues. The primary issues have been: a) agreeing on the definition for New York City black start capability; b) payments for black start capability from divestiture to the present; c) amount of black start capability needed; and d) the payment terms going forward.

A meeting of the parties was held at Con Edison's headquarters on March 30, 2004. Various proposals resulted from that meeting, and additional proposals have been discussed since then. As of this writing, however, not all the remaining issues have been resolved. Although complete agreement has not been achieved, the NYISO reports that it has reached agreement on most issues and intends to file tariff revisions at FERC. Recent attempts to test the designated black start units in New York City, however, have shown that some major generators designated in the black start plan are still not yet available to operate should another blackout occur.

RESTORATION PROCESS AND CHRONOLOGY

Efforts to restore the New York State transmission system and to restore electric service to customers commenced immediately after the blackout began. NYISO operators, transmission owners, and generation owners began exchanging information on the status of their facilities and assessing measures that needed to be implemented. Extensive communications both in New York and with surrounding areas formed the basis for decisions on restoration measures for both local and statewide restoration. The May 20, 2004 RWG Report contains extensive details on the sequence of restoration measures leading up to the full restoration of the New York Transmission System and the ultimate restoration of electric service to all New York customers. The RWG Report includes an excellent compilation of facts, findings, explanations, and helpful recommendations that are consistent with our data and analysis. The New York transmission and generation owners and the NYISO should analyze the RWG Report

and take all appropriate steps identified in that report to rectify or improve restoration procedures and capabilities.

Immediately prior to the blackout, at 4:00 pm on August 14, the New York State electric demand (load) was approximately 28,000 MW. As a result of the blackout, over 22,000 MW of customer load lost electric service, leaving 5,700 MW of load in service in upstate portions of New York. Upstate New York was then connected only with Ontario generation at Niagara and St. Lawrence and with Quebec generation near Massena. New York Power Authority (NYPA) generators at Niagara and St. Lawrence continued to operate throughout the event, and one medium sized generator in Rochester continued to operate. In southeast New York, a connection to New Jersey allowed some customers in Northern New Jersey to receive electric service through transmission feeds from New York in the Ramapo area.

The NYISO, as part of its statewide system restoration process, directed the NYPA Gilboa plant to commence black start operation, and it was ready to generate at approximately 4:30 p.m., less than 20 minutes after the start of the blackout. The transmission lines connecting Gilboa to the New York State grid, however, could not be successfully re-closed for over three hours after the blackout, in part because of large voltage differences between the Gilboa and Fraser Substations. There has been no explanation as to why this problem persisted or what could have been done to bring voltage differences within tolerances. An analysis of whether or how the transmission outlets for Gilboa could have been re-energized more rapidly is needed. In addition, the resultant three-hour delay in the black start of Gilboa warrants a reconsideration of the NYISO restoration and black start procedures which, according to the NYISO, considers only very controlled conditions and did not provide for the type of islanding that occurred on August 14, 2003. Additionally, according to the NYISO, the New York restoration plan assumes that the Gilboa station is black started and restoration of transmission proceeds outward from the station, energizing facilities as it progresses to restore the system. The RWG report, however, does not explain why Gilboa, and connecting 345 kV lines which were de-energized, was unable to black start according to the NYISO-

described restoration plan. Gilboa generation, a key component of the NYISO statewide system restoration plan was unusable for three hours during which re-connection to PJM was delayed while load and generation were being balanced in New York[3] . The NYISO RWG should identify the reasons that the transmission outlets for Gilboa could not be re-energized more quickly. Based on the lessons learned from the three hours it took to restore the transmission and allow Gilboa to operate, the RWG should also determine what new procedures and/or equipment are required to use the Gilboa black start generation promptly and decide whether any associated changes are needed in the NYISO restoration plan.

By 7:20 p.m., about three hours after the start of the blackout, the NYISO was able to complete the 345 kV transmission connections from Marcy (Utica) to New Scotland (Albany) to Gilboa to Fraser (Delhi) and to begin operations of the Gilboa generating facility. The Marcy-New Scotland 345 kV line itself took almost three hours to re-energize[4] but there is no explanation of whether problems occurred to delay this re-closure or whether anything could be done differently to expedite line re-closure. With Gilboa operating and these transmission lines energized, the NYISO was able to proceed with the process of restoring the 345 kV system south from New Scotland, down the Hudson Valley, and reaching Westchester County just before 10 p.m.

Meanwhile, New York's re-connection to the PJM system and the rest of the operating Eastern United States power grid (except New England and the Canadian Maritime Provinces) was not accomplished until 7:07 p.m. Although this reconnection was deemed to be one of the highest priorities of the NYISO because it would provide a strong stabilizing force for the New York State transmission system, the inability to match frequencies between New York and PJM blocked an earlier attempt to re-close at 6:02 p.m. Unbeknownst to the NYISO, however, a 230 kV line from Dunkirk, NY to Western Pennsylvania was automatically reclosed when equipment in Western New York sensed a frequency match between the two systems. When Con Edison operators were

[3] RWG Report May 20, 2004, pages 9 and 11.
[4] RWG Report May 20, 2004, page 10.

directed by the NYISO to reclose manually on the Ramapo 500 kV line using a synchroscope,[5] Con Edison and NYISO operators were unaware that the two systems were already in synchronism.[6] Con Edison's operators immediately closed the circuit breakers, and the 500 kV transmission line from Ramapo to Branchburg (NJ) was energized, helping to cement a strong tie to PJM. The NYISO was then able to direct the restoration of the 345 kV transmission grid from Ramapo through Rockland and Westchester Counties to Yonkers, completing that path at about 8 p.m. At shortly after midnight on August 15, these two transmission paths, one from upstate New York and the other from Ramapo, were connected together at the Sprainbrook (Yonkers) Substation. Without adequate generation supply from upstate to serve some load in New York City, however, it was not possible to extend the restoration of the 345 kV system into New York City at that time.

Restoring New York City presented some unique difficulties. Because of the excessively high voltages that can occur on underground cables when they do not carry electric current, it is necessary to connect customer load to draw current at the same time as the re-energization of the underground cables. When the customer load draws current, it helps to control the high voltages. But there has to be adequate power supply from the grid to serve that customer load and energize the underground transmission. Until the underground transmission system was energized in New York City, generators there could not be started and connected to the transmission system.

Earlier, at 4:36 p.m., Con Edison's operators requested each of the designated New York City black start generators to begin their black start procedures so they would be ready when called upon. Based on the continued operation of the PJM system in New Jersey and of the upstate portion of the New York electric system, Con Edison deemed it preferable at that time to attempt first to re-establish transmission connections with the

[5] A synchroscope is a device to detect whether systems to be interconnected are in synchronism, i.e., whether the frequency and phase angle are sufficiently close at either end.

[6] According to Con Edison, it was not until several months later that post-blackout analyses determined that the two systems had already been synchronized.

rest of New York and with New Jersey and to use the strength of the interconnected grid to maintain stable frequency and voltages while connecting New York City generators and load. The local generators would then be connected to the transmission system as it became energized.

While a few of the "rapid re-energization" generators in New York City were ready to re-start within as few as two hours after the start of the blackout, only one of the designated black start generators within New York City was actually ready to start before the restoration of the transmission system from New Jersey to Ramapo to Westchester was underway even though these black start generators are intended to be able to start without the help of the transmission system. Our review confirmed that only one black start generator appeared to be fully ready and able to start, two black start generator locations totally failed to start (until start-up power could be provided from the grid), and one black start generator started a single steam unit twelve hours after the blackout began. While some of the barge mounted gas turbines in New York City (not designated as black start generators at that time) could have come on line during the early hours of the blackout, there was not enough other black start generation available in the necessary locations to allow the black start restoration of the New York City transmission grid without the ties from upstate New York and from New Jersey. Even so, once the Con Edison transmission grid was energized, New York City black start generators, if they had been available to start earlier than they actually did, could have hastened the overall restoration process**.**

The NYISO and its market participants should make sure that adequate, timely, and dependable black start generation resources are available in New York State, and in New York City in particular. Each black start generator should perform an annual test of all black start equipment, including a full start-up, to demonstrate that it is capable of providing the start-up power needed for the associated major generating unit both rapidly and safely.

As previously noted, Con Edison chose not to use the black start generation initially to energize the system, but instead to rely on the grid being re-energized from

outside the City. To restore the transmission ties between New York and New Jersey, Con Edison and NYISO operators worked with operators at Public Service Electric and Gas of New Jersey (PSEG) and PJM. From the outset of the blackout and continuing for about six hours, Con Edison's operators worked with PSEG's operators to accomplish the re-connection of transmission ties between New York City and New Jersey. Con Edison reported that by 9:23 p.m. PJM confirmed the ability to re-close a PSEG tie to New York City and to deliver 100 MW to Con Edison. Con Edison logs showed that it contacted PSEG no less than five times over the ensuing hour and a half before PSEG agreed to re-close the connection. At 11 p.m., a 345 kV transmission path from PSEG's Hudson Substation (Jersey City, NJ) to Farragut (Brooklyn) to Goethals (Staten Island) to East Coast Power Generating Station (Linden, NJ) was completed, allowing the East Coast Generating Station to supply power to New York City. Completing the north-south 345 kV transmission re-energization between New York City and Yonkers, however, could not be accomplished until about 6:30 a.m. on August 15. In orderly succession thereafter, the 345 kV transmission system in New York City was re-energized, allowing the re-start of New York City generators and allowing the restoration of electric service to more, and eventually all, New York City customers.[7]

As noted above, Con Edison's decision to rely on the restoration of synchronous transmission ties rather than New York City black start generators was based in part on information about the continued operation of the majority of the electric system in New Jersey and and other areas of PJM. The restoration of the PJM connections to Western New York and at Ramapo took longer than expected, requiring over two and a half hours and delaying the bulk system restoration process. The restoration of a direct transmission tie between New York City and New Jersey, however, took over six and a half hours, and the transmission tie was not restored until one and a half hours after PJM informed NYISO that there was power available to make that connection. As previously reported, the NYISO "statewide" restoration plan did not provide for extending the 345 kV

[7] As previously noted, the black start restoration option was not available to Con Edison, and the black start units were not readily available for use in shortening the restoration time.

transmission grid all the way into New York City. It was not until the overnight hours of August 14-15, that the NYISO could allocate the power that Con Edison needed to serve sufficient New York City load to energize 345 kV transmission lines from Yonkers down to New York City.[8] Consequently, the ability to re-start many generators in New York City had to await the restoration of the transmission system to those power plants. The unavailability of power from areas outside New York City ultimately delayed the restoration of power in New York City.

An analysis is needed of why it took so long to get assistance to New York from adjacent areas that had not blacked out. The NYISO RWG should determine why it took longer than expected to reconnect with PJM and other areas and what can be done to improve the ability to re-synchronize more rapidly the New York State transmission system with PJM or with other areas in the event of a future blackout. In addition, Con Edison should work with the NYISO and PJM to better understand the extended time period it took to restore the connection from Hudson Station in New Jersey to Con Edison's Farragut Substation, to determine whether improved protocols are needed and possible, and to put those protocols in place. Finally, the NYISO should work with the TOs to determine the optimum procedures for allocating power for the purpose of controlling transmission voltages and facilitating the restoration of the entire New York State transmission system.

KeySpan, which operates the Long Island electric system for LIPA, used the numerous black start gas turbines on Long Island to energize segments of the LIPA transmission system and provide start up power for the base load generators on Long Island. It segmented the transmission system into four separate "islands" (i.e., portions of the transmission system temporarily separated from other portions of the electric system), each consisting of transmission, generation, and customer loads. Then, the KeySpan operators were able to balance increasing amounts of generation and customer load in each of the "islands" until the individual "islands" were ready for reconnection to one

[8] RWG Report May 20, 2004, p.12.

another. At 5:12 a.m. on August 15, the Long Island transmission system was connected to the rest of New York State via the transmission line from Long Island to a Con Edison Substation in Yonkers, further stabilizing the Long Island system and enhancing the ability to complete the restoration of electric service to all customers on Long Island.

NYISO Communication with Transmission and Generation Operators During the Blackout

DPS Staff reviewed extensive data received in response to information requests, including the actual conversations between transmission and generation operators during the blackout. The documents demonstrated both the extensive nature of the communications, as well as the confusion as to what had happened, and the exact status of the transmission and generation facilities after the start of the blackout. System operators must have clear and accurate status information to make appropriate and timely restoration decisions. This information is necessary in order to make decisions on how to restore the system. As a result of the extensive nature of the event, there was a lack of complete and accurate information about the status of the transmission and generation facilities in the early stages of the August 14 blackout, resulting in restoration decisions being delayed. The RWG should investigate ways to more rapidly assess system conditions following a blackout.

To obtain the necessary transmission system information, the NYISO and TO system operators shared the information that was available to them. To collect generator status information, the NYISO Customer Relations Department teamed with the NYISO's Market-Monitoring Unit. Beginning the evening of August 14 and continuing throughout the NYISO's restoration, generators were called, and reports on their physical condition and estimated time to return to service were communicated, compiled, and transmitted to the NYISO's operation department where the information was confirmed and used to prepare the next steps of the restoration effort.

Communication Between
New York City Generators and Con Edison

DPS Staff also reviewed communications between the New York City generators and Con Edison by listening to audio tapes and reviewing transcripts of conversations of system operators, generator operators, dispatchers, and others. From the beginning of the blackout and throughout the restoration period, there were frequent telephone conversations among the operators, engineering personnel, and company managers. During the hours that it took to restore the transmission system, re-establish the connection from New Jersey to New York, and then re-energize the transmission system into New York City, the tapes and transcripts showed that there was continued uncertainty as to whether or not the black start generators were available to operate, when the New York City non-black start generators would receive power they needed from the transmission grid to initiate re-start procedures, and when the black start generators could also connect to the grid (after the decision was made not to depend on the black start generators for re-energization of the system). Also, as part of the restoration effort, Con Edison dispatched personnel to several of the generating plants to provide replacement parts and assistance in their installation. Based on the recorded conversations during the subsequent reconnections, it appears that Con Edison and the owners of New York City generation had not sufficiently drilled and trained together to make sure that all personnel understood and were practiced in the procedures for bringing generators onto the system after a blackout. While there is no evidence that these communication difficulties significantly delayed the restoration for this particular outage, especially given that the primary delays were due to the extended time it took to provide connections with the rest of New York and PJM, such communication and procedural difficulties could be a problem in the future.

Staff concludes that there is a need for developing or refining the written procedures that should be followed when starting or re-starting generators to be connected to the transmission grid after a blackout in New York City. There is also a need for periodic training of generator and transmission owner personnel on how to re-

connect generation safely and quickly to the transmission system after a blackout. Consequently, each of the generation owners in New York City should develop written procedures for starting/re-starting generators after a blackout, including how to isolate facilities and how to re-connect to the transmission grid. Necessary advice and review should be provided by the Con Edison. In addition, Con Edison should develop and present annual training sessions for personnel operating local black start generators in the City. The training session should cover all the information needed by generator personnel to isolate equipment rapidly and safely from the transmission system and to re-connect rapidly and safely to the transmission system at the appropriate time

PROTECTING THE NEW YORK SYSTEM AGAINST FUTURE EVENTS

Previous reports demonstrate that the events leading up to the August 14, 2003 Blackout had their genesis in states to the south and west of New York. The reports from the Joint International Taskforce contain numerous recommendations to address the findings of shortcomings in training, right of way management, information and communication, and operating decisions that occurred in areas outside of New York State**.** While numerous opportunities for improvements within New York State were identified, the reports do not explain the causes for the separation of the New York State transmission grid from PJM, from Ontario, and from New England. For New York to consider all appropriate and necessary protective measures against external events such as occurred on August 14, 2003, it will be necessary to understand fully the complex electric system reactions that occurred during the minutes and seconds before and after the separation of the transmission connections to the other states.

Toward that end, computer models have been developed to use each of the thousands of pieces of information that have been assembled and to simulate how the transmission system came apart and how the blackout propagated in New York. Work is continuing by industry engineers on the studies that could respond to many of the unanswered questions. It is likely that more will be known by the end of 2005 about the

way in which transmission, generation, and load shedding performed in response to the events of that day. A report is expected from working groups under the guidance of the Northeast Power Coordinating Council, by the end of 2005, describing how the blackout occurred in the Northeast and recommending further studies.

The next step is modeling changes that could be made to the transmission system to see if those changes could prevent or mitigate the consequences of similar events. Some of the more conventional steps that are being examined include reviews of protective relay settings for transmission lines and generators, evaluations of the adequacy of underfrequency and undervoltage load shedding, assessments of the adequacy of transmission connections within New York and with our neighbors, and use of sophisticated measurement devices (phasor measurement) to monitor the status of the entire Eastern Interconnection (most of the United States and Canada east of the Rockies).

Beyond the many recommendations from the earlier reports, some less conventional proposals have also been made. In addition to general assertions that more transmission and generation needs to be built, there have been some proposals that involve untested concepts for addressing this specific situation.[9]

SUMMARY OF CONCLUSIONS

1. The RWG Report of May 20, 2004 provides an excellent compilation of facts, findings, explanations, and helpful recommendations for the transmission and generation owners in New York State. In particular, the recommendation of the RWG to extend the scope of the statewide restoration plan to include New York City and Long Island is important and needs to be addressed.

[9] Examples include: 1) reducing the size of the Eastern Interconnection, either by physical separation or by back-to-back high voltage direct current (HVDC) ties; 2) similarly isolating New York State from the Eastern Interconnection by either opening all the existing transmission ties or by replacing them with HVDC connections; 3) creating the ability to isolate defensively the New York State transmission grid from surrounding states based on warnings of impending adverse conditions on the grid; and 4) using phase angle regulators or flexible alternating current transmission system (FACTS) devices to control all power flows.

2. As a result of the extensive nature of the event, there was a lack of complete and accurate information about the status of the transmission and generation facilities in the early stages of the August 14 blackout, and resulted in restoration decisions being delayed.

3. The NYISO statewide system restoration plan includes the black start of the Gilboa units. The use of those units was delayed significantly by the unavailability of transmission lines connecting that plant to the transmission system. A three hour delay in the start of this critical facility delayed the New York State bulk system restoration process, possibly by up to three hours. An analysis of whether or how the transmission outlets for Gilboa could have been re-energized more rapidly is needed. In addition, the three-hour delay in the black start of Gilboa warrants a reconsideration of the NYISO restoration and black start procedures.

4. The restoration of the PJM connections to Western New York and at Ramapo took longer than expected, requiring over two and one half hours and delaying the bulk system restoration process. The causes of this delay needed to be analyzed.

5. Con Edison's decision to rely on the restoration of synchronous transmission ties rather than New York City black start generators was based in part on information about the continued operation of the majority of the electric system in New Jersey and PJM. The restoration of a direct transmission tie between New York City and New Jersey, however, took over six and one half hours, and the transmission tie was not restored until one and one half hours after PJM informed NYISO that there was power available to make that connection. An analysis is needed of why it took this long to get assistance to New York City from adjacent areas that had not blacked out.

6. The owners of the majority of the designated New York City black start generating units that commenced black start procedures were either unable to start those black start generators, or to use those black start generators to start the accompanying steam generators, or to start those steam generators using black start generators in a timely manner so that they would be ready to connect to the transmission grid when it

was energized. The delay in bringing those units into service contributed to the overall delay in the restoration time.

7. The NYISO did not, until the overnight hours of August 14-15, allocate to New York City the power that Con Edison needed to serve sufficient load to energize 345 kV transmission lines from Yonkers down to New York City. The ability to re-start many generators in New York City had to await the restoration of the transmission system to those power plants. The delay in making this power available ultimately delayed the restoration of power in New York City.

8. There is a need for developing or refining the written procedures that should be followed when starting or re-starting generators to be connected to the transmission grid after a blackout in New York City.

9. There is a need for periodic training of generator and transmission owner personnel on how to re-connect generation safely and quickly to the transmission system after a blackout in New York City.

SUMMARY OF RECOMMENDATIONS

1. Each of the New York transmission and generation owners, and the NYISO, should analyze the RWG Report and take all appropriate steps identified in that report to rectify or improve restoration procedures and capabilities.

2. RWG should investigate ways to more rapidly assess system conditions following a blackout.

3. The NYISO RWG should identify the reasons that the transmission outlets for Gilboa could not be re-energized more quickly. Based on the lessons learned, new procedures and/or equipment should be identified to ensure the prompt availability of Gilboa black start generation. Recommendations should be made for any necessary changes in the NYISO restoration plan.

4. The NYISO RWG should determine why it took longer than expected to reconnect with PJM and other areas and what could improve the ability to re-synchronize

more rapidly the New York State transmission system with PJM or with other areas in the event of a future blackout.

5. Con Edison should work with NYISO and PJM to better understand the extended time period it took to restore the connection from Hudson Station in New Jersey to Con Edison's Farragut Substation. If improved protocols are needed and possible, they should be put in place.

6. The NYISO and its market participants should make sure that adequate, timely, and dependable black start generation resources are available in New York State, and in New York City in particular. Each black start generator should perform an annual test of all black start equipment, including a full start-up, to demonstrate that it is capable of providing rapid-and safe start-up power needed for the associated major generating unit.

7. The NYISO should work with the TOs to determine the optimum procedures for allocating power necessary to control transmission voltages and facilitate the restoration of the entire New York State transmission system.

8. Each of the generation owners in New York City should develop written procedures for starting/re-starting generators after a blackout, including how to isolate facilities and how to re-connect to the transmission grid. Necessary advice and review should be provided by Con Edison.

9. Con Edison should develop and present annual training sessions for personnel operating local black start generators in New York City. The training sessions should cover all the information needed by generator personnel to isolate equipment rapidly and safely from the transmission system and to re-connect rapidly and safely to the transmission system at the appropriate time.