NEW YORK STATE DEPARTMENT OF PUBLIC SERVICE

INVESTIGATION REPORT ON CON EDISON'S JULY 2019 OUTAGES IN MANHATTAN AND BROOKLYN

NOVEMBER 2020

CASE 20-E-0588 – IN THE MATTER OF AN INVESTIGATION INTO CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.'S JULY 2019 MANHATTAN CUSTOMER SERVICE OUTAGES.

CASE 20-E-0587 – IN THE MATTER OF AN INVESTIGATION INTO CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.'S JULY 2019 SOUTHEAST BROOKLYN CUSTOMER SERVICE OUTAGES.

This report was prepared by assigned Staff of the Department of Public Service and does not necessarily represent the views of the Public Service Commission or of the individual Commissioners.

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SUMMARY

During the summer of 2019, Consolidated Edison of New York, Inc. (Con Edison or Company) experienced two sizable outage events eight days apart from each other. The first negatively impacted multiple networks in mid-town Manhattan and the second negatively impacted customers served by the Flatbush system in Brooklyn. Smaller-scaled outage incidents also occurred during the summer in other parts of the Company's territory, including Staten Island and Queens, that raised concerns by local officials.[1] While the underlying cause and conditions were different, the outage events led the Department of Public Service (Department) to question both operational aspects and communication activities within Con Edison. As a result, staff of the Department (Staff) began an investigation of the Company's performance during these events. This report provides the findings of the investigation and Staff's recommendations. The report focuses on the Manhattan and Brooklyn events, although certain recommended actions also apply on a systemwide basis and will address many of the components that caused the smaller-scaled outage incidents.

The first outage event occurred on Saturday, July 13, 2019 at approximately 6:47 p.m. The event resulted in additional outages and eventually caused approximately 73,000 customers to lose electric service on Manhattan's West Side from 5th Avenue to the Hudson River and from 31st Street to 71st Street. In Manhattan, underground networks are used, which are connected to area substations through distribution feeders; individual customers are served by service lines off the network or, in the case of larger customers, directly by a distribution feeder. The underground networks are highly reliable; however, insufficient supply due to operational failures in the area or transmission-level substations can cause the loss of a network and consequently a sizeable number of customer outages.

Following an electrical fault of a distribution cable, three relays, located at Con Edison's West 65 St. substation, mis-operated due to missing neutral wire connections. The mis-operation of those relays, in turn, caused the disconnection and isolation of several transformers at the West 49 St. substation and led to the loss of power to several area substations and six

[1] These incidents include approximately 11,750 customer outages in the Jamaica network of Queens on July 21, nearly 3,000 customer outages in the Fox Hills load area of Staten Island on July 16, and approximately1,400 customer outages in the Livingston section of Staten Island on July 14.

networks in midtown Manhattan.[2] Due to resulting overload conditions during the event, Con Edison manually de-energized two of those networks. Nearly 73,000 customers on Manhattan's West Side lost electric service as a result of the faulted cable and mis-operating relays.[3]

After the initial outage, Con Edison began analysis and restoration efforts. Restoration of the networks and electric service to customers commenced at 9:58 p.m. and by 11:10 p.m., Con Edison restored service to the initial five networks affected and the associated 63,000 customers. The remaining network and approximately 10,000 customers were restored by 11:40 p.m. The immediate cause of the power outage was determined to be missing neutral wire connections on three protective relays which led to the loss of major transmission-level transformers at the West 49th Street transmission Substation.[4] This was a significant work practice deficiency as further discussed within this report.

The second outage event began on Sunday, July 21, 2019 and occurred in the Flatbush system, which supplies approximately 132,000 customers from nineteen 27kV feeders emanating from one area substation. Nearly 99,000 customers in the northern and more commercial portion of the system are supplied by an underground network system, similar to those discussed in the Manhattan event. The remaining customers are in the southeast portion of Brooklyn, which is a more residential area of the system. Approximately 30,000 of these customers receive service via the predominately overhead 4kV grid and another 3,600 customers receive service through the overhead Cropsey Loop, supplied by two 27kV feeders.

On July 21, 2019, several days into a heat wave, Con Edison experienced multiple feeder failures between 3:59 p.m. and 7:11 p.m. As the event progressed, the timing between the failures of the feeders quickened despite the Company's efforts to reduce stress on the Flatbush

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[2] *See generally* Public Hearing, *Electric Power System Reliability*, before New York State Legislature, Senate Standing Committee on Energy and Telecommunications, Senate Standing Committee on Corporations, Authorities and Commissions, Assembly Standing Committee on Energy, Assembly Standing Committee on Corporations, Authorities and Commissions (Sept. 3. 2019), pp. 18, 23-4.

[3] Con Edison Manhattan Report (Oct. 2, 2019), Redacted, p. 15, Appendix 7.1, p. 47. The customer count represents the number of metered services. However, a metered service can represent a large commercial building or large master-metered apartment complex. Overall, the outages affected over 200,000 people and impacted commercial activities, residential buildings, transportation systems, and traffic control.

[4] *See generally* Con Edison Manhattan Report (Oct. 2, 2019), Redacted, pp. 31-34; Public Hearing, *Electric Power System Reliability*, before New York State Legislature, Senate Standing Committee on Energy and Telecommunications, Senate Standing Committee on Corporations, Authorities and Commissions, Assembly Standing Committee on Energy, Assembly Standing Committee on Corporations, Authorities and Commissions (Sept. 3. 2019); Con Edison Media Relations *Con Edison Statement – Preliminary Findings Re: West Side Power Outage* (July 15, 2019).

system through voltage reduction. Con Edison determined that in order to prevent further failures and maintain service to the underground network, customers served by the 4kV grid would be intentionally interrupted, thereby reducing load and stress on the 27kV feeders that remained in service. At 7:32 p.m., Con Edison intentionally interrupted service to the 4kV grid, resulting in the loss of service to approximately 30,000 customers supplied by it. Because feeder failures take significant time to repair, Con Edison implemented measures to restore some customers such as deploying mobile generators in areas where 27kV supply feeders failed and placing certain unit substations back into service after sectionalizing the 4kV grid. By 11:00 p.m. on July 21, Con Edison had restored approximately 8,000 customers and the 3,600 Cropsey Loop customers. Over the course of the next day (July 22), Con Edison restored an additional 17,000 customers before thunderstorms entered the area that evening and caused approximately 11,000 new outages system-wide[5], 1,400 of which were in the Flatbush area. Overall, it took until 3:00 a.m. on July 23 for the Company to restore service to all customers affected by the de-energization of the 4kV grid.

Adequate communications are vital to customers who rely on this information for planning purposes during outage events and today's customers expect the most accurate and current information to be provided to them through a variety of outlets. During the Manhattan and Brooklyn outage events, Con Edison did not communicate well and failed meet the expectations of its customers, the public, or the Department for a New York investor-owned utility to provide timely, accurate, and detailed information through public communications. In fact, Con Edison chose to limit the release of beneficial information, e.g., details on what actions the Company took to shed load during the Brooklyn event and basis for such actions, specific restoration estimates, etc., that would have been useful to customers and the public. The Company also failed to have robust and proactive interaction with governmental officials. These events were instances where Con Edison, yet again, failed to communicate properly and executed tasks at minimum level rather than responding and addressing the existing circumstances and severity that warranted enhanced levels of information exchange and transparency. Many of the

[5] Con Edison Media Relations (2019, July 22) *Con Edison Restores Almost All From Southeast Brooklyn Outage as New Storm Wreaks Havoc* [Press Release] https://www.coned.com/en/about-us/media-center/news/20190722/con-edison-restores-almost-all-from-southeast-brooklyn-outage-even-as-new-storm-wreaks-havoc

inadequacies were the result of clear deficiencies in Con Edison's procedures, further highlighted later in the report.

In addition to its investigation, the Department organized a review of the events by an independent panel (Panel) of experts focused on the technical aspects of the events.[6] Both the Department's review and the Panel's review resulted in findings and recommendations for corrective actions or operational improvements. Con Edison also performed a review into the cause of the outages, its actions during the events, and provided reports explaining why these actions were taken. Con Edison's reports also included self-identified recommendations, which were reviewed as part of the investigation completed by the Department and the Panel.

Staff recommends that Con Edison implement the recommendations contained in this and the Panel reports as they are intended to mitigate similar events from reoccurring across Con Edison's electric system, enhance the preparation and reaction should an event occur in the future, provide for more efficient restoration of service, and improve communications with all stakeholders. Con Edison should seek to implement the majority of the recommendations no later than February 28, 2021. However, certain recommendations should be completed by December 31, 2020 or sooner due to their nature, actions already taken by the Company, or because of their association with its emergency response plans. Appendix A of this report provides a complete listing of each Staff recommendation and respective targeted completion date. Appendix B contains the Panel recommendations.

Staff also recommends that Con Edison file an implementation plan indicating for each recommendation by Staff and the Panel whether it agrees to implement the recommendation or that it does not believe the recommendation should be implemented. For each recommendation accepted, Con Edison should provide specific implementation steps; expected costs, implementation schedule(s) with start and end dates; its priority relative to other recommendations; significant interim milestones (if applicable); and deliverable(s) which demonstrate the recommendation is being implemented. For each recommendation not fully accepted, Con Edison should provide justification for not implementing the recommendation with

[6] The Panel, as discussed in External Reviews and Recommendations section of this report, is comprised of Mark Adamiak, Principal, Adamiak Consulting; Bruce Bernstein, Consultant and electrical cables and joints specialist; Professor Mladen Kezunovic, Regents Professor, Eugene E. Webb Professor and Site Director of Power Engineering Research Center at Texas A&M University; Kenneth Linsley, Principal at Green Mountain Transformer Consultants; and Professor Sakis Meliopoulos, Georgia Power Distinguished Professor in the School of Electrical & Computer Engineering, Georgia Institute of Technology.

specifics regarding implementation costs, concerns regarding the targeted completion date, and/or technical feasibility. Proposed alternatives to a recommendation should demonstrate how such alternatives effectively address the underlying intent of the original recommendation and identify any outstanding risks when using the alternative approach. The implementation report should be filed by November 30, 2020.

MANHATTAN OUTAGE EVENT

I. CHRONONOLGY OF EVENT

On Saturday, July 13, 2019 a significant Con Edison power interruption occurred at 6:47 p.m. affecting Manhattan's West Side from 5th Avenue to the Hudson River and from 31st Street to 71st Street. Thereafter, additional related outages within this area occurred at 7:09 p.m., 7:18 p.m., and at 9:17 p.m. In total, 72,669 customers lost electric service.[7] Restoration of customer electric service commenced at 9:58 p.m. and was fully completed by 11:37 p.m.[8] No injuries were reported as a result of this event.[9] The cascading sequence of events began with an electrical fault in a distribution cable.

Following an electrical fault of a 13.8kV distribution cable (35261) on Manhattan's West Side, three relays, located at Con Edison's West 65th Street area distribution substation, mis-operated due to missing neutral wire connections. The mis-operation of those relays, in turn, caused the disconnection of various transformers and associated feeders at the West 49th Street transmission substation from area distribution substations directly serving the customer demands of several Manhattan distribution networks. This led to the loss of electric service to the Plaza, Lincoln Square, and Rockefeller Center networks. Thereafter, Con Edison also reduced voltage and then manually disconnected additional components, which had become overloaded, to protect them and the system. This led to the loss of service to the Hudson and

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7 DPS-004(Manhattan)(M), p. 2. The system that experienced the outage is served by six area substations which in turn supply nine distribution networks via 141 primary 13.8kV network feeders and 2,061 network transformers that step the voltage down to 120 volts (208 volts phase-to-phase). The number of electric customers served by the nine networks combined is 79,777, which is approximately 2.4 percent of Con Edison's total customer base. Yet, their aggregate peak demand of 1,080 MW accounts for 8.2 percent of the overall system peak. The nine networks span an area of 2.2 square miles, yielding a load density of 491 MW per square mile. – Reference: Con Edison "Report to the North American Electric Reliability Corporation," October 22, 2019 (NERC Report), Redacted, p. 3.

8 DPS-005(M), p. 1.

9 Con Edison Manhattan Report, Redacted (Oct. 2, 2019), p. 4.

Columbus Circle networks at 7:09 p.m. and 7:18 p.m.[10] Later, an overheating transformer at the West 42nd Street substation automatically disconnected, resulting in the loss of service to the Pennsylvania network at 9:17 p.m. Collectively, these automatic and manual disconnections led to the loss of power to various service area distribution substations and six networks in midtown Manhattan.[11] Based on the system design and fact that the weather was normal during the event, the transformer de-energizations or overloads that resulted in customer service interruptions should not have occurred.[12]

Con Edison began restoration efforts shortly after the initial outage. Initial attempts to rapidly restore customer load remotely were unsuccessful. Consequently, manual on-site resets were required resulting in full restoration of interrupted customer load at 11:37 p.m., five hours after the initial event.[13] Following additional work to replace damaged equipment and to test the equipment before returning it to service, the system was returned to its resilient and redundant design levels by Wednesday, July 17, 2019 at 3:46 a.m.[14]

In summary, the July 13, 2019 loss of electric service impacted 72,669 customers. The outage impacted commercial activities, residential buildings, transportation systems, and traffic control. Lights were out in many of New York City's popular nighttime destinations and public venues such as Madison Square Garden, Broadway theatres, Carnegie Hall, and

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[10] De-energization of a network is also referred to as "load shedding." Load shedding is an emergency operating procedure (typically of last resort) to disconnect customer load either through manual operator intervention or automatically invoked by protective devices to protect equipment from damage and to mitigate or prevent potentially higher levels of customer service interruptions and their durations. Customer service interruptions that are directly caused by circuits being de-energized to isolate and extinguish short circuits are considered loss of load, but are technically not considered load shedding.

[11] *See generally* Public Hearing, *Electric Power System Reliability*, before New York State Legislature, Senate Standing Committee on Energy and Telecommunications, Senate Standing Committee on Corporations, Authorities and Commissions, Assembly Standing Committee on Energy, Assembly Standing Committee on Corporations, Authorities and Commissions (Sept. 3. 2019) pp. 18, 23-24; DPS-004(M), pp. 4, 6; NERC Report, Redacted, pp. 9-10; DPS-006(M)-01, pp. 2-3; Con Edison Manhattan Report, Redacted, pp. 10-11, 14, 15, Appendix 7.1, p. 47.

[12] The temperature was 83°F with calm winds and clear skies, consistent with the forecast.

[13] DPS-004(M)-01, p. 8.

[14] Id., pp. 7-8.

restaurants.[15] The subway system experienced widespread delays and limited service, as the Metropolitan Transportation Authority ("MTA") had to close various stations in Manhattan.[16]

II. DPS REVIEW AND RECOMMENDATIONS

Con Edison cooperated in the post analysis phase and assigned a number of subject matter experts and experienced personnel to respond to and analyze this incident, which included expeditious and detailed responses to multiple information requests. In the process, the Company's employees participated in regular review meetings with Staff which included discussion of preliminary findings, information request responses, recommendations, subsequent actions and ongoing progress, as well as site visits of the Con Edison control center and relevant substations. In parallel, the Company cooperated with the Panel in the form of in-person interviews, responses to information requests, site visits and providing information obtained from third-party testing of Con Edison equipment. Additionally, Con Edison, working with staff, actively sought to mitigate and address the root causes that directly contributed to the incident, in order to correct system issues and prepare for the Summer of 2020.

A. ROOT CAUSE ANALYSIS

Background

Con Edison conducted a post-event overall analysis that included data review and equipment testing. During this time, several discussions were held between the Company and Staff to examine the specifics of the incident and to discuss the process being used to identify the root cause. Staff also issued several detailed technical information requests which likely prompted further ideas to help guide the root cause analysis process.

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[15] NERC Report Redacted, pp. 15, 23; New York Times, Patrick McGeehan, *A Burning 13,000-Volt Cable Touched Off Manhattan Blackout, Con Edison Says* (July 15, 2019); New York Times, Michael Paulson, *Blackout Darkens Broadway, but Songs Brighten Sidewalk Scenes* (July 13, 2019).

[16] Con Edison Manhattan Report, Redacted, Appendix 7.4, p. 57, Advanced Metering Infrastructure – MTA Dashboard. The outages caused transit disruptions on the A, C, D, E, F, M, 1, 2, and 3 trains in both directions in Manhattan. @NotifyNYC. ".@NYCTSubway Due to a power outage, expect mass transit disruptions on the A, C, D, E, F, M, 1, 2, and 3 train service in Manhattan in both directions. http://mta.info. Multilingual & ASL Link: http://on.nyc.gov/2gFqaVT." *Twitter*, 13 Jul. 2019, 8:12 P.M., https://twitter.com/NotifyNYC/status/1150196334923866112.

As a result of this analysis, the Company confirmed that the three transformers at the West 49th Street Substation were disconnected due to mis-operation (unintended and unnecessary activation) of protective devices ("87N relays").[17] The loss of these three major transformers contributed to the loss of two other major transformers (one at the West 49th Street Substation and another at the West 42nd Street Area Substation) due to overload conditions. The Company determined that the mis-operations of the 87N relays were caused by omitted neutral wire connections between several sensors and their associated relay protective devices .[18] Con Edison indicated that the 87N relay mis-operation would only become apparent during a fault condition such as the one that occurred in this event, and not under normal circumstances.[19]

Con Edison found that Company engineering drawings for the problematic 87N relays had the correct wiring shown, but corresponding vendor drawings (approved by Con Edison) did not reflect the correct wiring.[20] A different crew of technicians retrofitting relaying for a fourth transformer discovered and corrected the discrepancy between engineering drawings in 2013 (for the fourth transformer). However, Con Edison did not go back to check whether these discrepancies existed on the other three transformer circuit breaker relays that had been retrofitted in 2008.[21]

Analysis and Findings

During the system upgrade process for retrofits of relays, inconsistencies arose between Company and vendor wiring drawings. This led to the omitted wiring between sensors and relays which caused the relay mis-operations. Thus, the omitted wiring was the true root cause of the incident. The Company failed to identify the omitted relay wiring in the vendor drawings it approved in 2008; failed to associate the error when it was discovered in 2013 during

[17] *See generally* Public Hearing, *Electric Power System Reliability*, before New York State Legislature, Senate Standing Committee on Energy and Telecommunications, Senate Standing Committee on Corporations, Authorities and Commissions, Assembly Standing Committee on Energy, Assembly Standing Committee on Corporations, Authorities and Commissions (Sept. 3. 2019) pp. 18, 23-24. Protective devices, such as 87N relays, continuously monitor system conditions. If they sense power system abnormalities, they can react by causing circuit breakers or other switching devices to operate to disconnect energy flow thereby protecting equipment from damage and enhancing overall reliability. Protective relays can fail (or mis-operate) in two essential ways: (a) failure to act as intended when necessary; or (b) acting unnecessarily when not intended.

[18] Id.; Con Edison Manhattan Report, Redacted, p. 38.

[19] Id.

[20] Con Edison Manhattan Report, Redacted, pp. 38-39.

[21] NERC Report, Redacted, p. 9.

a similar retrofit with the work done in 2008; and failed to detect the omitted wiring in commission testing of those retrofits. This represents three separate missed opportunities to detect the missing wiring and points to significant flaw in work practice review/quality control which if done correctly, would have avoided the incident altogether.

Given these findings from the investigations, Con Edison developed a design drawing feedback process that requires review of engineering drawing packages of projects if drawing or field discrepancies are found in similar projects in order to determine if any other inconsistencies between the Company and vendor wiring drawings existed. This process update was completed by the end of 2019.[22]

The incident was further exacerbated by the Company's inspection process that failed to detect closed transformer cooling oil valves on a transformer at the West 42nd Street Area Substation which contributed to the transformer becoming over-heated and consequently was automatically removed from service resulting in loss of service to approximately 10,000 customers. The fact that the transformer cooling oil valves were closed for no apparent reason points to a serious failure of the Company's inspection process, which must be rectified to prevent similar situations from occurring again.

Recommendation

- Con Edison should fully discuss in its implementation plan how the design drawing feedback process it developed after this incident will be monitored and self-audited to ensure there are no inconsistencies between Company's and vendor's wiring drawings that could lead to a similar situation as in July 2019.
- Con Edison should update its inspection procedures to include a process for inspecting transformers cooling systems on a regular basis to verify that the valves are in the proper operational positions. This should include verification by a supervisor after the valve position is changed for any reason.

[22] Id., p. 45.

B. 87N RELAYS INSPECTION AND TESTING

Background

Based upon its root cause conclusion and following additional analyses regarding the Manhattan outage, Con Edison became concerned that more 87N relays on its system might also be problematic. Staff also had several discussions with the Company regarding this issue and what the next steps would be for remediation. Following these discussions, the Company identified 211 other 87N relays on its system, and took one of the three following mitigation actions:[23]

- Relays Removed from Service – Removed 166 87N relays from service pending review of their acceptability;
- Relays Remaining In-Service – Left nine 87N relays in service that were deemed essential for protection of the electric grid, and deemed acceptable for remaining in service; or
- Relays Off-Line and Out-of-Service – Did not isolate thirty-six 87N relays because they were associated with out-of-service transformers on stand-by.

To verify the integrity and acceptability of all 87N relays, Con Edison proposed four separate methods: (a) primary injection testing[24] for new or retrofitted installations to confirm proper operation; (b) a review of pertinent historical operations[25] that demonstrated proper operation; (c) installation of non-intrusive monitors or relay changes either of which would allow detection of potential issues; and (d) primary injection testing (as above) on existing equipment during scheduled outages.[26] This is an on-going effort with all 87N relays planned to be restored to service by the end of 2020.[27] As of November 6, 2020, 142 of the 211 87N relays have been verified as acceptable and are in service.[28]

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[23] Id., p. 23.

[24] Primary injection testing is essentially a simulation of a short circuit on equipment to verify that protective devices operate as intended. This form of testing requires that the equipment be removed from service and isolated from the rest of the power system. Other than for new installations or retrofits, primary injection testing is difficult to schedule and perform on existing equipment.

[25] Review of pertinent historical operations is the monitoring and post-evaluation of equipment that experiences pertinent fault disturbances to verify that protective devices operated as intended. This potentially can provide the same information as primary injection testing, but it dependent upon actual experiences.

[26] Con Edison Manhattan Report, Redacted, pp. 40-44.

[27] Con Edison 87N Relay Restoration Report, July 17, 2020.

[28] Con Edison 87N Relay Restoration Report, August 20, 2020.

Analysis and Findings

The Company decided to take most of its installed 87N relays out of service (pending verification of their integrity) while leaving some in service that it deemed to be acceptable. The Panel indicated that this approach increased the risk that equipment could more likely be damaged during a fault.[29] Notwithstanding, Staff concurs with the Company's approach as an interim mitigation measure to prevent future relay mis-operations and unintended outages; albeit with a certain degree of increased risk.

The Panel also raised the issues that the timeline for completion of the 87N relay verifications is excessively long, and that the verification methods – other than those involving primary injection testing – are theoretically sound but have not been proven.[30] Staff concurs with these observations.

Recommendations

- Con Edison should seek ways to further expedite the verification of the correct installation and operation of 87N relays that were taken out of service following the incident.
- Given its decision following the incident to use other methods besides primary injection testing to verify the proper operation of the 87N relays, Con Edison should provide an analysis that validates using either the review of pertinent historical operations, the installation of non-intrusive monitors, or making relay adjustments will be able to verify the correct installation and operation of 87N relays.

C. EMPLOYEE TRAINING

Background

The Con Edison electric system – particularly in New York City – is one of the most complicated systems and most crucial infrastructures in the world. A key component of maintaining this system is the expertise and experience of the Company's employees. Consequently, appropriate and comprehensive employee training provided on a regular basis is essential to help maintain and improve staff expertise, experience and capabilities necessary to

[29] Panel Manhattan Report, p. 32.
[30] Panel Manhattan Report, pp. 32-33.

assure performance expectations are achieved – particularly as circumstances change and emergencies arise.

Analysis and Findings

Historically, Con Edison has provided a robust training program for its employees and has a highly skilled proficient workforce. Nevertheless, this incident exposed shortcomings in its overall training program which contributed to the root cause, showing that improvements in training are needed. This and other factors, including the complexity and criticality of the Con Edison's electric system, its aging infrastructure, evolving technologies and new requirements,[31] require more intensive training. Consequently, Staff finds that Con Edison should thoroughly review its training programs and make improvements to help its employees meet existing and potential challenges, particularly preparing for and responding to contingency events. Accordingly, the Company should be required to produce a Training Enhancement Report that includes innovations and alternative approaches in class-room/online learning, company manuals and supplements, on-the-job training, incident lessons learned reviews,[32] operational drills, inter-disciplinary coordination and knowledge sharing, and reviewing other utility developments. The training improvements should be coupled with designs for follow-up testing to gauge understanding and competence.

To improve understanding and reduce the potential for errors, Staff also recommends[33] that Con Edison review its technical documents to replace unclear language with clear-cut specific terminology.[34]

Recommendation

- Con Edison should produce a Training Enhancement Report to further improve its overall training program and meet the challenges of the future. The report should address a number of topics including classroom, online and on-the-job training, new technologies and procedures, improvements in company manuals, sessions to review lessons learned,

[31] New requirements may consist of more stringent reliability, resiliency, safety, environmental, regulatory or other standards, and/or changing customer needs.
[32] The Panel recommended that training be enhanced with the inclusion of lessons learned reviews – Recommendation #17. Panel Manhattan Report, p. 52.
[33] Staff Recommendation #3 to replace ambiguous unclear language with terminology having more clarity.
[34] Panel Manhattan Report, p. 61 (Recommendation #25).

operational drills, and discussions between departments and disciplines to improve communication and coordination. Additionally, the report should implement or improve follow-up testing to validate employee understanding and competence.

- Con Edison should review all technical documents to replace unclear language with clear-cut specific terminology.

D. SYSTEM PLANNING

Background

Proper system planning ensures that sufficient electric assets are in place to adequately meet customer demand and adhere to applicable reliability and resiliency standards. In addition to transmission and distribution circuits, electric assets predominantly consist of transformers,[35] surge arrestors,[36] circuit breakers,[37] protective relays,[38] reactive power sources[39] and remote monitoring and control equipment.[40] Overall the system should be planned and designed to meet applicable reliability criteria, resiliency requirements and safety standards at just and reasonable costs.

Analysis and Findings

Con Edison's System Planning adheres to a redundant design for the West Side Midtown Manhattan power system (i.e., NYS PSC N-2 Design Criteria[41]), which is intended to assure that peak load can be served even after the loss of any two circuits or transformers

[35] Transformer are devices that convert one voltage to another to enable efficient transmission and utilization of electricity.

[36] Surge arrestors (also referred to as "lightning arrestors") are devices attached to transformers and other power system equipment to avert excessive voltage surges and/or electrical flow through the equipment caused by such occurrences as lightning strikes by "bleeding" off these harmful conditions before they damage the power system equipment.

[37] Circuit breakers are devices (along with switches) that can energize and de-energize circuits to allow energy to flow or not flow.

[38] Protective relays are devices that continuously monitor system conditions and react to power system abnormalities causing circuit breakers or other switching devices to operate to disconnect energy flow thereby protecting equipment from damage and enhancing overall reliability. Protective relays can fail (or mis-operate) in two essential ways: (a) failure to act as intended when necessary; or (b) acting unnecessarily when not intended.

[39] Reactive power sources are devices which help control voltage levels and energy flows on the power system.

[40] Remote monitoring and control equipment (also referred to as "SCADA" or "supervisory control and data acquisition" equipment) are devices which measure, record and transmit conditions and data to a central location, and also allow power system equipment to be operated or adjusted remotely.

[41] New York Public Service Commission Specification E-11-2, dated 1962.

following a system disturbance. Notwithstanding that more stringent level of reliability, the Panel offered additional recommendations for System Planning to further improve reliability. These include:

- Reassess and augment asset management practices company-wide particularly addressing data monitoring, collection and analyses to enhance maintenance strategies (Panel Recommendation #27).[42]
- Monitor operating conditions of transformers, and apply estimation techniques to determine potential loss of life[43] on transformers to assist in determining replacement or refurbishment schedules (Panel Recommendation #22).[44]
- Install additional circuit breakers to individually isolate only faulted equipment while leaving non-faulted equipment in service to protect equipment while also enhancing reliability (Panel Recommendation #24).[45]
- Reassess protective device coordination with the intent of adopting shorter clearing times (Panel Recommendation #11).[46]
- Migrate to relays and recording equipment that are accurately and precisely synchronized system-wide to an absolute time standard (Panel Recommendation #14).[47]
- Update the surge arrestor selection process for both new and existing installation with an emphasis on protecting equipment in terms of voltage ratings and energy ratings (Panel Recommendation #23).[48]

The Panel's recommendations are reasonable and they should be fully addressed in Con Edison's implementation plan. The Company should be required to provide detailed justifications for any recommendation it does not believe should be implemented.

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42 Panel Manhattan Report, p. 62.

43 In comparison to a "normal" expected lifetime, transformers may experience "loss of life" (i.e., accelerated aging) due to a number of factors such as excessive loading and over-heating; excessive voltage surges experienced that may be caused by lightning strikes or switching operations; and excessive energy flows caused by faults on connected circuits.

44 Panel Manhattan Report, p. 57.

45 Id., p. 60.

46 Id., p. 46.

47 Id., p. 49.

48 Id., p. 59.

Recommendation

- Con Edison should continue to investigate ways to improve system reliability and resiliency, as identified in post event preliminary findings, at just and reasonable costs including consideration of and responding to the Panel's recommendations pertaining to system planning. The Company should be required to provide detailed justifications for any recommendation it does not believe should be implemented.

E. SYSTEM UPGRADES

Background

Much of the results of system planning studies and recommendations lead to system upgrades being made. These system additions and improvements should be rigorously designed and projects should be managed in an efficient and effective manner that avoids errors and produces successful projects.

Analysis and Findings

An integral part of assuring proper installation and operation of power system equipment lies with the project design process. Competent project design avoids inconsistencies and ambiguities in drawings, specifications and other related documents. Project design is brought to reality with competent project management that coordinates resources with requirements and deals with challenges while focusing on meeting the expected outcomes. An important aspect of assuring a successful project is the robustness of testing procedures to officially validate the acceptability of equipment prior to being placed into service. Additionally, if errors or defects are identified in a specific project, lessons learned should be documented and applied to other similar projects to determine if the same problems exist.

During the system upgrade process – for the retrofits of relays that ultimately mis-operated and directly resulted in the incident – Con Edison failed to identify omitted relay wiring in vendor drawings that it approved, failed to associate the same error discovered in a similar project[49] with previous retrofits, and failed to detect the omitted wiring in commission testing of the retrofits. This represented three separate missed opportunities to have detected the missing

[49] Con Edison had already instituted improvements to reduce discrepancies in its project design drawings in 2013. However, the 87N relays that mis-operated and caused this outage incident were installed prior to 2013.

wiring and have avoided the incident from occurring. In short, the Manhattan outage was avoidable.

Subsequent to the July 2019 Manhattan outage event, preliminary findings led to Con Edison self-identifying three recommendations pertaining to the system upgrade process:

- Improve outcomes through expanded use of its quality control checklists for its central engineering department[50] to help assure the correctness and quality of engineering drawings. This approach was implemented and completed at the end of 2019.[51]
- Improve the standardization of commissioning instructions through the Protective System Testing Department developing new commissioning guidelines and primary injection testing methods for new installations or modifications.[52] This recommendation has since been implemented.[53]
- Help identify commonly occurring errors through a design drawing feedback process that requires review of engineering drawing packages of projects if drawing or field discrepancies are found in a similar project were found.[54] This development was completed by the end of 2019.[55]

The Panel recommended (Panel Recommendation #4) that primary injection testing be incorporated as a requirement for all new and upgraded breakers.[56] Also, the Panel (Panel Recommendations #5 and #26) went further and suggested that Con Edison not only improve the quality control and review of its technical drawings[57], but also improve its overall quality control processes and documentation Company-wide and relying on industry standards as a basis.[58]

Staff concurs, based on the findings, with the remedial actions taken by Con Edison to improve overall quality control and agrees with the Panel's recommendations for further improvement in this area as well.

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50 Con Edison self-identified Recommendation #2, Con Edison Manhattan Report, Redacted, pp. 40-42.
51 Con Edison Manhattan Report, Redacted, p. 44.
52 Con Edison self-identified Recommendation #3. Con Edison Manhattan Report, Redacted, pp. 44-45.
53 Id., p. 44.
54 Con Edison self-identified Recommendation #4. Con Edison Manhattan Report, Redacted, p. 45.
55 Id.
56 Panel Manhattan Report, p. 36.
57 Id., p. 37.
58 Id., p. 62.

Recommendation

- Con Edison should improve its system upgrade quality control processes with an emphasis on investigating and adopting industry standards.
- Con Edison should verify that all new, retrofitted or out-of-service for maintenance facilities with 87N relays will be tested and validated using primary injection testing before being placed into service.

F. SYSTEM ASSESSMENTS

Background

System assessments should consist of timely and appropriate inspections, testing and analyses of power system equipment to help assure proper initial and continued operation.

Analysis and Findings

As discussed in the Root Cause Analysis and the System Upgrades sections, the Company failed to detect the omitted wiring in commission testing of breaker upgrade work among two other missed opportunities. Although the inconsistencies in the Company's and vendor's wiring drawings led to the root cause of the incident, appropriate testing could have detected these flaws, and therefore could have preempted and avoided the incident and outage.

Additionally, as stated in the Chronology of Events, a fourth transformer was removed from service due to overheating caused by heavy loading and further exacerbated by closed oil valves which should have been open. Transformer cooling systems[59] are essential for maintaining operating capability, flexibility and efficiency, and to avoid equipment damage. The Company failed to properly inspect the transformer valves to assure they were open.

The Panel suggested several additional System Assessment areas to improve upon including:

[59] Transformers are generally cooled such that their insulated coil windings are immersed in a tank of oil to absorb and diffuse the heat generated by energy flowing through the windings. Transformer cooling systems may supplement simple oil cooling with: (a) the oil flowing naturally through external air-cooled radiators; (b) fans attached to the external radiators to circulate cooling air through the radiators (also referred to as "forced-air"); and (c) cooling oil being pumped through the external radiators (also referred to as "forced-oil") rather than flowing naturally.

- Conducting regular visual checks of transformers and other equipment to detect abnormal conditions (Panel Recommendation #20).[60]
- Improve periodic testing of SCADA[61] system connectivity and remote control operability (Panel Recommendation #16).[62]
- Identify and assess potential technologies which can detect hidden protective system failures (Panel Recommendation #12).[63]
- Evaluate underground cable assessment technologies and adopt those that are more effective and predictive than existing methods (Panel Recommendation #7).[64]
- Update the feeder testing procedures to replace the use of direct current high potential ("DC HiPot") testing with a more effective approach, given that DC HiPot testing imposes a voltage higher than operating levels, and therefore is potentially damaging (Panel Recommendation #9).[65]

Overall, Staff agrees with the Panel's conclusions that Con Edison's System Assessment processes need to be improved to help assure proper operation and performance of its electric system.

Recommendations

- Con Edison should develop a program to upgrade and enhance its testing and inspection protocols and procedures.

G. OPERATION AND MAINTENANCE

Background

Power system operation and maintenance ("O&M") – consisting of equipment adjustments, preventive care, replenishments, and repairs – should be undertaken in a timely and

[60] Panel Manhattan Report, p. 55.
[61] SCADA is a Supervisory Control and Data Acquisition system which allows system operators to monitor the power system and manually operate and control devices on the system remotely.
[62] Panel Manhattan Report, p. 52.
[63] Id., p. 47.
[64] Id., p. 42.
[65] Id., p. 45.

efficient manner to help assure low cost reliable lifetime performance and prevention of equipment damage.

Analysis and Findings

During the power restoration process, Con Edison had problems getting operating personnel to affected substations due to traffic congestion caused by the power outage and loss of traffic signals. The Panel recommended that Con Edison improve system restoration contingency plans to address operator travel difficulties and/or improve the ability to reset equipment remotely (Panel Recommendation #15).[66]

The Panel also suggested several recommendations pertaining to the Company's extensive network of 27 and 13.8kV underground cable serving its distribution load given that the initiating event in this incident was a distribution cable failure. These recommendations included improvements in cable maintenance processes and technologies as currently widely used in the industry (Panel Recommendation #6)[67], evaluation of the potential for rejuvenating XLPE[68] cable that may be more cost effective than cable replacements (Panel Recommendation #8)[69], and adoption of a program to avoid splicing new cable into old cable (Panel Recommendation #10).[70]

Staff agrees that Con Edison needs to improve its contingency plans and procedures. Staff also agrees that the Company should identify ways to improve its operation and maintenance procedures and techniques for its 27 and 13.8kV underground cable and its entire fleet of power system equipment. Staff recommends that the Company be required to develop improvements in its contingency plans and procedures (including preparation for a wider range of contingencies), and to develop improvements in its overall operation and maintenance procedures for all of its power system equipment in order to achieve reliable performance and to prevent equipment damage.

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66 Id., p. 51.
67 XLPE cables are underground cables using cross-linked polyethylene insulation.
68 Panel Manhattan Report, p. 46.
69 Id., p. 43.
70 Id., p. 46.

Recommendation

- Con Edison should develop improvements in its contingency plans and procedures and develop improvements in its overall operation and maintenance procedures for all of its power system equipment in order to achieve reliable performance and to prevent equipment damage.

H. SYSTEM MONITORING

Background

Power system data and conditions should be monitored, consolidated and analyzed accurately in real-time to provide excellent situational awareness and to allow system operators to make informed decisions for actions that may need to be taken, particularly under emergency conditions. Accurate and timely real-time analyses that predict outcomes based upon actual power system characteristics and conditions can allow system operators to test the impact of potential actions beforehand and enable them to make better decisions in maintaining reliability. This would help avoid costly counterproductive mistakes; particularly during major disturbances.

Analysis and Findings

Company operators had sufficiently accurate and timely real-time information on power system conditions during the incident to allow them to assess the situation and rapidly proceed towards both equipment protection and restoration. The real-time information enabled operators to invoke emergency voltage reduction and load shedding to avoid damage to electric equipment. As a result, no major equipment was severely damaged, and any major equipment that was disconnected during the incident was returned to service during the restoration process.

While Con Edison was able to effectively respond during this event, the Panel offered recommendations to enhance operator situational awareness. These improvements include migration to digital technologies to improve equipment monitoring and better detection of abnormalities and hidden failures in real-time (Panel Recommendation #13).[71] This approach would provide additional data monitoring for improved reliability. It would also increase information processing to better assist operators in identifying data inconsistencies and errors;

[71] Id., p. 48.

determining root causes of incidents in real-time; and developing and modeling solutions more rapidly. Additionally, the Panel recommended that analysis of transformer alarming and monitoring information be improved, and clear operational protocols for responding to abnormalities be amplified to enhance timely protection of this critical equipment (Panel Recommendation #19).[72]

As the system continues to become more complex, improving operator situational awareness and providing clear operational protocols is necessary to protect critical equipment such as transformers[73] and to maintain reliability. These recommendations by the Panel, if implemented, will enable Con Edison to better react to more complex problems in the future and therefore should be a good investment. Consequently, Staff agrees with the Panel and recommends that the Company develop improvements in its overall System Monitoring procedures that will contribute to better situational awareness particularly with respect to critical equipment such as transformers; and additionally, improve the clarity of protocols for responding to system abnormalities.

Recommendations

- Con Edison should improve its overall System Monitoring procedures to enhance situational awareness, particularly with respect to critical equipment such as transformers and should improve the clarity of protocols for responding to system abnormalities.

I. PROBLEM ANALYSIS

Background

Following the occurrence of a problem or failure, good problem analysis should consist of the root causes being accurately identified and specifically documented, followed by development of viable and effective mitigation, correction and improvement measures that address both the problem/failure and the associated impacts in a timely manner. In undertaking root cause determinations, Staff expects the Company will conduct appropriate and adequate

[72] Id., p. 54.

[73] Transformer failures, while rare, are problematic since failures may cause collateral damage and result in reliability problems. Additionally, the availability of transformer spares is limited, and transformer replacements are both expensive and time consuming. Consequently, transformers should be protected with protective relaying and operational protocols from conditions that may lead to premature damage and failure.

testing and analyses to isolate and identify the real root cause(s) of a problem or failure with relative certainty, while also eliminating other initially suspected causes. In developing solutions and remediation measures, a number of viable alternatives should be developed and evaluated to produce a desired course of action but should not result in undue delay.

Ultimately, to help avoid re-occurrences of similar problems or failures, the problem analysis process should culminate in development of a lessons learned report which is widely disseminated and discussed.

Analysis and Findings

As noted in the Chronology of Events, Con Edison identified the root cause of the incident to be omitted wiring in the 87N relays which caused the loss of three major transformers and subsequent customer outages. The Company traced the problem leading to the faulty wiring as being inconsistencies between the Company's and vendor's wiring drawings related to the relay upgrades. Both Staff and the Panel concur with these findings.

The Panel found that Con Edison developed a listing of lessons learned but failed to address these findings in its self-identified recommendations. Thus, the Panel recommended (Panel Recommendation #1) that the Company issue a comprehensive review of lessons learned to identify, review, and explain all factors contributing to the incident.[74]

Staff agrees with the Panel that the Company should broaden the problem analysis and produce a comprehensive Lesson Learned Report. Staff recommends that the Lessons Learned Report should fully describe the incident and associated events in detail,[75] and be widely disseminated to maximize the training value for employees.

Recommendation

- Preliminary findings led Con Edison to develop an initial listing of lessons learned, Con Edison should now produce a more comprehensive Lessons Learned Report following the

[74] Panel Manhattan Report, p. 33.

[75] The Panel recommended a Lessons Learned Report that included discussion of recommendations and conclusion made by others, and also included an implementation plan for agreed upon recommendations. Completion of a Recommendation Report and an Implementation Plan are included as separate DPS staff recommendations in the Prioritization Section.

occurrence of any significant problem or failures it encounters, and widely disseminate the report to relevant employees for discussions and training.

BROOKLYN OUTAGE EVENT

The Flatbush system is supplied by nineteen 27kV distribution feeders from the Bensonhurst No. 2 Substation. The Flatbush system provides service to approximately 132,000 customers split between two distinct geographic locations and load areas: approximately 99,000 customers in the northern and western portion of the system are fed by an underground network or directly by one or more of the nineteen distribution feeders. Approximately 30,000 customers in the southern and eastern portion of the system are fed by an overhead 4kV grid. This 4kV grid is comprised of thirty-seven 4kV feeders that run between pairs of 15 unit substations located throughout the southeastern portion of the Flatbush system. These unit substations are supplied by fifteen of the network's nineteen 27kV distribution feeders. In addition, another 3,600 customers in the southeast portion of the network are fed by an overhead auto-loop, called the Cropsey Loop, which is fed by two of the 27kV distribution feeders.

Customers in the Flatbush system, both overhead and underground, typically do not receive service directly from the main feeder runs; rather, as is characteristic of Con Edison's electric distribution system, customers are fed from "branches or spurs" that divide the main feeder into segments, with each branch feeding small clusters of customers. Various equipment on both the 27kV feeders and the 4kV grid, including automatic and manual switches, interrupters and reclosers, act to sectionalize each cable. This allows Con Edison to limit feeder fault impacts such that a single failure on a distribution feeder does not interrupt service to all customers located along that feeder; instead, faults are isolated, and only customers on the faulted section are affected.

This section of the report will provide a chronology of the Brooklyn Event and discuss various components of the Flatbush system's design and operation, as they relate to the outage event as well as how Con Edison reacted to the conditions presented to them. This includes context as to how each component performs during the event and Staff's recommendations concerning how to better develop or enhance these components. Components discussed include fault limiting equipment, relay sensitivity, feeder testing, 4kV grid operation procedures, voltage reduction procedures, and control room operation procedures. This section will also discuss network components and operations related to the restoration of the Flatbush 4kV grid. This includes 4kV restoration guidelines and the deployment of mobile electric

generators. Finally, this section will discuss how Con Edison conducts after action reviews as they relate to the evaluation of the network's design and operational performance after an event.

I. CHRONOLOGY OF EVENT

A. PRECEDING EVENTS

On Sunday July 14, 2019, Con Edison received weather forecasts indicating high temperatures for the upcoming week. The forecast called for consecutive days with high temperatures that would have the possibility to exceed Con Edison's system design criteria of a temperature variable[76] (T_V) of 86° F. The next day, on Monday July 15, Con Edison officially began to mobilize in order to secure the necessary staffing and resources to preempt possible system operating complications. The Company began to operate under an Incident Command Structure (ICS) as dictated by its internal specifications, and the Brooklyn/Queens operating region was operated at an "Upgraded" ICS level.[77] That afternoon, Con Edison notified internal and external parties, including the Department, that the Company will be mobilizing its Distribution Engineering Situation Room (DESR) to serve as a centralized planning, coordination and communication source during the upcoming heat wave.

On Tuesday July 16, when the maximum temperature that day for the New York City region was approximately 90°F, Con Edison opened its Logistics Operations Center at 6:00 p.m. in order to begin procuring additional emergency resources that may be needed during the heatwave. These resources included 13 mobile electric generators to supplement the 28 Con Edison already had on hand, dry and wet ice, and contractor resources. Con Edison also restored feeders that were currently out of service for scheduled work and began to shift its internal and contractor workforce, reassigning crews to perform transformer cooling activities. At 7:00 p.m., Con Edison escalated its Brooklyn/Queens ICS operating level to "serious," increased its staff on-hand, and moved certain personnel to 12-hour shifts. Con Edison's DESR also held the first company-wide conference call at 8:00 p.m. that evening. Periodic conference calls were

[76] Temperature Variable is a nonuniformly weighted, rolling average of three day's temperature data, which Con Edison uses as an indicator for operational heat decisions and planning.

[77] Con Edison has four ICS operational levels – Routine, Upgraded, Serious and Full Scale – that each call for specific mobilizations and actions to be taken. Operating at specific levels is dependent on multiple factors including forecasted load and current system conditions.

scheduled every four hours, continuing through the remainder of the week to provide timely updates on mobilization efforts between key operational groups.[78]

Con Edison also began to implement measures to reduce the stress on its system. Wednesday July 17 marked the second consecutive day with a forecasted maximum temperature for the New York City region near 90°F and elevated the Tv to 83.3°F, approaching Con Edison's design standard. Based on this forecast, Con Edison activated its Distribution Load Relief Program, calling for participants in certain networks of the Brooklyn/Queens and Staten Island regions to reduce electric load or operate generators for six-hour periods during the evening.[79] This program is in place to provide load relief[80] but was not implemented in the Flatbush network due to the fact that the network had not experienced a second contingency situation.[81] Based on continued high temperature forecast on Thursday July 18, Con Edison sent notification that it would activate its Commercial System Relief Program[82] for participants in all networks on Friday July 19.[83]

In response to the continuing feeder contingencies in Queens, Con Edison mobilized two mobile electric generators in order to provide grid support while repairs were being made. This is in addition to four mobile electric generators deployed in the early morning hours of July 17 in Queens to support the Richmond Hill network. One of the generators was requested for the Rego Park network by 12:00 p.m. on July 17 and the other was requested for the Flushing Network by 8:00 a.m. on July 18 as each had two feeders out of service.

On Friday, July 19, Con Edison opened its Corporate Emergency Response Center (CERC) at its New York City Headquarters due to the severe weather conditions expected to continue over the coming weekend. The CERC is only activated during "Full Scale" level events and serves as a main hub where Con Edison personnel from all different departments work under

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78 DPS-026(Brooklyn)(B) - Con Edison Review of July 21, 2019 Flatbush Network Event Report (Con Edison Flatbush Report), Redacted, pp. 25-27.

79 Con Edison Demand Response Notification emails.

80 According to the response to DPS-088(B), under Con Edison Engineering Operation Procedure EOP-5022, load relief can only be requested via Demand Response programs when the next contingency would result in a condition yellow (i.e. the next two contingencies would result in either an outage to more than 15,000 customers or the overloading of distribution equipment) or if a voltage reduction of 5% or greater has been ordered.

81 DPS-007(B)-01 – Attachment, 2005-2019 Flatbush OAs, Redacted.

82 This program is in place to reduce peak network demand by having participants reduce their usage during specific periods and can only be implemented when the next day's forecasted load reaches 92% of the peak summer forecasted load, which was met as Con Edison forecasted 12,300 MW of demand.

83 Con Edison Flatbush Report, Redacted, p. 27.

a centralized ICS, coordinating their emergency response actions. As a result, the DESR team was relocated to the center. Representatives from various external stakeholders were also invited, including, but not limited to, the New York City Office of Emergency Management and the Department of Public Service; Con Edison also dispatched personnel to staff the New York City Emergency Operation Center.[84]

Throughout the work week, Con Edison also responded to scattered events across the service territory, such as overhead transformer issues, smoking manholes, and feeder contingency concerns in Queens and Staten Island.

B. OUTAGE EVENTS IN FLATBUSH

On Saturday July 20, the Flatbush system experienced its first 27kV feeder failure at 8:19 p.m. Feeder 4B17 automatically disconnected, establishing a first contingency condition. This failure was due to an electrical fault associated with a failed splice. The loss of feeder 4B17 also meant that its associated unit substation would be unable to supply the 4kV grid. Feeder 4B17 is also one of two feeders that supplies the Cropsey Loop and due to its loss, the Cropsey Loop was being fed by only feeder 4B19, the other feeder that serves the loop. No customer outages were experienced, and Con Edison operators immediately began working to restore the feeder, which can typically take between ten and twenty hours from disconnection to restoration.

At 2:19 p.m. on Sunday, July 21, an internal failure of breaker B3047 at the East 71st Street unit substation removed the 4kV bus from service and automated protective schemes disconnected the unit substation. The supply feeder to this substation remained in service, thereby allowing it to continue to supply the underground network. Since feeder 4B17 was still in the process of being restored, and the breaker failure prevented the supply of electricity to the 4kV grid, the 4kV grid was elevated to a second contingency. The Flatbush underground network remained in a first contingency.[85]

Con Edison began experiencing additional feeder outages on Sunday. At 3:59 p.m., feeder 4B01 automatically disconnected due to a fault at a splice. The loss of feeder 4B01 caused the Flatbush underground network to be in a second contingency and the 4kV grid in a

[84] Con Edison Flatbush Report, Redacted, p. 27.
[85] Id., p. 10.

third contingency. With the underground network now at a second contingency, the Control Center operators ordered a 5% voltage reduction at the Bensonhurst No. 2 Area substation at 4:07 p.m., in accordance with the Company's procedures, to alleviate stress on the feeders.[86]

At 4:48 p.m., another feeder, 4B19, automatically disconnected. At the time, Con Edison was unaware as to what had caused the fault and proceeded to perform the tasks associated with a faulted cable, namely to locate the failure. After the event, however, it was found that the feeder disconnected due to the operation of an electromechanical Westinghouse Type CM phase balance relay[87] despite no corresponding fault on the feeder. Con Edison stated that its review of Supervisory Control and Data Acquisition (SCADA)[88] data for the two feeders showed an imbalance in their phase currents at the time of disconnection, indicating that the relay operated per design in tripping due to this measurement.[89] The loss of service to feeder 4B19 resulted in an outage to all 3,600 customers served by the Cropsey Loop, as they were being fed radially from 4B19 after the loss of feeder 4B17 on Saturday.[90] The loss of this feeder also elevated the Flatbush network to a third contingency and the 4kV grid to a fourth contingency. Seven minutes later, at 4:55 p.m., Con Edison raised the ordered voltage reduction at the Bensonhurst No. 2 substation to 8% as required by the Company's procedures.[91]

At 5:46 p.m., feeder 4B12 disconnected from service due to a faulted splice. As a result, the Flatbush network was elevated to a fourth contingency and the 4kV grid to a fifth contingency. In response to the loss of feeder 4B12, Con Edison operators began to seek options to provide relief beyond the voltage reduction. Operators initially chose to de-energize the supply to three of the four 27-to-4kV stepdown transformers. Specifically, at 6:11 p.m., stepdown feeder 3111 was disconnected; at 6:14 p.m., stepdown feeder 3112 was disconnected; at 6:17 p.m., stepdown feeder 3110 was disconnected.[92] Between 6:27 p.m. and 6:51 p.m., Con Edison

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[86] Id., pp. 10-11.

[87] Con Edison currently utilizes electromechanical Westinghouse Type CM phase balance relays throughout its service territory. These relays normally operate by tripping the feeder breaker when a prescribed current difference, or imbalance, between phases is detected.

[88] SCADA, or supervisory control and data acquisition, allows for remote monitoring and control of field assets. Con Edison operators at the Brooklyn/Queens Control Center or the Energy Control Center can remotely open or close switches, breakers and other equipment rather than having to send someone out to the field to manually operate them.

[89] Con Edison Flatbush Report, Redacted, pp. 24-25.

[90] DPS-003(B) – 01, Redacted, p. 3.

[91] Con Edison Flatbush Report, Redacted, pp. 11-12.

[92] Id., p. 12.

operators took further pre-emptive steps to prevent overloading equipment in the 4kV grid. This included the de-energization of the last in-service 4kV stepdown feeder, stepdown feeder 3113, and the de-energization of 4kV feeders 3025, 3026 and 3007. These actions resulted in a loss of service to approximately 3,800 customers, in addition to the almost 3,600 customers on the Cropsey Loop already out of service.[93] Although a large number of customers were already out of service, and system conditions were not improving in response to mitigating actions, Con Edison neglected to release any form of proactive communications, either addressing current outages or warning customers about possible outages.

At 7:06 p.m., feeder 4B14 opened automatically due to a faulted splice.[94] The loss of this feeder elevated the underground network and 4kV grid to a fifth and sixth contingency, respectively.[95] Within the next two minutes, breakers associated with 4kV feeders 3006 and 3042 tripped at their respective unit substations due to overcurrent conditions.[96] It was at this point that operators began to discuss how to proceed with de-energizing the 4kV grid with Con Edison's Engineering and System Operations departments.[97]

Five minutes later, at 7:11 p.m., feeder 4B11 disconnected. Following the outage event, it was determined that loss of this feeder was due to the operation of a Westinghouse Type CM electromechanical relay. Like feeder 4B19, system monitoring equipment showed that there was no fault activity during the time of relay operation. The loss of feeder 4B11 put the underground network into a sixth contingency and the 4kV grid into a seventh contingency. Due to the loss of these six feeders and seven unit substations, 4kV grid distribution equipment was beginning to experience overloads.[98]

At 7:13 p.m., Con Edison was able to return feeder 4B17 to service, upgrading the Flatbush network and 4kV grid back to a fifth and sixth contingency, respectively. Con Edison still needed to energize the associated substation in order to relieve overloading in the grid and operators concluded that they would not be able to do so in time to prevent further cable failures.

At 7:21 p.m., the regional Vice President of Brooklyn/Queens Operations, after conferring with operators, made the decision to de-energize the 4kV grid in order to prevent a

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93 Id.
94 Id.
95 Id.
96 DPS-014(B)-01, Redacted.
97 Con Edison Flatbush Report, Redacted, pp. 12-13.
98 Id., p. 13.

complete shutdown of the Flatbush network, which would have resulted in the loss of service to all 132,000 customers and potentially serious damage to system components. Regional operators at the Brooklyn/Queens Control Center requested that operators at the Energy Control Center perform the de-energization. Due to a combination of issues, as discussed later in detail, Con Edison was unable to begin de-energizing the 4kV grid until 7:32pm. This action interrupted service to nearly 30,000 customers.[99]

C. CUSTOMER RESTORATION AND RESTORAL OF THE FLATBUSH 4KV GRID

At the time of de-energization, there were five feeders out of service – 4B01, 4B11, 4B12, 4B14 and 4B19. Con Edison operators promptly began working on restoring customers. Although feeder 4B17 was restored at 7:13 p.m., Con Edison was unable to return the Cropsey Loop to service until 9:34 p.m. when the feeder recloser, or switch, was closed in on 4B17. A total of 3,600 customers were restored to service, being fed radially from feeder 4B17.[100]

By approximately 12:00 a.m. on the morning of July 22, nearly 11,000 customers on the 4kV grid had been returned to service. These customers were supplied by 4kV feeders running between unit substations associated with in-service 27kV feeders. Customers were restored when each 4kV feeder breaker was closed remotely by operators via SCADA controls between 10:44 p.m. and 11:40 p.m.[101] Con Edison used a general procedure in order to carry out these restorations. First, transformer breakers were closed at in-service unit substations. Next, 4kV breakers were closed to open feeder tie switches, and finally, the tie switches were closed. When enough 4kV feeders were available to support a unit substation that lost its 27kV supply, following a review of system load conditions, the associated 4kV breakers were closed to re-energize the unit substation.[102]

At 2:36 a.m. on July 22, feeder 4B12 was partially restored to service. An underground, sectionalizing switch was manually operated via SCADA controls in order to isolate the faulted portion of the feeder, and Con Edison operators were able to restore the unfaulted

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[99] Id.
[100] DPS-002(B)-01, p. 1.
[101] DPS-014(B)-03.
[102] DPS-051(B)-01.

portion from the Bensonhurst No. 2 substation. The feed to the 4kV grid was on the faulted portion of the feeder and was not restored.[103] At 3:44 a.m., feeder 4B01 was also partially restored. Like 4B12, a sectionalizing switch was used to manually isolate the faulted portion of the feeder, and Con Edison operators were able to restore the unfaulted portion from the Bensonhurst No. 2 substation, however, the faulted portion of the feeder that serves the 4kV grid was not restored.[104]

Con Edison also began mobilizing and placing its mobile electric generators throughout the Flatbush grid. Generators were generally placed on 4kV feeders that ran between two out-of-service unit substations and were used for either grid support or customer restoration. The generators were used to restore customers to service while field crews energized out-of-service equipment. The first two generators mobilized were on location at approximately 11:30 p.m. Saturday night, both being used for customer restoration. Together, these generators accounted for the restoration of approximately 600 customers. By 7:00 a.m. the following morning, another three mobile electric generators had been placed throughout the Flatbush network; one was hooked up in parallel with a 4kV feeder in order to provide grid support and the remaining two were used to restore 167 and 393 customers respectively. The last two mobile electric generators utilized during the event were on location by approximately 11:00 a.m. One was used for the restoration of approximately 223 customers at approximately 2:00 p.m. and the other was used for grid support at 9:00 p.m. that night. In total, approximately 1,400 customers were temporarily restored using generators throughout the restoration of the 4kV grid.[105]

The first feeder to be fully restored and able to serve the 4kV grid was 4B14. This feeder was restored at 10:42 a.m. on July 22 and its unit substation was returned to service at 11:26 a.m. Although feeder 4B19 was restored at 2:24 p.m., its associated unit substation was not restored until 5:49 p.m. when its bank breaker was closed, approximately 3.5 hours later.[106] This delay between feeder and unit substation restoration was significantly longer than all others; for all other feeders and unit substations, it took less than an hour to restore the unit substation after complete feeder restoration.

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[103] DPS-063(B)-03.
[104] Id.
[105] DPS-014(B)-04 Suppl. 1, Redacted.
[106] DPS-003(B)-01, Attachment – "Exhibit Preliminary Analysis Flatbush Contingency", Redacted.

At 3:28 p.m., feeder 4B11 was also restored and its unit substation was energized at 4:07 p.m.[107] At 4:56 p.m. on July 22, Con Edison completed repairs on the portion of feeder 4B12 that was still out of service. At this point Con Edison has restored a total of approximately 27,000 customers.[108]

Although feeder and customer restoration had started to progress, Con Edison experienced the first of two setbacks at 6:34 p.m. on July 22 when thunderstorms began to impact the area. First, 4kV feeder 3049 tripped due to a downed cable and resulted in 491 customer outages. Second, at 6:55 p.m., 4kV feeder 3013 also tripped, resulting in another 902 customer outages. During these events, Con Edison continued to prioritize the remaining 4kV grid outages, while also handling new outages resulting from the storms.[109]

Feeder 4B12 was completely restored at 8:54 p.m. and the associated unit substation transformer breaker was closed at 9:41 p.m., effectively restoring the unit substation.[110] At 11:30 p.m., work was completed by field crews, and the last 4kV feeder was fully restored. By 3:00 a.m. on July 23, all customers served by the Flatbush 4kV grid had been restored to service.[111] The duration of restoration, from the time the 4kV grid was de-energized to when the last customers were restored, was just over 31 hours.[112]

In addition to the previously described restoration methods involving closing feeder and bank breakers, some customers on 4kV feeders were restored using Kyle switches, to sectionalize or reconfigure the 4kv grid, and using secondary ties to link certain circuits together. Throughout the day on July 22, approximately 3,100 customers across 10 different 4kV feeders were restored by closing each feeder's three single-phase overhead Kyle switches.[113] Furthermore, customers on one radial transformer on 4kV feeder 3046 were restored to service when Con Edison field crews made secondary ties to another radial transformer on 4kV feeder 3045.

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[107] Id.
[108] DPS-014(B)-03,04,05, Redacted.
[109] DPS-054(B)-01, 03.
[110] DPS-003(B)-01, Attachment – "Exhibit Preliminary Analysis Flatbush Contingency", Redacted; DPS-063(B)-03.
[111] Feeder 4B02 disconnected automatically at 2:14 a.m. on July 23rd due to a fault in an underground splice and was restored to service less than two days later, at 12:53 a.m. on July 25th. This failure did not result in additional customer outages. DPS-003(B)-01, Redacted.
[112] Con Edison Flatbush Report, Redacted, p. 17.
[113] DPS-014(B)-05, Redacted.

While feeder restoration was ongoing, Con Edison left the voltage reduction initiated on July 21 in place. At 12:13 a.m., on July 23, Con Edison finally terminated the 8% voltage reduction at the Bensonhurst No. 2 substation.[114] At that time, all 4kV feeders had been restored and only a portion of one 27kV feeder, 4B01, was partially out of service.[115] By 1:30 p.m., Con Edison restored the portion of feeder 4B01 that was still out of service and energized the unit substation, thereby restoring all feeders that failed prior to de-energization of the 4kV grid back to their normal operating configuration.[116] At 3:30 p.m. on July 23, Con Edison officially demobilized CERC and at 4:17 p.m. Con Edison demobilized the DESR, marking the end of the event.[117] Repairs on the faulted portion of feeder 4B01 were completed at 5:42 p.m.[118]

[114] Con Edison Flatbush Report, Redacted, p.12.
[115] DPS-014(B)-03, 04 (Redacted), 05; DPS-003(B), Redacted.
[116] DPS-063(B)-03.
[117] Con Edison Flatbush Report, Redacted, p. 28; Electric Incident Reporting System Notification Email, sent Tuesday July 25 at 4:25 p.m.
[118] DPS-081(B)-01.

II. DPS REVIEW AND RECOMMENDATIONS

A. LIMITING THE IMPACT OF 27KV FEEDER FAULTS

Background

Underground sectionalizing switches, known as interrupter or isolation switches, are used to isolate the faulted portion of a feeder to allow for the restoration of the unfaulted portion. There are approximately 300 manual isolation switches on primary distribution feeders across Con Edison's underground system. These switches allow the Company to manually isolate a fault and reconfigure the system after a substation breaker trips; all primary distribution feeders are designed to have a substation breaker open anytime a fault occurs on the feeder to protect critical equipment at the substation. Interrupter switches allow for the partial restoration of the feeder while a field crew performs the required repairs on the isolated section.

In 2016, Con Edison worked with a manufacturer to develop an automatic underground interrupter switch that would be able to "sense" a fault on the load side of a primary feeder and automatically operate before the substation breaker. This operation would isolate the fault and leave the remaining portion of the feeder in service. These new automatic interrupter switches also provide remote grounding, which allows for the clearing of backfeed conditions, or reverse power flows, also preventing faults on the feeder. In Con Edison's internal evaluation report regarding its response to the Brooklyn outage event, the Company indicates that it will perform targeted equipment upgrades, including the installation of four of these new automatic interrupter switches.[119] These automatic underground sectionalizing switches will help Con Edison in its pursuit to build more flexible, dynamic and resilient grids.

The proposed interrupter switches are currently in the prototype stage with two 13kV units being evaluated. Con Edison plans to install two 27kV switches on the Flatbush 27kV feeder 4B06. Although this feeder did not experience any issues during the event, Con Edison believes it is best suited for the trial installation of the interrupter switches. Feeder 4B06 has dual potheads, or two legs, coming out of the Bensonhurst No. 2 Substation and currently has manual sectionalizing switches. The Company can utilize the existing structures and simply replace the manual switches with the new automatic interrupter switches. An interrupter switch will be installed on each leg of the feeder in order to provide the maximum benefit. The feeder also has a

[119] Con Edison Flatbush Report, Redacted, p. 38.

small number of primary sections and joints, allowing for the activation of the interrupter switch to isolate most of each leg while keeping the other portions in service.[120] The installed interrupter switches will also be integrated with Con Edison's proposed microprocessor relays, expanded upon in a later section of this report. Feeder protection will be coordinated upstream with the microprocessor relays and downstream with the interrupter switches. This will allow the interrupter switch downstream, closer to the fault, to activate first and only remove a portion of the feeder from service, instead of the entire feeder.[121] The Company plans to evaluate the performance of the interrupter switches on feeder 4B06 in a pilot program. Following this evaluation, another two interrupter switches will be installed on feeder 4B08 by 2023.

Analysis and Findings

Con Edison used manual underground sectionalizing switches to partially restore two of the 27kV feeders. These manual switches were used after feeder failures to isolate portions of the feeders supplying the 4kV grid and allowed for the restoration of the unfaulted portions from the Bensonhurst No. 2 Substation.[122] After the partial restorations of the two 27kV feeders, Con Edison was able to restore approximately 5,000 customers. The new interrupter switches could have automatically isolated the faulted portions of the feeders and prevented or reduced the number of customers impacted. Staff concurs with Con Edison in that there are numerous benefits associated with the installation of automatic interrupter switches. Additionally, the Panel found the need for supplemental interrupting devices on 27kV equipment to isolate the faulted components of the electrical grid.[123] By automatically sensing, reconfiguring and restoring portions of primary feeders, time will be saved that would have normally been spent on traditionally restoring equipment to service. In the Flatbush system, the new automatic interrupters will help limit the impact to the Flatbush 4kV grid by limiting the amount of load shifted due to a fault on a 27kV feeder. Since faults can be isolated, remaining portions of the feeder can stay in service and additional load may not need to be relieved by adjacent feeders. This will improve the reliability of the network.

[120] DPS-048(B)-01,05,06,07.
[121] DPS-056(B)-15.
[122] DPS-063(B)-03.
[123] Panel Brooklyn Report, pp. 50-52.

Con Edison's plan to establish a pilot program to evaluate the performance of the 27kV automatic sectionalizing switches in the network system is adequate as there are no automatic 27kV interrupters installed on the Company's system, and it would not be practical to fully implement interrupters throughout their service territory without first validating their benefits. A significant amount of effort and time is required to install a single interrupter due to an extensive installation process; a feeder outage must be taken, existing equipment may need to be removed, new equipment including necessary feeder splicing and SCADA must be installed, and a new manhole structure may need to be built in some cases where physical space is limited. This pilot program will highlight the possible benefits and inconveniences of using the new interrupters and, based on the issues identified, the Company will be able to reconfigure them as necessary.

It is Staff's view that the Company is taking a conservative approach, however, by planning to install automatic interrupters on only two 27kV feeders through 2023 and it has not yet developed a detailed workplan for the use of these switches for other feeders in the Flatbush network and in other networks across the Company's territory. Rather than waiting until 2023 to analyze whether the installation of automatic interrupter switches should be ramped up, Con Edison should begin planning, by December 31, 2020, how to rapidly expand the use of interrupter switches in the Flatbush network and throughout the Company's territory if the new devices prove to be efficient and useful during the 2020 evaluation of the pilot program. Considering the benefits that these interrupters can provide to the isolation of feeder failures, Con Edison should be more aggressive and begin to prioritize the installation locations, identify necessary infrastructure upgrades, such as vault sizes, and determine overall costs impacts.

<u>Recommendation</u>

- Con Edison should develop a plan by December 31, 2020 to expand the use of 27kV automatic interrupter switches in the Flatbush network and throughout its territory based on the success of interrupter prototypes that the Company plans to install on Feeder 4B06.

B. LIMITING THE IMPACT OF 4KV DISTRIBUTION FAULTS

Background

Kyle switches can be found across Con Edison's electric distribution system, primarily on non-network circuits, 4kV grids, and autoloop systems. Kyle switches are used for multiple purposes, including isolating portions of faulted 4 kV feeders and switching customers to in-service feeder sections. Kyle switches curtail cascading feeder failures because they have the lowest pickup rating, or trigger point, of all devices on the 4kV feeder main run and will be the first device to open for a fault condition.[124] This opening will isolate faults from traveling further upstream and prevent the failure of more important and expensive equipment. Generally, the opening of Kyle switches is automatic, in that they are set to open and disconnect the feeder when they detect a flow of current that is not within a specified operational range. In addition, Kyle switches may be operated remotely through SCADA control after establishing appropriate communication channels or manually by personnel in the field. When determining where to install Kyle switches on a feeder, Con Edison usually selects locations on the feeder main run at the approximate feeder midpoint.[125] This allows for reducing the number of customers affected by a fault on the feeder, ideally by nearly half.

Although the primary purpose of a Kyle switch is to sense and interrupt fault currents and automatically restore service after momentary outages, these switches can also be used proactively to reconfigure a 4kV grid. A fault on a 4kV feeder without a Kyle switch would disconnect the feeder from both of its two supplied unit substations and all customers served by that feeder would experience an outage. However, with the use of remotely controlled Kyle switches, system operators could easily radialize the 4kV grid, allowing for 4kV feeders to provide service to customers up to the opened Kyle switch after a fault on the feeder. Operating the grid in this way, or in radial mode, a single fault would only affect customers on one-half of the 4kV feeder.[126]

[124] DPS-055(B)-01.
[125] DPS-050(B)-01.
[126] Id.

Analysis and Findings

During the Flatbush event, Con Edison determined that operating the 4kV grid in a radial mode was not a viable option for several reasons. First, of the 37 4kV feeders in the Flatbush 4kV grid, four feeders did not have Kyle switches installed at the time and would not have been able to be monitored and controlled remotely with SCADA. Next, Con Edison explained that manual operations would have been necessary to place the Flatbush 4kV grid in radial mode because automated controls for all Kyle switches were not yet available. According to the Company, the time required by dedicated resources to perform these operations was prohibitive in the middle of an event with multiple contingencies.[127] Finally, Company procedures discourage operating the 4kV grid in radial mode. Specifically, EO-4095, *Distribution System Operation Under Contingency and/or Elevated Load Conditions*, prompts operators to manipulate mid-point Kyles, or block the switches closed, to ensure radial operations do not occur under certain conditions and to reduce the risk of cascading events. In the procedure, blocking Kyle switches closed is identified as beneficial to ensure the unit substation feeder breaker will trip rather than the mid-point Kyle. Further, the procedure states "a fault on a primary feeder risks a mis-coordination between the Kyles and the unit substation breaker."[128]

Although operating the 4kV grid in a radial mode would not have eliminated all customer outages, Staff contends that radial operations would have reduced stress on the Flatbush 4kV grid and may have led to a lesser overall customer impact and limited equipment damage. Interestingly, following the de-energization of the 4kV grid, the first step the Company took was to place the de-energized Flatbush grid in radial mode by opening Kyle switches. The Company operated the 4kV grid in a radial mode as restoration was occurring.

As a result of the Flatbush event, Con Edison took some steps to better utilize Kyle switches within the 4kV grid, including the installation of Kyle switches on each of the four 4kV feeders that did not have one in the summer of 2019. Con Edison has also taken actions to develop and install new SCADA overhead control functions that will allow operators to issue a command to quickly transition the Flatbush 4kV grid to radial mode. Con Edison stated it will perform a load flow analysis for 3rd contingency conditions or worse going forward to better

[127] DPS-074(B)-01.
[128] DPS-011(B)-03.

inform the Company's next steps.[129] The enhanced operational SCADA functions would make 4kV grid radial operations a viable option for Company control room operators and would help mitigate overload conditions and prevent cascading events. The use of these enhanced functions should be included in Company procedures and additional analyses should be performed to substantiate the advantages of operating in radial mode on the Company's other 4kV grids.

Con Edison acted properly in installing Kyle switches post event in the Flatbush 4kV grid. The constraints noticed in Flatbush during the outage event, however, are not unique to that area and similar mitigating strategies using Kyle switches could be adopted and implemented to appropriate areas throughout the Company's territory. Additionally, the Panel found the need for Con Edison to implement methods to limit fault impacts in 4kV grids.[130] Thus, Con Edison should continue to install additional Kyle switches in other 4kV grids throughout the Company's territory.

Recommendations

- Con Edison should seek to expand the installation of Kyle switches on 4kV feeders, where operationally feasible, in other 4kV grids throughout the Company's territory to limit impact of distribution feeder faults.
- Considering that Kyle switches have been installed on all feeders in the Flatbush 4kV grid and that enhanced SCADA control functions are available to operators, Con Edison should operate the Flatbush 4kV grid and other 4kV grids that are supplied by a network system in radial mode when appropriate.
- Company Specification EO-4095 should reflect the use of enhanced SCADA functions and the radial operations of 4kV grids.

C. MINIMIZING RELAY SENSITIVITY

Background

Con Edison uses phase balance relays to detect faults locally on 4kV feeders and equipment before they can travel and affect the 27kV feeder system. The relay operates by

[129] DPS-083(B)-01(e).
[130] Panel Brooklyn Report, p. 54.

comparing the magnitude of electric currents between two feeder phases. When the relay is triggered by a phase imbalance that is below the relay's design threshold, it will de-energize the 27kV feeder. Currently, the relays operate when the imbalance between phases exceeds 10% to 15% of their normal load current.[131] Con Edison uses Westinghouse type CM phase balance relays (CM relays) and, in July 2019, the Company had 26 CM relays throughout its electric distribution system; 15 in the Flatbush network in Brooklyn and 11 across several load areas in the Bronx/Westchester service area.[132]

During the Flatbush event on July 21, two 27kV feeders disconnected due to operations of their phase balance relays. At the time, Con Edison did not observe any corresponding feeder faults, although a review of SCADA data after the event confirmed the presence of phase imbalances. As a result, the Company treated each disconnect as it would a feeder failure and proceeded to perform a High Potential (Hipot) voltage test on each feeder. By doing so, the Company actually caused damage to each of the feeders which needed to be repaired before being placed back into service.

Analysis and Findings

The activation of the phase balance relays during the Flatbush event in absence of a feeder fault combined with the fact that both relays were operating within manufacturer's specified limits seemed unusual. The two feeders affected were loaded within the range where phase balance relays are most sensitive, meaning that the imbalance recorded was enough to trigger operation, even though it was well below the acceptable operation threshold. While it is possible that a low current fault triggered the relay operation, Con Edison speculates it was more likely that an alive on backfeed condition, when electrical current flows back into a feeder that should otherwise be shut-down, or other fault-finding activity caused the relay to activate.[133] Con Edison also considered that the relays may have been triggered due to increased unit substation size in response to increased demand and the addition of single, pole-operated switches, which has increased the likelihood of imbalances between current phases.[134] After the event, Con

[131] DPS-056(B)-02, 03.
[132] DPS-056(B)-01.
[133] Con Edison Flatbush Report, Redacted, p. 19.
[134] Id., p. 25.

Edison tested and confirmed that both phase balance relays were within specified calibration limits. A review of 20 years of internal data did not find any instances of unintended operations of the phase balance relays on the two 27kV feeders.[135]

The relay operations appeared to have been outside of the Company's control during the event, but actions are needed to avoid similar relay issues in the future. In seeking to improve upon the current phase balance scheme in the Flatbush network, Con Edison analyzed multiple options. The Company explored raising the balance relay activation thresholds and replacing CM relays with microprocessor relays. The Company also explored other methods of detecting faults locally at a unit substation and then transfer tripping back to the area substation. Con Edison ultimately chose to pursue replacing the current CM phase balance relays with microprocessor relays. These microprocessor relays are more accurate and operate on negative sequence current, another method to compare phase loads, instead of phase balance. The Company began replacing CM relays in the Flatbush network in October 2019, starting with relays that have lower or more sensitive settings.[136] Con Edison expects to complete the replacement of all CM relays by Spring 2020 in the Flatbush network and end of 2020 system-wide.

Con Edison is acting appropriately in replacing the 26 CM electromechanical relays (15 of which are in Flatbush) with microprocessor relays, rather than the other options that were initially explored. The Company realized and Staff concurs that raising the set point of the current electromechanical relays may provide some security during light load conditions, but it is only a short-term solution and is a less reliable form of protection under high load conditions. In its review, the Panel also identifies concerns with raising the tolerance set point and proposes that improvements be made to Con Edison's relay protection schemes.[137] Moreover, detecting faults locally at a unit substation and then transfer tripping back to an area substation would add another layer of complexity in the form of additional telecommunication channels required for every unit substation.[138] This complexity, along with associated costs and expected timeframe to install all necessary equipment, makes this alternative unfeasible. Conversely, microprocessor relays are more accurate and do not require activation set point changes. These relays will likely provide

[135] Id.
[136] DPS-056(B)-14.
[137] Panel Brooklyn Report, pp. 33-34.
[138] DPS-056(B)-17.

more security to the system and prevent relay operations similar to those experienced during the event. Con Edison has completed the installation of all 15 microprocessor relays in the Flatbush network.

Although Con Edison is acting correctly in pursuing complete CM phase balance relay replacement throughout its territory, the schedule with which the Company plans to carry out these replacements should be fast-tracked for the remaining 11 relays, all located in the Bronx/Westchester load areas. By doing so, it will eliminate all CM phase balance relays in Con Edison's system and associated potential issues. The electromechanical relays in the Bronx/Westchester region are all on feeders that either supply a 4kV substation, provide an alternate supply to a 4kV substation, or supply an autoloop system. As demonstrated during the Brooklyn event, improper imbalance relay operations are not something Con Edison can plan for and are often random in nature. Further, during high load conditions, a single feeder coming out of service for an imbalance relay operation can lead to cascading feeder failures and widespread customer outages.

Recommendation

- Con Edison should replace all remaining Westinghouse type CM electromechanical phase balance relays with microprocessor relays as soon as operationally feasible to enhance the means of detecting and clearing faults at 4kV unit substations throughout the Company's territory.

D. CABLE INVESTMENT IMPROVEMENTS

Background

Con Edison utilizes three main types of cable for 4kV and 27kV feeders in the Flatbush system: Paper Insulated Lead Cable (PILC), Cross-Linked Polyethylene (XLPE), and Ethylene Propylene Rubber (EPR). The Company currently uses EPR cable exclusively throughout its systems because this type of cable contains environmentally friendly materials and provides enough dielectric strength for its application.[139] PILC and XLPE are the oldest of the cable types that are found throughout Con Edison's system and the use of both has been

[139] DPS-027(B)-02.

discontinued due to a combination of cost, environmental issues, lack of flexibility, and overall ineffectiveness. The Company has been steadily working to decrease the amount of PILC cable sections and their associated Raychem 3W-1W joints throughout the electric distribution system. Between 2013 and 2019, Con Edison replaced several cable sections as part of various capital programs within the Flatbush system. The work scope included the installation of fuses and sectionalizing switches; the total cost of this work was nearly $7.1 million.[140]

To further analyze the 27kV feeders that failed during the event, Cable Technologies Laboratory (CTL), an independent cable consulting firm was retained by Con Edison at Staff's direction, to dissect and analyze samples of failed feeder sections. Five samples from different feeders that failed during the event were provided for analysis; one feeder was not analyzed because the failed portion was discarded by the Company before the investigation was announced. The dissection and analysis were performed under the supervision of Con Edison, Staff and the Department's consultants.

Analysis and Findings

As part of the Brooklyn outage investigation, a review of the historic reliability of all 4kV feeders and the failed 27kV feeders was performed to determine whether there were issues with the service and equipment in the Flatbush system. Although these issues may not have had any direct impact on customers during the Brooklyn outage event, it is important to review them to understand the Company's investment actions to improve the system. For the 4kV feeders, the frequency and duration performance values for each feeder were analyzed over the last 10 years; steady and improving reliability values would indicate prudent investment in the system. For the 27kV feeders, a failure history would illustrate whether feeders were consistently failing for the same reasons or at the same locations.

The review of the historical failures for a set of Flatbush 27kV feeders showed PILC, vintage XLPE, and Raychem 3W-1W joints as the main cause of cable section failures in the last ten years. In Con Edison's Annual Report on Electric Service and Power Quality provided to Staff from 2015 to 2019 in accordance with the Commission's October 12, 2004

[140] DPS-009(B)-03, 04, 05, Attachment 1 - Estimated 4kV spend; DPS-010(B)-03,04,05, Attachment 1 -27kV summary.

Order Adopting Changes to Standards on Reliability of Electric Service[141], the Company identified these specific types of cable sections and joints to be some of the largest contributors to primary feeder failures during high load conditions in the summer period. The Company currently has capital programs in place to fund their removal and replacement system-wide. Con Edison has replaced nearly 3,700 sections of PILC cable throughout its entire service territory from 2015 to 2019, effectively lowering the amount of PILC cable remaining in service in the Company's primary electric distribution system to approximately 8%.

In CTL's report summarizing the findings of the cable dissections and analysis, CTL identified several issues that could have played a role during the outage events; specifically, CTL noted two related factors that may have influenced the development of the failures in the feeders prior to and during the event – thermal degradation of PILC cable inside transition joints and partial discharge at the interfaces between components of heat shrink joints.[142] For these joints, CTL explained that they are difficult to assemble, and several factors such as moisture impregnation, paper deterioration, and voltage spikes,[143] lead to an increased likelihood of failure at specific locations. As previously mentioned, Con Edison identified the vulnerability associated with these joints and is currently addressing their replacement in the Flatbush system through a variety of programs. One failed cable section from the event was not made available for analysis to CTL, as the section was disposed of by Con Edison prior to realizing that the failure was part of a major outage event. Going forward, Staff believes that Con Edison should save all failed cable and joint specimens during expected heat waves, so that each could be analyzed to identify cable improvements.

The Flatbush event highlighted key components of Con Edison's system that the Company should continue to invest in to maintain and/or improve the reliability of specific feeders in the Flatbush area. As shown through our analysis, PILC and Raychem heat shrink joints contributed significantly to feeder failures during the Brooklyn event. In addition, our review of the 4kV and 27kV feeder performances in the last ten years showed mainly steady and improving reliability values for the 4kV grid and no signs of consistent 27kV feeder failures for

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[141] Case 02-E-1240, Proceeding on Motion of the Commission to Examine Electric Service Standards and Methodologies, Order Adopting Changes to Standards on Reliability of Electric Service (issued October 12, 2004).
[142] DPS-079(B) – Final CTL Report, p. 90.
[143] Id., pp. 92-95.

the same reasons or at the same locations. Con Edison was acting appropriately with the replacements of failure prone cable components and the installation of sectionalizing switches throughout the area. The Panel raises concerns with older cables and specific joints. These concerns included Con Edison prioritizing the removal of PILC and better defining a method for evaluating, identifying and removing aged XLPE.[144]

In reply to Staff interrogatories, Con Edison noted that in 2003, the Company opened the Cable and Splice Center for Excellence, now known as Con Edison's cable center, in response to the 1999 Washington Heights network shutdown. This center was initially opened to improve the performance of PILC cable and systems, and research is currently tracked through Con Edison's Distribution Engineering Distribution Cable Systems Section. Since 2010, Con Edison notes that the percentage of PILC cable on their system has been significantly reduced, in part due to their own findings and contributions from other utilities, partners and vendors.[145]

In Con Edison's internal report evaluating its response to the Brooklyn outage event, the Company identified several components of the Flatbush system that will be strengthened to reduce the likelihood of similar outage events. Con Edison plans to invest approximately $13.8 million between 2020 and 2023 to perform risk reduction work across the Flatbush 4kV grid and 27kV feeders to improve the electric distribution system. The work scope includes the identification and replacement of problematic cable sections and joints. In determining the amounts and locations of cable to be removed and replaced, Con Edison reviewed a list of all current cable and wires in the Flatbush 4kV grid and chose to remove all remaining vulnerable cable sections.[146] Staff has been tracking this work and verified that multiple cable sections and joints have been replaced by the Company since July 2019. These investments will be beneficial to the network's reliability. Thus, Con Edison is effectively targeting vulnerable system components by budgeting approximately $13.8 million over the next four years (2020-2023) to replace PILC cable sections, vintage XLPE cable sections, and Raychem 3W-1W joints in the Flatbush network. Con Edison's investment actions, however, should not be limited to only the Flatbush system, and a workplan should be established by the Company to apply these actions

[144] Panel Brooklyn Report, p. 33.
[145] DPS-098(B)-02.
[146] DPS-050(B)-03.

in other areas of the Company's territory, particularly in networks that are associated with 4kV grids. Hardening other parts of the Company's territory will help mitigate similar outage events.

Recommendation

- By December 31, 2020, Con Edison should establish a workplan to apply investment actions identified during the Flatbush event (e.g., replacement of Paper Insulated Lead Cable, vintage XLPE cable, Raychem 3W-1W joints) to networks associated with 4kV grid systems throughout the Company's territory.
- During expected heat events, Con Edison should save all cable and joint failure specimens so that each can be studied and used in internal Post Event Analyses.

E. HIGH POTENTIAL TESTING OF PRIMARY FEEDERS

Background

As part of the feeder restoration processes, Con Edison performs Hipot voltage tests to locate a fault, if unknown, and verify that there are no additional faults on cable and equipment prior to returning a feeder to service. Two different types of Hipot tests are used by Con Edison. The first, and preferred type, is the Very Low Frequency (VLF) Hipot test, which utilizes an alternating current (AC) voltage signal or power source. The second is a direct current (DC) Hipot test, which uses a DC power source. Hipot tests are performed by applying a higher-than-operating voltage to a cable section. The feeder passes the test if the voltage level is sustained, and the cable satisfies certain leakage requirements. If a feeder fails the test, the additional damage is repaired, and the feeder is retested until it passes. Since the tests use a higher voltage than what the cable is designed for, Hipot tests could be destructive to certain cable. DC Hipot tests are considered more destructive than VLF tests and are not recommended for extruded cables, such as XLPE, due to a higher chance of cable insulation degradation.[147]

The use of Hipot tests, including when to perform them, their duration, the voltage levels used, the necessary equipment, hook-up configurations and waiver criteria, is outlined in a specification, or operating procedure, that Con Edison maintains. The specification outlines many

[147] DPS-096(B)-03.

conditions when Hipot tests are performed, though in general, they are performed on all feeders following failures. Additionally, whenever a feeder needs to be removed from service for significant work (when four or more sections of cable are installed or replaced) the feeder is Hipot tested.[148] During the Brooklyn outage event, the Company followed this specification to determine the need for testing prior to returning the 27kV feeders back to service after repairs. As per the Con Edison's specification, Hipot tests could be waived, in certain instances, to reduce feeder restoration times. Thus, the decision to use these tests is crucial to the restoration process and affects outage times during an event.

Hipot tests are also used by Con Edison as a form of proactive maintenance to find issues on a feeder under controlled circumstances, rather than during high load periods. Within Con Edison's Hipot specification, it is stated that feeders that have not been Hipot tested in the last three years, either before returning to service after a feeder outage or after having significant work performed, are marked to be proactively tested. These feeders are listed in Con Edison's online Feeder Management System and are designated as "Appendix A" feeders, in reference to the Company specification. As detailed within the specification, pre-emptive Hipot tests are performed on a routine basis on feeders in networks with a Network Reliability Index (NRI)[149] greater than 0.2.[150]

Analysis and Findings – Testing of Failed Feeders During the Flatbush Event

Within Con Edison's specification, there are multiple sections that list criteria for when to perform a Hipot test. Additionally, there are certain instances when a Hipot test can be waived or deemed not required. The waiver conditions include: network feeder contingencies, local conflicts, next contingency resulting in overloads or customer outages, customers out of service, extreme weather and evidence that additional damage on the feeder is very unlikely.[151] The Control Center Shift Manager, District Operator, or the System Design Department Manager of Distribution Engineering is responsible to determine when to waive a Hipot test based on these

[148] DPS-068(B) – Attachment 1 – EO 4019 – "Testing procedures on 4,13,27kV Cables," p. 5.
[149] The Network Reliability Index (NRI) is a statistical value that Con Edison uses to prioritize work within their distribution networks. It is calculated using several factors such as network composition, feeder dynamics and component failure rates during different conditions. DPS-088(B)-1.
[150] DPS-096(B)-04.
[151] DPS-068(B) – Attachment 1 – EO 4019 – "Testing procedures on 4,13,27kV Cables," p. 3.

conditions. Specifically, in 4kV systems, waiving a Hipot test is at the discretion of the Regional Engineering Managers.[152]

Con Edison performed Hipot tests on three of the six failed 27kV feeders during the Brooklyn outage event and waived the tests on the other feeders. In reviewing details pertaining as to why each test was waived, it was observed that two of the waived Hipot tests were due to reasons not explicitly outlined in the Hipot testing specification. These two waived Hipot tests were associated with the two Flatbush 27kV feeders that were restored partially by isolating the faulted sections of the feeders. The waived test time coincides with when each feeder was partially restored. The recorded reason for waiving each test was "fault beyond disconnect manhole," meaning that the test was waived because the faulted section of the feeder was isolated.[153] Although this would be a valid reason to waive a Hipot test for faster restoration of a feeder, it is not explicitly listed as one of the Company's Hipot waiver criteria. In subsequent information provided by Con Edison, the Company explained that the criteria listed in the specification are simply categories and the actual, quantifiable conditions as to when to waive a Hipot are event-specific. Con Edison further elaborated that there are very wide and varied circumstances that contribute to the decision to waive a Hipot test, and real time conditions and loads play a large role in the waiver consideration.[154]

During an outage event, it is important for Con Edison to prioritize the restoration of customers in a timely manner, including waiving Hipot tests when certain system conditions are met. The Company acted appropriately in waiving the Hipot tests for three of the of the six feeders during the Flatbush event. Had the Company performed Hipot tests, the customers served by these feeders could have sustained outages for a longer period. However, Staff contends that Con Edison should further define appropriate conditions as to when to proceed with or waive a Hipot test. Considering the diverse network configurations and high load conditions when Hipot tests are needed, the recommended changes to the Hipot specification will strengthen the Company's testing processes and leave less room for interpretation to Con Edison's system managers.

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[152] Id.
[153] DPS-044(B)-01.
[154] DPS-090(B)-01(a).

Recommendation

- Con Edison should establish more detailed waiver criteria in the Company's Hipot testing specification (EO-4019) to ensure that feeders are assessed and tested appropriately during an outage event.

Analysis and Findings – Hipot Testing as a Maintenance Method

The use of Hipot testing, as detailed in Con Edison's specification, is the only form of proactive feeder fault detection Con Edison utilizes to maintain network feeders (i.e., 13kV, 27kV and 33kV feeders) in the electric distribution system; Con Edison does not regularly perform Hipot tests on 4kV feeders and sees little value in the practice. The Company notes that the basic nature of 4kV feeders is that they function or are faulted and need repair.[155] Since most of the Company's underground high voltage feeders are located in conduit sections, other forms of in-situ feeder maintenance methods are impossible to perform without expensive feeder excavation; currently, the Company primarily performs feeder excavations to install or repair conduits when spare conduits are unavailable.[156] Con Edison monitors the loading on cables via multiple sources, such as SCADA, in order to ensure that they are operating in acceptable ranges, and the Company performs repairs or replacements as required or scheduled.

Con Edison's specification is modelled on the IEEE Standard (Std) 400-12, *IEEE Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5kV and Above.*[157] This standard provides information on the various testing methods available for shielded cables and is often used to assist cable owners in selecting appropriate tests for specific applications. Con Edison has an active leadership role in the development and revision of this standard, as one of the Company's technical expert serves as the Chair of the IEEE working group responsible for the standard.[158] So far, of the numerous tests outlined within the standard, Con Edison has found that the Hipot test has been the only practical and effective method to evaluate the condition of underground network distribution feeders, including the Flatbush network, because the Company's networks are multibranched with different cable types

[155] DPS-009(B)-03.
[156] DPS-094(B)-01.
[157] DPS-068(B)-01.
[158] Id.

operating on the same branch.[159] However, Staff and the Panel believe that further improvements could be made to Con Edison's cable testing methods. The Panel's report recommends that the Company continue to evaluate current and emerging cable assessment technologies.[160]

Con Edison established a three-year timeframe for Hipot testing feeders in 2015 based on an observed trend peak design condition occurring every three years. This is to ensure that most feeders are tested prior to experiencing a peak design condition. By the end of 2019, 84% of feeders in networks with an NRI greater than 0.2 had been Hipot tested in the last three years. Con Edison believes that this is a good indication that most feeders are being tested within the timeframe.[161] As of January 2020, there were 85 Appendix A feeders[162], across 28 of 65 N-2 contingency networks that have an NRI greater than 0.2. Con Edison believes its approach is conservative, as reportedly even networks with an NRI value above 0.2 have not had a history of reliability problems due to primary feeder outages.[163] Con Edison notes that the NRI prioritizes at-risk networks and uses a value of 1.0 as a safe target; networks with an NRI below 1.0 are deemed reliable, although Con Edison stresses that the NRI should always be improving and approaching a value of 0. The Flatbush network is one of the 28 N-2 contingency networks with an NRI greater than 0.2, and although its NRI is below the company target NRI threshold of 1.0, it has not had an NRI below 0.2 in the last ten years and over the last ten years, the Flatbush network NRI has decreased from 2.431 in 2009 to 0.377 as of 2018.[164] Considering that Con Edison determined the three-year timeframe for Hipot testing in 2015, when the Company switched to testing based on network reliability instead of how often the feeder came out of service,[165] this timeframe may not still be as valid due to system improvements over the last couple years and a more, or even less, frequent timeframe may be needed.

Con Edison has explored numerous other options to develop a predictive maintenance strategy towards distribution feeders. Methods included tests and trials using outside services and vendors to detect partial discharge across feeder branches, in order to proactively replace at risk cable. As previously alluded to, these methods proved to either be too inefficient

[159] Id.
[160] Panel Brooklyn Report, pp. 40-42.
[161] DPS-095(B)-01.
[162] Id.
[163] Id.
[164] DPS-068(B)-01; Con Edison Flatbush Report, Redacted, Appendix 2.
[165] DPS-095(B)-01.

or far too expensive to implement, due to Con Edison's complex network design.[166] Although Con Edison has demonstrated a need to use Hipot tests, how the Company implements these tests leaves some room for improvement. Con Edison is currently reviewing its Hipot testing specification to determine better minimum requirements to specify if and when to perform Hipot tests on 4kV feeders. In addition to determining specific testing requirements for 4kV feeders, Staff believes that Con Edison should further re-evaluate its specification and analyze whether the current three-year cycle for testing is adequate for network feeders.

Recommendation

- Con Edison should determine whether the time frame to proactively Hipot test primary distribution network feeders (currently over three years) is appropriate and strengthen the Company's testing procedure accordingly to ensure all feeders are tested adequately.

F. LACK OF SPECIFIC PROCEEDURES TO DE-ENERGIZE 4KV GRIDS

Background

Operational procedures are critical to ensure that everyone is working from the same playbook. They are important for safety, increase efficiency, reduce operator errors, and establish a clear chain of command. Furthermore, special operating procedures addressing non-routine situations can be used to document items for consideration and are excellent training tools. Overall, Con Edison has four other 4kV grids in Queens and one in the Bronx with similar configuration as the Flatbush system. However, there is no procedure to direct and guide the Company's operations team to prepare for, execute, and restore from the de-energization of a 4kV grid. This resulted in confusion and inefficiencies in Con Edison's control rooms on the night of July 21, 2019.

One of the specifications in use on July 21, 2019 was EO-4095, *Distribution System Operation Under Contingency and/or Elevated Load Conditions* (EO-4095). The objective of this specification is to provide guidance for actions to be taken and activities to be pursued by Company Operations Departments when unusual operating conditions, such as multiple contingencies above the design criteria and/or elevated system loading, arise on the

[166] DPS-068(B)-01.

distribution system. EO-4095 contains a section named "Actions Prior to a Possible Network Shutdown," that details the decision factors, impacts, communications, responsibility, and method for a network shutdown.[167]

Analysis and Findings

Con Edison has been using 4kV grids to serve customers for decades, and yet, when confronted with an event requiring load shedding, there was no specification or procedure available to the Company's operations team. Conversely, the Company has procedures for how to de-energize underground networks. Staff was initially informed that EO-4095 provided most operations guidance during the event.[168] However, as our investigation continued, the Company confirmed that the Flatbush area outage was not classified as a network shutdown, instead the Company termed the event on July 21, 2019 as a "de-energization." Therefore, most of this procedure was not applicable to the event. The absence of a procedure for de-energization of a 4kV grid added confusion to an already chaotic operating environment, created disorder between the Company's control rooms, and resulted in no restoration planning prior to dropping service to more than 30,000 customers. Evidence supporting these findings is provided below.

The Staff investigation included a review of operator phone calls between Con Edison's Brooklyn/Queens Regional Control Center and Energy Control Center (specifically the Bulk Power Control Room and the District Operation Control Room). Leading up the Flatbush 4kV grid de-energization, there is evidence of Company Operations Staff expressing uncertainty on where the de-energization of the Flatbush grid could be performed from and how long the operation would take. While attempting to mitigate additional feeder failures, taking calls, and placing reports on feeder maintenance and restoration activities, Con Edison operators were disrupted with calls seeking clarification on how the Flatbush 4kV grid de-energization would occur.

The Company's inability to execute the Flatbush 4kV grid de-energization without issues made the need for a procedure apparent. Due to a combination of technology, process, and human performance factors, the order to de-energize the Flatbush 4kV grid needed to be given

[167] DPS-011(B)-03 – Attachment 24 – EO-4095 – "Distribution System Operation Under Contingency and/or Elevated Load Conditions."
[168] Con Edison Flatbush Report, Redacted, p. 14.

twice to two separate operating locations before the task was properly executed. At first, the Energy Control Center Operator was given the order. However, this operator was unable to log in to the appropriate server. Once this was corrected, the operator found that the link to remotely access the correct server was not working. Due to the delay experienced at the Energy Control Center, the permission to de-energize the Flatbush 4kV grid was granted to the Brooklyn/Queens Regional Control Center. Operators at the Brooklyn/Queens Regional Control Center executed the order.[169] Although the issues encountered at the Energy Control Center only delayed the de-energization by a matter of minutes, these problems make obvious the lack of formal planning and preparation by Con Edison for this event.

In order to minimize the length of customer outages and communicate accurate estimated times for restoration, it is important to prepare for restoration prior to taking actions such as de-energizing a 4kV grid or performing a network shutdown. The Company identifies this need in EO-4095, where planning for restoration is required prior to performing a network shutdown. This planning is meant to, among other things, help estimate the length of time the network might be down.[170] However, no planning was performed prior to de-energization because, the Company reasons, dropping power to the 4kV Flatbush grid was not a "network shutdown." In making this classification, the Company admits that it was operating without a procedure on the night of July 21, 2019.[171] Moreover, in response to Staff interrogatories the Company alludes to restoring a 4kV grid as being much simpler than that of a Network restoration, and yet it took the Company more than two days to fully restore service to Flatbush customers.

The issues addressed above could have been alleviated with a procedure for 4kV grid operations during a contingency event, and with five other 4kV grids on the Con Edison system with similar configuration to the Flatbush 4kV grid, this procedure should already exist. Despite the Brooklyn Event, Con Edison has still not identified this lack of procedure as a problem. Staff, however, concludes that the lack of a procedure is a significant shortcoming that

[169] DPS-042(B)-01.
[170] DPS-011(B)-03 – Attachment 24 – EO-4095 – "Distribution System Operation Under Contingency and/or Elevated Load Conditions," Section 8.2.3.
[171] DPS-024(B)-03.

lead to extended restoration times and lack of appropriate communications with customers and municipal leaders.

Recommendation

- Con Edison should revise EO-4095 *Distribution System Operation Under Contingency and/or Elevated Load Conditions*, or create a new procedure entirely, to provide detailed guidance for the preparations, decision factors, responsibility, required communications, and operator step-by-step direction to perform load shedding or de-energization of the 4kV grids.

G. LACK OF GUIDANCE FOR RESTORING 4KV GRIDS

Background

By 11:00 p.m. on July 21, less than four hours after shedding the Flatbush 4kV grid load, approximately 8,000 de-energized customers and all 3,600 Cropsey Loop customers were restored to service in the Flatbush area.[172] As outlined in Con Edison's internal evaluation report detailing the Company's response to the Flatbush event, a general methodology was followed when performing customer restoration. First, feeder and substation equipment, such as breakers and switches, were either opened or closed to slowly restore 4kV feeders and add customers back onto the grid. Second, as supply 27kV feeders were restored, their respective unit substations were restored as well and more 4kV customer loads were added to the system. Finally, 4kV feeders that ran between unit substations that were out of service were temporarily restored using generators, and these feeders were among the last to be permanently restored.[173]

Nearly all the 30,000 customers fed by the 4kV grid were restored to service by 11:30 p.m. on July 22;[174] complete restoration occurred at approximately 3:00 a.m. on July 23 when the few remaining single outage customers were finally restored.[175] The disparity in restoration times for the 4kV grid customers can be attributed to many different reasons. First, on certain 4kV feeders, there were secondary events, like damage to company structures, that

[172] Con Edison Flatbush Report, Redacted, p. 17.
[173] DPS-051(B)-01.
[174] DPS-014(B)-03 (Redacted), 04 (Redacted), 05.
[175] Con Edison Flatbush Report, Redacted, p. 17.

prevented the Company from immediately restoring customers. These secondary events included downed wires, an underground fault due to a blown joint and feeder breaker damage.[176] Next, restoration was performed using various methods such as remotely operating feeder breakers and switches and dispatching crews to field locations to manually operate switches and perform the necessary work. Certain feeders were restored via mobile generators, which took additional time due to the associated logistics.[177] Next, on the night of July 22, while Con Edison crews were conducting field operations to restore the remaining customers out of service on the 4kV grid, thunderstorms rolled into the area. The storms contributed to two 4kV feeders tripping out of service, one of which was found to have a downed wire. These feeder failures led to approximately 1,400 additional customer outages in the Flatbush 4kV grid.[178]

Analysis and Findings

The general methodology of restoration described above is not based on any established guidelines as Con Edison does not currently have a specification, or operating procedure, for 4kV grid restoration. According to Con Edison, a 4kV grid restoration is performed on a real-time basis by evaluating the equipment, load density and weather conditions at the time of an event. Con Edison noted that throughout the event, it exercised caution when restoring 4kV feeders while there were still 27kV feeders out of service in the Flatbush network. In some instances, the Company timed restoration of 4kV feeders for later in the day and evening of July 22 when overall power usage in the area was lower. Con Edison asserted that these actions were taken to avoid stressing the in-service 27kV feeders, as any additional feeder outages would not only have impacted restoration efforts but may have also led to additional customer outages.[179] Con Edison further explained that the difference between a traditional network restoration and that of a 4kV grid has to do with the necessary amount of analysis required; in a traditional network, hundreds of mega-watts need to be supplied instantaneously by a set number of available feeders without overloading equipment.

[176] DPS-014(B)-01 (Redacted), 05.
[177] DPS-014(B)-04, Redacted.
[178] DPS-054(B)-01.
[179] DPS-063(B)-02.

Con Edison explained that it uses a more formalized approach to restore a traditional network, since if even a single piece of equipment malfunctions, the entire network could remain out of service, whereas a 4kV grid does not need the same approach because it can be restored in segments, on a feeder and unit substation scale, based on real time analysis of system conditions.[180] As previously stated, Con Edison was intentionally hesitant to energize 4kV feeders, fearing the amount of load and subsequent stress these feeders would add to the supply feeders. Six of the feeders in the 4kV grid, serving approximately 4,000 customers, had no equipment or overload issues and were unaffected by secondary events. These six feeders were returned to service at an average duration of 8.5 hours. This is a concern as other feeders with no equipment issues were restored within 4 hours, and it's possible that some customers served by the six feeders could have been restored within the same 4-hour timeframe. Had restoration methods for the six feeders failed, further cascading failures to the 4kV grid would not have occurred in the manner they would have during the restoration of a traditional network. Thus, Con Edison's decision to exercise caution in restoring these feeders was not a good one, and the Company could have restored the feeders and customers quicker.

During the event, Con Edison used the transformer turns ratio along with each 4kV feeder's projected 2019 summer peak loads, to determine how much load would be added to the 27kV feeders when the 4kV feeders were energized.[181] To assist in the restoration analysis, Con Edison projected 2019 summer peak loads based on the peak load days experienced by the Flatbush 4kV grid in 2018 because they were the most relevant data available. Using Con Edison's standard operating and emergency feeder ratings, we determined that the additional load added by the six 4kV feeders would not have had a significant impact on the respective 27kV feeders that supply them; the approximate total loading after energization would have still been much lower than each feeder's emergency rating. For example, one 27kV feeder was at approximately 65% and 41% of its normal and emergency rating, respectively, prior to re-energization of a 4kV feeder and at 67% and 43% after re-energization of the 4kV feeder. Con Edison does not have a formal procedure that dictates when and how to proceed with adding 4kV feeder loads on 27kV feeders, noting that operating and planning decisions concerning whether to

[180] DPS-052(B)-01.
[181] DPS-097(B)-01, 02, 03, 04, 05, 06.

add load are not based on static rules.[182] Again, Con Edison may have exercised too much caution in delaying the energization of these 4kV feeders. With proper feeder loading thresholds and best practices for feeder load analysis, Con Edison operators would have had a more defined process to determine adequate measures to restore 4kV feeders in a way that did not negatively impact the loading on source distribution feeders in the Flatbush network. These measures could include the use of distributed energy resource technologies and mobile electric generators.

The fact that the Company does not have established written guidance for 4kV grid restoration is a clear inadequacy that needs to be rectified. Although the 4kV grids across the Company's service territory are unique due to differences in circuit design and load density, the general methodology used during the Flatbush events could be applied to all other 4kV grids. Establishing a written guidance for a 4kV grid will facilitate a more effective and efficient restoration during future events. This guidance will provide a concrete methodology on how to restore a 4kV grid, accounting for conditions prior to de-energization and providing standards for when and how to conduct necessary load analysis. Regarding the differences in analysis necessary in a network compared to a 4kV grid restoration prior to and after de-energization, the Brooklyn Event clearly highlighted these inconsistencies and the need for specific restoration guidelines.

<u>Recommendations</u>

- Given 4kV grid load shed events do not occur on a routine basis and Con Edison is currently lacking any procedure or written guidance for restoration, Con Edison should develop a written guidance on how to restore a 4kV grid efficiently and effectively.
- Con Edison should develop a process to better evaluate and implement measures to restore customers served by 4kV feeders with no equipment or overload issues in the Flatbush 4kV grid and other 4kV grids that are supplied by a network system. These measures could include the use of mobile electric generators and other distributed energy resource technologies.

[182] DPS-101(B)-06.

H. PROPER DECLARATION OF "CONDITION YELLOW" AND "CONDITION RED"

Background

The Con Edison electric system is interconnected with all major electric utilities in New York State along with both the New England Independent System Operator and the Pennsylvania – New Jersey – Maryland (PJM) pool. To ensure that the Con Edison System does not adversely affect the reliability of these many interconnections, the Company is required to make certain declarations to alert other system operators of major system issues or disturbances. Con Edison's System Operation Procedure "Guide for Action in a System Emergency" (SO5-12-30) provides detailed guidance on the circumstances that would prompt operations personnel to make distribution system condition declarations.

On a normal blue-sky day, the Con Edison system operates under "Condition Green." Operations personnel may declare a "Condition Yellow" or "Condition Red" if needed depending on the severity of a situation. These declarations serve as a communication tool within the Company and prompt actions that include, but are not limited to, the implementation of corporate emergency response procedures, additional staffing, reporting requirements, public communications, and the mobilization of available resources.

Analysis and Findings

On July 21, 2019 at 4:10 p.m., the on-watch Senior System Operator declared a "Condition Yellow," which denotes that the next contingency may result in loads on equipment exceeding emergency ratings and actions taken by the Company to relieve these loads will impact customers. This declaration was taken as part of implementing a voltage reduction per Electric Operations Procedure *EOP-5022 Automated Voltage Reduction Program and Demand Response Programs*. The procedure states, "as soon as the operator initiates voltage reduction, an e-mail notification is sent automatically to all parties listed above with specific messages as to what type of outbound communication to issue."[183] Therefore, the declaration of a "Condition Yellow" is not confined to the Company's operations department. When a "Condition Yellow" occurs, this declaration triggers numerous communication requirements both inside and outside of the

[183] DPS-040(B)-01 – Attachment 1 - EOP-5022 – "Automated Voltage Reduction Program and Demand Response Programs", Redacted, p. 9.

Company.[184] Con Edison remained in a "Condition Yellow" until July 23, 2019 at 12:19 a.m. when voltage reduction was terminated by Electric Operations.

During its response to the Brooklyn Event, Con Edison did not make a "Condition Red" declaration as was required by the Company's Operation Procedure. The Company procedure provides four conditions under which a "Condition Red" should be declared:

1. emergency overloads exist,
2. part of the system is in voltage reduction,
3. load shedding has occurred and a large number of customers has been interrupted (greater than 15,000 customers) due to one event, or
4. a substation or network has been shut down.[185]

During Staff's investigation, Con Edison could not justify why a "Condition Red" was not declared. Through investigation interrogatories, the Company argues that "load shedding had occurred due to multiple distribution feeder outages and not a single event," and therefore the criteria for "Condition Red" was not met.[186] Staff disagrees with this argument. Con Edison leadership gave one order to de-energize the Flatbush 4kV grid, and in doing so interrupted service to more than 30,000 customers. That command, which had not ever been given before, should have resulted in the declaration of a "Condition Red" and is, without question, a single event. Staff concluded that multiple conditions and reasons existed on the night of July 21, 2019 for Con Edison to make a "Condition Red" declaration, and in not doing so Con Edison failed to properly communicate the severity of the issues in Brooklyn within the Company and externally. Following the declaration of a "Condition Red," the Company's Public Information Office may have altered the urgency and messaging related to the Brooklyn event in corresponding fashion. Staff will be addressing improvements for improved communications later in this report.

[184] Id., pp. 8-11.
[185] DPS-011(B)-03 - Attachment 12 - System Operation Procedure "Guide for Action in a System Emergency" (SO5-12-30).
[186] DPS-069(B)-01.

Recommendation

- Con Edison should clarify its procedures to transition to a condition red when load shedding occurs on a 4kV grid

I. EXTENDED LENGTH OF VOLTAGE REDUCTION

Background

Con Edison implements voltage reduction in accordance with its Electric Operations Procedures (EOP) Specification EOP-5022 - *Automated Voltage Reduction Program and Demand Response Programs*. The Company utilizes voltage reduction to relieve voltage and thermal stresses on network feeders (i.e., 13kV, 27kV and 33kV feeders) to prevent cascading feeder failures. Con Edison claims that voltage reduction provides significant reliability benefits when a network is at or beyond its design contingency level. As stated by the Company, after voltage reduction is applied to network feeders, the frequency of feeder failures is, on average, over 80 percent less than it was prior to voltage reduction being applied. This is because voltage reduction decreases the voltage stress on the feeder insulation without significantly increasing the thermal stress on the equipment.[187] Con Edison applies voltage reductions at area substations, the power source for the feeders, either on a five percent or eight percent basis depending on severity of conditions as outlined within its procedure. Higher percentages of reduction are not possible without violating minimum voltage requirements.

Analysis and Findings

During the Brooklyn Event, Con Edison implemented a five percent voltage reduction at the Bensonhurst No. 2 substation at approximately 4:00 p.m. on July 21, 2019. The Company stated that the Flatbush network met condition 1, criteria 4.2.1, of Specification EOP-5022 at that time wherein the average temperature variable was expected to be greater than 85°F for two days and two or more feeders were out of service. [188]

At 4:55 p.m. on July 21, 2019, Con Edison implemented an eight percent voltage reduction when the Flatbush network met condition 2, criteria 4.2.2, of Specification EOP-5022.

[187] DPS-020(B)-05.
[188] DPS-103(B)-01.

Under condition 2, the average temperature variable needs to be greater than 82°F for two days, the network load must be greater than 85 percent of peak design, and more than two feeders must be out of service.[189] The eight percent voltage reduction remained in effect until 12:13 a.m. on July 23, 2019. In total, the voltage reduction was in effect for approximately 32 hours.

The Company's decision to implement voltage reduction prior to de-energizing the 4kV grid was appropriate. However, the extended duration of the eight percent voltage reduction seems excessive, and Con Edison had the opportunity to reduce it to a five percent voltage reduction or terminate this voltage reduction sooner. The Bensonhurst No. 2 Area Substation serves the Flatbush and Brighton Beach networks and any voltage reduction applied at this substation affects both networks. Therefore, approximately 132,400 customers in the Flatbush network and 30,000 customers in the Brighton Beach network, which had no feeder outages, were subject to 8 percent voltage reduction for approximately 32 hours. Con Edison doesn't have good monitoring equipment to verify whether or not this extended voltage reduction was detrimental to residential customers. When asked about the worst-case minimum service voltage that could have been experienced by customers served by the Brighton Beach network and those served by the Flatbush underground network, Con Edison estimated the worst-case minimum service voltage for customers in the Brighton Beach network but could not provide an estimated voltage for the Flatbush network customers. For the Brighton Beach network, the Company indicated there were no feeder failures during the Brooklyn Event, and the worst-case customer would have experienced voltages eight percent lower than the low-end of the "normal voltage range," which is equivalent to about 12.5 percent below the nominal voltage for each voltages class. Regarding the Flatbush network, Con Edison does not have reliable or granular data for the impact that the 6th contingency feeder failures could have had on voltage experienced at the individual customer level.[190] As a result, the Company could not speculate whether the Flatbush network customers experienced any increased potential for degradation effects on their electrical equipment.[191]

Con Edison indicated that it decided to maintain the eight percent voltage reduction at the Bensonhurst No. 2 Area Substation because the voltage reduction algorithm

[189] DPS-088(B) – Attachment 2 – EOP 5022 – "Automated Voltage Reduction Program and Demand Response Programs," Section 4.2.
[190] DPS-103(B)-05.
[191] DPS-103(B)-07.

contained in EOP-5022 recommended active voltage reduction until the network, at a minimum, returned to an N-1 condition.[192] Moreover, when questioned whether there were any light load periods during which the eight percent voltage reduction could have been reduced to five percent or terminated; the Company responded that "light load conditions are not a criterion for the reduction or termination of voltage reduction. EOP-5022 specifies that operators may exit voltage reduction, at a minimum, when the network returns to N-1 state."[193]

Con Edison's December 22, 2014 Voltage Reduction Study Report indicates that when the minimum service voltage is 8.3 percent below the nominal value, American National Standards Institute (ANSI) standards require that such conditions shall be limited in extent, frequency and duration and corrective measures shall be undertaken within a reasonable time to improve service voltages to not more than five percent below the nominal value.[194] When asked how Con Edison interprets and complies with the ANSI requirement whenever it implements an eight percent voltage reduction, the Company stated that ANSI Standard C84.1 defines service voltage limits for normal and first contingency design areas when either all supply feeders are in service or a single supply feeder is out of service, respectively. Given that the Flatbush network is designed for N-2 contingency and the outage event involved multiple feeder outages, Con Edison claims that the referenced ANSI Standard was not applicable for the Brooklyn Event. However, Con Edison contends that to minimize the duration of the voltage reduction, the Company's operational philosophy during emergency conditions is to restore feeders in a timely manner to support the integrity of a network or load area which will reduce the need for, and the duration of, the eight percent voltage reduction.[195]

While the Company is correct that ANSI Standard C84.1 does not cover N-2 designed networks, Staff cannot ignore the requirements of the ANSI standards, particularly the statement that when the minimum service voltage is 8.3 percent below the nominal value, such conditions shall be limited in extent, frequency, and duration. As mentioned above, when Con Edison implemented an 8 percent voltage reduction, customers in the Brighton Beach network could have experienced voltages as low as 12.5 percent below the nominal voltage. Furthermore, the Company had no idea what the worst-case minimum service voltage was for customers in the

[192] DPS-103(B)-02.
[193] DPS-103(B)-03.
[194] DPS-020(B)-01 Attachment 2 – Con Edison December 22, 2014 Voltage Reduction Study Report, p. 18.
[195] DPS-103(B)-04.

Flatbush network. Staff cannot speculate what the ANSI Standard requirements would have been had it addressed N-2 designed networks. However, Staff does not believe Con Edison should rely strictly on the algorithm that requires the system to be in an N-1 condition before the 8 percent voltage reduction is reduced. Algorithms cannot conceivably account for all real-time situations of an electrical network. Humans must make the ultimate decisions.

Staff recommends that the Company change its voltage restoration algorithm to restore voltages based on actual conditions rather than solely the N-1 condition required by the algorithm. For example, throughout the 8 percent voltage reduction period, Con Edison should have taken into account the same conditions considered when deciding to implement the 8 percent voltage reduction, namely, temperature variable, network load, and the number of contingencies. Based on these factors, the combination of the load reduction resulting from de-energization of the 4kV grid, low load periods, the average temperature variable and contingencies would have been considered when deciding to maintain the 8 percent voltage reduction. Had these factors been considered, it is very likely that the Company would have been able to reduce the voltage reduction to 5 percent during overnight hours.

Recommendation

- Con Edison should change its voltage restoration algorithm to restore voltages based on actual conditions rather than solely the N-1 conditions required by the current algorithm.

J. INCOMPLETE CONTROL ROOM RECORD KEEPING

Background

As a part of their routine work, Control Room operators are required to keep detailed logs and records of operations, status of equipment, communications, and system emergency declarations. This is important for several reasons including the documentation and chronology of major events, facilitating thorough turnovers between operators, and to track equipment issues and trends. Over the course of the investigation, Department Staff used control room records, logs, and recorded phone calls to shed light on the actions taken by System Operations Leadership in response to the Brooklyn Event. In order to perform a thorough

assessment on the performance of System Operations Leadership, it is important to have a full understanding of the information available at the time critical decisions were made.

Analysis and Findings

Staff requested the specific status updates required to be provided every three hours, per the Company's procedure, sent to the Con Edison Operations team by a position known as the Feeder Boss. The responsibilities of the Feeder Boss include preventing or mitigating feeder process delays and providing guidance to the District Operators. To perform these duties, the Feeder Boss will communicate with Operations and Bulk Power Staff.[196] Per procedure, the Feeder Boss is directed to email updates to a distribution list including Electric Operations, Substation Operations, and the Bulk Power team. These updates include a status summary for each feeder involved along with estimated time of restoration. In addition, updates are required for significant status changes such as the restoration of feeders that were previously out-of-service.[197]

No formal records of any communications made between the Feeder Boss and System Operations Leadership were provided to Department Staff from the Brooklyn Event. In response to Staff's request for the mandatory status updates, the Company stated that since System Operations Leadership was present at the Energy Control Center during the Brooklyn Event, updates from the Feeder Boss were provided in person. This is problematic for two reasons: first, per procedure the Feeder Boss is required to provide updates to more than System Operations Leadership alone. As stated, updates are also required to be distributed to the Substation Operations and the Bulk Power Team. Since communications addressing feeder maintenance and estimated time of restoration were kept within Electric Operations, this resulted in a major gap in information to other organizations. Second, the lack of formal recordkeeping hindered Con Edison's and Staff's investigation of the event and should be addressed to prevent future recurrence.

[196] DPS-011(B)-03 – Attachment 2 - Con Edison System Operation Procedure "Distribution System Condition Yellow," (SO5-3), p. 3.
[197] Id.

Even though updates were provided by the Feeder Boss to Company leadership in person, Staff expects these conversations to be formally documented. Keeping an official record creates a timeline for major events and aids in post event analysis by tracking equipment issues and trends. Further, updates provided by the Feeder Boss are critical to perform thorough turnover between operators. Due to the importance of documenting these communications, Staff interprets the system operation procedure to require written status updates every three hours. If this is unclear to the Company, Con Edison should revise the document to require these status updates be maintained as written records.

Recommendation

- Con Edison should revise the *Distribution System Condition Yellow* system operation procedure to require the three-hour status updates from the Feeder Boss be written records regardless of whether or not verbal updates are provided.

K. DEPLOYMENT OF MOBILE GENERATORS

Background

Con Edison primarily deploys mobile electric generators for two purposes. The first is to restore service to customers by providing a direct source of power to feeders or primary distribution cables when their normal supply sources are not operating. The second purpose is to provide grid support as mobile electric generators can be hooked up and run concurrently with the electric distribution system to maintain normal operation. Con Edison often uses mobile electric generators in load areas and networks that are more sensitive to multiple feeder failures. Con Edison currently utilizes engineering specifications that detail how to connect electric generators to feeders and how to maintain and operate them.[198]

In the days leading up to the Brooklyn Event, when Con Edison had first begun to operate under an Incident Command Structure in response to the forecasted heat event, the Company opened its Logistics Operations Center and procured emergency resources for its electric distribution system. These additional resources included an additional 13 mobile

[198] DPS-064(B)-01(b).

generators; the Company already had 28 emergency generators in its inventory.[199] By July 19, the Company had already begun pre-positioning emergency generators throughout its service territory based on system conditions.

Seven 2MW generators were mobilized during the restoration of the Flatbush 4kV grid. Specifically, five generators were attached to overhead portions of feeders for customer restoration and two were used to support the 4kV grid.[200] Although Con Edison was already in possession of more than forty mobile generators, it took the Company additional time to restore customers via generator because the equipment needed to be transported from a Company property to the identified location and connected to the overhead feeders.[201]

Analysis and Findings – Generator Deployment

Upon our analysis of the outage event, the customers who were restored via generators would have faced outages longer than those who were restored by other means. Had Con Edison waited until corresponding 27kV feeders and unit substations were returned to service, customers served by some affected 4kV feeders would have been out of service for significantly longer times. Additionally, Staff contends that Con Edison acted appropriately in utilizing two mobile generators in parallel with 4kV feeders in order to provide "grid support". This practice, known as paralleling, or operating a generator to supply power in sync with a feeder to provide voltage concurrently, is a well-established and regarded technique in the power industry. Not only does the parallel operation of generators add a redundant power supply, supporting the feeder in case of emergency, but it also helps maintain and stabilize the required voltage. Although, Con Edison acted appropriately in securing generators to provide grid support and temporarily restore some customers, further improvement opportunities were observed within the Company's generator deployment activities and are discussed herein.

Con Edison's engineering specifications detail how to connect electric generators to the distribution system and how to maintain and operate them. However, the Company does not have a specific guideline or technical specification on prioritization of generator deployments during an event, and deployment is more often based on event circumstances, such as the amount

[199] Con Edison Flatbush Report, Redacted, p. 26.
[200] DPS-014(B)-04 Suppl. 1, Redacted.
[201] DPS-082(B)-03.

of customer loads to be supported by generators and, to a lesser extent, the number of customers that can be restored.[202] Con Edison, through information requests sent by Staff, provided a timeline for generator activities, including deployment and hook-up to 4kV feeders. This timeline detailed when each generator arrived on site, when the generator was used to temporarily restore customers and when each 4kV feeder was ultimately fully restored to service without the use of a generator. Of the five generators used for customer restoration, only one took less than four hours to hook-up, and the others took between six and 9.5 hours. Further, one of the generators had an equipment issue that caused it to be disconnected after it was originally connected.[203] The large discrepancies between the times it took for generators to be hooked up to the electric distribution system illustrates the need for Con Edison to develop a more standardized approach for their generator activities. Similar to Staff's recommendations for 4kV grid restoration, Con Edison should develop guidelines regarding the Company's usage of generators within a 4kV grid. This would be beneficial to better organize generator activities and efficiently restore customers after an outage event.

During the Brooklyn Event, the Company used generators on 4kV feeders that operated between unit substations served by failed 27kV feeders.[204] Two other 4kV feeders fit these criteria but did not have generators hooked up to them, either to provide grid support or restore customers. After evaluation, we discovered that Con Edison initially planned to restore these feeders with generators, but throughout the course of grid restoration, other preferred restoration methods were adopted by the Company.

For one of the 4kV feeders, Con Edison made the decision to utilize a generator at approximately 1:40 a.m. on July 22. The generator was requested from a Con Edison facility in Queens and was placed on location at 1:30 p.m. that same day. Almost two hours later, at approximately 3:30 p.m., one of the feeder's supply 27kV feeders was restored to service, and Con Edison decided it was best to restore the feeder from the unit substation instead of using the generator. Con Edison did not explain why this generator took approximately 12 hours to be placed on site and why it was not hooked up expeditiously after it was on location. The inadequate deployment and poor management of this generator illustrate the need for set guidance

[202] DPS-064(B)-01(a).
[203] DPS-064(B)-01(d), (e), (f)); DPS-082(B)-01, 02, 03.
[204] DPS-064(B)-01(c).

on the generator deployment process, including accounting for quick transport and setup. For the other feeder, Con Edison planned to use a generator for restoration, but decided to use its supply 27kV feeder when it was restored at 10:42 a.m. on July 22. A generator was requested and secured from a Staten Island Con Edison facility for this feeder, arriving on location at 11:23 p.m. on July 21, at the unit substation on the opposite end than what was initially planned. This generator was hooked up to the feeder at 8:36 a.m. on July 22.[205] For each feeder, there was a big gap between the time Con Edison decided to use a generator and when a decision was made to restore service using a 4kV feeder from a repaired unit substation. Customers served by these two feeders may have been restored faster, even if on a temporary basis, if Con Edison was following a guideline on prioritization of generator deployments during the outage event. The lack of a guideline was likely the cause of these gaps and an area that the Company could improve on.

Con Edison has expanded its inventory of mobile electric generators. The Company obtained approximately 20 generators, most with a rated capacity of 2 MW, that were available during the summer of 2020. As part of developing guidelines to better use and deploy mobile electric generators, Con Edison should evaluate whether the current number of generators and generation capability are sufficient to mitigate future outages. The guidelines should also identify locations where the generators could be placed during events.

Recommendation

- Con Edison should establish guidelines to improve its use of mobile electric generators for the Flatbush 4kV grid and other 4kV grids with similar system configurations to facilitate timely restoration of customers after an outage event.

L. CON EDISON AFTER ACTION REVIEWS

Background

After action reviews document major events that have occurred within an organization. When an unplanned loss of electric service occurs, these reviews work to pinpoint what went wrong, identify who was involved, and document proposed improvements to procedures and processes. When an organization experiences a success, these reviews identify

[205] DPS-082(B)-03.

what certain groups are doing that sets them apart from others, how they adapt to changing circumstances, and best practices that can be shared with a broader audience to promote success across the entire organization. For corrective actions, an after-action review lays out a pathway to correct the identified problems. This process is used as a training tool for the organization to avoid repeating issues and to reinforce critical thinking and creative problem solving to stop problems when they are small and keep them from growing. The after-action review process is used industry wide and is a well-accepted practice. Training classes and guidelines for successful after-action reviews are readily available for interested Companies.

If a Company is not asking the questions "what went wrong?", "what went right?", and "what can we do better next time?", positive change and improvement is less likely to occur. After action reviews, whether being used following a success or failure, are invaluable tools to develop, maintain, and advance organizational excellence.

Analysis and Findings

Con Edison's procedure *Corporate Response to Incidents and Emergencies* recognizes the importance of after action reviews by requiring all organizations to conduct or participate in this process following a Serious or Full-Scale Level Response, and follow-up with all responsible parties for implementation of opportunities for improvement.[206] As part of the investigation, a review of the Company's after action report was performed.[207] This report was developed following an after action review meeting conducted on August 23, 2019.

Staff found the after action report to be superficial and ineffective for the following reasons. First, the report fails to include the operations organization in any meaningful way. Not one corrective action is identified for this organization. While Staff specifically requested after action documentation for the Operations Organization, Con Edison failed to provide evidence that an after action review was completed.[208] This is puzzling since numerous areas for improvement for the Operations Organization were identified by the Company during its investigation, yet none of these issues were captured in the Company's after action report. For example, due to a combination of technology, process, and human performance factors, the order to de-energize the

[206] DPS-011(B)-03 – Attachment 26 – CI-260-4 "Corporate Response to Incidents and Emergencies".
[207] DPS-025(B)-04, Redacted.
[208] DPS-042(B)-01.

Flatbush 4kV grid needed to be given twice to two separate operating locations before the task was properly executed by the Operations Organization. Following the Brooklyn Event, this issue prompted the Company to make changes to the operator's electronic log book, perform login checks for affected operators, and perform an assessment for technology solutions for distribution control centers.[209] This operations issue, along with the corrective actions performed to correct and prevent future occurrences, is absent from the after action report.

The after-action report also excludes the findings of the Company's own internal evaluation report. The internal evaluation report makes several recommendations specific to Enhanced Operational Tools designed to assist operators going forward by using new and existing SCADA.[210] These recommendations are made without any background on how they were developed or justification as to why they are needed as a result of the outage event. The Company fails, both in the after-action report and the internal evaluation report, to identify the operational issues faced on July 21, 2019. Considering the impact and involvement of the Operations Organization on the Brooklyn Event, it is unacceptable that the scope of the after-action report excludes the Operations Organization entirely.

Second, the meeting used to develop the after-action report was not held in a timely manner. The timing of an after-action meeting is critically important. The closer an after action is performed relative to the event itself, the more effective, reliable, and accurate the fact finding, and resultant corrective actions will be. With the passage of time, specific details and underlying issues from an event become less clear or are forgotten altogether. In this case, the after-action review meeting held to develop Con Edison's report took place 30 days after the outage event. As a result, the eight corrective actions developed by Con Edison at the August 23, 2019 meeting are insufficient to address the many issues surrounding the de-energization of more than 30,000 customers. For example, one corrective action states "Staffing levels for all groups involved in a heat event should be re-evaluated to ensure they are at the proper level. Specifically, IT, Customer Operations and Supply Chain."[211] This corrective action is vague, with no requirement for implementation or to demonstrate the re-evaluation was completed. Further, the corrective action is confusing since it first requires *all* groups to perform a staffing evaluation

[209] DPS-042(B)-01(e).
[210] Con Edison Flatbush Report, Redacted, p. 38.
[211] DPS-025(B)-04 – Attachment 1 – Confidential After Action Report (AAR), Redacted.

and then goes on to call-out three specific groups to take action. By waiting a month to perform an after action meeting, the Company demonstrates an indifference to the process itself and a lack of commitment to develop substantive and thorough areas for improvement following a major event.

Third, for large events such as the Brooklyn Event, having only one after action meeting to identify and document issues and proposed improvements for all organizations in the Company is inappropriate and considered a poor practice. Performing one after action meeting does not provide enough focus, time, or attention to identified areas of concern. Con Edison would have been better off performing several smaller after-action meetings targeting organizations that were most involved or experienced notable issues during the event. The Company should revise the *Corporate Response to Incidents and Emergencies* procedure to specify a threshold at which the after-action process will be performed on a smaller scale (organization by organization) rather than Company-wide. For large events, Staff expects multiple after-action meetings to occur within the Company in order to identify areas for improvement and best practices at an organizational level.

Going forward, Con Edison should develop a formal after-action process for the Operations and Communication Organizations. There are many resources available, within and outside of the utility industry, to guide the Company in this endeavor. The Company should provide training for supervisory personnel within the organizations to lead after action meetings and identify root cause problems following unusual and/or major system events. This process, performed shortly after an event, is essential to identify areas for improvement, operator knowledge gaps, and strengths to be maintained. Staff expects this information to be formalized and disseminated to the broader Company and individual organizations to reinforce after action findings with all parties.

Recommendation

- Con Edison should develop a formal after-action process for the Operations and Communication organizations. The Company should provide training for supervisory personnel within the Operations organizations to lead after action meetings following unusual and/or major system events.

- Con Edison should revise the *Corporate Response to Incidents and Emergencies* procedure to specify threshold(s) at which the after-action process will be performed on a smaller scale (organization by organization) rather than Company-wide.

EXTERNAL PANEL REVIEW & RECOMMENDATIONS

The Department engaged an independent Panel comprised of academic and industry subject matter experts with advanced knowledge in electrical transmission and distribution systems to conduct a review, separate and parallel to Staff's assessment, of the events and Con Edison's practices with respect to the Manhattan and Brooklyn outage events. The Panel consisted of Mark Adamiak who specializes in relay protection and communications, Bruce Bernstein known for his expertise in electrical cables and joints, Professor Mladen Kezunovic from Texas A&M University, Kenneth Linsley who specializes in electric distribution transformer design and analysis, and Professor Sakis Meliopoulos from Georgia Institute of Technology. The scope of work was technically focused and included an assessment of actions leading up to the event, an evaluation of how Con Edison acted during the event, evaluation of the Company's review and how it plans to address shortcomings identified, and identification of other process improvements to help prevent similar incidents in the future. The Panel carried out their investigation using numerous sources, including but not limited to site visits, in-person interviews, information requested from the Company, other information obtained during third-party testing of Con Edison equipment, public information and the Panel's understanding of electric power principles and utility best practices.

I. CONSULTANT PANEL REVIEW OF MANHATTAN EVENT

The Panel's report concurred with the findings of Con Edison regarding the company's root cause identification and generally agrees with the Company's five self-identified recommendations. However, the Panel indicated that those recommendations focused heavily on remediation of the potentially problematic 87N relays, and insufficiently addressed other areas of general concerns, such as improvements needed in cable maintenance and testing, relay settings, transformer operations, project quality control and asset management. Additionally, the Panel voiced concern regarding the potential increased risk posed by the 87N relays being removed from service as well as those remaining in service or in standby mode without being tested. The Panel also opined that the proposed testing schedule is excessively long and some of the proposed testing procedures have not been verified as being effective. With regard to lessons learned as identified by Con Edison, the Panel indicated that not all of those lessons flowed through to Con Edison's self-identified recommendations.

Based upon its review, the Panel identified an additional twenty-seven improvement recommendations for Con Edison to undertake. These supplemental recommendations pertained to Con Edison's self-identified recommendations; 27kV and 13.8 kV feeder cable testing and maintenance; relay timing and coordination; situational awareness, transformer operations and maintenance; and other broader recommendations. In comparison to the Company, the Panel expanded the analysis and took a more comprehensive approach to further improve overall corporate procedures and processes.

Staff finds the twenty-seven recommendations presented in the Panel's final report to be well grounded and potentially beneficial. As previously described within this report, DPS staff proposes that Con Edison respond to all recommendations as part of its implementation plan and explain the Company's views on the appropriateness, practicality, value and expected effectiveness of each. To the extent that the Company agrees with any of the Panel's recommendations that can be implemented prior to filing its implementation plan, the Company should do so.

II. CONSULTANT PANEL REVIEW OF BROOKLYN EVENT

The Panel, in their review findings, generally agreed with Con Edison's conclusions and self-identified recommendations to further strengthen the electric distribution system. However, the Panel also determined additional areas for improvements that should be addressed by Con Edison and proposed supplemental recommendations. In total, the Panel submitted twenty recommendations that focus on six specific categories. These six categories are: cable testing and maintenance; relay timing and coordination; breakers; rapid restoration and situational awareness; transformer operations and maintenance; and a general category on broader issues. Along with these recommendations, the independent expert panel also proposed a prioritization matrix in order to assign levels of importance to each recommendation and how timely they should be implemented. As stressed by the Panel, although it may be prudent for Con Edison to actualize certain recommendations sooner than others, all recommendations should be considered and applied by the Company.

Department Staff generally agrees with the expert panel's findings and associated reasonings for the recommendations proposed in the Panel's report. Some of the recommendations identified by the Panel are based on findings that were similar to Staff's observations, and these recommendations mirror recommendations put forward by Staff in this

report. Specific Panel recommendations regarding improving relays devices, revised feeder testing, and the removal and replacement of vulnerable cable types, echo many of the same observations and findings that Staff discusses in prior sections of this report. As previously stated, Con Edison should address the recommendations in the Panel's report as part of its implementation plan.

COMMUNICATIONS DURING THE EVENTS

The importance of timely, accurate, and effective communications with customers, customer groups, elected and government officials, emergency management offices, and the media cannot be overstated, particularly when a utility is confronted with a significant outage event. Reliable and trustworthy communications are critical to informing the public before, during and after an outage event while ensuring the successful restoration of power. It is also imperative that communications are established with these key stakeholders as soon as possible, and that the information provided contains clear and precise details that will enable proper preparation and planning. This is particularly true when unexpected outages occur as was the case with the Manhattan and Brooklyn events.

Communications must be established quickly and continue for the duration of the event. During significant outage events, the electric utilities' emergency response plans and other internal procedures require utilities to consistently provide timely and relevant information to all stakeholders, keeping in mind that each stakeholder segment has unique needs for message contents, timing, and frequency.[212] For instance, customers want to know why they lost power and when it will be restored, and utilities require customer information to adequately understand the full extent of outages. Government and elected officials want to know when the utility is going to restore a safe environment for their constituents to promote public safety. Lastly, the media depends on regular updates on the utility's restoration efforts which is in turn shared with stakeholders through various communication means, including social media, video news conferences, etc.

[212] Case 17-E-0758, In the Matter of the December 15, 2017 Electric Emergency Plan Review. Con Edison Electric Emergency Response Plan (ERP) Section 7, Orange & Rockland Electric ERP Section 2, NYSEG Electric ERP Section 9, National Grid Electric ERP Section 17, and Central Hudson Electric ERP Section 6.

I. DPS REVIEW OF MANHATTAN AND BROOKLYN EVENTS

To ensure successful communications during outage events it is imperative that a comprehensive, seamlessly-integrated communications organization be swiftly assembled. This organization's staff must possess the requisite knowledge and skills to address and manage the utility's Commission-approved emergency response plan's (ERP) procedures and related activities. To this end, utilities are obligated to clearly establish and fully document emergency communication policies and procedures in their ERPs that differentiate roles and set individual responsibilities.

In addition to its obligations under its ERP, Con Edison is also bound by specific criteria and actions that measures its customer notification performance during outage events through its Outage Notification Incentive Mechanism (ONIM).[213] The ONIM is a component of Con Edison's customer service quality incentive mechanism that was put in place by the Commission under its approval of Con Edison's proposed merger with Northeast Utilities.[214]

A. ONIM NOTIFICATION REQUIREMENTS

Background

Since 2002, Con Edison has been subject to an ONIM that defines communication expectations for prompt and effective communications when sizable outages occur. The ONIM identifies specific actions that Con Edson must perform using a variety of communication vehicles. Activities listed in the ONIM include contacting the New York City Office of Emergency Management and the Department; sending out a telephone system broadcast message on the general Con Edison customer assistance line; contacting all affected life support equipment customers; contacting city and local government officials who serve in the affected areas; contacting affected critical facilities, e.g., hospitals and nursing homes; notifying the media; and, dispatching a mobile command center vehicle to the affected area. ONIM activities may or may not apply depending on whether the outages occur in locations supplied by a single area substation or are more widespread in nature. The ONIM also establishes time periods when the

[213] Case 00-M-0095, Joint Petition of Consolidated Edison, Inc. and Northeast Utilities - Approval of a Certificate of Merger, Order Approving Outage Notification Incentive Mechanism (ONIM) (issued April 23, 2002)
[214] Case 00-M-0095, supra, Opinion and Order No. 00-14 (issued November 30, 2000).

communications should be completed, which varies based on the extent of the event as shown in Table 1 below.

<table>
<tr><th colspan="4">ELECTRIC SERVICE OUTAGE EVENT
AND
TIME PERIODS FOR INTITATION OF COMMUNICATION ACTIVITIES</th></tr>
<tr><td colspan="2">For An Outage In A Load Area Supplied From A Single Area Substation</td><td colspan="2">For Simultaneous Outages In More Than One Load Area</td></tr>
<tr><td>Outage Event (Number of Customers and Minimum Duration Period)</td><td>Time Period for Completion of Communications As Measured from the End of the Minimum Duration Period [1]</td><td>Outage Event (Number of Customers and Minimum Duration Period)</td><td>Time Period for Completion of Communications As Measured from the End of the Minimum Duration Period</td></tr>
<tr><td>At least 70,000 customers out of service at the same time for at least one hour
OR
An entire network (with fewer than 70,000 customers) out of service for at least one hour</td><td>Three hours</td><td rowspan="2">At least 70,000 customers out of service at the same time for at least one hour</td><td rowspan="2">Three hours</td></tr>
<tr><td rowspan="2">At least 40,000 customers out of service at the same time for at least two consecutive hours</td><td rowspan="2">Two hours</td></tr>
<tr><td rowspan="2">At least 20,000 customers out of service at the same time for at least three consecutive hours</td><td rowspan="2">One hour</td><td rowspan="2">At least 40,000 customers out of service at the same time for at least two consecutive hours</td><td rowspan="2">Two hours</td></tr>
</table>

Table 1

In addition to the timeliness of performance, Con Edison is also measured on the content of the information conveyed. Finally, the ONIM requires that Con Edison submit a review of how it performed under the ONIM following triggering events and establishes financial

consequences for noncompliance with the requirements, which were increased in the 2004 rate case proceeding.[215]

Analysis and Findings

Both the Manhattan and Brooklyn outages triggered the OINIM. Accordingly, Con Edison filed letters with the Department on September 11, 2019 and September 23, 2019 for the Manhattan and Brooklyn events, respectively. In both of these letters, Con Edison stated that it met the requirements of the ONIM for both outage events, as well as providing a description of actions it had taken to comply.

Con Edison concluded in its September 11, 2019 letter for the Manhattan outage (which resulted in more than 70,000 outages) that Con Edison complied with the requirements when at least 40,000 customers lost power for two hours across multiple load areas.

With respect to the Brooklyn event, Con Edison's September 23, 2019 letter indicates when the de-energization of the 4kV grid occurred, it raised the overall outage number systemwide to over 40,000 customers and it complied with the ONIM activities for that requirement. However, Staff similarly identified communication gaps when applying the relevant facts to the ONIM during the Brooklyn outage. Specifically, Con Edison's September 23, 2019 ONIM letter states: "[t]he trigger for 40,000 customers out of service simultaneously for more than two hours was 21:38 hours." As such, Con Edison, per the ONIM timing table, was required to meet all ONIM communication requires within two hours of the 21:29 p.m. ONIM time trigger (i.e., by 23:38 p.m. on July 21, 2019). While Con Edison's September 23, 2019 ONIM letter provides a variety of times and communications efforts, no evidence was presented that the ONIM timing and content requirements were met once the 40,000-outage metric was triggered between 21:38 p.m. and 23:38 p.m. as to municipal communication and media notification. Staff did find that Con Edison communicated appropriately with Life Support Equipment customers and critical facilities.

The investigation determined Con Edison's ERP and its related policies (which incorporate certain aspects of the ONIM) also warrant further amendment and clarification. First, the investigation determined that Con Edison also has a Corporate Policy Statement 810-2 Corporate Affairs Crisis Communications that is, according to Con Edison, a guidance document

[215] Case 04-E-0572, Con Edison - Rates, Order Adopting Three-Year Electric Rate Plan (issued March 24, 2005).

that may be implemented, in whole or in part, during a corporate event. The Statement attempts to document aspects of the ONIM, however, but fails to accomplish this task. Most notably, the statement does not require press releases when 20,000 customers are without power. In order to comply with the ONIM, in each instance when an outage event listed in Table 1 occurs, there are several actions Con Edison must complete.

Second, Con Edison attempted to replicate the requirements in the ONIM in its procedure EOP 5023, *Communication Guidelines in the Event of an Electric Emergency*, which is incorporated by reference in its ERP. Review of that document shows that Con Edison is not excused from local event response when outages occur systemwide.[216] EOP 5023 states "if any" of the triggers are met actions in Section 4 of its procedures should be taken (Section 4 assigns the ONIM requirements and who is responsible for executing them). Con Edison failed to address that entire networks were lost during the Manhattan event and that there were more than 20,000 customers out of power served by a single area substation during the Brooklyn event, thereby increasing the communication requirements due to sizable numbers of customer interruptions in a compact area or load area.

Third, Staff's investigation also determined that Con Edison has procedures in place when voltage reduction must be implemented that, in addition to operational procedures, includes specific notification and communication measures that must be performed.[217] However, Con Edison has neither a general nor targeted communications plan in place during outages involving load shedding or dropping sizable amounts of customers. These failures, relative to communication procedures, are shortcomings that led to the negative community perception. Having operational procedures in place for these types of events is imperative should the electric system face conditions that would warrant implementation of emergency actions by Con Edison. However, it is equally critical that Con Edison have in place robust communication procedures with appropriate triggers working in parallel with operational procedures during load shedding events.

As mentioned earlier, Con Edison has in place specific criteria in which it rates the severity of outage events. Take, for instance, when load shedding is initiated by the company and

[216] DPS-004(B)-01 – Attachment 6 – EOP-5023 Rev 15 2016 – Communication Guidelines in the Event of an Electric Emergency.

[217] DPS-004(B)-01; DPS-040(B)-01 – Attachment 1 – EOP-5022, "Automated Voltage Reduction Program and Demand Response Programs", Redacted, p. 3.

a large number of customers are interrupted (greater than 15,000 customers) which was the case during the Brooklyn outage event. In this case, Con Edison, based on its severity rating criteria, would be required to make a "Condition Red" declaration, which is the most severe classification Con Edison's utilizes for outage events. During situations like these (load shedding, Condition Yellow or Red) Con Edison must implement its internal corporate emergency response operational procedures.[218] This ensures that system operators and other operational employees know a serious event is underway within Con Edison's system. What is lacking, however, are procedures that specify the actions and assignment of responsibility for the coordination of communication activities, both internally and externally.[219] Not tying in communications into the most severe event classification is counter intuitive to accepted industry standards and the basic moral obligation Con Edison has to its customers. Con Edison must take affirmative actions based upon the situation at hand and, in turn, the Company must be prepared to go above and beyond operational requirements. A load shedding event during a heatwave in July certainly warrants a higher level of communication than perhaps a similar event on a cool autumn day. In addition, it is imperative that Con Edison's Public Information Officer be one of the first notified when the company is instituting a load shed and/or declaring a Condition Red in order to quickly and efficiently begin all communications activities.

Con Edison's prompt and open communications responses during an outage need additional Company focus. Con Edison should provide transparency to customers before, during, and after all significant outage events by increasing its communications organization's emphasis and commitment. This can only be done through internal and external outreach and education, on specific remediation efforts; by developing, exercising, and implementing vigorous communications procedures to ensure an understanding of Conditions Yellow and Red declarations, voltage reduction, load shedding, etc., under what circumstances each would be implemented, the specific timing and actions to be taken by Con Edison's communications organization and what might be asked of customers during these types of events. in order to set realistic expectations when these types of events occur.

[218] DPS-011(B)-03.
[219] DPS-069(B).

Recommendation

- Con Edison should revise Corporate Instruction 810-2 and Emergency Operations Procedure 5023 to provide clarity to all actions to be taken by the Company when the ONIM is triggered and include that such actions will not be discretionary.
- Con Edison should develop a comprehensive and detailed communications procedure that requires Con Edison to notify customers and the public prior to and during load shedding, Conditions Yellow and Red events in the affected areas within its service territory. The process should be included in the Company's ERP. The process will provide, at a minimum:
    - Specific examples of system conditions that would warrant a load shedding event, e.g., prevent loss of an entire grid or network, the span of load shed may enlarge depending on worsening system conditions, etc.; and,
    - Specifics on how the Company will educate customers and the public about load shedding activities when advanced notice is and is not available (e.g. incorporating into voltage reduction messaging, automatic notifications, etc.).

B. PRESS RELEASES AND BRIEFINGS

Background

Similar to the other New York Investor-owned electric utilities, Con Edison uses press releases as the backbone of its communications during outage events. The information contained in press releases feeds general communications activities including interactive voice response (IVR) scripts and social media posts. During significant outage events, Con Edison uses specific internal procedures regarding certain communications activities including the use of press conferences/briefings to provide key information to customers, government officials, and other key stakeholders, including the media, along with those required by the ONIM.

Analysis and Findings

Communications prior to an event is a well-known practice by utilities and is appropriately included in Con Edison's emergency response plans.[220] When the ONIM is

[220] Because the Manhattan event did not occur during a time when conditions historically trigger outages, the lack of issuing press releases before the event is acceptable.

triggered, and the event reaches certain outage numbers (e.g., 40,000) as noted in Con Edison's ERP and its referenced policies, Con Edison is required to both issue a press release and hold a press briefing.

Press Releases

Con Edison issued only two press releases over the course of the 70,000 customer Manhattan outage event, each lacking enough detail to be useful to affected customers and the public. Staff's investigation of the Manhattan event confirmed that Con Edison did not issue its first press release timely per its ONIM requirements. In addition, this press release was non-informative as it contained a two-sentence opening paragraph; the first sentence merely gave the number and location of the outages, and the second sentence stated that updates would be provided. The final press release, issued at 11:15 p.m., over three hours later, included an opening of one sentence stating that Con Edison had restored 62,000 customers and was working to restore the remaining customers "by midnight." *Notably, Con Edison did not provide specific ETR information earlier using its press releases, despite having restored 50 percent of customers within the first three hours of the outage and the majority of customers by approximately 11:00 p.m.* Con Edison, per its ERP, is required to provide timely, relevant and accurate information and update same as it becomes available. As such, Con Edison should have issued a press release closer to 9:00 p.m. when the Company knew better its anticipated restoration timing. Moreover, when asked for information on other communication efforts, including website and social media postings, Con Edison responded to both questions: "The Company's social media postings were the press releases…". Since Con Edison's press releases lack beneficial data, it is even more troubling that the company continually relies exclusively on press release language rather than posting pertinent and detailed information to social media or to its website.

With regards to the Brooklyn event, which Con Edison categorized as a 40,000 customer event, the Department's investigation revealed that despite having called a demand response event on July 18, 2019, mobilizing its CERC and calling a second demand response event on July 19, 2019, and calling a third demand response event on July 20, 2019, Con Edison issued no press releases updating the public, government officials, and other key stakeholders to prepare for potential outages due to the stress on the system. For example, on July 21, 2019, Con Edison issued a press release at 5:15 p.m., just two hours before the event, that included a request for

customers in southeast Brooklyn to conserve energy and announcing an 8 percent voltage reduction to maintain system reliability and protect equipment. However, there was no specific mention of the possibility of outages should system conditions continue to deteriorate. As discussed in this report, Con Edison was well aware of the deteriorating system conditions at the time of this press release but failed to provide any indication that preventative measures may need to be taken. Con Edison clearly missed an opportunity to properly inform and advise customers in the affected areas of the strong possibility that deteriorating system conditions may lead to customer outages.

Con Edison eventually issued its first press release for the multi-day Brooklyn outage on 8:30 p.m., nearly one hour after the de-energization occurred. The press release, however, failed to include the specific reason for the Flatbush outages; rather, the press release referred only to "33,000 outages in the southeast Brooklyn neighborhoods of Canarsie, Flatlands, Mill Basin, Old Mill Basin, Bergen Beach, and Georgetown due to continued heat and high usage." Con Edison again, missed an opportunity to be being transparent and straightforward with customers, government officials, and other key stakeholders by explaining the actions were intentional and why the outages were necessary (e.g., such as messaging that Con Edison deliberately caused the outages and the rationale was that the failure to do so may have led to the loss of an additional 100,000 customers). served by the underground network. It was not until 11:00 p.m., over three hours after the de-energization, that Con Edison issued a subsequent press release which said, "Con Edison made a preemptive move to take those customers in southeast Brooklyn out of service in order to protect vital equipment and to help restore power as soon as possible." The following day, July 22, 2019, at 10:30 a.m., Con Edison issued a one paragraph company statement that said, "The actions we took were necessary to prevent longer outages to the impacted customers that would have occurred as a result of additional equipment damage." While the releases were attempts to provide customers with additional information, Staff finds these later press releases to be insufficient as they again fail to provide a clear, detailed rationale/explanation of why the outages occurred and why the specific areas were impacted. Staff asserts that customers, government officials, and other key stakeholders demand and deserve better.

Con Edison is well acquainted with the Department's expectation for providing appropriate information and criticism of providing limited information following notable events

as memorialized in Staff reports on Tropical Storms Irene and Lee and the 2018 Winter and Spring Storms.[221] Accordingly, there is no reasonable excuse that Con Edison continues to repeat the same short fallings regarding its communication efforts again and again. Clearly, Con Edison fails to understand that customers and the public expect honest and transparent information in real time during significant outage events. Over several significant outage events, as detailed in the United Westchester and Moreland Commission reports, customers and government officials have continued to echo the same disapproval with Con Edison's lackluster communication – they want timely and accurate information from the Company, whether they like what they hear or not.[222] More forthcoming and meaningful information is better than deficient and/or ambiguous reports which are, simply put, unacceptable considering that customers rely solely on Con Edison for information about their outages.

Press Briefings

In addition to press releases, holding press briefings is an efficient measure to disseminate information. Following the Manhattan outage, Con Edison participated in multiple press briefings, including a briefing approximately three hours into the event, another briefing when restoration was nearing completion, and the last briefing on the next afternoon. The Company, however, failed to implement this valuable communications tool following the Brooklyn outage event. Con Edison indicated more than once to Staff that they did not hold or participate in any press conferences during the Brooklyn event because, in Con Edison's opinion, the threshold requirements to hold a press conference were not met and that the internal procedure that sets forth when the Company would do a press conference/briefing is a document that "…may be implemented, in whole or in part, during a Corporate Event."[223] Con Edison further indicated that, in its opinion, the ONIM did not contain a requirement for press conferences/briefings. After the Department requested more detail on this issue, Con Edison did

[221] Case 11-M-0481, In the Matter of the Outages Caused by Hurricane Irene and Tropical Storm Lee, Utility Performance Report Following Hurricane Irene and Tropical Storm Lee (issued June 29, 2012); Case 19-M-0285, In the Matter of Utility Preparation and Response to Power Outages During March 2018 Winter and Spring Storms. 2018 Winter and Spring Storms Investigation (issued April 18, 2019) (2018 Winter and Spring Storms Report).

[222] Case 19-M-0285, supra., United Westchester March 2018 Storm Response Report. (Comments on behalf of United Westchester filed May 21, 2018). The Moreland Commission on Utility Storm Preparation and Response, "Moreland Commission on Utility Storm Preparation and Response Final Report," dated June 22, 2013.

[223] DPS-004(B)-1 – Attachment 1 –810-2 Corporate Affairs' Crisis Communications.

not produce any internal procedures or guidance illustrating the criteria to be used by its employees to determine when a press conference/briefing is warranted.

The decisions on whether to hold press briefings need to reflect the circumstances. First, Con Edison, per its ERP, was required to hold a press briefing for the Brooklyn outage upon the triggering of its ONIM, which, by Con Edison's own admission, was triggered. Second, given the fact that the Brooklyn outage occurred during a heat wave and the Company had a major outage event just over a week earlier, Con Edison should have held press briefings as it did in the case following the Manhattan event. This failure, as well as the lack of transparency in the press releases, added to the confusion and frustration felt by the public and yet another missed opportunity to provide its customers and the public with open and honest communications. Common sense and flexibility in any utility's response efforts is required to ensure the Company is continually seeking to do its best for its customers, particularly through its communications efforts. Con Edison failed to exercise both during the Brooklyn outage and rather than using every tool at its disposal to communicate with its customers during an outage event, Con Edison instead consciously performed solely to what it considered the basic communication requirements.

<u>Recommendations</u>

- Aside from Con Edison's existing press release requirements of its ERP and the ONIM, Con Edison should develop a written process to issue press releases and/or company statements as soon as practicable before or immediately following a significant load shedding event or other notable events that warrant detailed communications. Press releases should contain pertinent and detailed information at the beginning of each release, e.g., cause and extent of outages, speak to customers who have not been restored, etc. The process should be included in the Company's ERP.
- Aside from Con Edison's existing press release requirements of its ERP and the ONIM, Con Edison should develop more accurate and depictive press release templates that provide timely, clear and thorough details to customers regarding actions the Company has, is, or will be taking in response to adverse system conditions, e.g., load shedding, de-energization, flooding, etc.

- Aside from Con Edison's existing press briefing requirements of its ERP and the ONIM, Con Edison should develop a comprehensive, consistent and detailed process for conducting press conferences and / or briefings during outage events. The process should include, but not be limited to, a clear decision-making process and threshold requirements to be used by the company. The process should be included in the Company's ERP.

C. COMMUNICATIONS LACKED RESTORATION ESTIMATES

Background

Customers depend on estimated times of restoration (ETRs) to make health and safety decisions for themselves and their families, particularly when there is no warning prior to a significant outage. ETRs allow customers to determine whether there is a need to relocate, assess basic resource and supply needs, and address any medical needs in a household that may be impacted by an extended outage. Municipalities rely on ETRs to plan properly for the care and safety of people and protection of property, and government officials look to utilities for accurate restoration times to inform their constituents. Further, to be instructive, ETRs must contain enough detail to set realistic expectations for customers, government officials and other key stakeholders. The ETR information released by an electric utility must be accurate and made widely accessible to all to ensure that customers and other stakeholders can plan accordingly. It is imperative that customers receive specific ETR information and know they can trust the information provided by their electric utility.

To ensure accessibility, the utilities communicate ETRs through their websites, call centers, press releases, municipal calls, email and text messages, automated outbound calls, and website banners. The purpose of using website banners on the utilities' outage pages during significant outage events is to provide key pieces of information that are useful to affected customers, including outage numbers. Website banners are also used on the utilities' outage pages during significant outage events to provide key restoration information. The banners are easily activated and should be updated with current information as an event evolves.

Analysis and Findings

Con Edison failed to communicate detailed ETRs, instead relying on general statements in its communications with customers and the public during both the Manhattan and

Brooklyn outage events. For example, during the Brooklyn outage event, not only did Con Edison's website banners recite a vague range of ETRs, e.g., "Service restored through tonight," "Service restored tonight into tomorrow," but no accompanying press release provided any specific information on ETRs. Particularly during the Brooklyn outage event, as restoration progressed and as additional information became available, Con Edison should have issued specific ETRs to the affected customers per its ERP requirements.[224] Further, while restoration continued, Con Edison should have been refining the ETRs based on progress being made in the field. Con Edison instead continually pushed out the vague ETRs described earlier, without any notification to customers explaining why this was being done. For any outage event, Con Edison is expected to assess damage to its system and create a restoration plan that takes into account resource needs (e.g., labor, equipment, and materials) in order to determine clear and accurate ETRs. However, the Company provided no specific restoration information at any time during the Manhattan or the Brooklyn events. This is a serious failure and it is contrary to acceptable industry practices and its ERP (and ONIM) requirements.

During the Brooklyn event, Con Edison did employ the use of banners on its outage page, however, the banners failed to communicate pertinent restoration information regarding the event to customers. Approximately one hour after the event occurred, Con Edison posted its first website banner merely stating that "Due to heat, about 33,000 customers in Brooklyn have been taken out of service for repairs. Service restored tonight through tomorrow."[225] As with the press releases, Con Edison should have provided a brief explanation of the outage cause so that customers would have known that the Company had taken preemptive action to avoid further outages and system damage and identified actions being taken by the Company to accomplish restoration. Con Edison did not update its banner with outage and ETR information until July 22, 2019 at 12:30 a.m. which stated "Due to heat, about 23,000 customers in Brooklyn have been taken out of service for repairs. Service restored through today." Based on the timing of feeder failures, actions being taken by operators, and the limited area impacted, the Company should have been able to indicate which neighborhoods would continue to see prolonged outages. Providing customers and the public with more precise knowledge of when

[224] Case 17-E-0758, In the Matter of the December 15, 2017 Electric Emergency Plan Review, Consolidated Edison 2018 Electric Operations Emergency Response Plan (filed April 11, 2018).
[225] DPS-004(B)-02(f) – Attachment 6 – (Website updates).

service would likely be restored would have enabled customers to take appropriate actions and may have avoided the anger and frustration pointed at Con Edison during and after the event. Staff sees the lack of estimated restoration times a key failure to constructively interact with customers.

Recommendations

- Aside from Con Edison's existing ETR reequipments in its ERP and ONIM, Con Edison should develop a detailed process for promptly communicating outage causes and specific ETR information, reasons for and timely notification of ETR revisions to its customers. This process should be included in the Company's ERP.
- Aside from Con Edison's existing ETR reequipments in its ERP and ONIM, Con Edison should develop a process and related materials that provides targeted communications to customers that remain out of service as restoration efforts continue until all customers have been restored. This should include advanced notice to customers whose ETRs will not be met along with a clear explanation of why ETRs are not being met. This process should be included in the Company's ERP.

D. COMMUNICATIONS WITH GOVERNMENT AND ELECTED OFFICIALS

Background

During outage events, utilities are required to engage and maintain communications with government officials, particularly the elected representatives of the affected areas within its service territory. This is done using blast emails, automated outbound telephone calls, press releases, and municipal conference calls. In order to be effective during an unexpected outage event, it is imperative for a utility to have a formal process (including regional contact lists) to rapidly establish and maintain communications with government officials.

Analysis and Findings

Con Edison has no such formal communication process in place for use during load shedding events which resulted in strong criticism directed at the company during both the Manhattan and Brooklyn outage events, including from Governor Cuomo, Mayor DeBlasio, as well as members of the State Legislature and the City Council for Con Edison's lack of clarity in

the information being provided to them and the public, in addition to allegations that the Company was not prepared.[226]

Staff's investigation determined that rather than implementing a dedicated outreach program for government and elected officials, Con Edison simply forwarded press releases to these groups and has asserted this is sufficient to fulfill its communication obligations. Most notably, during the Brooklyn outage event , Con Edison, interestingly, indicated that it had forwarded each press release issued to government officials, and relied exclusively on this practice as fulfilling its communication obligation to this stakeholder group, as the primary tool used to provide information to government officials.[227] While it is a good practice to provide press releases directly to government and elected officials, merely forwarding press releases, which have been shown earlier to lack the most crucial details, should not serve as the only form of communication. Additionally, press releases alone do not give government officials the localized information they need to answer constituents' questions or allay concerns when power is abruptly turned off without explanation from Con Edison. The Department's investigation revealed that Con Edison apparently failed to maintain and use regional government contact lists to disseminate information as is required by its ERP.

When pressed for more documentation regarding the Company's telephone and conference calls with government officials during the Brooklyn outage event, Con Edison relied on the New York City Office of Emergency Management's conference calls to act as the Company's primary municipal outreach. Con Edison did provide an internal spreadsheet; however, this information was limited and it could not be deciphered if Con Edison actually made individual outbound calls, which is what would have been in order, or if these were incoming calls only, nor could Con Edison confirm same.[228][229] In fact, Con Edison indicated that a comprehensive contact list by region for external organizations, which include elected officials, does not exist under its internal Communications with the Public During Load Management

[226] https://www.nytimes.com/2019/07/22/nyregion/brooklyn-power-outage-nyc.html.
[227] DPS-005(B)-02.
[228] DPS-039(B)-02.
[229] Additionally, information provided in the comments column of the spreadsheet consisted of details such as "sent press release, sent update on customer restoration, ETR update, responded to inquiry re Flatbush outages", etc. There were no details provided on what the precise inquiries were, rather just a terse note regarding the action to be taken.

Power Outage procedure.[230] Not having quick access to an accurate list of government and elected officials in each of Con Edison's Regional Corporate Affairs Department and Westchester County and failure to make outbound phone calls to government and elected officials during significant outage events is unacceptable and is a practice that must be part of an effective communications strategy for Con Edison. Given government officials' past criticism of Con Edison's failure to provide adequate information in prior outage events, the Company failed again to exercise good judgment to improve its relationships with government officials by continuing to perform to at or below the minimum requirements in its emergency response plan and internal procedures.

Recommendation

- Aside from Con Edison's existing government contact requirements in its ERP and the ONIM, to resolve the omission identified by Staff, in its internal procedures, Con Edison should develop a comprehensive and detailed process to notify federal, state, and local government officials as well as community organizations when sizable outages occur in a focused area. The process should be included in the Company's Communications with the Public During Load Management Power Outage procedure as well as in its ERP. The procedure should include, at a minimum, the following:
    - A comprehensive contact list of federal, state, and local elected and government officials, and community organizations for each of Con Edison's Regional Corporate Affairs Departments and Westchester County, to be used for communicating targeted emergency and / or outage information to local elected and government officials before and during significant outage events. This list should be reviewed and updated semi-annually each year;
    - Specific information to be shared with government and elected officials before, during and after an outage event, how that information will be shared, and the minimum frequencies of communications; and,
    - A dedicated electronic system to be used for memorializing and tracking all communications, e.g., emails, telephone calls, made to and received by federal,

[230] DPS-004(B)-01 – Attachment 2 – Corporate Instruction 260-7 Guidelines for Communications with the Public during Load Management Power Outages, Section 4.1.

state, and local government officials as well as community organizations, that memorializes all relevant details regarding such communications.

E. COMMUNICATION WITH INDIVIDUAL CUSTOMERS

Background

Con Edison's Customer Outreach group is charged with coordinating internal and external outreach messaging such as email blasts, among others which includes sending email blasts to customers who have provided email addresses.[231] These types of email blasts can only be sent by the Company to customers who have subscribed to these services and act as an important and effective tool that provide customers with relevant information before, during and after a storm event. The use of email in this digital world often acts as the primary form in which customers prefer to receive both general and specific information about outages. However, Con Edison failed to use this ERP-required communication vehicle at all prior to or during either the Manhattan or Brooklyn outage events.

Analysis and Findings

Con Edison, like all other electric utilities, maintains contact information for its customers including phone numbers, email addresses, etc. that are used as direct touch points for a variety of reasons, especially during outage events. But Con Edison did not utilize this information during the Manhattan and Brooklyn events. The Company did not send a single blast email to customers immediately following the Manhattan outage to inform customers of ETRs or provide any information about the outage. Prior to the load shedding in Brooklyn, the Company did not utilize its email blast to customers asking them to reduce energy consumption, or announcing that five and eight percent demand reductions had been instituted in southeast Brooklyn, why these measures were necessary or what future steps may be necessary if the demand reductions were not successful in relieving stress on the system. The Company did not send any email blasts out after the Brooklyn outage event informing customers that Con Edison had pre-emptively shut down the Flatbush 4kV grid to avoid further outages and damage to its

[231] DPS-004(B)-01 – Attachment 3 –2-0-1 CUSTOMER OPERATIONS GENERAL – Corporate Event Customer Response Plan, Section 6.3.

equipment or at any time thereafter summarizing known or anticipated restoration information. Con Edison failed to send any targeted messaging to any customers, particularly the affected customers, prior to or during the Brooklyn outage event.[232]

Con Edison has the ability to isolate affected customers to send blast emails to them with targeted messaging regarding their outages. In fact, on July 26, 2020, three days after restoration was completed in Brooklyn, Con Edison sent out two emails to only those customers that were affected by the Brooklyn outages apologizing for the inconvenience caused by the outages and providing reimbursement information. Con Edison, however, failed to provide customers with any specific outage or ETR information through the use of any medium, particularly through blast emails during the Brooklyn outage event. Instead, customers were forced to either call the Con Edison customer service number to ask a customer service representative for an ETR or rely on the vague information that the company was pushing out through its website, press releases, and social media posts, none of which contained specific ETR data.[233] Additionally, Con Edison continually failed to share any explanation when the high level restoration estimates were moved out on each subsequent day of the outage event. Because this outage was isolated to one local area, Con Edison should have been messaging directly to these affected customers consistently by sending emails with information regarding their specific outages during the event.

In short, if Con Edison was fully capable of sending emails to a specific customer group three days after restoration was complete, it could and should have issued blast emails during the outage event. Con Edison, due to past customer criticism, is fully aware of its customers' expectations for straightforward communication; nonetheless, it continues to lack transparency and honesty with its customers, which only serves to enhance the distrust and frustration customers have towards the Company. Con Edison has been counseled by Staff in the past on this very subject.[234] Con Edison's failure to send a single email to customers prior to the outage or to affected customers during the actual outage period cannot be explained, is simply unacceptable and must be improved.

[232] DPS-004(B)-02(b).
[233] DPS-004(B)-02(e), (f).
[234] 2018 Winter and Spring Storms Report, Recommendation 57.

Recommendation

- Aside from Con Edison's existing blast email requirements in its ERP, Con Edison should develop a detailed and comprehensive process for issuing blast e-mails to customers in accordance with its internal procedures. Blast email content will include, but not be limited to, summaries of the information contained in press releases. The process should be included in the Company's ERP.

ACCOUNTABILITY MEASURES

I. PERFORMANCE PROTECTIONS

As part of Con Edison's rate proceedings, the Company is held accountable for its service levels through a Reliability Performance Mechanism (RPM).[235] The RPMs establish thresholds for determining acceptable, reliable service to customers and failure to meet each threshold standard results in a related negative revenue adjustment to the utility. The negative revenue adjustments are paid through shareholder funds to the benefit of customers. The RPMs in place during the July 2019 outage events included multiple electric performance metrics divided into four categories: system-wide threshold standards, major outage, remote monitoring system and program standards. As discussed in detail below, the outage events resulted in a combined negative revenue adjustment of $15 million.

The Manhattan event triggered the network major outage metric under the major outage category. As per the established RPM, a network major outage is defined as the interruption of service to 15 percent or more of the customers in any network for a period of three hours or more. Revenue adjustments for the network major outage metric are dependent upon outage duration and are structured as follows: for an outage duration greater than 3 hours and up to 6 hours, an adjustment of $5 million is applicable; for an outage duration greater than 6 hours and up to 12 hours, an adjustment of $10 million is applicable; and, for an outage duration greater than 12 hours, an adjustment of $15 million is applicable. However, only one revenue adjustment is applicable to any single system failure that results in multiple interruptions. During the Manhattan event, three of the six networks impacted had 15 percent or more of customers interrupted for more than three hours but were restored before the six hours. As previously

[235] Case 16-E-0060, Con Edison - Rates, Order Approving Electric and Gas Rate Plans (issued January 25, 2017).

discussed in this report, these network interruptions were all attributed to a single system failure. Therefore, the event resulted in Con Edison incurring a negative revenue adjustment of $5 million. This revenue adjustment was applied as a credit to customers as part of Con Edison's most recent rate plan, approved by the Commission in January 2020.[236]

For radial systems, such as the 4kV grid in the Flatbush area, a major outage is defined as the loss of service to 70,000 customers for three or more hours. Therefore, this measure was not triggered following the outage in Brooklyn. This event, however, played a significant role in Con Edison's failure to meet both the radial frequency and duration system-wide measures. The large number of customer interruptions and lengthy outage durations associated with the Brooklyn event adversely impacted the calculation of these metrics. Outages of this magnitude and duration are typically associated with major storms, which are excluded from the calculation.[237] Con Edison's RPM, however, specifically states that heat events are not excludable. Therefore, the Company's failure to meet these two metrics resulted in Con Edison incurring a negative revenue adjustment of $10 million ($5 million for each measure). Because the frequency and duration performance measures are calculated on a calendar year basis, the ratepayer credit was not applied during the last rate case and will be deferred for future ratepayer benefit.

II. ADDITIONAL PROTECTIONS

To account for the July outage events, and to better hold Con Edison accountable for failure to meet expected service quality levels, the Commission revised the Company's RPMs in January 2020 to modify the definition of a major outage for both the network and radial systems. The revised network major outage maintains its definition of an event interrupting service to 15 percent or more of the customers in a network for a period of three hours or more, however, it eliminates the extent that a common mode of failure would cap the negative revenue adjustment to better represent customer impact versus system conditions. The revised definition

[236] Case 19-E-0065, Con Edison - Rates, Order Adopting Terms of Joint Proposal and Establishing Electric and Gas Rate Plan (issued January 16, 2020).

[237] As defined in 16 NYCRR Part 97, any outages resulting from a major storm, or a storm that accounts for at least 10% of the customers interrupted within an operating area or customers out of service for at least 24 hours, are excluded from the threshold standard calculations. In the calculation of Con Edison's radial frequency and duration measures, severe wind, rain, thunder and snow-storms are most often excluded.

establishes the area substation as the highest level for failure. Therefore, if more than one network served by a single area substation has 15 percent or more customer outages, the outages will be considered as a single event for the purpose of determining the revenue adjustment. If the failure is not contained in the area substation and travels to other area substations and networks, as in the case of the Manhattan event, those would be counted as separate failures under the new RPM.[238] Additionally, the associated revenue adjustments for a network major outage were also revised. The revenue adjustments are still dependent upon outage duration, but were increased as follows: $10 million for the initial outage with a duration between three and six hours; $15 million for the initial outage with a duration between 6 and 12 hours; and, $25 million for the initial outage with a duration greater than 12 hours. Subsequent network major outage will also be subject to a revenue adjustment, although at a lesser extent than the initial outage.[239]

As established in the 2019 rate plan, a radial major outage is now defined as one event that results in the sustained interruption of service to at least 12,500 radial customers for 180,000 or more customer hours. This new definition captures the intention of the metric established in the 2016 rate plan, since 70,000 customers out of service for 3 hours would be 210,000 customer hours, but also now considers smaller-scale outages that occur for longer durations, such as the Brooklyn outage event. Under the revised definition, the Brooklyn outage event would have triggered the radial major outage metric. The revenue adjustment for a radial network outage was kept at $10 million per event.

Finally, the Company's maximum annual exposure, or the maximum revenue adjustment possible through the major outage metric, was increased from $30 million to $110 million. The increased maximum revenue adjustment places a larger emphasis on the importance of providing adequate and reliable electric service, and better considers the negative impacts that such outages have on customers and the Company's service territory.

[238] Furthermore, the RPM also now accounts for double-area substations, or substations that are located at the same geographic location in the same building, or adjacent buildings, that are served by the same sub-transmission feeders. If a major outage occurs at a double-area substation whose peak load is less than 500 MW, the event would be considered a single event for the purpose of calculating the revenue adjustment.

[239] The revenue adjustment for each additional event is as follows: $7.5 million for an outage with a duration between three and six hours; $10 million for an outage with a duration between 6 and 12 hours; and, $15 million for an outage with a duration greater than 12 hours.

APPENDIX A - LIST OF DPS STAFF RECOMMENDATIONS

#	Recommendation	Targeted Completion
Manhattan Outage Event		
1	Con Edison should fully discuss in its implementation plan how the design drawing feedback process it developed after this incident will be monitored and self-audited to ensure there are no inconsistencies between Company's and vendor's wiring drawings that could lead to a similar situation as in July 2019.	December 31, 2020
2	Con Edison should update its inspection procedures to include a process for inspecting transformers cooling systems on a regular basis to verify that the valves are in the proper operational positions. This should include verification by a supervisor after the valve position is changed for any reason.	December 31, 2020
3	Con Edison should seek ways to further expedite the verification of the correct installation and operation of 87N relays that were taken out of service following the incident.	February 28, 2021
4	Given its decision following the incident to use other methods besides primary injection testing to verify the proper operation of the 87N relays, Con Edison should provide an analysis that validates using either the review of pertinent historical operations, the installation of non-intrusive monitors, or making relay adjustments will be able to verify the correct installation and operation of 87N relays.	February 28, 2021
5	Con Edison should produce a Training Enhancement Report to further improve its overall training program and meet the challenges of the future. The report should address a number of topics including classroom, online and on-the-job training, new technologies and procedures, improvements in company manuals, sessions to review lessons learned, operational drills, and discussions between departments and disciplines to improve communication and coordination. Additionally, the report should implement or improve follow-up testing to validate employee understanding and competence.	February 28, 2021
6	Con Edison should review all technical documents to replace unclear language with clear-cut specific terminology.	February 28, 2021
7	Con Edison should continue to seek ways to improve system reliability and resiliency, as identified in post event preliminary findings, at just and reasonable costs including consideration of and responding to the Panel's recommendations pertaining to system planning. The Company should provide detailed justifications for any recommendation it does not believe should be implemented.	February 28, 2021

#	Recommendation	Targeted Completion
8	Con Edison should improve its system upgrade quality control processes with an emphasis on investigating and adopting industry standards, in furtherance of the initiative the Company commenced following this incident.	February 28, 2021
9	Con Edison should verify that all new, retrofitted or out-of-service for maintenance facilities with 87N relays will be tested and validated using primary injection testing before being placed into service.	February 28, 2021
10	Con Edison should develop a program to upgrade and enhance its testing and inspection protocols and procedures.	February 28, 2021
11	Con Edison should develop improvements in its contingency plans and procedures and develop improvements in its overall operation and maintenance procedures for all of its power system equipment in order to achieve reliable performance and to prevent equipment damage.	February 28, 2021
12	Con Edison should improve its overall System Monitoring procedures to enhance situational awareness, particularly with respect to critical equipment such as transformers and should improve the clarity of protocols for responding to system abnormalities.	February 28, 2021
13	Preliminary findings led Con Edison to develop an initial listing of lessons learned, Con Edison should now produce a more comprehensive Lessons Learned Report following the occurrence of any significant problem or failures it encounters, and widely disseminate the report to relevant employees for discussions and training.	December 31, 2020
Brooklyn Outage Event		
14	Con Edison should develop a plan by December 31, 2020 to expand the use of 27kV automatic interrupter switches in the Flatbush network and throughout its territory based on the success of interrupter prototypes that the Company plans to install on Feeder 4B06.	December 31, 2020
15	Con Edison should seek to expand the installation of Kyle switches on 4kV feeders, where operationally feasible, in other 4kV grids throughout the Company's territory to limit impact of distribution feeder faults.	-
16	Considering that Kyle switches have been installed on all feeders in the Flatbush 4kV grid and that enhanced SCADA control functions are available to operators, Con Edison should operate the Flatbush 4kV grid and other 4kV grids that are supplied by a network system in radial mode when appropriate.	December 31, 2020
17	Company Specification EO-4095 should reflect the use of enhanced SCADA functions and the radial operations of 4kV grids	December 31, 2020

#	Recommendation	Targeted Completion
18	Con Edison should replace all remaining Westinghouse type CM electromechanical phase balance relays with microprocessor relays as soon as operationally feasible to enhance the means of detecting and clearing faults at 4kV unit substations throughout the Company's territory.	December 31, 2020
19	By December 31, 2020, Con Edison should establish a workplan to apply investment actions identified during the Flatbush event (e.g., replacement of Paper Insulated Lead Cable, vintage XLPE cable, Raychem 3W-1W joints) to networks associated with 4kV grid systems throughout the Company's territory.	December 31, 2020
20	During expected heat events, Con Edison should save all cable and joint failure specimens so that each can be studied and used in internal Post Event Analyses.	-
21	Con Edison should establish more detailed waiver criteria in the Company's Hipot testing specification (EO-4019) to ensure that feeders are assessed and tested appropriately during an outage event.	December 31, 2020
22	Con Edison should determine whether the time frame to proactively Hipot test primary distribution network feeders (currently over three years) is appropriate and strengthen the Company's testing procedure accordingly to ensure all feeders are tested adequately.	December 31, 2020
23	Con Edison should revise EO-4095 Distribution System Operation Under Contingency and/or Elevated Load Conditions, or create a new procedure entirely, to provide detailed guidance for the preparations, decision factors, responsibility, required communications, and operator step-by-step direction to perform load shedding or de-energization of the 4kV grids.	February 28, 2021
24	Given 4kV grid load shed events do not occur on a routine basis and Con Edison is currently lacking any procedure or written guidance for restoration, Con Edison should develop a written guidance on how to restore a 4kV grid efficiently and effectively.	February 28, 2021
25	Con Edison should develop a process to better evaluate and implement measures to restore customers served by 4kV feeders with no equipment or overload issues in the Flatbush 4kV grid and other 4kV grids that are supplied by a network system. These measures could include the use of mobile electric generators and other distributed energy resource technologies.	February 28, 2021
26	Con Edison should clarify its procedures to transition to a condition red when load shedding occurs on a 4kV grid.	December 31, 2020

#	Recommendation	Targeted Completion
27	Con Edison should change its voltage restoration algorithm to restore voltages based on actual conditions rather than solely the N-1 conditions required by the current algorithm.	February 28, 2021
28	Con Edison should revise the Distribution System Condition Yellow system operation procedure to require the three-hour status updates from the Feeder Boss be written records regardless of whether or not verbal updates are provided.	December 31, 2020
29	Con Edison should establish guidelines to improve its use of mobile electric generators for the Flatbush 4kV grid and other 4kV grids with similar system configurations to facilitate timely restoration of customers after an outage event.	February 28, 2021
30	Con Edison should develop a formal after action process for the Operations and Communication organizations. The Company should provide training for supervisory personnel within the Operations organizations to lead after action meetings following unusual and/or major system events.	February 28, 2021
31	Con Edison should revise the Corporate Response to Incidents and Emergencies procedure to specify threshold(s) at which the after action process will be performed on a smaller scale (organization by organization) rather than Company-wide.	December 31, 2020
Communications		
32	Con Edison should revise Corporate Instruction 810-2 and Emergency Operations Procedure 5023 to provide clarity to all actions to be taken by the Company when the ONIM is triggered and include that such actions will not be discretionary.	December 31, 2020
33	Con Edison should develop a comprehensive and detailed communications procedure that requires Con Edison to notify customers and the public prior to and during load shedding, as well as Condition Yellow and / or Red events, in the affected areas within its service territory. The process should be included in the Company's ERP. The process will provide, at a minimum: • Specific examples of system conditions that would warrant a load shedding event, e.g., prevent loss of an entire grid or network, the span of load shed may enlarge depending on worsening system conditions, etc.; and, • Specifics on how the Company will educate customers and the public about load shedding activities when advanced notice is and is not available (e.g. incorporating into voltage reduction messaging, automatic notifications, etc.).	December 31, 2020

#	Recommendation	Targeted Completion
34	Con Edison should develop a process to issue press releases and/or company statements as soon as practicable before or immediately following a significant load shedding event or other notable events that warrant detailed communications. Press releases should contain pertinent and detailed information at the beginning of each release, e.g., cause and extent of outages, speak to customers who have not been restored, etc. The process should be included in the Company's ERP.	December 31, 2020
35	Con Edison should develop more accurate and depictive press release templates that provide timely, clear and thorough details to customers regarding actions the Company has, is, or will be taking in response to adverse system conditions, e.g., load shedding, de-energization, flooding, etc. The templates should be included in the Company's ERP.	December 31, 2020
36	Con Edison should develop a comprehensive, consistent and detailed process for conducting press conferences and/or briefings during outage events. The process should include, but not be limited to, a clear decision-making process and threshold requirements to be used by the Company. The process should be included in the Company's ERP.	December 31, 2020
37	Con Edison should develop a detailed process for promptly communicating outage causes and specific ETR information, reasons for and timely notification of ETR revisions to its customers. This process should be included in the Company's ERP.	December 31, 2020
38	Con Edison should develop a process and related materials that provides targeted communications to customers that remain out of service as restoration efforts continue until all customers have been restored. This should include advanced notice to customers whose ETRs will not be met along with a clear explanation of why ETRs are not being met. This process should be included in the Company's ERP.	December 31, 2020
39	To resolve the omission identified by Staff, in its internal procedures, Con Edison should develop a comprehensive and detailed process to notify federal, state, and local government officials as well as community organizations when sizable outages occur in a focused area. The process should be included in the Company's Communications with the Public During Load Management Power Outage procedure as well as in its ERP. The procedure should include, at a minimum, the following: • A comprehensive contact list of federal, state, and local elected and government officials, and community organizations for each of Con Edison's Regional Corporate Affairs Departments and Westchester County, to be used for communicating targeted emergency and / or outage information to local elected and government officials before and during significant outage events.	December 31, 2020

#	Recommendation	Targeted Completion
	This list should be reviewed and updated semi-annually each year; • Specific information to be shared with government and elected officials before, during and after an outage event, how that information will be shared, and the minimum frequencies of communications; and, • A dedicated electronic system to be used for memorializing and tracking all communications, e.g., emails, telephone calls, made to and received by federal, state, and local government officials as well as community organizations, that memorializes all relevant details regarding such communications.	
40	Con Edison should develop a detailed and comprehensive process for issuing blast e-mails to customers in accordance with internal procedures and Commission Orders, e.g., Outage Notification Incentive Mechanism, Orders approving Emergency Response Plans, etc.; and, content will include, but not be limited to, summaries of the information contained in press releases. The process should be included in the Company's ERP.	December 31, 2020

APPENDIX B - LIST OF PANEL RECOMMENDATIONS

MANHATTAN OUTAGE EVENT

THE 27 PANEL RECOMMENDATIONS RELATED TO CON EDISON'S LESSONS LEARNED AND SELF-IDENTIFIED RECOMMENDATIONS REGARDING THE JULY 2019 MANHATTAN OUTAGE:

1. Develop and Issue Lessons Learned Debriefing Document.
2. Publicize Improvements to System.
3. Enhance 87N Relay Verification Plan.
4. Implement Primary Injection Testing in Commissioning Procedures.
5. Quality Control to Ensure Correct Technical Drawings.

Cable Testing and Maintenance

6. Implement Existing Cable Assessment Technologies.
7. Evaluate Emerging Cable Assessment Technologies.
8. Consider Rejuvenation of Old XLPE Cable Systems.
9. Modify Feeder Testing Specifications and Eliminate the Use of DC HiPot Tests.
10. Prevent Connection of Old PILC Cables to New Splices.

Relay Timing and Coordination

11. Reassess and Shorten Fault Clearing Times.
12. Proactively Search for Hidden Protection System Failures.
13. Implement Emerging Technologies to Detect System Abnormalities and Hidden Failures in Real-Time.
14. Ensure Time Synchronization Across All Systems Rapid Restoration and Situational Awareness.
15. Update Rapid Restoration Procedures to Include Remote/ Manual Resetting Guidelines and Traffic Contingency Plans for Reaching Unmanned Substations.
16. Regularly Test Remote Controls and SCADA Connectivity.
17. Enhance Personnel Training Program.
18. Ensure Data Captured and Transmitted by Digital Relays Enable Adequate Situational Awareness.

Transformer Operations and Maintenance

19. Enhance Transformer Situational Awareness.
20. Implement Regular Visual Checks to Ensure Early Identification of Malfunctioning Equipment.
21. Verify Transformer Commissioning and Maintenance Procedures Ensure Full Cooling and Capabilities.
22. Quantify and Track Transformer Loss of Life Through Hot Spot Device Data.
23. Update Arrester Selection Procedure to Ensure Appropriate Voltage and Energy Ratings.

Other Recommendations

24. Implement Adequate Fault Isolation Mechanisms.
25. Eliminate Ambiguous Terminology.
26. Improve Quality Control Processes Company-Wide.
27. Improve Proactive Asset Management Company-Wide.

BROOKLYN OUTAGE EVENT

THE 21 PANEL RECOMMENDATIONS RELATED TO CON EDISON'S LESSONS LEARNED AND SELF-IDENTIFIED RECOMMENDATIONS REGARDING THE JULY 2019 BROOKLYN OUTAGE:

Cable Testing and Maintenance

1. Further Explore Existing Cable Testing Technologies
2. Evaluate Emerging Cable Assessment Technologies
3. Rejuvenate Old XLPE and EPR Cable Systems
4. Investigate and Address Increased Failure Rates for the 27 kV Flatbush Network
5. Modify Feeder Testing Specifications to Completely Eliminate the Use of DC HiPot Tests
6. Avoid Splicing Old PILC Cables to New Cables
7. Consider Upgrade of Voltage on 27 kV and 4 kV Networks
8. Ensure Adequate Training of Personnel Responsible for Heat and Cold Shrink Cable Splices

Relay Timing and Coordination

9. Review Settings on Phase Balance Relays Prior to the Summer Peak Loads
10. Implement Digital Protection Technologies

Breakers

11. Implement Improved Fault Isolation Mechanisms
12. Increase AC HiPot Testing Voltage on 5 kV Class Breakers to Comply with Manufacturers' Recommendations
13. Optimize Breaker Ground Connections by Replacing Aluminum Ground Buses with Copper Where Possible, or Using Antioxidation Posts on Aluminum Ground Bus Tabs Rapid Restoration and Situational Awareness
14. Implement Technologies to Detect Down Conductors
15. Enhance the SCADA System by Implementing Automated Alarms and Regular Maintenance Procedures

Transformer Operations and Maintenance

16. Enhance Transformer Situational Awareness
17. Estimate and Track Data for Transformer Loss of Life in an Asset Database, Accounting for Phase Loading to Identify Greatest Accumulated Loss of Life
18. Validate Calculations for Top Oil and Hot Spot Temperatures to Assess and Monitor the Effectiveness of External Cooling

Other Recommendations

19. Ensure Adequate Demand Response Resources Prior to Summer Peak Loads
20. Review NRI Data and Calculations to Identify Best Practices from High Performing Networks that can be Applied to Other Operating Areas
21. Eliminate Ambiguous Terminology with Respect to Cable Classifications