Carlos A. Gavilondo
Acting Assistant General Counsel & Director

October 2, 2017

Via Electronic Filing

Honorable Kathleen H. Burgess, Secretary
New York State Department of Public Service
3 Empire State Plaza, 19th Floor
Albany, NY 12223-1350

Re: Case 12-E-0201 – Proceeding on Motion of the Commission as to the Rates, Charges, Rules and Regulations of Niagara Mohawk Power Corporation d/b/a National Grid for Electric Service; Annual Asset Condition Report Filing

Dear Secretary Burgess:

Pursuant to the Joint Proposal approved by the New York Public Service Commission March 15, 2013 in Cases 12-E-0201 and 12-G-0202, and the September 17, 2007 Order in Case 06-M-0878, Niagara Mohawk Power Corporation d/b/a National Grid submits this annual "Report on the Condition of Physical Elements of Transmission and Distribution Systems" ("Asset Condition Report").

Thank you for your attention to this matter.

Respectfully submitted,

/s/ Carlos A. Gavilondo
Carlos A. Gavilondo

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REPORT ON THE CONDITION OF PHYSICAL ELEMENTS OF TRANSMISSION AND DISTRIBUTION SYSTEMS

CASE 12-E-0201

THE STATE OF NEW YORK PUBLIC SERVICE COMMISSION

THREE EMPIRE STATE PLAZA

ALBANY, NY 12223

OCTOBER 1, 2017

nationalgrid

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Chapter 1. Executive Summary

Pursuant to the Joint Proposal approved by the New York Public Service Commission (PSC) March 15, 2013 in Cases 12-E-0201 and 12-G-0202, and the September 17, 2007 Order in Case 06-M-0878, Niagara Mohawk Power Corporation d/b/a National Grid ("National Grid" or the "Company") submits this annual report on the physical condition of its transmission and distribution ("T&D") facilities.

The Company's primary mission is the safe and reliabile delivery of electricity to customers and the transmission of electricity to support regional electricity markets. This report outlines the results of inspections and analyses of the Company's assets. Presently, the physical elements of National Grid's T&D infrastructure are generally adequate to provide safe and reliable service. However, this report highlights asset and system conditions that require continued monitoring and evaluation, as well as asset and system conditions that require investment to ensure continued safe and reliable service. The asset and system conditions identified in this report guide the development of the Company's capital investment and maintenance plans.

1. A. Asset Condition

The Company evaluates asset condition to determine which assets should be replaced before their performance negatively impacts the provision of safe and adequate service. The physical elements of National Grid's T&D facilities in New York have a service life ranging up to 100+ years of age. While many assets have passed their typical asset life, detailed engineering evaluations of conductor and structures continue to show that 'older' assets are in serviceable condition. Often times assets require only repair and selected replacement as opposed to a complete rebuild. Station equipment service life has also been extended through the use of diagnostic test results and equipment class history to guide replacement decisions. Thus, an asset's projected service life is sometimes used to identify assets requiring further engineering analysis and, in asset planning, it is a factor that can help predict the volume of assets that will require replacement in the future.

1. A. 1. Transmission System

National Grid's transmission system comprises transmission lines and substations operating at 115kV, 230kV and 345kV. National Grid has approximately 4,800 circuit miles of 115kV lines, 500 miles of 230kV, and 700 miles of 345kV. These facilities are extensively interconnected with facilities owned by other transmission owners in New York, surrounding states, and Canada.

Overall, the condition of National Grid's bulk power transmission system (345kV and 230kV) is safe and adequate to provide service, though there are issues in each asset class that present condition and obsolescence concerns. Likewise, the 115kV system is generally safe and adequate for service; however, there are specific areas of poor condition. Specific areas of interest include:

1. A. 1. 1. Structures

There were four (4) steel structures graded at visual level 5 (significant pitting) requiring investment in 2016 (see Table 2A-7). The Company has annual inspection programs to identify and replace any priority reject poles when they are identified. No priority reject poles were found in 2016.

1. A. 1. 2. Phase Conductors

Conductor, static wire and splice issues and failures pose safety and reliability risks. The overhead line refurbishment program provides a systematic long-term approach to address issues related to conductor condition, shield wires, supporting hardware and splices. Lines that have had multiple conductor failures over the previous five years due to condition issues are also being addressed.

1. A. 1. 3. Substations

A number of transmission substations have significant structural and asset condition issues that will require major refurbishment projects rather than individual asset replacement projects. For example, National Grid is proceeding with substation rebuild projects for Gardenville 115kV, Huntley, and Dunkirk, and will be redeveloping projects for Rotterdam, Lockport 115kV, Lighthouse Hill 115kV, Oswego 345kV and Inghams stations.

1. A. 1. 4. Circuit Breakers

The oil circuit breaker population is experiencing degradation that requires additional maintenance and creates system reliability and customer service concerns. A ten-year circuit breaker replacement strategy was approved in December 2010 to address oil circuit breakers posing the greatest safety and reliability concerns. A list of 125 potential breaker replacement candidates is discussed in Chapter 2. Many of these breakers will be replaced as part of their respective station rebuilds.

1. A. 1. 5. Transformers
National Grid has over 500 transformers in service. There are approximately 30 power transformers on the transmission system that have been placed on a "watch list" that provides for closer monitoring of condition and performance. Surveillance and regular dissolved gas analysis ("DGA") sampling enables the Company to prioritize transformer replacements appropriately.

1. A. 1. 6. Protection and Controls
National Grid maintains approximately 19,000 individual protection relays on the transmission system. Approximately 84% of the relay population consists of electromechanical relays on which degradation, such as worn contacts and frayed wiring insulation due to heat, is expected. Calibration drift was also found in electromechanical and solid state relays, indicating electrical/mechanical component failures (i.e., capacitors, coils, resistors). Further, solid state relays exhibit problems such as card failures and obsolescence. A strategy was approved to replace the relays. In general, the replacement plan will be implemented on a line-by-line basis.

Other asset groups and details of the performance of these assets are also provided in Chapter 2A, along with descriptions of programs to address concerns relating to these assets.

1. A. 2. Sub-Transmission System

National Grid's sub-transmission system comprises lines and substations typically operating at voltages at or below 69kV. National Grid has approximately 4,800 circuit miles of overhead sub-transmission lines and 1,100 circuit miles of sub-transmission underground cable. With certain exceptions noted in this report, the physical elements of National Grid's sub-transmission infrastructure are safe and adequate, although many sub-transmission assets have been in service for nearly a century.

Inspection and Maintenance program activities generate asset condition information and remediate asset condition issues. If a significant number of condition concerns are identified on a particular circuit, a detailed engineering review may be conducted leading to a comprehensive line refurbishment project.

1. A. 2. 1. Overhead System Assets
National Grid has approximately 67,000 wood structures and approximately 2,800 steel towers on its sub-transmission system.

1. A. 2. 2. Underground System Assets
Underground cables identified as poor performers and verified as being in poor condition continue to be replaced. There are approximately 1,100 circuit miles of sub-transmission cable. Approximately one-half is more than 47 years old and

one-third is more than 60 years old. A long term program has been initiated in the City of Buffalo to begin replacement of 23kV PILC cable.

1. A. 3. Distribution System

The Company's distribution system comprises lines and substations operating at 15kV and below. There are approximately 40,000 circuit miles of overhead primary wire and approximately 7,500 circuit miles of underground primary cable on the system supplying over 400,000 overhead, padmount and underground transformer locations. Additionally, there are over 500 substations providing service to customers.

With certain exceptions noted in this report, the distribution system is generally in safe and adequate condition to provide electric service. National Grid continues to gather data and monitor assets in a proactive manner to ensure that any adverse trends are identified. Inspection and Maintenance program activities generate asset condition information and remediate asset condition issues. Program work on the distribution system is summarized in Exhibit 3.

1. A. 3. 1. Overhead System Assets

For calendar year 2016, approximately 255,700 distribution pole inspections were completed, representing approximately 21 percent of the population. Based on these inspections, approximately 7,800 poles have been identified as requiring replacement over the next three years.

Also based on calendar year 2016 inspections, 329 transformers (out of a total population of approximately 338,300) were identified as candidates for replacement over the next three years.

1. A. 3. 2. Underground System Assets

There were over 2,900 manholes and vaults inspected in calendar year 2016. The inspection results can be found in Exhibit 3.

1. A. 3. 3. Distribution Substations

While generally adequate for providing safe and reliable service, these systems require investment to address condition-related degradation in the areas of (1) primary equipment and (2) secondary protection and control cabling insulation.

1. A. 3. 4. Indoor Substations

National Grid has thirty-four (34) 23-4.16kV indoor substations in Buffalo and seven substations elsewhere that were built in the 1920s through the 1940s and have been targeted for replacement. These stations present a number of reliability and safety concerns. Nineteen substation rebuilds in Buffalo have been completed. The five-year capital investment plan also discusses on-going and proposed indoor substation work.

1. A. 3. 5. Metal-Clad Substations

Metal-clad equipment, when deteriorated, is prone to water and animal ingress which could lead to failures. The Company has utilized advanced testing techniques based on electro-acoustic detection to identify potential issues. The initial review using these techniques identified a number of locations where minor repairs or refurbishments are recommended.

1. A. 3. 6. Power Transformers

There are over 40 power transformers that supply the distribution system that have been placed on a "watch list" and are being monitored more closely. A contingency plan has been identified for transformers on the watch list.

1. A. 3. 7. Circuit Breakers

National Grid has approximately 3,900 circuit breakers and over 140 spares on the distribution system. Based upon condition, obsolescence or poor performance, certain families of breakers are targeted for replacement or refurbishment.

1. A. 3. 8. Protection and Controls

Approximatly 31,500 in-service relay systems that protect distribution station equipment are electromechanical types that do not support modern fault recording and analysis. Moreover, a number of these relays are no longer supported by the manufacturer and replacement parts are no longer available.

Other asset groups and details of the performance of these assets and any programs developed to address concerns relating to these assets are described in Chapter 2.

1. B. Organization of the Filing

The remainder of this document consists of the following:

- Chapter 2 - Asset Condition focuses on the details of physical assets on the system and provides further insights into the condition of those assets as they relate to transmission, sub-transmission and distribution.

- Chapter 3 - Exhibits that support this Asset Condition report.

Chapter 2A. Transmission System Asset Condition

This chapter provides a detailed condition report of the Company's transmission assets. Specifically, it describes physical condition information, age profile of assets, and explanations of how the information is used to identify high risk facilities that may require intervention. Where programs are proposed to address specific problem areas, a description of the proposed remedial actions is provided.

Table 2A-1 provides an inventory of key system elements.

Table 2A-1
Transmission Asset Types (115kV and above)

Main Asset	Quantity
Steel Structures (Towers and Poles)	19,118
Wood Poles	46,395
Phase Conductor (Circuit miles)	6,000 miles
Cables (Circuit miles)	53 miles
Substations (including transmission line locations with motorized switches)	310
Oil Circuit Breakers	321
SF6 Circuit Breakers	488
Transformers	533
Batteries	256
Surge Arrestors	753
Sensing Devices	1,421
Reactors	31
Disconnect Switches	1,838
Relays	19,368

2. A. 1 Summary of Condition Concerns

2. A. 1. 1. Steel Structures / Wood Poles

Field inspection data obtained during foot patrols for steel structures have shown a reduction in observed level 5 - Significant Pitting and level 6 - Very Severe Deterioration steel structures over the past three year (see Table 2A-7). In addition, the Company has annual inspection programs to identify and replace any priority reject poles when they are identified. Of the 1,006 wood poles inspected by Osmose there were 14 reject wood poles identified in 2016, of which 5 were restorable with Osmose C-trusses.

2. A. 1. 2. Phase Conductors

Conductors, static wire and splice failures pose potential safety and reliability concerns. The conductor clearance strategy (SG163)[1] was developed to address this concern. Additionally, the Overhead Line Refurbishment Program provides a long-term approach designed to address issues regarding conductor condition, shield wires and splices. Lines that have had multiple conductor failures over the previous five years (shown in Table 2A-16) are being addressed. All of the overhead line refurbishment and conductor clearance projects listed in this document are associated with the 115kV system.

2. A. 1. 3. Substations

A number of transmission substations have significant asset condition and configuration issues that will require major refurbishment projects rather than individual asset replacement. National Grid is proceeding with substation rebuild projects for Gardenville 115kV, Huntley, and Dunkirk, as well as redeveloping projects for Rotterdam, Lockport 115kV, Lighthouse Hill 115kV, Oswego 345kV, Inghams and Boonville stations.

2. A. 1. 4. Circuit Breakers

The oil circuit breaker population is experiencing degradation requiring additional maintenance and creates system reliability and customer service concerns. A ten-year circuit breaker replacement strategy was approved in December 2010 to address oil circuit breakers that pose the greatest safety and reliability concerns. A list of potential breaker replacement candidates has been assembled (see Table 2A-28). Many of these breakers will be replaced as part of their respective station rebuilds.

2. A. 1. 5. Transformers

National Grid has approximately 533 transmission transformers in service. Table 2A-32 provides a list of transformers currently being monitored. In some instances, further evaluation is necessary to properly understand their condition. Surveillance and regular

[1] SG163 supersedes previous clearance strategy SG029 to allow the advancement of the North American Electric Reliability Corporation (NERC) recommendation entitled “Consideration of Actual Field Conditions in Determination of Facility Ratings.” For non-bulk circuits, SG163 suspended SG029 Version 3.

dissolved gas analysis ("DGA") sampling will enable the Company to appropriately identify and prioritize replacement.

2. A. 2. Overhead System

2. A. 2. 1. Overhead Lines

The majority of steel structures on the transmission system have been in service since the 1930s (see Figure 2A-6). While engineering analyses continue to show that 'older' assets are often serviceable, overhead line assets experience declining reliability as the effects of environmental, mechanical and electrical degradation result in a failure to meet original design standards. In many cases assets require only repair and selected replacement as opposed to a complete rebuild.

The Overhead Line Refurbishment Program is designed to comply with the National Electrical Safety Code (NESC). Overhead line refurbishments, occurs following in-depth materials assessments and engineering evaluations. Actual physical condition and the severity of equipment deterioration determines whether and when overhead transmission refurbishment will proceed.

Many of the existing candidates for refurbishment were initially screened using five-year average reliability statistics, a process which incorporates the following factors: (1) customer, (2) exposure, (3) inspection, and (4) condition-related reliability performance. The resulting list of potential refurbishment projects, along with feedback from field personnel and engineering, is used to prioritize future overhead line refurbishment projects.

In general, the approach for refurbishing overhead lines involves only the replacement of in kind overhead line components deemed to be in poor condition or failing to meet appropriate NESC requirements. If components are unlikely to perform adequately for at least 15 years, they may also be replaced when justified by an engineering evaluation and cost considerations. Condition issues are identified through engineering field inspections and, when appropriate, materials testing and analysis. For example, samples of older conductors may be tested to determine strength and ductility. Ground line inspection data may also be analyzed to determine if the NESC strength requirements are being met.

If a significant amount of line component replacements are necessary, alternatives to a one-for-one replacement are examined by Transmission Planning. For example, a line upgrade may be considered if transmission planning studies show that (1) a system re-configuration is a better option than a straight one-for-one in-kind replacement, or (2) another line might be cost effectively de-commissioned as a result of the upgrade.

2. A. 2. 1. 1.Condition and Performance Issues

Transmission lines are inspected on a recurring basis as follows:

- Aerial visual patrol: once each year
- Aerial infrared patrol: once each year
- Ground-based (foot) visual patrol: once every 5 years
- Wood pole inspection and treatment (Osmose): once every 10 years (guideline)
- Steel tower footing inspection and repair: once every 20 years (guideline)
- Tower painting: once every 20 years (guideline)

For ground-based visual patrols, issues are entered into an inspection database (Computapole) via a hand held computer. For the aerial visual and aerial infrared patrols, issues are entered into Computapole manually. Each problem is given a priority code as follows:

Table 2A-2
Priority Codes

Priority Code	Required Response
Level 1	Problem must be repaired/addressed within one week
Level 2	Problem must be repaired/addressed within one year
Level 3	Problem must be repaired/addressed within three years
Level 4	Inspection findings “for information only”
Level P	Problem with a corrective action performed at the time of the inspection process

2. A. 2. 1. 2. Remedial Actions Performed

The Company’s Overhead Line Refurbishment Program establishes a systematic asset replacement and refurbishment approach for addressing overhead lines, targeting both wood pole and steel structure lines. Reliability improvements resulting from this program will be gradual and long term in nature. The program sets forth the following refurbishment categories: safety, life extension, and full refurbishments. Life extension refurbishments seek to improve reliability and extend the useful life of a line 15-20 years. Safety refurbishments seek to safely secure a line for approximately 5 years until a more comprehensive refurbishment or replacement project can be completed. The focus of a safety refurbishment is mostly at critical crossings (such as over roadways, parking lots, railways, and navigable waterways) where potential public safety concerns are the highest and corrective action is immediately required. A safety refurbishment is often pursued when severe degradation issues need to be addressed and will sometimes precede more comprehensive Article VII or Part 102 refurbishment projects. More comprehensive refurbishments will be based upon condition and typically are targeted to last beyond 15-20 years.

The Company uses a comprehensive screening tool to help prioritize circuits when considering condition-based refurbishments projects. This prioritization methodology is discussed in detail in section 2.A.2.1.3 below, and is solely for the purposes of screening. A circuit's prioritization score and project scope will be determined after engineering field inspections and evaluations have been completed. Next, a circuit refurbishment project selection is then made. The following overhead line refurbishment projects are in conceptual engineering (E2E Step 0). During this part of the process, an engineering condition evaluation, which includes a field survey, will be completed. Based upon this condition assessment, an appropriate refurbishment scope and schedule will be determined.

Table 2A-3
Overhead Line Refurbishment Projects in Conceptual Engineering

Project Number	Title	Voltage	Typical Installation Date
C003422	Lockport-Batavia 112 ACR	115kV	1930s-40s
C027425	Gardenville-Homer Hill 151-152 South ACR	115kV	1920s
C027436	Packard - Gardenville 180-182 ACR	115kV	1930s
C030889	Pannell-Geneva 4-4A ACR	115kV	1900s-20s
C036164	Colton - Browns Falls 1-2 ACR	115kV	1920s
C047816	Mortimer-Pannell 24-25 ACR	115kV	1940s
C05531	Brockport Tap ACR	115kV	1940s-50s
C069538	Huntley-Lockport 36-37 ACR	115kV	1930s-40s

The following overhead line refurbishment projects are underway or were completed since the last Asset Condition Report:

Table 2A-4
Overhead Line Refurbishment Projects now Past Conceptual Engineering

Project Number	Title[2]	Voltage	Typical Installation Date (Before)	Status
C033014	Alabama-Telegraph 115 ACR	115kV	1940s	Final Engineering

[2] Note that ACR stands for Asset Condition [and Reliability] Refurbishment.

Project Number	Title[2]	Voltage	Typical Installation Date (Before)	Status
C024359	Browns Falls-Taylorville 3-4 ACR	115kV	1920s	Construction
C027429	Homer Hill-Bennett 157 ACR	115kV	1950s	Completed
C039487	Ticonderoga 2-3	115kV	1920s	Preliminary Engineering
C003389	Gardenville-Dunkirk 141-142	115kV	1930s	Preliminary Engineering

The Company continues to evaluate the New Scotland-Leeds-Pleasant Valley corridor to determine what solutions are needed to enhance its reliability. A number of potential condition-based issues that may impact this corridor's reliability performance have been identified:

- potential exposure to cascading Type 3A/3B structure failure;
- the number of transmission crossings;
- tensile and torsional ductility tests on phase conductors;
- lightning performance; and
- susceptibility to damage from high winds based on current design criteria.

Osprey Mitigation:
Another overhead line remedial action outside of the refurbishment program discussed above includes Osprey mitigation efforts. Ospreys are birds of prey that build large nests of sticks, which can reach 4-7 feet in diameter and similar height, atop transmission structures. The nests typically weigh up to 400 pounds. Interruptions can occur when the nests come into contact with energized conductor or the bird droppings cause an arc between phase conductors.

There are growing populations of Ospreys in the Adirondack, Central and Southwest regions of NY. For Transmission, the problem area is in the Central region where the Ospreys have expanded from the Oswego River corridor through the Cicero Swamp over to the Mortimer-Pannell-Elbridge triangle.

The Company has addressed line outages caused by Ospreys on 115kV lines with the addition of new platforms atop poles adjacent to structures with nests, which is a proven alternative for the Ospreys to nest on as long as that site is the highest point within that area.

Avian mitigation efforts for future transmission lines will be either included as part of asset condition refurbishments or the Osprey Mitigation Program (C076662) when problems with danger nests on a line require action to improve reliability. The Ticonderoga-Whitehall #3 & Ticonderoga-Republic #2 115kV lines are heavily populated with Ospreys and platforms were included as part of the safety refurbishment project on these lines (C039487). In FY18 the Osprey Mitigation Program will focus on the Teall-Oneida #5 115kV line, adding poles and platforms adjacent to structures with nests.

2. A. 2. 1. 3. Screening Methodology Approach

National Grid uses a screening tool to help prioritize circuits when considering future transmission condition based refurbishments projects. This tool is solely for the purposes of initial screening. The circuits selected to be refurbished will based upon initial screening score, engineering field inspections, and internal evaluations.

The screening factors were determined based on the findings of an internal asset criticality review team and assigned the following weighting percentages:

Customer – 20%
Exposure – 20%
Reliability – 20%
Condition – 40%

Within each of the four categories, the attributes are given a score from 1 to 5, with 1 being best (least critical) and 5 being worst (most critical). The weight for each score is given an exponential value to emphasize the criticality in any particular category. The exponential factor was chosen to create separation in the importance of each category. Based on the asset criticality team review of the scoring system and desire to show separation in the importance of each category, an exponential factor (Score x $^{4.29}$) was applied resulting in the following approximate weights:

Score 1 – Exponential Weight of 1 (least critical)
Score 2 – Exponential Weight of 20
Score 3 – Exponential Weight of 100 (monitor)
Score 4 – Exponential Weight of 400 (recommended action)
Score 5 – Exponential Weight of 1000 (action required)

2. A. 2. 1. 4. Criteria used for Customer Score

For Customer, the factors used in the analysis for each transmission line include system security, peak load flow, generation, and congestion. For bulk transmission lines, these are the factors used. In the case of load transmission lines, the number of customers on the line as well as any potential stranded load is considered. These factors are used to determine what is called Line Importance Factors (LIF). The LIF scores are separated into 10 percentiles and given a score of 1 to 10 based on their relative rating. The percentages used to determine the LIF score for both bulk and load lines are shown below:

LIF Bulk = System Security (50%) + Peak Load Flow (20%) + Generation (20%) + Congestion (10%)

LIF Load = System Security (30%) + Stranded Load (25%) + Number of Customers (15%) + Generation (15%) + Peak Load Flow (10%) + Congestion (5%).

CUSTOMER SCORE:

Score 1 – LIF 1
Score 2 – LIF 2 to 4
Score 3 – LIF 5 to 7
Score 4 – LIF 8 to 9
Score 5 – LIF 10

2. A. 2. 1. 5. Criteria Used for "Exposure"

As described above, there are five groups (or ranges) of data that indicate the exponential weighting factor for the determination of the criticality score in each of the four categories. For Exposure, the factors used in the analysis include the numbers of crossings (road, rail, and water) as well as the regional population density (density per square mile). A weighting of these factors within the Exposure category was used to determine the overall Exposure score. In the case of overhead transmission lines, the formula used for the data was:

Crossing Score = [(0.33 x # of road crossings) + (0.33 x # of rail crossings) + (0.17 x # of river crossings) + (0.17 x # of water crossings)] / circuit length

Crossing Ranking:

Score 1 – Crossing Score less than 0.5 per mile
Score 2 – Crossing Score 0.5 to 2 per mile
Score 3 – Crossing Score 2 to 4 per mile
Score 4 – Crossing Score 4 to 8 per mile
Score 5 – Crossing Score more than 8 per mile

Population Density Ranking:

Score 1 – Density less than 1,000 people per sq. mile
Score 2 – Density between 1,001 to 10,000 people
Score 3 – Density between 10,001 to 25,000 people

Score 4 – Density between 25,001 to 100,000 people
Score 5 – Density over 100,001 people per sq. mile

EXPOSURE SCORE: 0.67 (Crossing Ranking) + 0.33 (Population Density Ranking)

2. A. 2. 1. 6. Criteria Used for "Asset Condition"

For Asset Condition, the factors used in the analysis for each transmission line includes the condition of the structures, the number of issues found per mile based on the most recent foot patrol inspection (5-year cycle), as well as the conductor and shield wire condition. Each of the four components is weighted equally (25%). Within each of the four components, the following criteria are used:

Structure Score = weighted average score between steel and wood = [Wood Score (# wood structures / (# wood structures + # steel structures)] + [Steel Score (# steel structures / (# wood structures + # steel structures)]

Where the wood score is based on the calculated strength loss calculated as a result of the ground line inspection (10-year cycle) for each structure along the line and placed into one of the following five categories with the responding wood structure score:

Wood Ranking:

Score 1 – Strength loss of no more than 2%
Score 2 – Strength loss of between 2% and 5%
Score 3 – Strength loss of between 5% and 10%
Score 4 – Strength loss of between 10% and 15%
Score 5 – Strength loss of greater than 15%

Wood Score = [(# of Score 5 x 1000) + (# of Score 4 x 400) + (# of Score 3 x 100) + (# of Score 2 x 40) + (# of Score 1 x 1)] / total # of wood structures.

The steel rating score directly corresponds to the score the structure received during a foot patrol inspection. Steel structures are rated from 1 to 5 based on the inspector's finding of rust and deterioration of the structure and footings are rated from 1 to 6. Training and guideline tools are given to the inspectors to help provide consistencies between inspection scoring along different lines. If footing scores are not provided, only the structure score is used.
Steel Ranking:

Score 1 – Inspection Rating 1
Score 2 – Inspection Rating 2
Score 3 – Inspection Rating 3
Score 4 – Inspection Rating 4
Score 5 – Inspection Rating 5 (and 6 for footings)

Steel Score = [(# of Score 5[&6] x 1000) + (# of Score 4 x 400) + (# of Score 3 x 100) + (# of Score 2 x 40) + (# of Score 1 x 1)] / total # of steel structures

The number of issues found per mile is scored based on the Level 1, 2 and 3 inspection issues identified in the 5-year foot patrol. The following provides the ranking based on the number of level 1 to 3 issues found on line per mile:

Issues Ranking:

Score 1 (1) – Less than 0.25 issues found per mile
Score 2 (40) – Between 0.25 and 0.50 issues found per mile
Score 3 (100) – Between 0.50 and 0.75 issues found per mile
Score 4 (400) – Between 0.75 and 1.00 issues found per mile
Score 5 (1000) – More than 1.00 issue found per mile

The circuit wire score is based on a combination of the conductor and shield wire relative ages. For the purpose of this analysis, the oldest relative age is used. The conductor score is based on the relative age of a conductor determined by the calculated tensile strength loss of the worse section of conductor found along the line. If the relative age of a conductor is not known and conductor testing results are unavailable, the actual age of the conductor can be used for a high level analysis approach. The following provides rankings based on the relative age of a conductor:

Conductor Ranking:

Score 1 (1) – Relative age of 49 years or less
Score 2 (40) – Relative age of 50 to 59 years
Score 3 (100) – Relative age of 60 to 69 years
Score 4 (400) – Relative age of 70 to 79 years
Score 5 (1000) – Relative age of greater than 80 years

The shield wire score is based on the relative age of a shield wire determined by the calculated tensile strength loss of the worse section of shield wire found along the line. If the relative age of a shield wire is not known and conductor testing results are unavailable, the actual age of the shield wire can be used for a high level analysis approach. The following provides rankings based on the relative age of a shield wire:

Shield Wire Ranking:

Score 1 (1) – Relative age of 39 years or less
Score 2 (40) – Relative age of 40 to 49 years
Score 3 (100) – Relative age of 50 to 59 years
Score 4 (400) – Relative age of 60 to 69 years
Score 5 (1000) – Relative age of greater than 70 years

Wire Score = 0.50 (Conductor Ranking) + 0.50 (Shield wire Ranking)
ASSET CONDITION SCORE: 0.33 (Structure Ranking) + 0.33 (Issues Ranking) + 0.33 (Wire Score)

2. A. 2. 1. 7. Criteria Used for "Reliability"

For Reliability, the factors used in the analysis for each transmission line includes a 5-year weighted Transmission Performance Score (TPS) which is comprised of outages along a line with respect to system security/availability, customer impact, and benchmarking. The weight of each criteria used are:

TPS = System Security/Availability (25%) + Customer Impact (50%) + Benchmark (25%)

Reliability Score:

Score 1 (1) – TPS greater than 97
Score 2 (40) – TPS 93 to 97
Score 3 (100) – TPS 89 to 93
Score 4 (400) – TPS 85 to 89
Score 5 (1000) – TPS less than 85

Figure 2A-5 below illustrates how the screening tool is used to identify transmission lines that are candidates for asset refurbishment projects showing a sample of commonly referred to circuits in the Company's Capital Investment Plan and Asset Condition Report. There are approximately five hundred (500) transmission lines and taps scored in the screening tool and comparing each one's relative priority score allows the Company to target higher priority lines with asset condition refurbishment projects.

Figure 2A-5
Key Screening Tool Circuits*

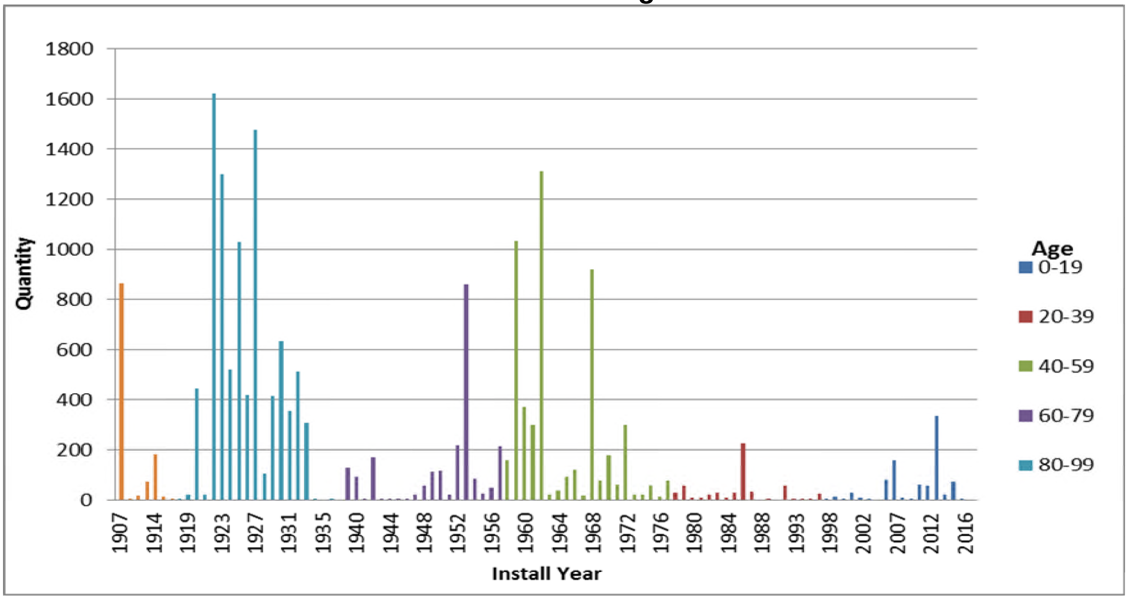
CIRCUIT_ID	Circuit Name	Voltage	Priority
T1090	Dunkirk – Falconer #161	115	Very High
T1100	Dunkirk – Falconer #162	115	Very High
T1260	Gardenville – Dunkirk #141	115	Very High
T1660	Niagara – Gardenville #180	115	Very High
T1890	Southeast Batavia – Golah #119	115	Very High
T1700	Niagara – Lockport #102	115	Very High
T1860	Pannell(Sta.122) –Geneva(Border City) #4	115	Very High
T2630	South Oswego – Nine Mile Pt.#1 #1	115	Very High
T1270	Gardenville – Dunkirk #142	115	Very High
T1450	Huntley – Lockport #37	115	Very High
T1690	Niagara-Lockport #101	115	Very High
T1700	Niagara-Lockport #102	115	Very High
T1160	Falconer – Homer Hill #153	115	Very High
T1230	Gardenville – Depew #54	115	Very High
T1500	Lockport – Batavia #108	115	Very High
T1510	Lockport – Batavia #112	115	Very High
T1810	Packard – Walck Road #129	115	Very High
T1550	Lockport – Mortimer #114	115	Very High
T5810	Ticonderoga-Republic #2	115	Very High
T5830	Ticonderoga-Whitehall #3	115	Very High
T1360	Homer Hill-West Olean	115	High
T3230	Malone – Lake Colby #5	115	High
T4030	Boonville-Porter #2	115	High
T1380	Huntley-Gardenville #38	115	High
T1390	Huntley-Gardenville #39	115	High
T2240	General Electric-Geres Lock #8	115	High
T1740	Niagara-Packard #192	115	High
T4300	Yahnundasis-Porter #3	115	High
T2660	Teall-Carr Street #6	115	High
T1080	Dunkirk – Falconer #160	115	High
T2120	Coffeen-Black River-Lighthouse Hill #5	115	High
T1570	Mortimer-Elbridge #2	115	High
T1340	Homer Hill-Bennett #157	115	High

*Inclusion in the table does not indicate a future project will be initiated. Final priority and project scopes will be determined based upon engineering field inspections and internal evaluations.

2. A. 2. 2. Steel Structures

The age distribution of the Company's steel transmission structures is given in Figure 2A-6, color-coded to show ages of steel structures in 20-year increments. The average age of these assets is 74 years old.

Figure 2A-6
NY Steel Structure Age Profile



Field inspection data obtained during foot patrols for steel structures have been recorded in Computapole. Condition ratings for steel structures are categorized as follows:

1 - Serviceable
2 - Intact
3 - Light Corrosion
4 - Light Pitting
5 - Significant Pitting
6 - Very Severe Deterioration

Table 2A-7 provides a list of current visual grading levels for steel structures entered into Computapole over the latest three full calendar years' worth of data.

Table 2A-7
Steel Structure Visual Grades

Visual Grade	2014	2015	2016	Total	%
1	1,574	2,573	1,431	5,578	47.2%
2	779	1,388	343	2,510	21.2%
3	477	940	686	2,103	17.8%
4	595	778	214	1,587	13.4%
5	22	9	4	35	0.3%
6	1	0	0	1	0.0%
Total	3,448	5,688	2,678	11,814	100.0%

A priority code is also assigned with each visual grade when a steel structure is inspected. Towers in worse condition would be coded visual grades 5 or 6. Engineering personnel will evaluate Visual Grade 6 towers after they are identified. Transmission lines with significant levels of Visual Grade 4 and 5 are targeted for a more comprehensive engineering inspection and analysis. This type of evaluation frequently uses more thorough analysis considering overall structural integrity and identifies severe corrosion at key support points.

2. A. 2. 2. 1. Condition and Performance Issues

Steel tower failures are infrequent. However, over the last 5 years there have been two steel tower failures on the New York Transmission system attributable to condition, confirming the need to evaluate and manage this asset class:

- March 2017 – Following a windstorm with gusts exceeding 80 mph in western NY, structure number 146 on the Gardenville-Dunkirk 141 – 142 lines partially collapsed and was replaced with a wood pole structure.

- June 2013 – Following the touch down of an F2 tornado with 125 mph winds in the area, four Type 3A structures on the Edic-New Scotland 14 line failed. A fifth structure (424) on this line suffered irreparable damage. Two structures (419 and 425) recently replaced prevented additional cascading failures.

2. A. 2. 2. 2. Remedial Actions Performed

Projects formerly identified as a result of the Steel Tower Strategy are being phased out. The more robust overhead line screening criteria, described in Section 2. A. 2. 1. 3, will be used to initially identify condition driven projects. This screening methodology accounts for the condition of steel towers based upon the 5-year foot patrol visual grading system. The following project (C027432) in Table 2A-8 is the last project to be refurbished under the Steel Tower Strategy. C027432 is in conceptual engineering (E2E

Step 0) and will be re-inspected using the steel visual grading in the Overhead Line Refurbishment Program to confirm the need for refurbishment.

Table 2A-8
Remaining Steel Tower Strategy Driven Project

Project Number	Title	Voltage	Typical Installation Date
C027432	Mountain-Lockport 103 and Beck-Lockport 104 STR	115kV	1950s

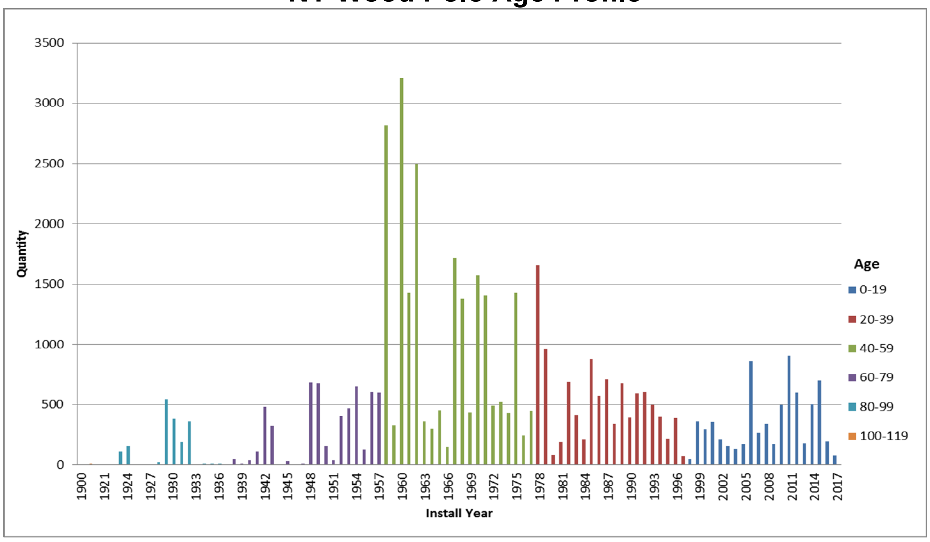
A steel tower painting program guides our approach toward the painting of steel structures to extend the service life of towers rated visual category 4 or better. The Company is working toward painting all of its 345kV and 230kV steel structures on a twenty-year cycle. For the 115kV circuits, painting priority is determined by applying visual rating codes.

In addition to the painting program, the Company performs a program of transmission footer inspections and repairs. This program systematically inspects foundations above and below grade and repairs damage primarily on a line-by-line basis.

2. A. 2. 3. Wood Poles

The age profile of the Company's wooden transmission poles is provided in Figure 2A-9. The average age of the Company's wooden transmission poles is 44 years.

Figure 2A-9
NY Wood Pole Age Profile



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2. A. 2. 3. 1. Condition and Performance Issues

National Grid inspects and treats the ground line of wood poles and structures on approximately a 10-year cycle. In addition, routine visual inspections of the entire structure are conducted once every five years. Wood poles and structures that do not meet the requirements of the NESC are classified as "rejects." Severely deteriorated wood poles and structures are classified as "priority rejects."

In general, reject poles and structures have two-thirds or less of their original design strength. Storm resiliency during severe weather events is the greatest concern for reject poles and structures. Failures can hamper service restoration efforts, increase outage durations and raise public safety concerns.

Priority reject poles and structures can potentially fail during "normal" weather conditions. For this type of reject pole, the residual strength may be below one-third of its original design strength and it is important to replace these poles and structures.

Consistent with the New York Public Service Commission Order issued on December 15, 2008, for Cases 04-M-0159 and 06-M-1467, priority reject poles are to be replaced within one (1) year of identification and reject poles within three (3) years of identification. If the construction crews, engineering, or the inspectors deem the situation poses a serious and immediate threat to the public or the delivery of power, the repair is done as soon as possible, but no longer than one week.

A continued growth in the population of woodpeckers is contributing to an increase in damage on wood poles. Wood pole and structure inspection criteria (per Strategy SG009, Version 2) were implemented at the end of 2007. As woodpecker damaged poles are identified, an appropriate priority code (i.e., maintenance code 526) and repair timeframe (generally within three years) is assigned. Progress is then tracked on an overall basis via Computapole monitoring.

Below is a brief summary of the only pole failure that has occurred over the last 3 years:

- July 2016 – a pole failure on the Niagara-Lockport #101 - 102 115kV line was caused by a combination of wind gusts and effective pole strength. This failure led to additional loading on adjacent structures cascading to include six failures on the #102 line. The transverse structure failures of the #102 line fell into the #101 line, which runs parallel approximately 40 ft away, and caused six pole failures on the 101 line. Twelve poles in all failed in this event.

Deteriorating wood cross arms are also being monitored. Below is a brief summary of the most recent wood cross-arm failure:

- April 2017 - the cross-arm on structure #45 on the 345kV Lafayette-Clarks Corners #4 line failed. Following the failure of this 1982 line, the entire circuit was aerially inspected. Other deteriorated cross arms and/or vee braces were identified and replaced. This circuit was younger than the circuits with the original failures. As a result, all wood H-frame 345kV structures are on the list of evaluation.

- May 2014 - structure #21 on the 345kV New Scotland-Alps #2 line failed. Structure #21 is a D-1501 similar to structure #156 that failed approximately 2 years prior. Both structure #21 and #156 are believed to have had the original laminated cross arms from the late 1960s.

National Grid collaborated with SUNY College of Environmental Science and Forestry on forensics of the failed D-1501 laminate cross-arm and v-brace from the New Scotland-Alps #2 345kV line as well as other samples taken from the line where it was determined that poor adhesion of the wood plies caused the failures. The Company expedited a project to replace these cross-arms at critical crossings on the #2 line, the Reynolds Road-Alps #1 345kV and the Alps-Berkshire #393 345kV lines. There are approximately 442 miles of lines across the transmission system with laminate cross-arms of that vintage and a replacement program has been developed.

2. A. 2. 3. 2. Remedial Actions Performed

A comprehensive wood pole management program and foot patrol inspections ensures "reject" poles, damaged poles, and rotting wood structures are replaced in a timely manner.

Table 2A-10 below lists foot patrol inspection results performed on wood poles over the last three calendar years. Inspectors assign priority level "Replace" codes for poles that appear broken, rotting or leaning on a scale of 1 – 3 with 1 being the highest replacement priority. They also assign priority level "Repair" codes for poles with lightning, insect, woodpecker or other damage on the same 1 - 3 scale. Poles that are in good overall condition are not assigned a priority level code.

Table 2A-10
Transmission Wood Pole Replace and Repair Codes from Computapole

Level	Replace Codes			Repair Codes		
	Number of Poles	Percent Codes vs. Inspections	Percent Completed	Number of Poles	Percent Codes vs. Inspections	Percent Completed
2014 Summary						
1	0	0.00%	100.00%	0	0.00%	100.00%
2	57	1.31%	100.00%	48	1.11%	100.00%
3	244	5.63%	23.40%	285	6.57%	17.10%
No Codes	3,788	87.38%				
Total Poles Inspected	4,335					
2015 Summary						
1	0	0.00%	100.00%	0	0.00%	100.00%
2	20	0.33%	100.00%	41	0.67%	100.00%
3	174	2.86%	12.60%	506	8.33%	16.40%
No Codes	5,444	89.61%				
Total Poles Inspected	6,075					
2016 Summary						
1	2	0.05%	100.00%	0	0.00%	100.00%
2	4	0.09%	25.00%	27	0.63%	92.60%
3	167	3.90%	3.60%	306	7.14%	2.94%
No Codes	3,877	90.50%				
Total Poles Inspected	4,284					

To provide reliable service and improve storm resiliency, the Company manages its large stock of in-service wood poles through the Wood Pole Management Program. Prompt identification and remediation of “reject” poles is particularly important due the increasing average age profile of in-service wood poles (see Figure 2A-9).

The combination of the Company’s Wood Pole Management Program and the Overhead Line Refurbishment Program help identify and address deteriorating lines.

2. A. 2. 4. Foundations

Computapole field inspection data are gathered on both steel and concrete foundations. Condition ratings for steel foundation types are categorized by the following scale:

1. Serviceable
2. Intact
3. Light Corrosion
4. Light Pitting
5. Significant Pitting
6. Very Severe Deterioration

Concrete foundations are categorized by the following scale:

1. Serviceable
2. Light deterioration
3. Medium deterioration
4. Severe deterioration
5. Very severe deterioration

Tables 2A-11 and 2A-12 include the last three full calendar year inspection results for steel and concrete foundations, respectively, for structures that had foundation ratings.

Table 2A-11
Steel Foundation Inspection Results

Visual Grade	2014	2015	2016	Total	%
1	1,227	2,453	1,145	4,825	64.0%
2	750	856	402	2,008	26.6%
3	110	324	48	482	6.4%
4	69	113	9	191	2.5%
5	22	7	2	31	0.4%
6	4	1	1	6	0.1%
Total	2,182	3,754	1,607	7,543	100.0%

Table 2A-12
Concrete Foundation Inspection Results

Visual Grade	2014	2015	2016	Total	%
1	1,061	1,669	964	3,694	86.9%
2	174	253	90	517	12.2%
3	13	10	12	35	0.8%
4	1	1	3	5	0.1%
5	0	0	2	2	0.0%
6	0	0	0	0	0.0%
Total	1,249	1,933	1,071	4,253	100.0%

The results provided in Tables 2A-11 and 2A-12 from standard Computapole field inspections, which are above the ground line, may differ from those inspections performed by the footer inspection and maintenance program which inspect foundations below the ground line and repair those that are defective.

Steel grillage foundation usage started in the 1920s. This type of steel foundation comprises the majority of lattice structure foundation types.[3] However, approximately five to ten percent of the lattice towers that were constructed prior to the use of the steel grillage design use a battered type concrete foundation which has a limited amount of

[3] Approximately 80 to 90 percent of steel structures in New York.

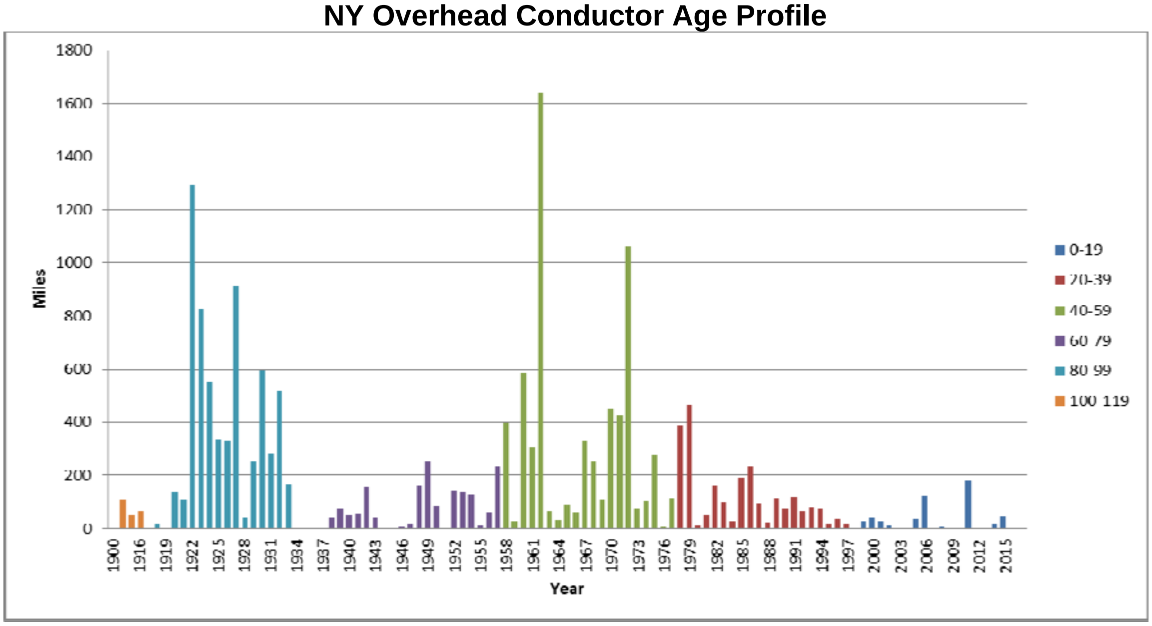
concrete exposed above the ground line. The remaining foundations (five to ten percent) are associated with steel poles and tend to be reinforced concrete.

2. A. 2. 5. Phase Conductor and Splices

There are approximately 18,000 conductor miles across the service territory at voltage levels 115kV and greater.

Figure 2A-13 shows the age profile of overhead conductors in the service territory, color coded to show ages of conductor in 20-year increments. Many miles of conductors are over 70 years old (installed in 1947 or earlier) with the average age of transmission overhead conductor 64 years[4]. The 115kV network is by far the oldest, with the oldest circuits being over 100 years old.

Figure 2A-13
NY Overhead Conductor Age Profile

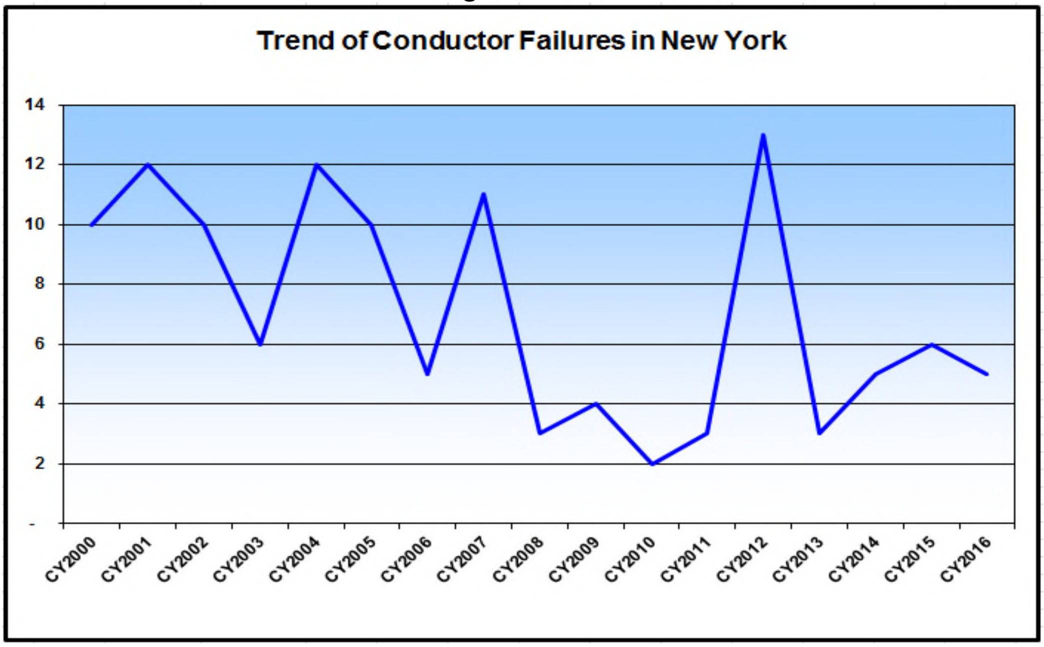


2. A. 2. 5. 1. Condition and Performance Issues

Conductor failures from calendar year 2000 to 2017 (Figure 2A-14) show appreciable annual variability. Failures reflect a general downward trend since 2001, albeit with a spike in 2012.

[4] This is for 345, 230 and 115kV transmission lines altogether.

Figure 2A-14



The total outage duration due to conductor failures shown in Figure 2A-15 shows a small increase in duration from 2011 to 2016, but still an overall continued downward trend in customer interruptions since 2004.

Figure 2A-15

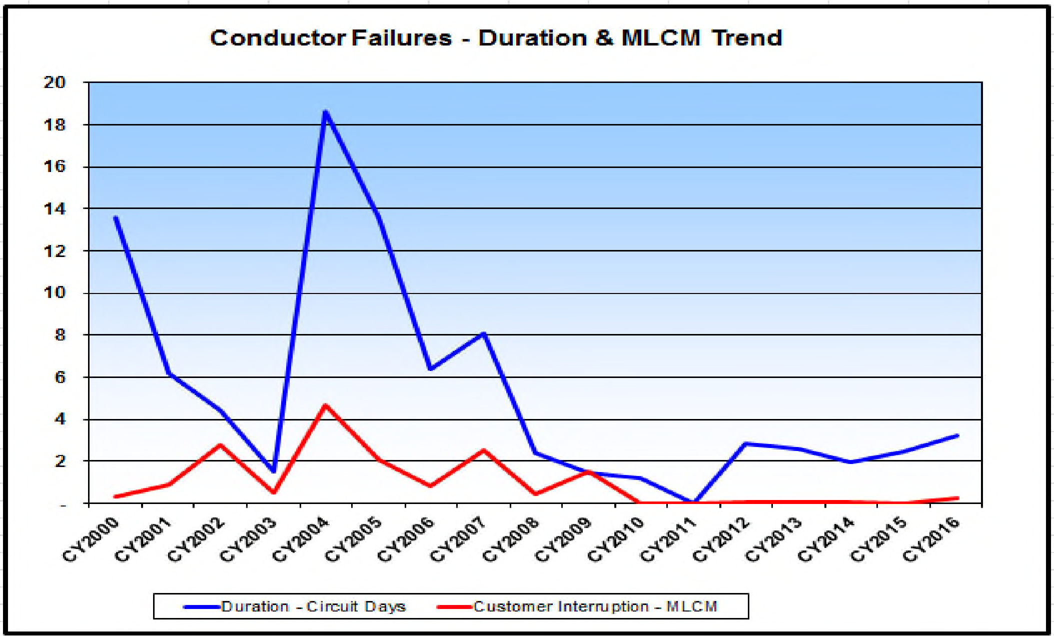


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Table 2A-16 lists those circuits with two or more phase conductor failures between 2012 and 2016, an indication that conductor condition may be a concern on these lines.

Table 2A-16
Lines with Multiple Phase Conductor Failures from 2012 to 2016

Circuit ID	Circuit Name	kV	Failures
T1490	Lockport-Batavia #107	115	8
T1860	Pannell (Sta.122) - Geneva (Border City) #4	115	3
T1260	Gardenville - Dunkirk #141	115	2
T2120	Coffeen-Black River-Lighthouse Hill #5	115	2
T1690	Niagara-Lockport #101	115	2

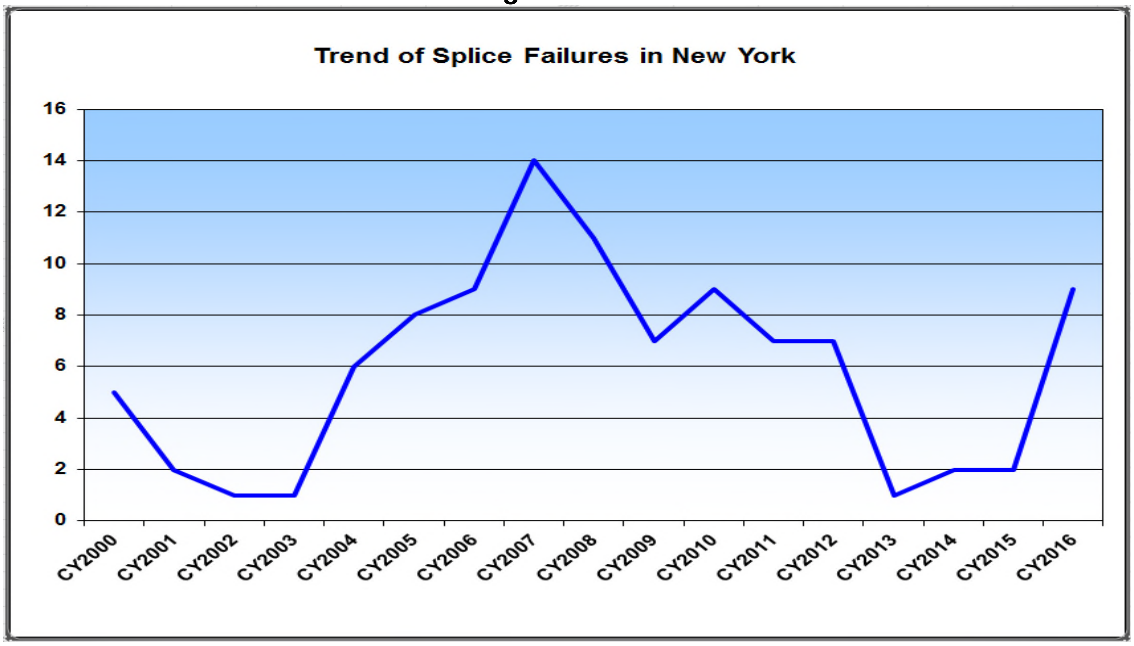
Conductor failures on the Lockport-Batavia #107 line are actually due to the Alabama-Telegraph tap off the #107 line. There is a refurbishment project in Step 2B (final engineering) to reconductor the tap and address other asset condition issues. The Pannell-Geneva 4 has a project in Step 0 (conceptual engineering) where conductor failed across the NYS Thruway in July 2015. The steel strands showed excessive corrosion with the protective Zinc coating almost completely worn away. The Gardenville-Dunkirk 141 & 142 lines have a project in Step 2A (preliminary engineering) for their full rebuild.. An asset condition refurbishment project on the Niagara-Lockport #101 and #102 lines is being initiated. The Coffeen-Black River-Lighthouse Hill #5 line tripped in 2015 when a downed conductor on the adjacent Coffeen-Black River #3 line came in contact with it.

There are three general types of conductor splices used in the NY transmission system for ACSR (Aluminum Conductor Steel Reinforced), AAC (All Aluminum Conductor), and copper conductor. Over time, expansion and contraction of a splice due to heating and cooling eventually allows for the penetration of oxygen and water. Once water and oxygen are present within the splice, the electrical interface between splice and conductor begins to break down increasing the resistance of the electrical interface. As electrical resistance increases so does the splice temperature. Eventually, the temperature of the splice will begin to rise and lead to failure if undetected. Elevated line operating temperatures and quality of splice installation are also factors that affect splice service life.

The Company has worked to better understand the cause of splice failures. Infrared inspections continue to be conducted every one to three years, depending upon voltage. Aerial infrared patrols are conducted annually in an effort to prevent splice failures. Aerial visual patrols are also done to identify potential conductor, splice, and shield wire concerns.

Figure 2A-17 below shows that splice failures on transmission lines spiked upward from 2015 to 2016. This increase is due to seven (7) splice failures on the Huntley-Lockport 37 115kV line in the past two years at the leading edge of splices on the 556.5 AAC portion of the line. An overhead line refurbishment project for the lines is now in Step 0 (conceptual engineering) which includes reconductoring the six mile 556.5 AAC section of the lines to remove all the remaining splices.

Figure 2A-17



2. A. 2. 5. 2. Conductor Clearance Program

The Transmission Conductor Clearance Program is an approximate eight year program to address clearance issues on the 115kV, 230kV, and 345kV system. The Company utilizes Aerial Laser Survey (ALS) information to identify potential clearance issues which then must be confirmed in the field by engineering personnel. Corrective actions include re-rating individual lines, structure modifications or replacement, temporary measures (such as restrictive fencing), or the relocation of conflicting structures below an affected transmission line.

In 1914, the NESC established criteria for the minimum distance required between electrical conductors and the ground (conductor phase-to-ground clearance) as well as a number of other parameters. Since the NESC design criteria typically undergoes revision and updates once every four years, each line constructed by National Grid meets different versions of the NESC. The applicable code at the time of construction is considered the 'governing code' for the design criteria. The 2012 NESC is the current governing code for new transmission lines located in New York.

The primary driver of the Conductor Clearance Program is safety. It outlines a systematic approach for mitigating the confirmed substandard transmission spans to the governing code which may create a potential safety issue to the public and Company's employees.

2. A. 2. 6. Insulators and Fittings

This asset group includes glass, porcelain and polymer insulators. Some insulators are more prone to failure due to moisture ingress as a result of design and manufacturing defects, most notably Lapp Polypace polymer insulators. Moisture penetration through the insulator's sheath to the fiberglass core can cause the insulator to fail. This failure can be through brittle fracture, a mechanical failure of the fiberglass, or flash-under, an electrical failure mode caused by tracking along or through the fiberglass rod. Catastrophic brittle fracture failures typically result in the conductor dropping from the structure.

Porcelain insulators are widely used on the transmission system. When refurbishments are conducted on transmission lines, existing insulators and fittings are frequently replaced with new ones. Replacement may be needed for many reasons:

- Older lines frequently have shield wire configurations that provide limited lightning protection resulting in repeated lightning strikes over time. This causes a breakdown of the ceramic glazing which reduces the electrical and structural characteristics of the insulator. Insulators damaged in this way are prone to tracking and flashovers.
- Avian use of the transmission lines for perching contributes to insulator contamination; the corrosive nature of the avian waste wears away at the glazing after extended exposure. In addition, the contaminants themselves are easily ionized and cause tracking and flashovers. Repeated tracking and flashovers burn off the insulator's ceramic glazing, reducing both the electrical and structural properties of the insulator.
- In rural areas, insulator strings are sometimes used for "target" practice by hunters.
- Continued exposure to the elements and severe weather wear away at the insulator glazing. Eventually the ceramic glazing wears off reducing both the electrical and structural properties of the insulator.
- Though not a prominent issue, conductor galloping can cause structural damage to an insulator string when insulators strike other objects.

2. A. 2. 6. 1. Remedial Action Planned

Insulators and fittings are examined to determine if replacement is needed during the field engineering walk-down of the Step 0 process which is performed prior to line refurbishment projects. Depending upon condition, insulators and/or fittings may be replaced on a targeted or complete line basis. Damaged insulators observed during comprehensive helicopter inspections are identified for replacement as part of planned refurbishment projects or as routine maintenance through the I&M program.

2. A. 2. 7. Retired and De-energized Overhead Lines

The Company has developed a strategy (USSC-12-048) and a prioritization method to address lines that are permanently de-energized. The prioritization includes an assessment of some initial circuits and a methodology for continuing with future assessments. Table 2A-18 lists the current set of prioritized de-energized line projects:

Table 2A-18
Active List of Prioritized Transmission De-Energized Line Projects

Region	Line	Length (mi)	Voltage (kV)
Northeast	Ticonderoga-Sanford Lake 4	22.2	115
Northern	Newstech Tap on Black River-Taylorville #2	3.8	115

2. A. 3. Underground Cables and Related Equipment

2. A. 3. 1. Cables

National Grid's underground transmission cable network is comprised of high pressure fluid filled (HPFF) pipe-type cable operating at 115kV, 230kV, and 345kV, and solid dielectric cable systems operating at 115kV. National Grid has 53.3 miles of underground transmission cable in service, approximately 80 percent of which are high-pressure fluid filled pipe-type, as shown in Table 2A-19. The installation year, by voltage and mileage, is shown in Figure 2A-20. An age distribution by number of circuits is shown in Table 2A-21.

Table 2A-19
Underground Cable Miles by Voltage

	115kV	230kV	345kV	Total
HPFF Pipe Type	22.1	20.2	0.7	43.0
Solid Dielectric	10.3	0	0	10.3
Total	**32.4**	**20.2**	**0.7**	**53.3**

Figure 2A-20
Underground Cable Age Profile

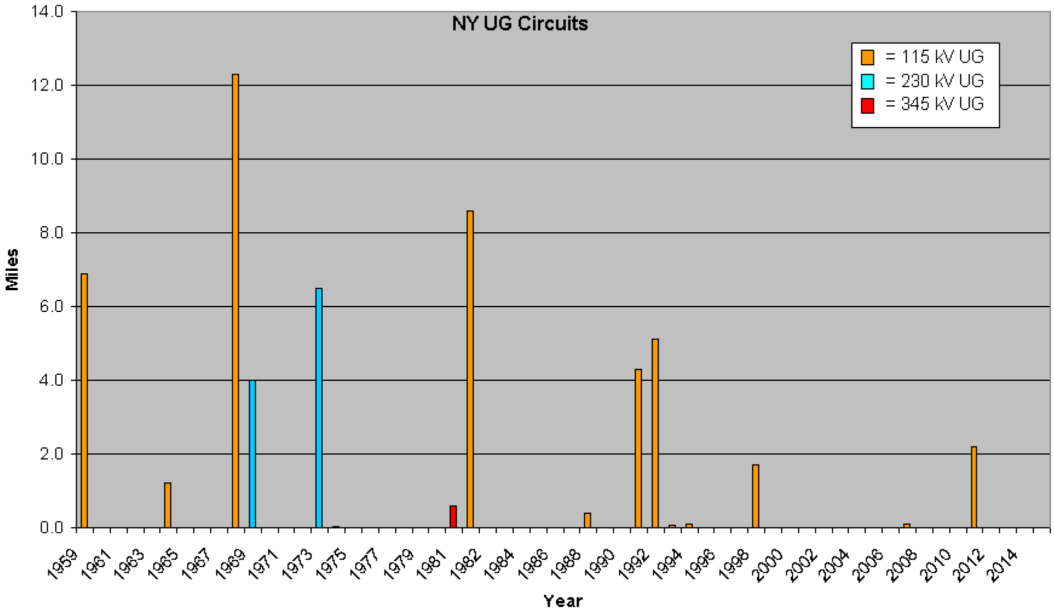


Table 2A-21
Asset/Age Profile Underground Cables (Circuits)

Asset/Age Profile (Years)	0-19	20-39	40-59	60+	Total
Underground Cables	6	15	16	0	37

2. A. 3. 1. 1. Condition and Performance Issues

Pipe Type Cables

High Pressure Fluid Filled (HPFF) pipe type cables consist of paper insulated conductors installed within a steel pipe. The pipe is filled with a dielectric fluid, which is maintained at a nominal pressure of 200 psi. Pressure is maintained on pipe type cables by means of "pressurizing plants" which contain pumps, pressure control valves, a fluid reservoir, and controls and alarms. The steel pipes and fluid reservoirs on a pipe type cable system contain relatively large volumes of dielectric fluid. There are potential environmental risks associated with release of dielectric fluid from these types of cables. While the likelihood of fluid leaks is rare, the consequential release volumes can be significant.

There are two major systems to be monitored on pipe type cable for both environmental integrity of the pipe system and to maintain reliable performance of the cables. They are the cathodic protection systems and the fluid pressurizing plants. The cathodic protection system protects the buried steel pipes from corrosion. Routine inspections are performed on the cathodic protection systems including annual surveys to determine that adequate protection exists along the cable routes. Bi-monthly visual and operational (V&O) inspections are also performed on the pressurizing plants.

A pressurizing plant condition assessment is on-going. This condition assessment is being undertaken by a combination of in-house personnel and external vendors and will form the basis of any future remedial work. Many of the current projects are a result of conditions identified during these assessments.

Table 2A-22 lists the locations of the pressurizing plants, cables served, manufacturer, and reservoir size.

Table 2A-22
Pipe Type Cables – Pressurizing Plants, Gas Cabinets, Crossover Assemblies

Station	City	Cables Served	Manufacturer	Reservoir Size (Gal)
Huntley Station	Tonawanda	Huntley-Elm #70	Jerome	15,000
Elm St	Buffalo	Elm-Seneca #71 Elm-Seneca #72 Elm St Bus Tie	Jerome	5,500
Seneca	Buffalo	Elm-Seneca #71 Elm-Seneca #72 Seneca-Gardenville #71 Seneca-Gardenville #72	Jerome	NA - Crossover Cabinet
Gardenville	W. Seneca	Seneca-Gardenville #71 Seneca-Gardenville #72	Jerome	5,500
Rochester Airport - East Portal	Rochester	Rochester #111 Rochester #113 Rochester #114	Jerome	3,500
E. Conklin	Onondaga	Conklin-Bailey #17A Conklin-Bailey #17B 10” Circulation Pipe	Salter	2,500
Teall Ave	Syracuse	Ash-Teall #7 Ash-Teall #8	Jerome	4,000
Temple St	Syracuse	Ash-Temple #9 Temple-Peat #10	Jerome	4,000
Oswego Steam	Oswego	Oswego-S Oswego #3 Oswego-S Oswego #5	Pikwit	4,000

Station	City	Cables Served	Manufacturer	Reservoir Size (Gal)
Trinity	Albany	Trinity-Albany Steam #5 Trinity-Albany Steam #9 Riverside-Trinity #18 Riverside-Trinity #19	Pikwit	8,000

The majority of the cable pressurizing plant equipment is of similar vintage to the high pressure fluid filled pipe-type cables on which they are installed. Cable pressurizing plants are electro-mechanical systems. As these systems get older, some age related problems are anticipated on both electrical and mechanical components. Some of these issues can be addressed by targeted component replacements, while others may require replacement of the entire pressurizing systems. Specific concerns are discussed in the “Remedial Actions Performed” portion of this chapter.

Another critical component of any pipe type cable is the cathodic protection system. The cathodic protection system provides protection against corrosion of the steel pipe. Pipe corrosion can result in fluid leakage and potentially lead to electrical failure. There are two primary types of cathodic protection systems installed on the National Grid pipe type cables. These include the older “Rectifier and Polarizing Resistor” systems, and the more modern “Rectifier and Polarization Cell” systems. The polarization cell is a battery-like device that is used to ground the cable pipe and to allow for a DC voltage to be impressed on the pipe. The polarization cell contains a liquid electrolyte (typically potassium hydroxide). A replacement for the polarization cell that doesn’t require use of caustic chemicals has been developed in recent years. This is referred to as a “Solid State Isolator” (SSI). National Grid has been replacing polarization cells with solid state isolators as deterioration of cells has been identified, or as part of specific cathodic protection system upgrades. Table 2A-23 provides a list of the type of cathodic protection systems installed on each of the high pressure fluid filled pipe type cable systems.

As a result of ongoing maintenance and inspection programs, National Grid has identified some condition issues with certain cathodic protection systems. Specific concerns are discussed in the “Remedial Actions Performed” portion of this chapter.

Table 2A-23
Cathodic Protection System Summary

Cable	Location	Rectifier and Polarizing Resistor	Rectifier and Polarization Cell	Rectifier & Solid State Isolator (SSI)	Notes
Huntley-Elm #70	West			X	

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Cable	Location	Rectifier and Polarizing Resistor	Rectifier and Polarization Cell	Rectifier & Solid State Isolator (SSI)	Notes
Elm St Bus Tie	West			X	
Elm-Seneca #71 Elm-Seneca #72	West West			X X	
Seneca-Gardenville #71 Seneca-Gardenville #72	West West			X X	
Rochester #111 Rochester #113 Rochester #114	West West West			X X X	
Conklin-Bailey #17A Conklin-Bailey #17B	Central Central		X X		To be converted to SSI
Ash-Teall #7 Ash-Teall #8	Central Central	X X			
Ash-Temple #9	Central	X			
Temple – Peat #10	Central	X			
Oswego-S Oswego #3 Oswego-S Oswego #5	Central Central	X X			
Trinity-Albany Steam #5 Trinity-Albany Steam #9	East East			X X	
Riverside-Trinity #18 Riverside-Trinity #19	East East			X X	

<u>Solid Dielectric Transmission Cables</u>
Solid dielectric transmission cables were installed beginning in the late 1980s. The solid dielectric cables represent a relatively low mile weighted average age profile. National Grid inspects transmission cable terminations and above ground cable equipment as part of the Substation V&O inspections. A small population of transmission cable terminations has been identified recently with cracks and/or fluid leaks. National Grid has replaced damaged terminations, and has increased sensitivity to a potential issue with transmission terminations as part of the V&O inspection process. Manhole inspections are also performed periodically. At this time, with the exception of a limited number of cable termination troubles, the installed solid dielectric transmission cables do not appear to have major condition issues.

2. A. 3. 1. 2. Remedial Actions Performed

2. A. 3. 1. 2. 1. Pipe Type Cables

In prior years, concerns were expressed regarding the pump and auxiliary equipment preventative maintenance program. Electric Operating Procedure (EOP) T009 was developed to formalize the maintenance requirements of the cable systems. The requirements of this EOP are incorporated into the Substation & Maintenance CASCADE system for implementation and tracking.

In the 2008 and 2009 Asset Condition reports, the Company identified a pressurizing plant at the Rochester Airport as being in a deteriorated condition and presenting a possible reliability risk. To address immediate issues, maintenance and replacement of failed components was performed in 2009. Conceptual engineering has been completed for the design of a replacement pressurizing skid within the existing pressurizing plant. An alternative solution to replace the pipe type cables with a solid dielectric cable system, thereby eliminating the cable pressurizing plant, is being developed.

Conceptual engineering for a project to add a pressurizing plant to the Trinity-Albany Steam #5 & #9 circuits has also been completed. When implemented, adding a pressurizing plant to these cables will reduce a “common-mode failure” reliability issue with these circuits and with the Riverside-Trinity #18 & #19 circuits.

The results of the pressurizing plant condition assessments will be used to prioritize future repairs and/or replacements.

A similar conceptual engineering project for Rochester Airport transmission lines (#111, #113, #114) is also under development. The report will consider another alternative which is to retrofit the lines with solid dielectric cables. The cost benefit and risk analysis of this option will determine the feasibility of the project. Retrofitting the lines with solid dielectric cables successfully will help National Grid plan the replacement of the rest of the pipe-type assets to optimize reliability and cost impacts on its customers. This project is driven by multiple factors as follows:

- The Asset condition which includes a 2004 pipe leak and recent termination failure.
- The circuits were installed when pipe-type cable installation was prevalent in the 1960's; however, pipe-type cable systems are maintenance intensive and are being replaced by solid dielectric cables.
- Pipe-type cable manufacturers and support are dwindling due to lack of business. Okonite is the only North American manufacturer left in the business.

Of the circuits in Table 2A-21, twenty-one (21) circuits between the age of 26-58 years old are pipe-type cables. This accounts for a total of forty-three (43) circuit miles which pose the same risk of lack of support in future. The rule of thumb for a pipe life-cycle is 25 years after which the pipe may experience failures due to pit-holes. A thorough pipe integrity assessment, if possible, could help prevent such failures and predict the life-cycle.

As the costs of cable projects are estimated to be between $10M to $20M per circuit mile depending on the condition, careful planning will be required to balance potential significant funding requirements against risk.

With regard to cathodic protection systems, upgrades and repairs such as replacing the polarization cells with solid state isolators have been on-going. The type of cathodic protection system identified as "rectifier and polarizing resistor", while still functional, is considered obsolete. National Grid plans to convert these systems to "Rectifier and Solid State Isolator" systems over time.

2. A. 3. 1. 2. 2. Solid Dielectric Transmission

National Grid has a population of approximately 126 terminations of this type installed at 115kV. The Company is monitoring this population of transmission terminations as part of the V&O substation inspection process to determine whether this is an isolated issue, or whether there is a larger concern with this type of cable termination. In 2015, three of these terminations were found to be leaking on the two underground dips associated with the North Creek to Warrensburg #5 115 kV line. Two leaking terminations were at the Carboy transition structure (at the Hudson River Crossing), and one was at the Bennett transition station (at the Schroon River Crossing). All four terminations at the Carboy transition station and the remaining two terminations at the Bennett transition station were replaced in FY2016.

2. A. 4. Right of Way Vegetation Management

National Grid's Vegetation Management Strategy (VMS), or Program, seeks to minimize interruptions due to vegetation contact. Other objectives of the VMS include providing a clear and safe work space and access for maintenance and inspection activities.

National Grid's strategic approach to vegetation management is to establish and maintain rights-of-way that are largely clear of all incompatible vegetation while maintaining a stable low-growing plant community that is pleasing to the eye and beneficial to wildlife. National Grid's strategic approach to manage vegetation adjacent to the right-of-way is to prune or remove selected danger trees where property rights allow.

Vegetation management work on transmission and sub-transmission right-of-ways currently is organized into two programs:

- Right-of-Way Floor Program – management of vegetation within the right-of-way corridor, and;
- Off Right-of-Way Danger Tree Program – management of vegetation adjacent to the right-of-way corridor also referred to as the utility forest.

2. A. 4. 1. Floor Program

To achieve its vegetation management objectives, National Grid utilizes an Integrated Vegetation Management (IVM) approach which emphasizes selective herbicide use to control incompatible vegetation. IVM integrates the use of various vegetation management methods on both the right-of-way floor and the adjacent utility forest targeting tall growing, undesirable vegetation. The vegetation management methods include the use of herbicide, supplied as a cut stump basal bark; dormant stem treatment application or foliar application as well as non-herbicide methods; hand cutting; mowing; selective mowing; and selective pruning. IVM is a system of controlling tall growing vegetation in which species are identified, action thresholds considered, possible control options evaluated, and then selective, physical, biological and chemical controls are considered and employed.

After using the IVM approach for more than two decades, a portion of the shrub community has become too tall and dense in certain areas, invading the mid-span "wire security zone." The shrub community may hide or mask undesirable tall growing species from the sight of treatment crews and patrols. As shrub communities become denser over time, they restrict access to large areas of the ROW, further increasing the chance of skips or missed stems during treatment. Shrub intrusion into the wire security zone reduces the vegetation free space between the conductor and brush. This increases the risk that as undesirable tree species emerge above the shrub canopy, or "escapes," a stem can quickly grow into the wire security zone and cause an interruption. In the last decade, transmission interruptions caused by trees growing into the lines on either the 115kV or the bulk transmission systems were attributed to the masking of an undesirable stem by a shrub community. Due to this relatively new risk, the Company has made a recent revision to the Program which includes the removal of shrub communities through mowing and follow-up application of herbicide in selected mid-spans where clearances are judged to be inadequate to allow the shrub communities to remain. These sites will continue to be maintained as grass/forb communities during the next maintenance cycle.

The success of IVM on Company ROWs can be directly attributed to the adoption of a long-range management plan. Long range plans are designed to improve reliability through a balanced ecosystem approach by fostering a mix of low-growing, compatible vegetation, the use of site specific prescriptive application methods, and the adherence to sound cyclical programming guidelines. Cyclical programming includes addressing maintenance of each ROW regularly. Cycle lengths for the right-of-way floor program range between four to eight years.

2. A. 4. 2. Danger Tree Program

The utility forest contains vegetation adjacent to the ROW floor where trees tall enough and close enough to electric conductors are capable of growing or falling into the conductors or structures. These trees are classified as danger trees and hazard trees. A danger tree is any tree on or off the right-of-way that, if it fell, could contact electric lines. A hazard tree is a danger tree which due to species and/or structural defect is likely to fall into the electric facility. National Grid prunes or removes danger trees and hazard trees to reduce the risk of off right-of-way tree-caused interruptions. Trees are pruned to achieve At Time of Vegetation Management (ATVM) clearance distance from vegetation, measured as a radius around the conductor. Danger tree cycles for transmission and sub-transmission line right-of-ways range from four to twelve years. The danger tree work is prioritized and scheduled based on interruption history, line prioritization, tree risk factor computed using tree height, conductor height and distance to line, and danger tree maintenance cycles. For sub-transmission, the Company's goal is to bring the cycle to six years. Recent experience shows an upward trend in sub-transmission tree contacts. From 2010 to 2016, the Company has had an annual average of 47 tree caused outages on the sub-transmission system. From 2014 to 2017 this has increased 140% for all interruptions and 62% for sub-transmission contact events not including major storms and momentaries. This year, 2017, is already demonstrating a 21% increase over the average.

In large areas across New York State, forest condition is being impacted by the Emerald Ash Borer (EAB) and the Company has started to feel the impact of trees falling into its transmission lines as seen by interruptions on the Huntley-Lockport 37 115kV line. It is expected that within a decade, all trees of the ash species will be either in decline or dead. The Company has developed a proactive mitigation plan to address the risk presented by the EAB infestation.

2. A. 4. 3. Patrols

The Company conducts a variety of patrols throughout the year to identify hazardous conditions that can compromise reliability of the electric system. National Grid Transmission Forestry personnel conduct one foot patrol and one aerial patrol each year on all 230kV and 345kV ROWs. Beginning in 2016 certain 115kV circuits will also be included in this patrol frequency due to changes in the NERC FAC 003-3 Standard. Otherwise, the Company conducts aerial patrols on 115kV ROWs once every two years (generally one-half of the circuits are patrolled annually). In addition, Operations personnel carry out periodic ground patrols and annual aerial patrols of all 115kV and higher circuits, which include identification of vegetation conditions.

2. A. 5. Substations

This section addresses the key elements of transmission substations including the inventory, condition and performance issues as well as other information for circuit breakers, disconnect switches, transformers, other equipment and substation rebuilds.

2. A. 5. 1. Substation Equipment Assessments and Asset Condition Codes

A common substation condition assessment approach has been initiated across all Transmission and Distribution substations. This includes, on a targeted basis, a visit to select substations by subject matter experts (SMEs) in the Substation O&M Services department to review the condition of the assets. The result is a report which gives each asset a condition code of 1 through 4, with 1 being acceptable and becoming less acceptable the higher the number, based on manufacturer family, condition, age and other relevant data (Table 2A-24) below.

Table 2A-24
Substation Condition Codes

Code	Classification/Condition	Implication
1 Proactive (Low)	Asset expected to operate as designed for more than 10 years	Appropriate maintenance performed; regular inspections performed
2 Proactive (Medium)	Some asset deterioration or known type/design issues Obsolescence of equipment such that spares/replacement parts are not available System may require a different capability at asset location	Asset likely to be replaced or re-furbished in 5-10 years; increased resources may be required to maintain/operate assets
3 Proactive (High)	Asset condition is such that there is an increased risk of failure Test and assessment identifies definite deterioration which is on going	Asset likely to be replaced or refurbished in less than 5 years; increased resources may be required to maintain/operate assets
4 Reactive (Very High)	Asset has sudden and unexpected change in condition such that it is of immediate concern; this may be detected through routine diagnostics, including inspections, annual testing, maintenance or following an event	Testing and assessment required to determine whether the asset may be returned to service or may be allowed to continue in service. Following Engineering analysis the asset will be either recoded to 1--3 or removed from the system

Manufacturer family evaluations, which would apply to GE type FK breakers, are composed of historical “family” performance and engineering judgment and experience. The condition code can be further refined by the site condition assessment described previously on the specific assets and local operations personnel input as to performance and maintenance history.

Aligned with the condition code is an impact code, higher numbers indicate higher impact as a result of failure, which combines with the condition code to provide a risk based framework for asset prioritization. As National Grid develops this approach, asset replacement and maintenance will be ranked based on condition, but prioritized based on risk.

In subsequent sections of this report, condition codes are used to summarize the status of the asset type population.

2. A. 5. 2. Circuit Breakers

There are 795 circuit breakers located in transmission substations. The types of circuit breakers used in the service territory are categorized as gas and oil. The majority of circuit breakers in the service territory are 115kV. The following provides a brief summary of each type.

- Gas Circuit Breakers (GCB) – There are 488 (60%) newer technology GCBs. The population of GCBs are in good condition, with the exception of the earliest vintage (1979).

- Oil Circuit Breakers (OCB) – There are 321 (40%) older technology OCBs.[5] The average age of OCBs is 45 years. Approximately five percent are greater than 60 years old. These circuit breakers are located at the Maplewood, Battle Hill, Inghams, Tilden, and Homer Hill substations. Projects to replace the OCBs at these five stations are in progress.

[5] Ninety percent are 115 kV, nine percent are 230 kV and one percent are 345kV.

An age profile is provided in Figure 2A-25.

Figure 2A-25

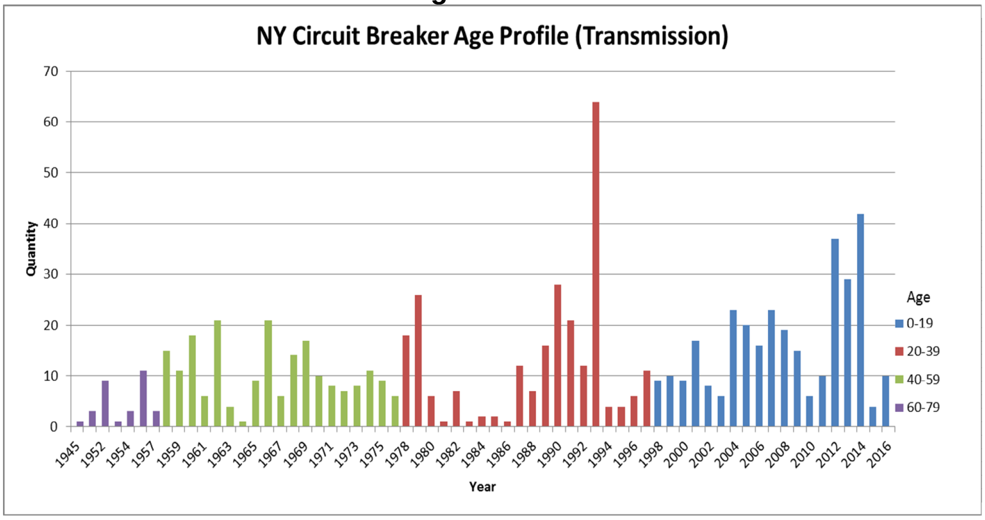


Table 2A-26
Circuit Breaker Age Profile

Asset/ Age (Years)	0-19	20-39	40-59	60-79	Total
All Circuit Breakers Within Respective Year Ranges	313	249	202	31	795

Predicted asset life of an OCB is 45 years with the earliest onset of poor performance predicted by age 40. There is evidence of deterioration through known failure mechanisms and in some cases circuit breakers are being kept in service using serviceable parts from retired equipment. This approach is not considered sustainable.

Due to the key function of interrupting faults carried out by circuit breakers, these assets cannot be allowed to become less reliable. As such, all circuit breakers should be replaced before they fail to operate as designed. Different deterioration modes and life limiting processes become known as switching devices age. Deterioration modes and factors that contribute to the end of life for OCBs include loss of elasticity of gaskets, allowing water ingress or oil leakage; frost jacking of porcelain to metal joints; excessive wear of moving parts; corrosion; etc. The anticipated asset life of OCBs is considered to have been reached when the cumulative effects of the life limiting factors result in an unacceptable level of performance and repair is either not possible or not economic.

2. A. 5. 2. 1. Condition and Performance Issues

In both Transmission and Distribution, circuit breakers are given a condition code based on manufacturer family and age data. Manufacturer family ratings are based on historical performance of that family. The condition codes are further refined by visual site surveys and operational tests performed on the specific assets.

The condition codes define the requirement to replace or refurbish based solely on the condition and performance of the asset while the replacement priorities also include criticality in terms of safety, environmental or reliability consequences of asset failure. This distinction recognizes that two assets, both with the same condition code, can have a different replacement priority due to the consequence of failure. Identified problematic circuit breaker families are listed in Table 2A-27, which also indicates how many are left on the system.

Table 2A-27

Circuit Breaker Type	Numbers Remaining
Allis Chalmers - BZO	23
Westinghouse – GM	39
General Electric - FK	63

The Company is improving its knowledge of the asset population's condition issues and as a result has reassessed replacement priority scores for circuit breaker populations and the number of highest priority units for replacement has been reduced.

2. A. 5. 2. 2. Remedial Actions Performed

The majority of the problematic circuit breakers are attributable to just three circuit breakers types, namely the Allis Chalmers Type BZO, the Westinghouse Type GM and the General Electric Type FK.

- **Allis Chalmers Type BZO –** The operating mechanisms in this family of breakers, manufactured in the 1950s through 1980s, are showing an increase in accumulator pump and o-ring failures. Design changes and changes in component manufacturers over the years require different replacement parts for various vintages and these parts are difficult to obtain. Mechanism wear has resulted in reduced levels of reliability, increased maintenance costs and a number of failures.

- **Westinghouse Type GM -** Test results from this family of breakers indicate contact timing problems and questionable insulation integrity.

- **General Electric Type FK –** There have been problems with bushing oil leaks and lift rods issues due to moisture ingress with these circuit breakers. In addition lead paint is prevalent in this family of breakers.

The average age of SF6 Gas Circuit Breakers is approximately 15 years. However, there are three Westinghouse 362SFA40 SF6 Gas Circuit Breakers (362kV) that are over 35 years old in service at Dewitt substation (1979) and two at New Scotland substation (1976). These are the oldest SF6 breakers in the system and experience gas leaks in the operating mechanism. This contributes to pole discrepancies which have resulted in reported instances of the breakers failing to close. The SF6 gas leakage has been reduced through maintenance on these five Westinghouse breakers. There are no plans to replace these breakers at this time and maintenance will continue to be performed to lessen the SF6 gas release to the atmosphere.

Table 2A-28
Potential Breaker Replacement Candidates

Location	Quantity	Voltage	Type
Batavia Station 01	4	115	FK-439 & BZO-115
Battle Hill Station 949	3	115	GM-3 & GM-6
Boonville Station	6	115	BZO-115 & GM-6
Cortland Station	4	115	FK-115, FK-439 & GO-3A
Curtis Street Station 224	2	115	FK-439
Dunkirk Station	5	230	230GW
Gardenville Station - New	5	230	FGK-230
Golah Station	3	115	FK-115 & 'FK-439
Homer Hill Switch Structure	6	115	BZO-121, 'FK-439 & GM-6
Huntley Station	8	230	FK-439, 2300GW & FK-115
Inghams Station	9	115	AA 10, GM-6, & BZO-121
Lighthouse Hill Station 61	6	115	FK-115 & RHE-64
Maplewood Station 307	1	115	FK-39
Marshville Station 299	1	115	FK-139
New Scotland Station 325	3	345	FGK-345
North Troy Station 123	5	115	GM-6 & FK-115
Oneida Station 501	5	115	RHE-64, FK-115 & GM-6
Oswego Switch Yard	5	115	FK-439 & 'FK-115
Packard Station	3	115	BZO-121
Porter Station	9	230	BZO-230 & FGK-230
Queensbury Station 295	3	115	GM-6
Rotterdam Station	6	230	BZO-121 & FK-115
Schuyler Station 663	2	115	FK-115
Teall Avenue Station 72	2	115	FK-439
Temple Station 243	4	115	GM-6
Terminal Station 651	2	115	FK-115
Ticonderoga Station 163	1	115	FK-115
Tilden Station 73	3	115	GM-6
Whitehall Station 187	3	115	GM-6
Woodard Station 233	3	115	FK-115
Yahnundasis Station 646	3	115	FK-439

When the opportunity exists, circuit breakers will be replaced as part of station rebuild projects.

2. A. 5. 3. Disconnect Switches

There are approximately 1,838 disconnect switches on the system.

2. A. 5. 3. 1. Condition and Performance Issues

All disconnect switches are monitored during annual thermo-vision checks and bi-monthly visual inspections. Disconnect motor mechanisms are also inspected on a 24-month schedule.

Disconnect switches will typically be replaced at the same time as their associated circuit breaker replacement or when defective units are identified by operations personnel through the Substation Equipment Replacement Request (SERR) process. A failure of a disconnect switch to operate generally poses no system or safety risk.

Disconnect switches with condition issues are described below.

- ITE MO-10 Disconnects – 115kV, 230kV, 345kV - There are nineteen of these disconnects in the service territory. These disconnects, installed between 1979 and 1984, have experienced a higher than normal rate of required hot spot repairs. The remaining units include:
    - Seven disconnect switches located at the Elbridge substation
    - Eight disconnect switches located at Dewitt substation
    - The remaining ITE disconnect switches at Elm substation (3) and Reynolds Rd. substation (1).

- Haefly-Trench Disconnects- 115kV - Twelve sets of these vertically mounted gang operated switches have had insulator failure at various locations. The insulators are post type and failed where the porcelain and cap are bonded together.

- Westinghouse Type V Disconnect switches -115kV - These disconnect switches are either inoperable or limited to manual operation at Curtis Street, Packard, Huntley, and New Gardenville substations. They have experienced motor, gear box, and adjustment problems due to mechanical wear, operating linkage problems, bearing problems due to lubrication issues, and insulators failing due to water ingress and thermal action.

- R&IE Type TTR-49 – 115kV & 230kV - There is one R&IE Type TTR-49 disconnect switch located in the Packard 230kV yard and five sets located at the Adams Switch station. These disconnects are old and in poor overall condition.

- There have been three (3) substations identified with liquid filled fuse-type disconnect switches. These switches were manufactured by S&C and installed when the substations were installed which was from the late 1950s to the early 1960s. The liquid filled fuses are no longer manufactured by S&C and there are limited to no spare parts. They are also a safety issue if one were to catastrophically fail since glass and chemicals could be expelled from the fuse case.

2. A. 5. 3. 2. Remedial Actions Performed

- ITE MO-10 disconnects – 115kV, 230kV, 345kV - These disconnect switches are monitored through annual thermo-vision inspections. Problems are corrected individually when identified.

- Haefly-Trench disconnect switches - 115kV - A review was performed in August 2008 that was the basis for possible replacement projects at Norfolk and Parishville substations.

- Westinghouse Type V disconnect switches -115kV – Generally, any issues on these disconnect switches are being addressed as they are identified. The disconnect switches at Huntley and Gardenville substations will be replaced with future station rebuild projects.

- R&IE Type TTR-49 – 115kV & 230kV - Issues with these disconnect switches are being addressed as they are identified.

- S&C liquid filled fuses – The liquid level inside the fuse is being monitored, but due to safety concerns are being identified for replacement.

Many of the most problematic disconnect switches are being addressed in conjunction with their associated breaker replacement strategies and substation rebuilds.

2. A. 5. 3. 3. Circuit Switchers

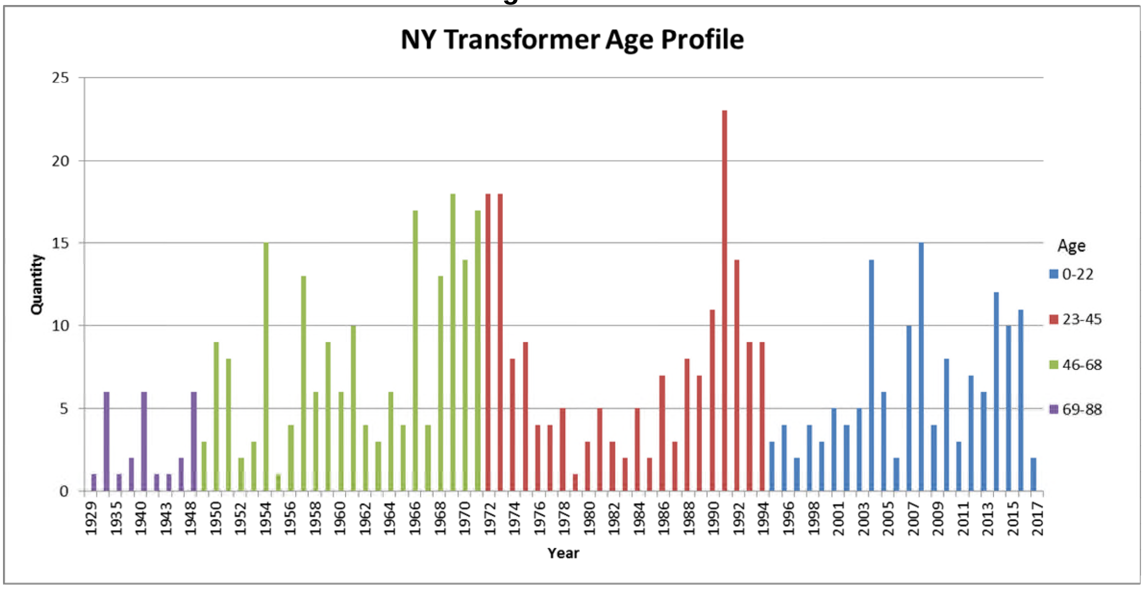
There were sixty-six (66) S&C Type G and Mark II circuit switches in-service identified to be replaced. In 2001 S&C Electric Company discontinued replacement component support for Type G and Mark II models. There is a lack of spare parts for these switches and increasing operational problems are being experienced in the system. The replacement of a circuit switcher generally requires the bus to be switched out to isolate the circuit switcher because there is typically no disconnect between the bus and the circuit switcher. The consequences of not doing this work will result in higher operation and maintenance costs as well as higher replacement costs under damage failure as opposed to a planned and scheduled replacement program.

A strategy was approved to replace thirty-nine (39) of these circuit switches at the most critical locations. Also approved in the strategy are the purchase of three (3) spare circuit switchers and one (1) mobile circuit switcher to help mitigate the reliability and safety concerns associated with any switches remaining in service.

2. A. 5. 4. Transformers

The transmission system has a transformer population of 533 units of various manufacture, type, and power rating at primary voltages greater than 69kV. An age profile is provided in Figure 2A-29, color coded to show ages of transformers in 20-year increments. There are currently thirty-one (31) system spares for the transmission transformer fleet.

Figure 2A-29



The numbers of transformers organized by age group are shown in Table 2A-30.

Table 2A-30
Transformer Age Profile

Asset/ Age Profile (Years)	0-22	23-45	46-68	69-88	Total
All Transformers Within Respective Year Ranges	140	178	189	26	533

Fifty-six percent of the total population of transformers is greater than 40 years old and the average age of transformers on the system is 39 years. Transformers installed in the 1950s and 1960s are approaching the end of their useful life based on known deterioration modes.

By the end of this decade the volume of transformers that may be in poor condition could rise to over two hundred (200) units. Although it is the Company's practice to assess the condition and risk associated with each transformer, power transformer age, by itself, is a useful indicator as to which transformers may be less able to perform their function due to accumulated deterioration. Paper insulation deteriorates with time and thermal loading history, and that deterioration is irreversible. As the paper degrades, the ability of the paper insulation to withstand mechanical forces is reduced and the mechanical integrity of the transformer is compromised when subjected to through faults or internal faults. In addition, the paper deterioration may lead to shrinkage of the winding packs thereby, reducing the mechanical stability of the transformer.

Given the possible substantial impact of power transformer failures on the transmission system, and the extensive lead times and disruption to normal operations, National Grid pursues a comprehensive approach to risk management of transformers. This includes thorough and regular reviews of the population and the generation of a 'watch list' of suspect and higher impact transformers for more frequent observation and review. National Grid also reviews each transformer individually to determine both condition and likely risks to the system before making a determination as regards to replacement or refurbishment requirements. Further, the Company is expanding its fleet of spare transformers to ensure there is adequate availability of units in the event of a failure given the long lead time for this equipment, as well as having mobile transformers available.

2. A. 5. 4. 1. Condition and Performance Issues

National Grid's maintenance program includes performing dissolved gas analysis (DGA) on transmission transformers annually. DGA is a cost effective condition assessment tool that detects anomalous behaviors within transformers which may indicate a developing fault. Analysis of this data is performed using the IEEE Standard C57.104.1991. Suspect units are placed on an enhanced sampling schedule. Power factor tests are performed on the transformers and their associated bushings, and an assessment of the load tap-changer is performed during routine maintenance. Additional transformer testing such as winding impedance, leakage reactance, transformer turns ratio (TTR), excitation, and sweep frequency response analysis (SFRA) may be recommended if a review of DGA results indicate that anomalous results need to be investigated further.

Table 2A-31 provides condition codes based on the most recent review. In 2015, nineteen (19) transformers were identified as condition code 4 (highest priority) due to elevated combustible gasses, poor transformer design, inadequate thermal capability or no known available spares. In addition, these units are aging and may be better served by replacement rather than maintenance or repair. Since that time, one of the units experienced an internal fault and was removed from the system in a controlled manner.

Table 2A-31
Transformer Condition Codes

Year	Code	1	2	3	4	Total
2016	TRF	450	40	36	7	533

Most of the transformers in condition 4 are single-phase units, and if identified for replacement, will be replaced with three-phase units.

The transformer condition codes are described as follows:

- Condition Code 1 – The transformer is expected to operate as designed for more than 10 years;
- Condition Code 2 – There is some deterioration or known type/design issues. There is obsolescence of equipment such that spares or replacement parts are not available. The system may require a different capability at the asset location;
- Condition Code 3 – The transformer condition is such that there is an increased risk of failure. Test and assessment identifies definite deterioration which is ongoing;
- Condition Code 4 – The transformer has sudden and unexpected change in condition such that it is of immediate concern; this may be detected through routine diagnostics, including inspections, annual testing, and maintenance or following an event.

A transformer with a condition code 4 is not automatically replaced, but may receive additional diagnostic testing and evaluation to further ascertain its condition. As a result of the further review, the transformer may be revised to a lower condition code.

2. A. 5. 4. 2. Remedial Actions Performed

The transformer watch list is based on condition and operational information, and is used to monitor those transformers of concern and to plan for a rapid replacement of the unit if its condition worsens. Table 2A-32 provides a list of transformers currently being monitored on the watch list. In some instances, further evaluation is necessary to properly understand the condition. Power transformers are managed through routine visual inspection, regular dissolved gas analysis (“DGA”) sampling, and electrical testing. Transformers with tap-changers are also maintained in accordance with substation maintenance standards. Continuous surveillance enables the Company to prioritize replacements appropriately. The Company completes a small number of pre-emptive transformer replacements. However, this approach may be revised in the future based on failure rates or improved tools to determine the condition of the fleet of transformers.

Below is a list of transformer replacement projects and their status:

- North Leroy No. 1 TRF Replacement – Preliminary Engineering
- Teal Avenue No, 1, 2, 3 4, TRF Replacements – Preliminary Engineering
- Woodlawn No. 1 LTC TRF, 2 TRF Replacements – Preliminary Engineering
- Hoosick No. 1 TRF Replacement – Planning
- Mohican No. 1 TRF Replacement – Planning
- Oneida No. 4 LTC TRF Replacement – Construction

- Harper No. 30, 40 LTC TRF Replacements – Preliminary Engineering
- New Gardenville No. 3, 4 LTC TRF Replacements – Preliminary Engineering
- Kensington Terminal No. 4, 5 TRF Replacements – Conceptual
- Seneca Terminal No. 3 LTC TRF Replacement – Preliminary Engineering

Table 2A-32
"Watch" List of Transmission Transformers

Station Location	Region	Equipment Descriptic	MVA	Voltage	Age
Altamont Station 283	NYED	1 TRF	5	115-34.5-4.8 KV 5 MVA	66
Ash Street Station 223	NYCD	1 TRF	40	115-12 KV 24/32/40 MVA	58
Bristol Hill Station 109	NYCD	1 LTC TRF	33.3	115-34.5 KV 20/26.7/33.3 MV/	23
Brockport Station 74	NYWD	4 LTC TRF	25	115-13.8 KV 15/20/25 MVA	36
Curry Road Station 365	NYED	2 LTC TRF	30	115-13.8 KV 18/24/30 MVA	44
Golah Station	NYWD	2 TRF	41.7	115-34.5 KV 25/33.3/41.7 M\	47
Hoosick Station 314	NYED	2 LTC TRF	10.5	115-13.8 KV 7.5/8.4/10.5 MVA	19
New Krumkill Station 421	NYED	1 LTC TRF	30	115-13.8 KV 18/24/30 MVA	45
North Akron Station	NYWD	1 TRF	9.375	115-34.5 KV 7.5/9.375 MVA	63
Queensbury Station 295	NYED	2 LTC TRF	30	115-34.5-4.8 KV 30 MVA	53
Roberts Road Station 154	NYWD	1 LTC TRF	20	115-13.8 KV 12/16/20 MVA	45
Scofield Road Station 450	NYED	1 LTC TRF	9.375	115-13.8 KV 7.5/9.375 MVA	49
Solvay Station 57	NYCD	1 TRF A	7	115-34.5 KV 5/7 MVA	87
Solvay Station 57	NYCD	1 TRF B	7	115-34.5 KV 5/7 MVA	87
Solvay Station 57	NYCD	1 TRF C	7	115-34.5 KV 5/7 MVA	87
Solvay Station 57	NYCD	2 TRF A	7.5	115-34.5-12 KV 5/7.5 MVA	87
Solvay Station 57	NYCD	2 TRF B	7.5	115-34.5-12 KV 5/7.5 MVA	87
Solvay Station 57	NYCD	2 TRF C	7.5	115-34.5-12 KV 5/7.5 MVA	87
Solvay Station 57	NYCD	3 TRF A	6.25	115-34.5 KV 5/6.25 MVA	60
Solvay Station 57	NYCD	3 TRF B	6.25	115-34.5 KV 5/6.25 MVA	60
Solvay Station 57	NYCD	3 TRF C	6.25	115-34.5 KV 5/6.25 MVA	60
Solvay Station 57	NYCD	4 TRF A	6.67	115-34.5 KV 5/6.67 MVA	88
Solvay Station 57	NYCD	4 TRF B	6.67	115-34.5 KV 5/6.67 MVA	88
Solvay Station 57	NYCD	4 TRF C	6.67	115-34.5 KV 5/6.67 MVA	88
Station 054	NYWD	1 TRF	9.375	115-4.16 KV 7.5/9.375 MVA	58
Station 140	NYWD	1 TRF	33.6	115-13.8 KV 18/24/33.6 MVA	44
Station 154	NYWD	2 TRF	3.75	115-4.16 KV 3.75 MVA	69
Telegraph Road Station	NYWD	2 LTC TRF	50	115-34.5 KV 30/50 MVA	26
Tully Center Station 278	NYCD	1 TRF	20	115-13.8 KV 12/16/20 MVA	53
Yahnundasis Station 646	NYCD	3 TRF	30	115-13.8 KV 18/24/30 MVA	41

2. A. 5. 5. Battery Systems

Battery and charger systems provide power to operate substation relay and control systems which allow station breakers to operate as designed.

Figure 2A-33

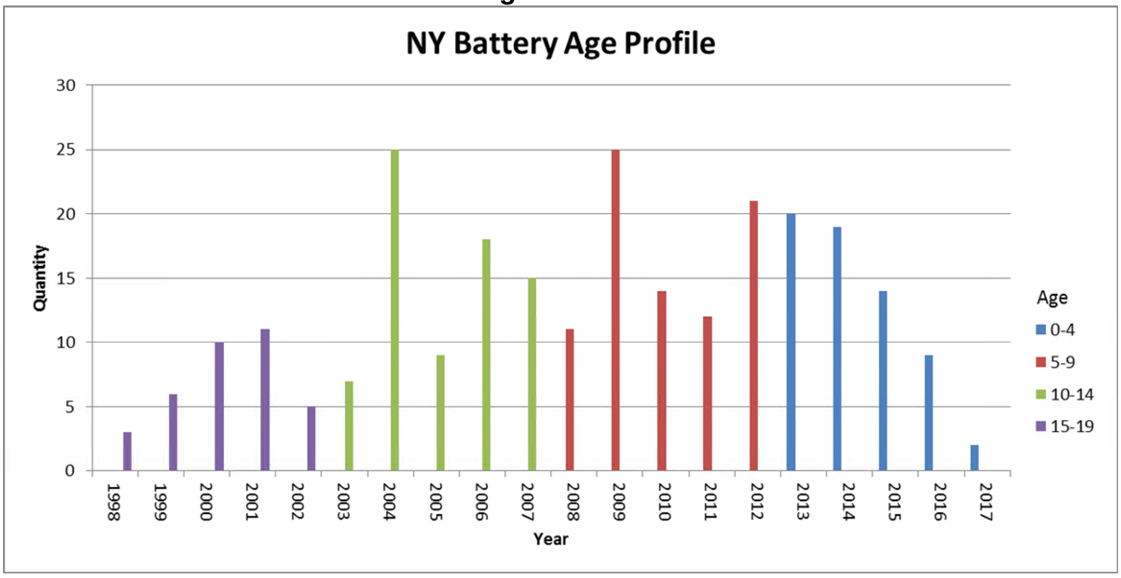


Table 2A-34
Battery Age Profile

Battery Asset Age Profile					
Asset Age	0-4	5-9	10-14	15-19	Total
Quantity	64	83	74	35	256

2. A. 5. 5. Remedial Actions Performed

National Grid's policy is to replace battery sets that are 20 years old or sooner if battery conditions determined through testing and inspection warrant replacement. The 20-year asset life is based on industry best practice and Company experience managing battery systems.

2. A. 5. 6. Surge Arrestors

The silicon carbide (SiC) surge arrestors at 115kV and above installed in the service territory are no longer an effective means of high side protection for transformers. Original installation dates are largely incomplete as surge arrestors were typically classified as part of transformer installations. Available information from manufacturers suggest that the silicon carbide (SiC) type surge arrestors over 30 years old should be replaced and therefore it was made into a best practice to replace them when the opportunity presented itself during on-going projects.

2. A. 5. 6. 1. Condition and Performance Issues

Due to condition and technology, SiC surge arrestors may no longer be effective. SiC gapped surge arrestors were manufactured and installed up to the mid-1980s. The technology is based on non-linear SiC resistors with a series controlled spark gap. The spark gap is in a controlled environment and provides the trigger to activate the arrestors into operation. This design is now obsolete and no longer manufactured due to developments in new technology. Metal oxide (MOV) gap-less surge arrestors have replaced the SiC resistors and are now the preferred method to control lightning and switching over-voltages. The lightning protection capability of MOV arrestors is superior to SiC and they reduce the likelihood of damage to adjacent equipment and also reduce the risk to personnel from lightning and switching over-voltages.

Currently, the lifetime of a silicon carbide surge arrestor is anticipated by National Grid to be approximately 20 to 25 years. The integrity of SiC beyond this time frame is hard to predict due to concerns over poor mechanical reliability (e.g. poor seals, internal corrosion, etc) and difficulty of monitoring the condition of the series gaps. Industry sources recommend that all silicon carbide arrestors in service over 13 years be replaced due to moisture ingress. Manufacturers' data suggest that moisture ingress is the direct cause in 86 percent of failures.

2. A. 5. 6. 2 Remedial Actions Performed

SiC surge arrestors will be replaced with MOV surge arrestors when they fail, or when a transformer is being relocated or placed in service from storage. When a surge arrestor fails, any remaining non-MOV arrestors protecting a transformer or station bus are replaced at the same time. This is a more efficient program but requires toleration of SiC failure risk for longer periods of time. Programmatic replacement of SiC surge arrestors was reviewed and this approach is not practical or efficient. Surge arrestors are co-located with their associated transformer and outage constraints would make the planned proactive replacement extremely difficult.

2. A. 5. 7. Relays

National Grid maintains electro-mechanical, solid state and microprocessor relay types on the transmission system for protection and control. The protection afforded by relays is important to the stability of the electric transmission system. Relays are designed to protect high-value system components from the effects of system failures and to quickly isolate system failures so that no additional damage can occur. The table below identifies the number of relays by type currently deployed on the transmission system.

Table 2A-35
Count of Relays by Type

Design Type	# of Relays	% of Total
Electro-mechanical and Solid State	16,243	84
Microprocessor	3,125	16
Total	**19,368**	

Several families of electro-mechanical and solid state relays are no longer sustainable on the transmission system. Further, many of these relays suffer from lack of manufacturer support such that technical support and spare parts are no longer available. Targeted relay replacements were selected based on family history, performance, field O&M experience and available manufacturer support.

With the advent of digital technologies, facilities can be upgraded resulting in greater capability and increased reliability. The first priority is to identify the worst performers and establish the appropriate remedial action. The Company also considers potential solutions to enable improved grid functionality and performance.

Microprocessor based multi-function relays are an ideal choice for a cost effective method to implement the transmission system protection. The upgrading of old protection systems with microprocessor relays can offer the following benefits:

- Micro-processor relays have proven good quality and high availability.
- Improved sensitivity, the executing or comparator component of old relays can only be operated at certain levels.
- A micro-processor relay which replaces multiple discrete relays results in reduced CT secondary burdens.
- Greater protection and control functionality, self-monitoring and the ability to record oscillographic information and Sequence of Events.
- Easy integration via network communications.
- Lower maintenance costs.

By replacing electro-mechanical and early generation solid state protection relays with technologically advanced integrated digital relays, performance, functionality and maintenance issues improve.

2. A. 5. 7. 1. Condition and Performance Issues

National Grid performs periodic testing of protective relays to ensure that the relay operates correctly and the overall protection scheme functions as designed.

On average, 20 percent of National Grid's relay packages (all types) are tested yearly based on scheduled maintenance intervals.

The relay families identified as those needing replacement because they are problematic, obsolete or no longer supported by the manufacturer are as follows, all of which are obsolete, offer no manufacturer support or spare parts:

- **GE (GCX13/17, CEY14/15/16GEYG, CEB) –** contact wear and bearing damage, setting drift.
- **GE (CFD, CPD, Type 40, MOD10, CFF, CR61/CT61, CS28A) –** resistor, capacitor, transistor and diode decomposition. Failed power supplies.
- **ABB (MDAR, REL301, REL302, SKDU/SBFU, HCB, LCBII) –** metal degradation, contact wear and setting drift.
- **ABB (KF) –** setting drift, metal degradation, bearing damage.
- **AREVA (OPTIMHO) -** resistor, capacitor, transistor and diode decomposition.
- **RFL (3253, 6710, 6745, 9300) –** metal degradation, setting drift.

Currently, relays are replaced based upon condition and performance issues and may also be replaced in conjunction with breaker or transformer replacements and station rebuilds for efficiency.

2. A. 5. 7. 1. Remedial Actions Performed

National Grid initiated a study to identify the worst performing relay families which include electro-mechanical and solid-state relays. The study reviewed the population of relay families for those relays that are at end-of-life, are functionally obsolete, are known to have family reliability concerns, or are considered obsolete because technical support and spare parts are no longer available from the manufacturer.

The study identified approximately 245 relays and 54 communication packages requiring replacement. Strategy paper SG157 was approved to replace the relays and communication packages. In general, the replacement plan will be implemented on a line-by-line basis. The relays to be replaced are included in Table 2A-36 below:

Table 2A-36
Relays to be replaced under Strategy SG157

Substation	Priority	Packages	Communication
Dewitt	1	6	0
Mortimer	2	8	0
Lockport	3	7	0
Batavia	4	5	0
Cortland	5	2	0
Gardenville - New	6	4	0
Tilden	7	5	0
Rotterdam	8	10	3
Huntley	9	13	0
Homer Hill Sw. Str.	10	10	0

Substation	Priority	Packages	Communication
Gardenville – Old	11	7	0
Golah	12	2	0
Temple	13	3	1
Watkins	14	3	0
Porter	15	4	1
Reynolds Rd	16	2	1
North Troy	17	2	1
Sta 64 Grand Island	18	2	2
Schuyler	19	4	0
Curtis	20	4	0
New Scotland	21	1	1
Packard	22	25	2
Woodlawn	23	2	1
Edic	24	4	0
Volney	25	4	2
Trinity	26	3	1
SE Batavia	27	2	0
Elbridge	28	3	0
Scriba	29	4	2
Walck Rd	30	1	0
Ash	31	3	3
Greenbush	32	2	0
S. Ripley	33	2	0
Terminal	34	4	0
Long Lane	35	2	3
Carr St.	36	4	0
Feura Bush	37	3	3
McIntyre	38	1	0
North Ogdensburg	39	1	0
Seneca Terminal St.	40	4	0
Riverside	41	7	3
Rosa Road	42	4	2
Independence	43	4	0
Grooms Road	44	0	1
Indian River	45	1	0
Lowville	46	1	0
Malone	47	1	0
N. Carthage	48	1	0
Ogdensburg	49	1	0

Substation	Priority	Packages	Communication
Total		**199**	**33**
Control House	**Priority**	**Packages**	**Communication**
Boonville	1	12	0
Geres Lock	2	18	0
Menands	3	4	1
Woodard	4	2	0
Mountain	5	4	0
Teall	6	2	2
Yahundasis	7	4	0
Total		**46**	**3**
Single Comm Packages	**Priority**	**Packages**	**Communication**
Rotterdam			1
Edic			1
New Scotland			7
North Troy			3
Reynolds Road			2
Alps			1
Altamont			1
Bethlehem			1
Grooms Rd			1
Total			**18**
Grand Total		**245**	**54**

The following stations are scheduled to have their relay packages replaced in FY18 and FY19: Bethlehem, Mountain, Seneca, North Troy, and Woodard.

2. A. 5. 8. Digital Fault Recorders (DFR)

National Grid currently has sixty-one (61) digital fault recorders deployed that capture and store data from the power system during times of instability or system anomalies. The data is then downloaded to perform post-event analysis. The analysis yields detailed information about the state of the system before, during and after the event.

2. A. 5. 8. 1. Condition and Performance Issues

There have been no performance issues to date; however, older DFRs require more maintenance. At this time, the newer DFRs have experienced good reliability; however, they do not have sufficient operational history to project long term reliability of these devices. It is expected that they would have approximately the same reliability as microprocessor relays since they are built on the same platform. We are experiencing increased maintenance on the seven older DFRs due to age related condition issues. These devices are based on an older platform and have spinning disk drives for storage.

2. A. 5. 8. 2. Remedial Actions Performed

New DFRs will be installed with major capital projects at select locations across the service territory to provide adequate coverage.

2. A. 5. 9. Remote Terminal Units (RTU)

NERC Recommendation 28,[6] released in response to the August 2003 blackout, requires the use of more modern, time-synchronized data recorders. Many in-service RTUs do not satisfy this requirement and obsolete RTUs will not work with modern Energy Management Systems ("EMS"). New RTUs being installed will provide more timely and reliable data than their predecessors. In the event of a minor or major system disturbance that may affect the ability of the system to withstand further contingencies, accurate data received in a timely manner is a necessity in the restoration process. Data received from the new RTUs will quickly identify key devices that have failed or have been affected by the event. The data will expedite isolation of the problem, reduce the duration of the interruption and in some cases avoid spread of the outage to other system components.

2. A. 5. 9. 1. Condition and Performance Issues

RTUs are being replaced under this program for the following reasons:

- The target RTUs do not meet the criteria outlined in NERC Recommendation 28, which places the Company at risk for being unable to provide synchronized system data during a system emergency.

- The target M9000 RTUs and equipment are legacy systems and are no longer supported by the manufacturer. Replacement parts are either difficult to obtain or unavailable. Failure of an RTU may be un-repairable, requiring a complete unplanned replacement on short notice. This situation could occur when data from the failing RTU is most critical, such as during system events, resulting in reduced reliability performance.

- Test equipment is obsolete and cannot be readily obtained or maintained. The PC based test equipment required for maintenance was acquired in the early 1990s and uses a DOS software platform.

- The targeted M9000 RTUs are not suitable for future integration of new substation devices and technology. The equipment does not have and cannot be

[6] North American Electric Reliability Council (NERC) "Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations," April 5, 2004 Page-162

modified to provide the capabilities required for modern supervisory control and data acquisition. This type of functionality is becoming standard to meet current reliability needs.

2. A. 5. 9. 2. Remedial Actions Performed

There are approximately 678 operating transmission and distribution RTUs under the Company's control, of which 158 units are being replaced under an ongoing RTU replacement program (SG002). To date all transmission projects within the strategy have been completed with the exception of those situated in Non-National Grid owned sites. Although new programs are under review/development to replace RTUs with the M9000 protocol, and to install new RTUs at stations that do not have one.

2. A. 5. 10. Station Rebuilds

Station rebuilds are appropriate where the number of asset related issues within the station are such that they require a comprehensive plan for replacement to achieve cost efficiency and maintain reliability of the system. Where a station rebuild is proposed, the Company will seek creative and innovative solutions and consider all appropriate alternatives. It should be noted that certain station rebuilds will occur within the same footprint while others will essentially be green field construction in an adjoining location to the existing station.

2. A. 5. 10. 1. Gardenville

Gardenville is a 230/115kV complex south of the Buffalo area with two 115kV stations in close proximity referred to respectively as New Gardenville and Old Gardenville which both serve regional load. New Gardenville was built between 1959 and 1969 and has some minor to moderate asset issues. Old Gardenville feeds regional load via eleven 115kV lines and was built in the 1930s. It has serious asset condition issues including, but not limited to: control cable, circuit breaker, disconnect and foundation problems.

Old Gardenville has had no major updates since it was built. Since 2004 there have been instances of busses tripping due to breakers not tripping for faults or other control issues. Occasionally, the bus trips via backup protection when a line breaker fails to operate for a fault. Since the entire station is problematic, a bus protection failure is likely and could lead to severe equipment damage and a large outage. Furthermore, there have been instances where lines have either tripped or failed to reclose due to bad wiring or other control issues. The worst condition control cables have been attended to in a separate project, but these are not considered to be permanent solutions. Rather, they are meant to correct control cable issues until all the cables can be addressed in a station rebuild.

The foundations at Old Gardenville are in extremely poor condition with more than half degraded and some even in full failure mode. This includes many structure foundations affecting the integrity of the structures themselves. Some circuit breaker foundations are in very poor condition raising the potential than an oil circuit breaker could move on its pad during a severe fault and lead to further damage and/or safety issues.

The project to rebuild the Old Gardenville 115kV station is in final engineering and construction.

2. A. 5. 10. 2. Dunkirk

Dunkirk Station is a joint substation at Dunkirk Steam Station shared by NRG and National Grid. The substation serves as an interconnection to the electrical grid at the 230, 115 and 34.5kV levels. The plant was originally constructed in the early 1950s by Niagara Mohawk as the owner of generation, transmission and distribution assets. National Grid's major equipment includes four transformers: two new 230/120/13.2kV 125MVA autotransformers and two 115/34.5kV 41.7MVA transformers supplying four 230kV, five 115kV and two 34.5kV lines as well as NRG's station service. National Grid retains ownership of most of the 230kV and 115kV switch yard; however, the controls are located in the generation control room owned by NRG.

There are many asset condition issues at the Dunkirk substation. The foundations are in poor condition in the 230kV yard, including many structure foundations, affecting the integrity of the structure itself. Some circuit breaker foundations are in very poor condition raising the possibility that an oil circuit breaker (OCB) could move during a severe fault leading to more damage and/or causing safety issues.

The five 230kV OCBs are Westinghouse type GW design (1958 through 1961) and would be part of the OCB replacement strategy, if not for this project. The 230kV Westinghouse Type O bushings are a concern as the power factor and capacitance results are trending upwards.

Differential relaying for the 230/120/13.2kV autotransformers is in need of upgrading (presently there is no tertiary differential). The 230, 115 & 34.5kV disconnects have become more problematic and are at the end of their life. The 230kV bushing potential devices (BPDs) have become problematic as they age and the remaining BPDs will likely have to be replaced in the near future. Fencing around the yard is not compliant with National Grid standards and requires repair at the base or a berm built up to restrict animal entrance.

The control cable system in the 230kV yard is of particular concern. It is clear that the conduit system carrying control wires has degraded to the point that the integrity of the control wires has been compromised. Control wires inside the plant have also seen insulation degradation. In some cases, the wiring is so poor that troubleshooting abilities are limited for fear of handling control wires with degraded insulation. Grounds, alarms or breaker misoperations happen more frequently during periods of heavy rain, indicating poor insulation below ground.

Within the last four years National Grid has replaced both 230-120-13.2kV 125MVA GE autotransformers with new ABB 230-120-13.2kV 125MVA autotransformers and all 115kV OCBs with new SF6 breakers, foundations and control cable.

The plant was originally constructed with generation, transmission and distribution assets combined, including station service, battery, relaying, alarm / annunciation, control and communications. All troubleshooting, maintenance testing, equipment replacement and upgrades require excellent knowledge of the plant operation. NRG and National Grid must maintain good lines of communication and share updated prints to preserve operation continuance. The separation of assets would help avoid inadvertent trips to line breakers or any possible equipment failures.

There are parallel efforts underway to address these issues. In the short term, a project was approved to install a new cable trench in the 230kV yard in 2009 and was completed in the summer of 2010. Control cables deemed faulty can be replaced using these new facilities. Conceptual engineering has been completed for a new control house and completely separate assets rebuilt within the existing yard. Other equipment, such as disconnects and potential transformers deemed to be at end of life will be replaced in place during a project to install a second bus tie breaker.

The Dunkirk station rebuild is in preliminary engineering.

2. A. 5. 10. 3. Rotterdam

Rotterdam is a large substation with 230kV, 115kV, 69kV, 34.5kV, and 13.2kV sections spread out over multiple tiers on a hillside. The 230kV yard is on the highest tier and is an important source for Schenectady, NY and the Northeast Region. The 230kV yard has had performance issues and one catastrophic failure of a Federal Pacific Electric ("FPE") breaker. These breakers have horizontal rotational contacts inside their tank as compared to vertical lift contacts in newer style circuit breakers. FPE breakers are no longer manufactured and spare parts are not available. There are two spare SF6 gas circuit breakers stored at Rotterdam to replace the FPE breakers if one were to fail at this station.

Two of the three 230kV auto transformers (#7 & #8) are proposed for future replacement. This family of Westinghouse transformers has shown a higher than normal failure mode in the industry due to its design (specifically, due to T beam heating and static electrification). The internal design leads to "hot spots" in the transformer windings that generate hot metal gases that could lead to transformer failure.

Many of the 115kV breakers and disconnect switches are showing signs of degradation and have had issues in the past with equipment damage or not operating correctly. The concrete foundations supporting the breakers and structures, the differential, and voltage supply cabinets are all in poor condition and require repair or replacement. Some need attention now and others within the next 5 years.

A master plan for the site is being developed to address the sequence in which the station should be rebuilt and the retirement/movement of the 69kV & 34.5kV assets in the station with an emphasis on the overall station/system needs, stability, reliability, maintenance and future upgrade/system improvement possibilities. The master plan identified the retirement/upgrade of the 69kV assets and then rebuilding the 115kV yard would provide the best value and most flexibility for rebuilding and reconfiguring the 230kV yard in the future. Improvements expected by rebuilding the 115kV yard first include the reduction in the number of transmission line crossings, easier access and maintainability, and greater operating reliability and efficiency.

There are many factors that will help determine the appropriate configuration of the 230kV yard in the future, including potential alternatives related to National Grid's submittal in response to the Energy Highway Initiative.

The Rotterdam station rebuild is in conceptual engineering.

2. A. 5. 10. 3. Lockport

Lockport is a 115KV transmission station with thirteen 115kV transmission lines tying through the East and West Bus sections and serves an important role in the 115kV system in western New York. The overall condition of the station yard and control room is poor. Work is required on control cable duct banks, breaker operators, structure painting and concrete equipment foundations that are significantly deteriorated.

Lockport was originally part of the 25 cycle system dating back to the 1910s. The structures are severely rusted and in need of painting before the steel becomes compromised. Typical conditions of the structural steel at the station along with column and breaker foundations are deteriorated and need to be repaired with several potentially needing full replacements.

The original manhole and duct system for control cables is in degraded condition which has caused control wire shorts, battery grounds and unwanted circuit breaker operations. Station maintenance crews are restricted in performing repairs due to the overall condition of the duct bank because single control cables cannot be replaced without adversely affecting adjacent control cables in the same ducts.

There are two new 115kV SF6 breakers while the remaining forty-year old 115kV, oil filled, BZ0 breakers show exterior rust and oil stains. Three of the 115kV oil breakers have continued hydraulic mechanism leaks common to the BZO style breakers. Failures of hydraulic system components have been notably increasing. Each of the oil BZO breakers has bushing potential devices which have been another source of failure.

Transformer #60 is a 115-12kV 7.5MVA transformer manufactured in 1941 which supplies Lockport's station service and Race Street Line 751. Race Street Line 751 is tied to the Race Street seasonal hydraulic unit. An alternate station service should be provided should TR #60 or station service fail.

The control room building is also in very poor condition and requires paint and floor repairs. Existing peeling paint is likely lead contaminated. It is an oversized building with continued maintenance costs for the original roof and the intricate brickwork. It contains a 90 ton overhead crane in the old 25 cycle frequency changer portion of the building which is presently used only to store old cable. The control house roof was repaired in the 1990s and brick pointing was also done to limit deterioration within the last 5 years. The old 25 cycle control circuitry has been disconnected with the DC battery to eliminate potential source of battery ground problems. Rodents are a frequent problem and signs of control wire damage are evident.

Conceptual engineering to rebuild the station in place was completed. The project has been deferred for further consideration in FY2021.

2. A. 5. 10. 4. Lighthouse Hill

Lighthouse Hill is a switching station in northern NY. It has two 115kV buses and seven transmission lines connecting to the station allowing delivery of power from generating facilities in the north to substations in the Watertown and Syracuse areas.

The condition of the station is fair to poor depending on the specific assets being considered. An integrated plan has never been developed for the station since numerous relay upgrades have been performed without any improvements to the station itself. The disconnect switches are in very poor and hazardous condition with failed insulators and repairs appear to work only temporarily due to the design configuration. Most of the OCBs are in fair condition, but several are obsolete and would pose a challenge to significantly repair.

The seven OCBs are located 200ft from the Salmon River, located about 70ft below the grade elevation. The station is located approximately one mile upstream of the NY State wildlife fish hatchery. Although the risk is low, any significant oil spill in the station would have a significant environmental impact. There is also the risk of a flooding event at the station given its elevation and proximity to the river.

The 6B transformer has a history of gassing and replacement should be considered in the next few years.

Another significant issue at the station is that the land is owned by Brookfield Power and operated as a shared facility under a contractual agreement. The hydro station was previously owned by Niagara Mohawk. Not having direct access to Brookfield's control room at Lighthouse Hill limits the Company's control over the housing conditions for the battery and relay systems. National Grid has controls on the first floor of the control house which is immediately adjacent and downstream of Brookfield's hydroelectric dam. A release from the dam would likely flood the control room area.

Conceptual engineering for a new substation, relocated to a greenfield site along an adjacent road in the clearing near the transmission right-of-way and away from any flooding risk is underway.

2. A. 5. 10. 5. Huntley

In 2005 NRG (the owners of the Huntley Generating Station) announced the retirement of the four 115kV connected generators at Huntley, and in 2016 NRG retired the Generating Station. The Company has been working on separation plans to accommodate the plant retirement.

The Huntley 230kV and 115kV Switchyards located at the Huntley Steam Station in Tonawanda, NY are shared facilities between NRG and National Grid. The Huntley Generating Station is owned by NRG. The station was built in the late 1930s and is a terminal point for eight (8) 115kV lines, four (4) 230kV lines, one (1) 230kV pipe type oil filled cable, with the 230kV switchyard supplied by two (2) generators owned by NRG. A 230kV 91MVAR Oil Filled Reactor used for overvoltage protection on the 230kV oil filled cable is also installed in the 230kV switchyard. Protection, control, communication, DC battery systems and AC station service supply for the 115kV and 230kV switchyard are located within the Huntley Generating station. Each of these systems is located in different locations and different levels within the Huntley power house. The ground source for the National Grid 115kV grounded wye system is derived from three (3) NRG owned 13kV-115kV step-up transformer banks.

The Company's asset separation and asset replacement plan is intended to separate the National Grid owned assets from the NRG owned Steam Station building, and replace assets that are in poor condition in the National Grid Substation.

The asset separation would involve a new control house on National Grid owned property, the installation of new control cables, and removal of the necessary equipment to complete a clear point of delineation between the NRG Huntley Generating Station and the National Grid Huntley Substation.

There are as well many asset condition issues at the Huntley substation. The foundations are in poor condition in the 230kV and 115kV yard, including many structure foundations, affecting the integrity of the structure itself.

Some circuit breaker foundations are in very poor condition raising the possibility that an OCB could move during a severe fault leading to more damage and/or causing safety issues. The 230kV and 115kV OCBs are either Westinghouse type GW design or General Electric type FK design and would be part of the OCB replacement strategy, if not for this project.

The majority of the disconnect switches are in poor condition and required extra maintenance over the past few years. Also a recent project was approved to have spares procured for Huntley station in case one had to be replaced.

This project has been approved and preliminary engineering has begun. The overall time-frame is anticipated to take five (5) years.

2. A. 5. 10. 6. Boonville

The Boonville substation was constructed in the 1950s and originally designed as a switching station for several 115kV transmission lines and the single source of the radial 46kV line to Alder Creek, White Lake, Old Forge, Eagle Bay and Raquette Lake. The use has not changed with the exception of the addition of a 23kV terminal for hydro generation.

The structural steel and foundations are deteriorated. The foundations have deteriorated due to the poor station drainage. The station was built alongside highway 12D in a farm field. Over the years it has sunk to an elevation lower than the highway and farm fields leaving drainage to no longer exist. This drainage issue is also present in the underground manhole and conduit system. The water surface level at the station causes the underground control cables to continuously be under water leading to their deterioration.

Electrically the station was designed with minimal redundancy and has antiquated relaying protection. The design has the single source transformer for the 46kV line to the Old Forge area connected off the south 115kV bus with no alternate method to supply the transformer if the south bus is out of service. The 115kV to 46kV transformer was replaced in the 1990s, but is still the only source and cannot be maintained properly due to outage restrictions. With no distribution at Boonville there is little need for a mobile sub connection. But there is a spare transformer for the 115/46kV TB#3 located at the station.

All of the electrical components at the station such as oil breakers, oil filled potential transformers and switches require replacement. The station control building is of brick design and needs reconditioning. The size of the building has also become an issue with the addition of EMS and relay upgrades over time. Also, the station perimeter fencing needs replacement on 3 sides.

The Boonville station rebuild is in conceptual engineering.

2. A. 5. 10. 7. Oswego

Three substations are located on the generation site owned by NRG which include a large 345kV switchyard (that was recently upgraded and in overall very good asset condition, except for the control house which is scheduled for future replacement) and 115kV and 34.5kV yards originally designed and integrated when the generating station and substations were owned by the same utility.

The 115kV substation is in poor condition with out-of-service equipment that has not been formally retired. Bus sections have been cut, rerouted, and breakers out of service with yellow hold cards. The disconnect switches to the OCBs are original to the station and are the pin and cap design that has an industry recommendation for replacement. The 115kV yard is sourced from the 345kV yard. This change occurred in the early

1990s, when Plants 3&4 that supplied generating power to the 115kV bus retired. The electro-mechanical relays and battery for this yard and the 34.5kV yard are still inside the generation plant which limits the Company's control and access to these assets.

The 34.5kV yard is the original to the 1940s plant 1&2 (retired decades ago). All equipment in the yard is of original vintage, is obsolete, and is in poor condition.

Recommendations for future conceptual engineering analysis include the immediate removal of the old R-55 breaker to meet standing EPA storage requirements, the retirement and removal of all permanent out of service equipment, and strategy for permanent separation or relocation of the yards to isolate the interests of National Grid from NRG.

This project has been approved and preliminary engineering has begun.

2. A. 5. 10. 8. Inghams

Inghams station is located in the town of Oppenheim, NY and is a connection between a hydro generating station and the transmission and distribution electric system. The transmission voltages at Inghams are 115kV and 46kV, and the distribution voltage at Inghams is 13.2kV. The Inghams station helps to moderate the electrical system as it has a phase angle regulator (PAR) type transformer.

The transmission planning department is looking to improve the capabilities of the PAR by specifying a replacement unit with a wider adjustment range.

The Inghams station was flooded in 2006 and remains a flood concern. After the station was repaired a new stone wall approximately five (5) feet tall was constructed along the station perimeter that is shared with the river boundary. The stone wall is considered a temporary measure as it will limit the current flow of the river if the river rises to flood heights again, but will not keep the station from being flooded.

The recommendation for the station is that the PAR be replaced and the existing PAR be kept as a spare unit, for emergency use. Also, the station will be relocated outside the current flood zone to be above the 500year flood zone line.

The Inghams station rebuild is in conceptual engineering.

2. A. 5. 10. 9. Future Additional Station Rebuilds

The following substations are in the long term conceptual engineering and/or system planning study phase for substation upgrade and/or rebuild: Harper, Elm Street, Sawyer Avenue, Seneca Terminal, Yahnundasis, Batavia, and Kensington Terminal.

Chapter 2B. Sub-Transmission System Asset Condition

This section provides the condition of overhead and underground elements of the sub-transmission system.

Table 2B-1 summarizes the key overhead and underground sub-transmission assets.

Table 2B-1
Sub-Transmission Assets

Sub-Transmission Main Assets	Inventory
Towers/Poles	69,947
Overhead Line Circuit Miles	4,800
Underground Cable Circuit Miles	1,100

2. B. 1. Overhead System

Table 2B-2 provides a breakdown of the sub-transmission system structures.

Table 2B-2
Structure Types

Asset	Inventory
Steel Structures	2,881
Wood Structures	67,066
Total	**69,947**

2. B. 1. 1. Steel Towers and Steel Poles

Table 2B-3 shows a breakdown of the Inspection and Maintenance program results for sub-transmission steel towers and poles in the last three calendar years. The most frequent three asset condition codes are shown in the table[1]. A summary of all categories is shown in Exhibit 3.

[1] Priority levels greater than Level 3 not shown in Table 2B-3.

Table 2B-3
Sub-Transmission Steel Towers and Steel Poles Inspection Results

Level	Loose Bolts – 534	Structural Damage – 537	Tower Legs Broken - 531	Total	Percentage Codes Completed
2014 Summary					
1	0	0	0	0	
2	0	11	2	13	100%
3	0	31	0	31	65%
2015 Summary					
1	0	0	0	0	
2	0	0	0	0	
3	1	12	4	17	12%
2016 Summary					
1	0	0	1	1	100%
2	0	1	2	3	0%
3	9	30	0	39	0%

In addition to the Inspection and Maintenance program, supplemental inspections are performed by the Company to determine if towers in the most deteriorated condition should be repaired or replaced.[2] Footing inspections on some lines have also been undertaken along with completing reinforcing and footing repairs. In a few cases, the estimated cost to repair deteriorated tower footings was excessive based on the overall condition of the tower which resulted in tower replacement. In other cases, the poor condition of a tower superstructure resulted in the footing being temporarily supported until the tower could be replaced or repaired. Typical superstructure problems included corroded, bent, detached or twisted members, tilted towers, past vehicular or storm damage and failed crossarms. In some cases, falling trees caused broken conductors or differential tensions on the towers, causing permanent bending or failure of members which required replacement. In some of these cases, the towers continue to function normally.

2. B. 1. 2. Wood Poles

Table 2B-4 below lists foot patrol inspection results performed on wood poles over the last three calendar years. Inspectors assign priority level “Replace” codes for poles that appear broken, rotting or leaning on a scale of 1 – 3 with 1 being the highest replacement priority. They also assign priority level “Repair” codes for poles with lightning, insect, woodpecker or other damage on the same 1 - 3 scale. Poles that are in good overall condition are not assigned a priority level code.

[2] The visual grading system described previously for transmission structures in Table 2A-7 is also used for sub-transmission towers.

Table 2B-4
Sub-Transmission Wood Pole Replace and Repair Codes from Computapole

Level	Replace Codes			Repair Codes		
	Number of Poles	Percent Codes vs. Inspections	Percent Completed	Number of Poles	Percent Codes vs. Inspections	Percent Completed
2014 Summary						
1	0	0.00%	100%	0	0.00%	100.00%
2	87	0.95%	91%	133	1.46%	93.40%
3	415	4.55%	46%	413	4.53%	39.40%
No Codes	8,425	92.36%				
Total Poles Inspected	9,122					
2015 Summary						
1	3	0.03%	100%	2	0.02%	100.00%
2	84	0.79%	54%	61	0.58%	75.40%
3	463	4.37%	2%	420	3.96%	2.40%
No Codes	9,798	92.45%				
Total Poles Inspected	10,598					
2016 Summary						
1	1	0.01%	100%	0	0%	100.00%
2	12	31.03%	92%	66	0%	54.50%
3	571	1.68%	0%	696	5%	0.01%
No Codes	13,344	92.44%				
Total Poles Inspected	14,436					

Table 2B-5 shows a more detailed breakdown of the Inspection and Maintenance program results of the most frequent four asset condition codes for sub-transmission wood poles in the last three calendar years.

Table 2B-5
Sub-Transmission Wood Pole Inspection Results

Level	Visual Rotting – 511	Wood Pecker – 526	Insects – 527	Leaning Pole – 512	Total	Percentage Codes Completed
2014 Summary						
1	0	0	0	0	0	
2	81	63	69	1	214	93%
3	415	222	177	11	825	43%

2015 Summary						
1	2	0	2	0	4	100%
2	82	36	24	1	143	62%
3	463	180	228	6	877	2%
2016 Summary						
1	1	0	0	0	1	100%
2	0	63	1	2	66	55%
3	571	531	163	1	1,266	1%

Most pole issues do not contribute significantly to interruptions, but often do present potential safety or environmental issues. Poles are replaced based on condition as identified through the inspection and maintenance process described above, and during overhead line refurbishment projects. Additional poles may be added or done concurrently based on engineering and line operations field walk-downs.

2. B. 1. 3. Overhead Line Refurbishment

There are approximately 4,800 circuit miles of sub-transmission overhead conductor. In addition to the Inspection and Maintenance program, the condition of circuit conductors, hardware, poles, overhead ground wires, drainage (in some cases) and towers is evaluated by Engineering personnel as related work is considered. Related work can include projects to improve reliability, upgrading circuits that are identified as being near their thermal limit or in poor condition. Conductor size and number of splices in a conductor are also reviewed to determine if replacement is warranted. Typically, #4 copper, #3 copper, #2 copper, #1 copper and Copper Copperweld conductors will be replaced on main lines and important tap lines. In all cases, these smaller conductors are over 65 years old and have had numerous splices installed on them due to past field incidents. In addition, these conductors are no longer standard relative to inventories available to fix or replace them.

The connection hardware between steel towers and insulator strings has also been problematic for older steel tower lines. There are two prevalent issues which have been identified on steel towers. First, the steel plate connecting the insulator string to the tower may become elongated and worn due to conductor movement. Second, the hooks that connect the insulator string to the tower plate become worn due to similar movement. In these cases, new hardware or steel plates are needed to prevent conductors from falling.

Overhead Ground Wires (Static Wires or Shield Wires) are usually located on specific lines and are installed with the original construction in most cases. Over time, these wires deteriorate and break depending on conditions and location. The refurbishment projects are reviewing cases where this has happened to determine if replacement is warranted to avoid future line outages and other potential safety concerns and keep the overall lightning protection consistent for these affected circuits.

2. B. 1. 4. Overhead Line Removals

Typically, when a line is de-energized due to the reduction/removal of demand loads (i.e. removal of a customer station) or due to reconfigurations to the system based on planning studies, the lines are "retired-in-place" so that they can be utilized at a future date if required and/or to maintain property rights in certain areas. In the past, removal of de-energized lines was dictated by emergency damage/failure type projects or in response to problem identification worksheet (PIW) safety concerns.

Primarily driven by safety, a de-energized line removal strategy was created identifying existing "retired-in-place" de-energized lines that the Company has determined will not be required/utilized at a future date based on the latest planning studies and therefore should be removed rather than repaired and maintained. National Grid adheres to the National Electrical Safety Code's general requirements for the inspection and tests of in-service and out-of-service lines (NESC Safety Rules for Overhead Lines, Rule 214). This rule requires the removal or maintenance in a safe condition of all assets that are permanently retired, which will maintain the safety of the public and field personnel when in proximity to de-energized lines.

The strategy has identified de-energized "retired-in-place" sub-transmission lines to be partially or completely removed. The active projects that need removal are shown in Table 2B-6 by removal priority.

Table 2B-6
Active List of Sub-Transmission De-Energized Line Removals

Priority	Region	Line Name	Voltage (kV)	Status
1	Southwest	Homer Hill-Ceres 809 Part I	34.5	Under Construction
2	Capital	School St-Watervliet etc.	13.2	Awaiting Scheduling
3	Frontier	TSC-Gardenville 92	69	On hold: incl. w/ Gardenville Sta. Rebuild
4	Capital	Rensselaer-Barnet 2-34.5kV	34.5	Awaiting Scheduling
5	Northeast	Spier-Glens Falls 8, Imperial Tap	34.5	Maintenance removal in progress

Priority	Region	Line Name	Voltage (kV)	Status
6	Mohawk	Terminal-Cornelia 43	46	Awaiting Scheduling
7	Central	Westmoreland-Yahnundasis 24/Clinton Tap 24	34.5	On Hold Awaiting Scheduling & Funding Project Approval
8	Central	Miller Brewing Wastewater Treatment Plant tap 26	34.5	Awaiting Scheduling To Complete
9	West	Homer Hill-Ceres 809 Part 2	34.5	Awaiting Scheduling
10	West	Sanborn-S. Cambria 406	12	Awaiting Scheduling
11	West	Cambria-Lockport 411	12	Awaiting Scheduling
12	Central	Buckley Rd Substation Tap 24	34.5	On Hold For D Conversion-Final Design

2. B. 1. 5. Sub-Transmission Automation

Sub-transmission lines typically supply numerous distribution substations. The Company has focused on a number of lines (see Table 2B-7) that have experienced multiple interruptions over the past several years causing both Customer Interruptions (CI) and Customer Minutes Interrupted (CMI).

To mitigate these interruptions, Sub-transmission Automation (SA) will be installed. The SA will re-configure the sub-transmission lines after an event to minimize the CI and the CMI impact on customers. National Grid currently uses two types of sectionalizing equipment, S&C ScadaMate switches with 6800 Series controls and G&W Viper Reclosers with SEL 651R controls.

When installing S&C ScadaMate switches, each switch utilizes 900Mhz line-of-sight radios to communicate with the other switches on the line. The S&C switches will determine the location of the fault and how to re-configure the line based on the conditions each sense. Line-of-sight communications is required for the automation logic to function properly. In addition to the SA switches, a number of repeater radios, a head end radio base station and RTU are required for the scheme.

When installing G&W reclosers with SEL 651R Controls, each recloser will utilize Verizon Cellular radios to communicate back to a centralized RTU. The Reclosers will send data to the RTU which will then determine the fault location based on the programmed logic in the RTU. This centralized automated platform will eliminate the need for multiple repeater radios. The number of SA Switches proposed to be installed on each line is included in the table below.

Table 2B-7
Sub-Transmission Automation Data (34.5kV)

Division	Line Names	Number of Customers	Customer Interruptions (CI)	Customer Minutes Interrupted (CMI)	Number of SA Switches Proposed
East	Nassau-Hudson #9	1,492	15,723	2,448,475	See note 1
	Snyders Lake-Hoag #9	959			See note 1
Central	Akwesasne-Fort Covington-Malone #26	4,528	26,312	4,072,182	8 See Note 2
	Akwesasne-Nicholville #23	3,727			5 See Note 2
	Nicholville-Malone #21	2,215			5 See Note 2
West	Phillips-Medina #301	3,536	128,126	15,032,766	5
	Phillips-Telegraph #304	2,924			4
	Gasport-Telegraph #312	4,174			4
	Delevan-Machias #801	2,329			2
	N.Angola-Bagdad #861	3,895			6
	Sherman-Ashville #863	2,205			6

Note 1: For the Nassau-Hudson #9 Line, the plan is to install two reclosers and upgrade the controls of a third existing recloser to form a loop scheme. On the Snyders Lake-Hoag #9, the plan is to install one recloser and upgrade the controls.

Note 2: These schemes will utilize the G&W Viper Recloser with SEL 651R Controls. They will be utilizing the centralized automated logic model.

2. B. 2. Vegetation Management

2. B. 2. 1. Rights-Of-Way Widths

National Grid maintains approximately 3,065 miles of sub-transmission overhead line facilities on urban and rural rights-of-way (ROW). Critical factors in the reliability of the sub-transmission assets are the relatively narrow widths of the ROW as well as the lower conductor heights, making the danger tree issue very important.

The most current reliability data will be used to maintain and prioritize work. ROW edge on sub-transmission is observed on the same cycle as the assigned floor cycle with work being scheduled based on the observed condition of the corridor.

2. B. 2. 2. Vegetation Management

In large areas across New York State, forest condition is being impacted by the pest, Emerald Ash Borer (EAB). It is expected that within a decade, all trees of the ash species will be either in decline or dead. National Grid funded a study to assess the risks and impacts associated with EAB in New York. Using the information obtained in the study, the Company developed a long-term strategy for addressing the issue.

Ultimately 100% of the Ash trees growing in proximity to National Grid US overhead assets will die. The rate of infestation and mortality within the Company's service area could put significant risk on our ability to deliver safe and reliable electric service to customers. The Company is implementing a risk-based and pro-active mitigation program to address the mortality of Ash trees adjacent to the overhead system. The investment to address the increased risk will be implemented over several years. The program is designed to maintain an Ash species removal rate above projected failure rates of Ash trees. Mortality rates for Ash trees are expected to begin to escalate over the next 3 to 4 years (*see Final Report, EAB Risk Assessment, National Grid NY*).

2. B. 3. Underground System

2. B. 3. 1. Underground Cables

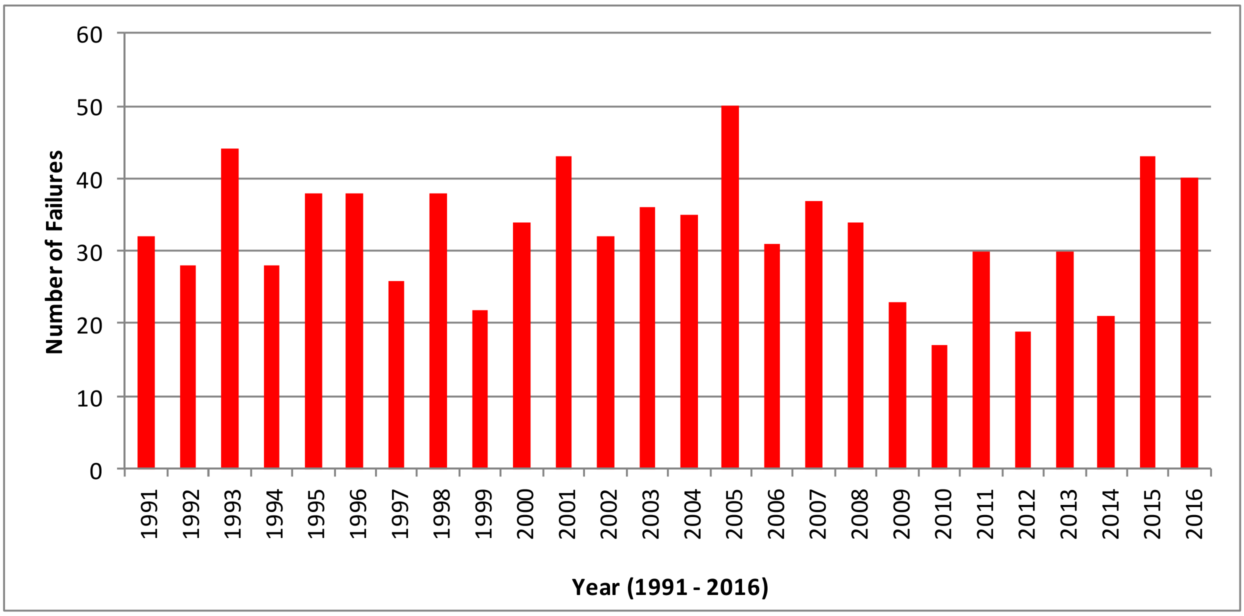
There are approximately 1,100 miles of sub-transmission underground cable. Planned cable replacements are driven by cable condition and performance history. The underground sub-transmission system consists primarily of paper-insulated lead-covered (PILC) and ethylene propylene rubber (EPR) type cables. There are also some Low Pressure Gas Filled (LPGF) type cables in the underground system.

Sub-transmission underground assets are replaced where they are considered to be in poor condition, have a history of failure, or are of a type known to have performance issues. Candidates for replacement are also evaluated based on loading considerations. Cable failures are tracked, but do not usually have an impact on reliability as the sub-transmission underground system is networked and individual cable failures will not necessarily lead to customer interruptions.

<u>2. B. 3. 2. Remedial Actions Performed</u>

Of particular concern is the sub-transmission cable system in the Buffalo area. There are approximately 433 miles of cable that supply the 23-4kV Buffalo distribution stations, LVAC network and customer owned stations. Numerous sections of the 23kV underground cables have been in service for over 80 years. See Figure 2B-8 for a graphical view of the Buffalo 23kV Sub-T cable failure data. A cable replacement program is being implemented to evaluate cables and assign priority levels to those in most urgent need of replacement. Replacement of the cables will improve reliability by reducing accumulating annual repair costs, customer outages and alleviate any thermal contingency concerns. Additional review will be conducted to develop a proactive plan for replacement of the remaining cables over a 15+ year time frame.

Figure 2B-8: Buffalo 23kV Sub-T Cable Failures from 1991-2016



Chapter 2C. Distribution Line Asset Condition

This section provides the condition of overhead and underground distribution system assets.[1] Since the population of certain distribution assets can be very large, even a small portion of a population requiring maintenance or replacement can be a significant annual management issue.

Table 2C-1 is an inventory of distribution overhead and underground system assets.

Table 2C-1
Distribution Line Assets[2]

Asset	Quantity
Overhead Distribution Circuit Miles	40,057
Underground Distribution Circuit Miles	7,597
Blade Cutout	15,896
Capacitor Installation	5,119
Elbow	78,960
Fuse Cutout	214,550
Handhole	75,913
In Line Fuse	467
Manhole	12,253
OH Regulator Installation	2,410
Pad	81,827
Pole	1,246,513
Pullbox	5,635
Recloser	1,415
Street Light Support	73,592
Switch Bypass	3,802

[1] Substation assets are covered in Chapter 2D.
[2] The majority of table data is from the National Grid Distribution Device & Structure Counts by Location downloaded 8-1-17. The reporting is by location rather than units (except for elbows). Each location can contain more than one unit. As an example, a count of "one" transformer location can include three single-phase distribution transformers that comprise a single three-phase bank. The data in the tables has not been rounded and the precision of the information should not be assumed to the degree of significant digits. Overhead and underground distribution circuit miles were taken from National Grid Blue Card Statistics - New York and New England downloaded on 3-27-17.

Asset	Quantity
Switch Gear	3,378
Switch Installation OH	24,839
Switch Installation UG	95
Transformer Distribution OH	338,299
Transformer Distribution UG	71,186
Transformer Ratio OH	13,218

Chapter 3, Exhibit 3 contains the Inspection and Maintenance Report summarizing program results from January 1, 2014 to December 31, 2016. Program activities generate asset condition information and remediate asset condition issues. The report does not include quantities of assets found in acceptable condition. More detailed analysis of asset condition for certain assets follows below.

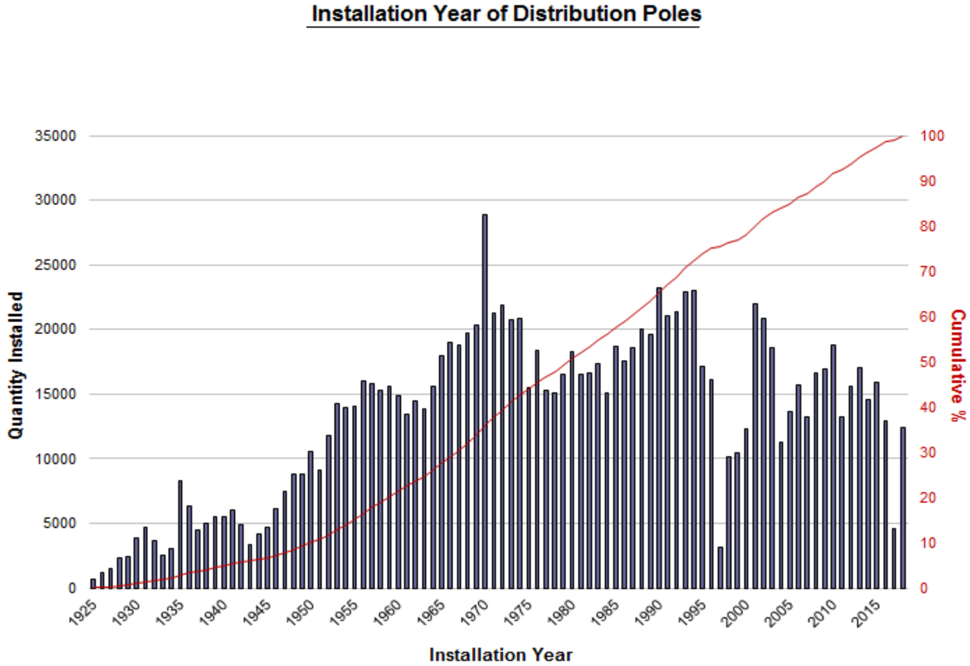
2. C. 1. Overhead System Assets

2. C. 1. 1. Wood Poles

Distribution structures include poles, system grounding, anchors and guying, crossarms, and riser pole equipment. There are approximately 1,246,513 distribution poles on the system with an average age of 38 years (Figure 2C-2). Distribution structures are in generally good condition, with 99 percent of structures inspected found in acceptable condition.[3] Some of the distribution assets are also attached to transmission or sub-transmission structures. The condition of those structures is discussed in either the transmission or sub-transmission section of this report rather than this section, as the distribution component is ancillary to the structure.

[3] A total of 255,732 poles were inspected (PSC Quarterly Report, Inspections Summary Report, Distribution Unique Inspections, Units Completed Table, December 31, 2016). Separate Computapole query indicates 247,930 poles had no pole related maintenance codes of any kind.

Figure 2C-2
Age Profile of Distribution Poles[4]



2. C. 1. 1. 1. Condition and Performance Issues

In Exhibit 3, the Distribution Overhead Facilities, Poles, Pole Condition heading summarizes the results of the Inspection and Maintenance program. Table 2C-3 shows a breakdown of the program results, including the four most frequent maintenance codes found.

[4] Approximately 12,000 poles without age data were listed. Poles with installation dates prior to 1925 are included as without age data.

Table 2C-3
Distribution Wood Pole Inspection Results[5]

Level	Visual Rotting – Top 116	Visual Rotting – Ground 111	Leaning Pole 117	Wood Pecker 114	Other 110, 112, 113, 115	Total	Percentage Completed
2014							
1	11	43	0	6	88	148	100%
2	1,920	1,155	521	273	264	4,133	99%
3	2,226	839	0	0	316	3,381	74%
2015							
1	2	25	1	0	195	223	100%
2	472	427	159	444	190	1,692	99%
3	3,410	2,047	209	212	1,264	7,142	20%
2016							
1	0	0	0	0	296	296	100%
2	0	0	0	950	0	950	73%
3	2.974	1,981	349	0	2,498	7,802	6%

Figures 2C-4 and 2C-5 compare the installation year profiles of poles inspected in 2016 against poles that are candidates for replacement based on those same inspection results.[6] This profile is consistent with past years. A small percentage of the poles inspected were candidates for replacement, typically those poles are between 30 and 80 years old.

[5] Data source is Distribution Computapole Report 1030. The four most frequent codes are shown on this table. Exhibit 4, Distribution Overhead Facilities, Poles, Pole Condition heading summarizes all the wood pole asset condition codes.

[6] The following asset condition codes were considered as most likely resulting in pole replacement: 110 - Broken/Severely Damaged, 111 - Visual Rotting Ground Line, 113 - CuNap Treated, 114 - Woodpecker Holes, 116 - Visual Rotting Pole Top, 117 Leaning Pole. The poles considered candidates for replacement also had the following Priority Level codes: 1 (one week), 2 (one year), 3 (three years), P (performed during inspection), 9 (temporary repair) and 7 (emergency).

Figure 2C-4
Install Year Profiles of Poles Inspected Versus Replacement Candidates

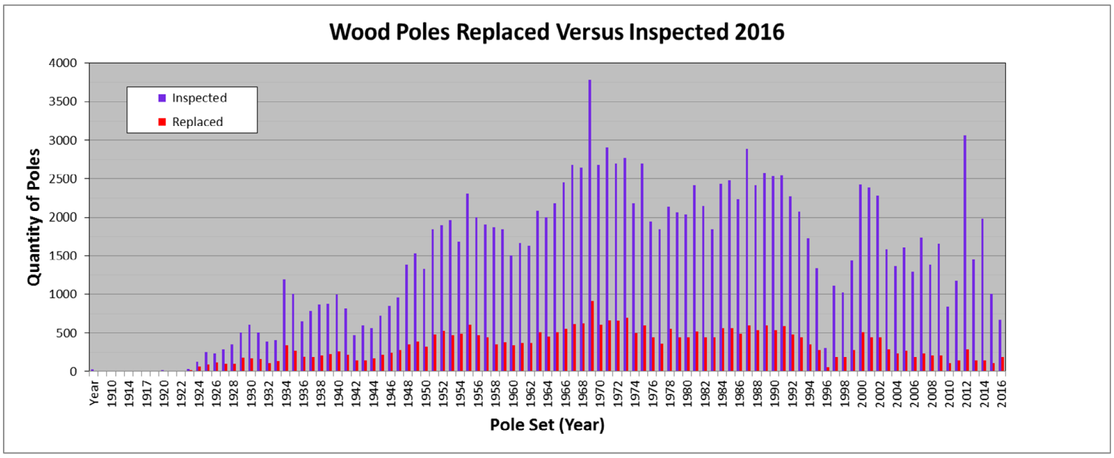
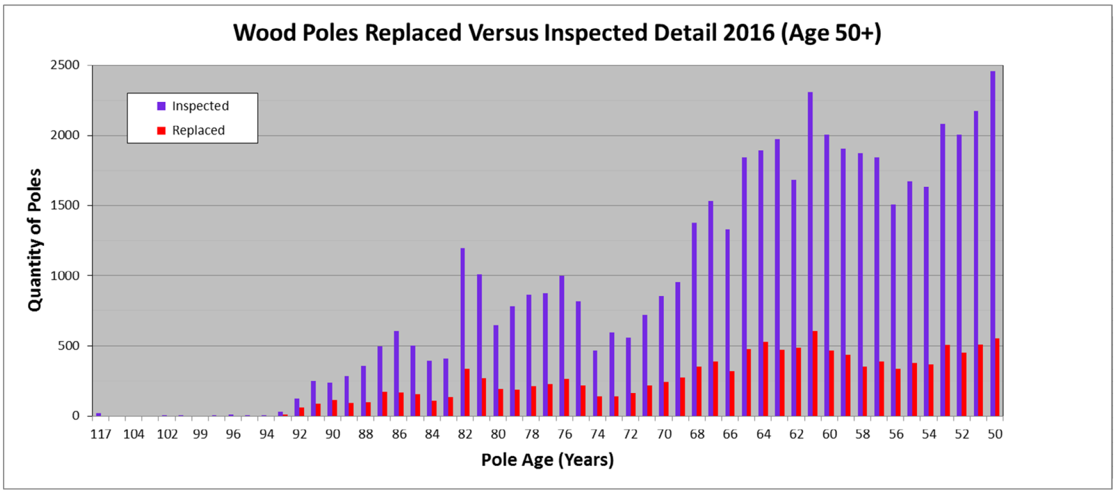


Figure 2C-5
Replaced versus Inspected Detail Based on Pole Age



2. C. 1. 1. 2. Remedial Actions Performed

A total of 11,635 poles were installed on the distribution system, including poles installed as part of the Inspection and Maintenance program and for other reasons such as new business.[7] Table 2C-6 shows the Inspection and Maintenance program results specific to distribution wood poles, further broken down by codes considered to require replacement. There can be multiple codes recorded per pole. The total number of inspected poles where no maintenance codes were found is also shown.

Table 2C-6[8]
Distribution Wood Poles Replace and Repair Codes

Level	Replace Codes			Repair Codes		
	Number of Poles	Percent Codes vs. Inspections	Percent Completed	Number of Poles	Percent Codes vs. Inspections	Percent Completed
2014 Summary						
1	68	0.02%	100%	81	0.03%	100%
2	3,543	1.54%	99%	624	0.27%	99%
3	3,134	1.36%	72%	1,281	0.55%	85%
No Codes	223,546	97%				
Total Poles Inspected	229,300					
2015 Summary						
1	98	0.03%	100%	123	0.04%	100%
2	1,417	0.55%	99%	191	0.07%	99%
3	5,867	2%	19%	1,439	0.56%	25%
No Codes	248,926	97%				
Total Poles Inspected	255,736					

[7] Table 2C-14, *infra*, summarizes the distribution system overhead and underground equipment installed between July 1, 2016 to June 30, 2017.

[8] The replace codes used for this table are: 110 - Broken/Severely Damaged, 111 - Visual Rotting Ground Line, 113 - CU NAP Treated, 114 - Woodpecker Holes, 116 - Visual Rotting Pole Top, 801 - Osmose Priority Pole, and 802 - Osmose Reject Pole. The repair codes used for the report are the balance of pole codes available in the Distribution Field Survey Worksheet. The total number of poles inspected is per the December 31, 2016 PSC Quarterly Report, Inspections Summary Report, Distribution Unique Inspections, Units Completed Table. Separate Computapole query indicates poles that had no maintenance codes of any kind.

2016 Summary						
1	173	0.06%	100%	124	0.04%	100%
2	953	0.37%	73%	0	0.00%	0%
3	5,408	2%	5%	1,748	0.68%	9%
No Codes	251,891	98%				
Total Poles Inspected	255,732					

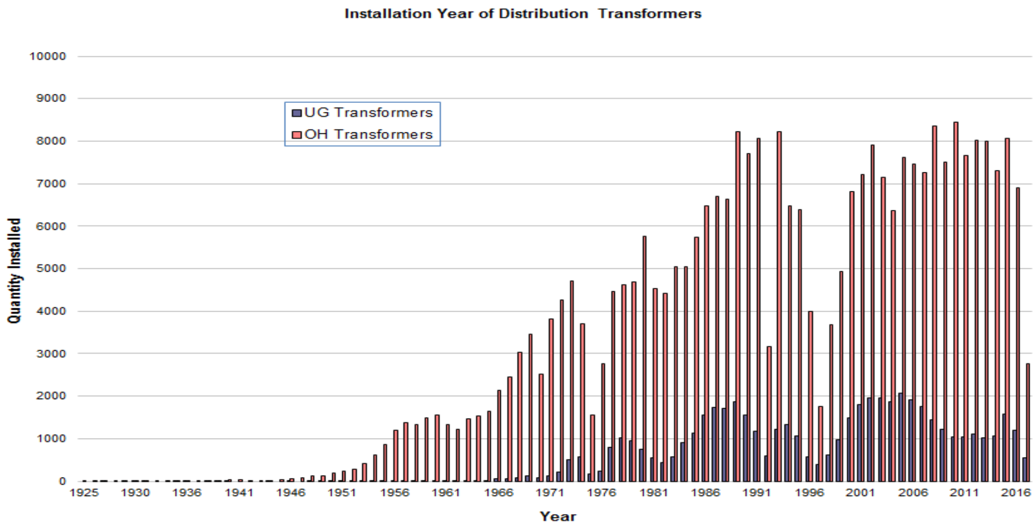
Between January 1 and December 31, 2016, inspections were completed on 255,732 distribution poles, representing 20 percent of the population. Based on inspection codes[9] approximately 6,534 poles are candidates for replacement over the next three years. The majority of the listed codes will not result in pole replacement. Multiple asset condition codes can be recorded for each pole.

2. C. 1. 2. Distribution Overhead and Padmounted Transformers

Figure 2C-7 shows the installation year profile data for overhead and underground distribution transformers on a per unit basis. The average age of overhead transformers is approximately 24 years for the 79 percent of transformers with age data. The average age of underground transformers is approximately 20 years for the 72 percent of transformers with age data.

[9] Data source is Computapole Report 1030 taking counts of the following maintenance codes considered as most likely resulting in pole replacement: 110 - Broken/Severely Damaged, 111 - Visual Rotting Ground Line, 113 - CuNap Treated, 114 - Woodpecker Holes, 116 - Visual Rotting Pole Top, 801 - Osmose Identified Priority Pole, and 802 - Osmose Indentified Reject Pole.

Figure 2C-7
Age Profile of Distribution Transformers[10]



2. C. 1. 2. 1. Condition and Performance Issues

For overhead transformers, the results of the Inspection and Maintenance program are found in Exhibit 3, under the Distribution Overhead Facilities, Pole Equipment, Transformers heading. Exhibit 3 also contains a separate "Distribution Pad Mounted Transformers" table.

2. C. 1. 2. 2. Remedial Actions Performed

Remedial action performed as part of the Inspection and Maintenance program is contained in Exhibit 3. Table 2C-8 shows program results specific to distribution overhead transformers, further broken down by codes considered to require replacement.

[10] A total of 81,100 overhead transformers and 19,531 underground transformers without age data are not shown. Transformers with installation dates prior to 1925 are included as without age data.

Table 2C-8[11]
Distribution Overhead Transformer Replace and Repair Codes

Level	Replace Codes: Number of Codes	Replace Codes: Percent Codes Completed	Repair Codes: Number of Codes	Repair Codes: Percent Codes Completed
2014 Summary				
1	6	100%	0	100%
2	299	99%	4,326	100%
3	0	100%	2,024	88%
2015 Summary				
1	6	100%	0	100%
2	166	99%	3,806	100%
3	149	17%	3,942	21%
2016 Summary				
1	18	100%	0	100%
2	36	94%	2,824	88%
3	275	10%	5,894	9%

The majority of the Priority Level 2 and Priority Level 3 maintenance codes reported were for code 157 - Improper or Missing Bond, and code 152 - Missing Ground Wire, respectively.

Table 2C-14 shows a total of 7,810 overhead distribution transformer units were installed under various blankets, programs and specific projects such as Inspection and Maintenance, Distribution Line Transformer Upgrade and new business activities. Table 2C-14 also shows that 1,088 padmounted transformer units were installed.

2. C. 1. 3. Conductors

There are approximately 40,000 circuit miles of primary overhead distribution conductor. No age profile data is available for conductors because age data was not recorded on system maps until after the implementation of GIS in 2000.

2. C. 1. 3. 1. Condition and Performance Issues

In 2016 approximately 7,400 circuit miles were inspected. In Exhibit 3, the Distribution Overhead Facilities, Conductor, Primary Wires/Broken Ties heading summarizes the results of the Inspection and Maintenance program for primary conductor.

[11] The “replace” maintenance codes used for this table are: 150 - Weeping Oil, and 151 - Bushings Broken/Cracked. The repair maintenance codes include: 152, 153, 155, 156, and 157. The data source for this table is a Computapole Report 1030.

Table 2C-9
Recorded Maintenance Codes Per Circuit Mile Inspected

Year	Circuit Miles Inspected	Percent of System	Conductor Codes[12]
2014	6,837	18%	215
2015	8,054	22%	231
2016	7,461	20%	241

2. C. 1. 3. 2. Remedial Actions Performed

Remedial actions performed as part of the Inspection and Maintenance program are provided in Exhibit 3. A total of 857 circuit miles of new conductor was installed on the distribution system, including conductor installed as part of the Inspection and Maintenance program, the Engineering Reliability Review program, the Planning Criteria program and new business.

2. C. 1. 4. Cutouts

There are approximately 214,500 cutouts on the distribution system.

2. C. 1. 4. 1. Condition and Performance Issues

Potted porcelain cutouts have been identified for replacement due to a mechanical failure mode and potential hazard associated with them. The strategy to replace potted porcelain cutouts has been included in the Inspection and Maintenance program. Beginning in the 2011 inspection cycle, the Company changed the Inspection and Maintenance program priority level for potted porcelain cutouts (maintenance code 281) from Priority Level 3 to Priority Level 2 to expedite the program.

The summarized results of the Inspection and Maintenance program for cutouts can be found in Exhibit 3 under the heading Distribution Overhead Facilities, Pole Equipment, Cutouts.

2. C. 1. 4. 2. Remedial Actions Performed

Remedial actions performed as part of the Inspection and Maintenance program are provided in Exhibit 3. As shown in Table 2C-10, the Inspection and Maintenance program has identified 54 potted porcelain cutouts from 2016 and replaced 15% percent of them.

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[12] The Conductor Codes used for this table are the same as used for Exhibit 3, Distribution Overhead Facilities, Conductors, Broken Wire/Broken Ties heading: 127 - Primary on Arm, 140 - Insufficient Ground Clearance, 141 - Damaged Conductors/Broken Strands, 145 - Damaged Stirrups/Connector, 146 - Improper Sag, 286 - Spur Tap Not Fused, and 402 - Infrared Problems Splice.

Table 2C-10
Potted Porcelain Cutout in the Inspection and Maintenance Program

	2014		2015		2016	
Status	**Units**	**%**	**Units**	**%**	**Units**	**%**
Replaced	380	70.24%	347	48%	8	14.81%
Pending	161	29.75%	369	51%	46	85.18%
Total	541		716		54	

2. C. 1. 5. Switchgear

There are approximately 3,378 switchgear on the system. Switchgears are generally in good condition with only a minimal number of issues discovered from the Inspection and Maintenance program.

2. C. 1. 5. 1. Condition and Performance Issues

There is no unique heading in Exhibit 3 for switchgear. Switchgear related maintenance codes are under various headings in the Distribution Underground Facilities table.

Between January 1, 2016 and December 31, 2016, inspections were completed on an estimated 608 switchgears. There were 12 Priority Level 1, 2 or 3 issues identified.

2. C. 1. 5. 2. Remedial Actions Performed

A total of 77 new switchgear units were installed on the distribution system.

2. C. 1. 6. Capacitors

There are approximately 5,119 capacitor banks on the distribution system providing reactive support. Capacitor banks are in generally good condition based on the number of maintenance codes recorded during inspections.

2. C. 1. 6. 1. Condition and Performance Issues

There is no unique heading for distribution line capacitors in Exhibit 3. Capacitor related activity is reported under various headings in the Distribution Overhead Facilities table.

Table 2C-11 shows the inspection results on capacitor banks between calendar years 2014 and 2016.

Table 2C-11
Capacitor Inspection Results

Level	Animal Guard Missing - 166	Improper/ Missing Bonding - 165	LA Missing/ Blown - 167	Blown Fuse - 164	Missing Ground - 163	Total	Percent Complete
2014							
1	0	0	0	0	0	0	-
2	0	0	0	33	34	67	100.00%
3	279	39	58	0	0	376	90.42%
2015							
1	0	0	0	0	0	0	-
2	0	0	0	46	14	60	100.00%
3	302	102	71	0	0	475	28.00%
2016							
1	0	0	0	0	0	0	-
2	0	0	0	49	17	66	90.90%
3	238	60	125	0	0	423	16.07%

The need to install animal guards is the most common code recorded against capacitor banks during inspection.

2. C. 1. 6. 2. Remedial Actions Performed

Table 2C-12 above shows the remedial action performed under the Inspection and Maintenance program. Capacitor maintenance is performed within the Inspection and Maintenance Program. Additionally, small capital projects are budgeted to address feeder level capacity and voltage support issues on the distribution system. As shown in Table 2C-14, a total of 97 capacitor units were installed between July 1, 2016 to June 30, 2017 on the distribution system, including those related to asset condition, feeder loading and voltage support.

2. C. 2. Vegetation Management

The Company's Distribution Vegetation Management (VM) Program consists of two components - cycle pruning and enhanced hazard tree mitigation (EHTM). The main purpose of the cycle pruning program is to create and maintain clearance between energized distribution conductors and vegetation, primarily tree limbs. The EHTM program is intended to minimize the frequency and damaging effect of large tree and large limb failures from alongside and above the Company's overhead primary distribution assets. This program assists in the Company's effort to provide reliable service to customers and meet regulatory targets.

The cycle pruning program has an interval of approximately 5½ years which is based on a combination of factors, including: length of the growing season, growth characteristics of the predominant tree species, and the amount of pruning clearance that can be obtained. National Grid schedules the distribution circuit vegetation pruning maintenance and adjusts for actual field growth conditions to yield an average 5½ year cycle. Actual circuit schedules range from 4 to 6 years.

Stable and consistent circuit pruning provides a measure of reliability. It is also important in maintaining public safety, reducing tree/conductor contact, improves line crew accessibility therefore improving efficiency in restoration and maintenance, and enhances the accuracy and efficiency of the line inspection process.

National Grid's EHTM program uses tree interruption prediction modeling based on historic tree interruption data as well as an estimated risk of future tree interruptions. This model takes into account customers at risk, miles of bare wire three phase construction, tree events per circuit mile, customers interrupted per tree event and the estimated overall cost to reduce the number of customers interrupted. The ranking provides a preliminary listing of circuits which are then field reviewed by arborists. Then a final list of circuits is developed that are expected to provide the most efficient and effective response to the mitigation. Once a circuit is chosen a circuit partitioning process is utilized to divide the circuit into prioritized segments based on number of customers served after each protection device. Hazard tree inspection intensity is then applied to the circuit segments accordingly. For example, within the main line portion of the circuit where future tree failures may cause a station breaker operation (lock-out) for the entire feeder, the highest inspection intensity is performed. For fiscal year 2017, hazard tree mitigation work was performed on 21 poor performing circuits.

In large areas across New York State, forest conditions are being impacted by the pest, Emerald Ash Borer (EAB). It is expected that within a decade, all trees of the Ash species will be either in decline or dead. National Grid funded a study to assess the risks and impacts associated with EAB in New York. Using the information obtained in the study the Company developed a long-term strategy for addressing the issue.

Ultimately 100% of the Ash trees growing in proximity to National Grid US overhead assets will die. The rate of infestation and mortality within the Company's service area could put significant risk on our ability to deliver safe and reliable electric service to customers. The Company is implementing a risk-based and pro-active mitigation program to address the mortality of Ash trees adjacent to the overhead system. The investment to address the increased risk will be implemented over several years. The program is design to maintain an Ash species removal rate above projected failure rates of Ash trees. Mortality rates for Ash trees are expected to begin to escalate over the next 3 to 4 years (see Final Report, EAB Risk Assessment, National Grid NY).

2. C. 3. Underground System Assets

National Grid's underground distribution system includes primary and secondary cables, secondary network cables, network protectors and transformers, manholes, vaults, and handholes. The Inspection and Maintenance Program inspected 16,384 unique underground facilities between January 1, 2016 and December 31, 2016. Items inspected include the condition of the underground structures themselves, and the condition of equipment within the structure, such as cables, splices, and network protectors. Padmounted transformers and switchgear are inspected with the overhead system and are discussed in the Overhead System Assets section above. Network system assets, a small portion of the underground system, are detailed in a separate section below.

2. C. 3. 1. Primary Underground Cables

There are approximately 7,597 circuit miles of primary distribution cable in the distribution system. The underground distribution system consists primarily of paper-insulated lead-covered (PILC), ethylene propylene rubber (EPR) type cables and cross-linked polyethylene (XLPE) type cables. Planned cable replacements are driven by cable condition and performance history. Network and radial events in the winter of 2012/2013 prompted a review of the existing cable replacement program. In 2013, National Grid selected an independent consultant to perform an assessment of the Company's Albany network system and provide a comparison to industry norms and best practices. This work included a review of Company standards, studies, policies, data management and guidelines. The findings were expanded and shared on a system-wide basis. In parallel, National Grid developed a defined criticality scoring metric to identify primary, secondary and secondary network cable replacement projects. A cable replacement program is being implemented to evaluate cables and assign priority levels to those in most urgent need of replacement.

2. C. 3. 1. 1. Condition and Performance Issues

In Exhibit 3, the Distribution Underground Facilities, Primary Cable heading summarizes the results of the inspection and maintenance program.

2. C. 3. 1. 2. Remedial Actions Performed

Remedial action performed as part of the Inspection and Maintenance program is shown in Exhibit 3, Distribution Underground Facilities.

2. C. 3. 2. Buffalo Streetlight Cable Replacement

This program replaces deteriorated underground street light cables and conduit in the Buffalo metropolitan area to address repetitive incidents of elevated voltage.

2. C. 3. 2. 1. Condition and Performance Issues

Elevated Voltage Testing has identified contact voltage incident rates that are 2 to 20 times the rates measured in other areas in the Company's service territory.

2. C. 3. 2. 2. Remedial Actions Performed

On April 15, 2013, the Company filed a comprehensive long-term street light refurbishment plan for the City of Buffalo in Case 12-E-0201. This program has been successful in reducing elevated voltage conditions in the Buffalo street light system.

2. C. 3. 3. Manholes, Vaults and Handholes

There are an estimated 12,253 manholes, 2,181 vaults and 75,913 handholes in the underground system.

2. C. 3. 3. 1. Condition and Performance Issues

There were 2,756 manholes, 223 vaults, and 14,131 handholes inspected from January 1, 2016 to December 31, 2016. The results of the Inspection and Maintenance program can be found in Exhibit 3, Distribution Underground Facilities.

In 2016, all Priority Level 1 maintenance codes were completed as follows: 117 instances were for maintenance code 600 – Broken/ Damaged. A significant amount of work was completed during inspection and listed as Priority Level P - performed during inspection.

Priority Level 2 maintenance codes have been reported as follows: 335 instances were for maintenance code 600 – Broken/Damaged, 1 was for maintenance code 741 – Door Broken/Damaged/Unsecured, 15 were for maintenance code 611 – Cable/Joint Missing, 70 were for maintenance code 616 – Improper Grade, 3 were for maintenance code 673 – Door Broken/damaged/unsecure, 35 were for maintenance code 620 - Rerack, and 3 were for maintenance code 705 – Damaged/Broken Ladder.

Priority Level 3 maintenance codes have been reported as follows: 1 instance for maintenance code 706 – Improper grade and 20 for maintenance code 621 – Ring/cover repair/replace.

2. C. 3. 3. 2. Remedial Actions Performed

Remedial work performed as part of the Inspection and Maintenance program can be found in Exhibit 3. For calendar year 2016, 2,483 maintenance codes were considered Priority Level P and performed during inspection. The majority of Level P repairs performed during inspections involved replacing nomenclature on manholes and handholes.

2. C. 3. 4. Network Systems

National Grid's network system is not extensive; however, the system is diverse and spread out among many communities. Table 2C-12 lists the networks including location (City & Division), peak load, number of supply substations, substation names, number of supply feeders and number of network protectors (on Grid or in Spot Networks).

Table 2C-12
Network Listing

City	Peak Load (MVA)	# of Supply Substations	Substations Names	# of Supply Feeders	# of NWP's on Grid	# of NMP's in Spots	Last Updated	Last Studied
Buffalo (Broadway)	1	1	Seneca Terminal Sta	3	4	3	Jun-2017	Aug-2015
Buffalo (Elm Street)	111	1	Elm Street	20	149	134	Jun-2017	Aug-2015
Niagara Falls	0.4	1	Gibson	3	8	0	Jun-2017	Aug-2015
Albany	32	2	Riverside, Trinity	10	85	36	Jun-2017	Apr-2010
Albany (34.5kV)	14.2	2	Riverside, Partridge	5	0	30	Jun-2017	Apr-2010
Glens Falls	2.4	2	Glens Falls, Henry St.	4	12	0	Jun-2017	Jan-2013
Schenectady	13	1	Front Street	5	45	9	Jun-2017	Jan-2014
Troy	11	1	Liberty Street	8	33	4	Jun-2017	Jan-2009

City	Peak Load (MVA)	# of Supply Substations	Substations Names	# of Supply Feeders	# of NWP's on Grid	# of NMP's in Spots	Last Updated	Last Studied
Cortland	1.98	2	Cortland, Miller St.	3	10	0	May-2016	Nov-2016
Syracuse (Ash Street)	26.4	1	Ash Street	10	91	37	Dec-2016	Dec-2016
Syracuse (Temple Street)	20.58	1	Temple Street	7	21	60	Apr-2016	Jun-2017
Utica	7.4	1	Terminal Street	4	27	13	Nov-2016	Feb-2017
Watertown	4.26	1	Mill Street	5	21	2	Jun-2016	Jul-2016

2. C. 3. 4. 1. Condition and Performance Issues

There is no unique heading for network equipment in Exhibit 3. This equipment is reported under various Distribution Underground Facilities headings. Vaults containing network equipment are included in the Manholes, Vaults and Handholes section above.

Table 2C-13 contains a summary of the results from the Inspection and Maintenance System on two Network System assets: network protectors and network transformers.

Table 2C-13
Network System Assets Inspection Results

	Network Protector		Network Transformer				
Level	Barrier Broken - 630	Oil Leak - 632	Bushing Broken /Cracked - 635	Low Oil – 637	Oil Weeping - 642	Other[13] 633, 638, 639, 643	Total
2014 Summary							
1	-	-	-	-	-	1	1
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	10	10
P	-	-	-	-	-	-	-
Total	-	-	-	-	-	11	11
2015 Summary							

[13] Other maintenance codes are not expected to affect reliability: 633 Network Protector Worn/Damaged Gasket, 638 Network Transformer Missing Ground, 639 Network Transformer Missing Nomenclature, and 643 Network Transformer Rusted/Peeling Paint.

1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
P	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-
2016 Summary							
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
P	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-

Between January 1, 2016 and December 31, 2016 a total of 2,979 manholes and vaults had been inspected with no maintenance codes related to network transformers and protectors reported. Maintenance codes found were related to the vault structure and are included in the manhole and vault section above.

Network assets are typically inspected on a shorter cycle than required for the Inspection and Maintenance program. National Grid Standard Maintenance Procedure SMP421.01.2 currently requires extensive visual inspections of network protectors and transformers annually. Depending on the network protector style, diagnostic overhauls are required every two to five years including cleaning, adjusting, lubricating and replacing broken or worn parts. Network protectors are also operationally tested annually, with improperly functioning units replaced or repaired. According to an internal scorecard, 2,979 manholes and vaults were inspected as of December 2016 with many containing network equipment.

2. C. 3. 4. 2. Remedial Actions Performed

Remedial action performed on vaults containing network equipment is covered above in the Manholes, Vaults and Handholes section. Work specific to network vaults in 2016 included the replacement of 25 network protectors and 21 network transformers across upstate NY network systems.

2. C. 3. 5. Arc Hazard Analysis

In February of 2015 National Grid and other utility companies sponsored additional EPRI research on 480 volt spot network systems. The goal of the research was to evaluate realistic arc flash events inside and outside of network protectors and to evaluate the performance of additional protection systems such as optical sensors.

The findings of this research were:

480 volt faults within network protectors do not sustain longer than 1.5 cycles if the associated network transformer is de-energized. Measured incident energy exposures were below 8 cal/cm^2.

All realistic open-air 480 volt fault scenarios outside network protectors, but within vaults self-cleared within four cycles. Measured incident energy exposures were below 8 cal/cm^2.

Based on the research findings, National Grid is no longer proactively installing secondary arc flash mitigation devices (link boxes) and is evaluating additional high side load-break switches to be installed on the high side of transformers in 480 volt spot networks. The high side switches originally purchased are not proving to be as robust as originally thought. Once new switches are chosen, a program to install them will be implemented.

Table 2C-14
Distribution System Overhead and Underground Equipment
Installed July 1, 2016 to June 30, 2017

Equipment	Project Type	Unit Count
Wood Poles (Units)	Blanket	7,343
	Program	3,065
	Specific	1,227
	Total	11,635
Overhead Transformer (Units)	Blanket	6,221
	Program	869
	Specific	720
	Total	7,810
Primary Conductor (Feet)	Blanket	591,433
	Program	42,965
	Specific	236,683
	Total	871,081
Capacitor Banks (1Ph/3Ph) (Locations)	Blanket	80
	Program	11
	Specific	6
	Total	97
Line Reclosers (Units)	Blanket	47
	Program	0
	Specific	4
	Total	51
Line Regulators (Units)	Blanket	55
	Program	1
	Specific	0
	Total	56

Equipment	Project Type	Unit Count
Switchgear (Units)	Blanket	33
	Program	0
	Specific	44
	Total	77
Primary Underground Cable (Feet)	Blanket	241,974
	Program	1,387
	Specific	271,652
	Total	515,013
Padmount/ UG/Net Transformer (Units)	Blanket	650
	Program	83
	Specific	355
	Total	1,088
Manholes and Vaults (Units)	Blanket	0
	Program	0
	Specific	53
	Total	53

Chapter 2D. Distribution Substation Asset Condition

This section addresses substations that contain assets typically operating at 69kV or below, beginning at the station level (i.e., those being rebuilt or replaced), and then addressing individual assets.

A summary of the equipment types and populations for key substation assets is provided in Table 2D-1.

Table 2D-1
Substation Asset Inventory

Main Asset	Inventory
Substations[1]	526
Circuit Breakers	3,922
Power Transformers	804
Batteries/Chargers	692
Surge Arresters	921
Sensing Devices	2,179
Voltage Regulators/Reactors	516
Capacitor Banks	69

2. D. 1. Substation Inspections and Work Orders

Substation Visual and Operational Inspections (V&O's) are performed bi-monthly on each substation. V&O's are considered preventive maintenance since inspections identify defects in substation equipment for appropriate mitigation. Annual levels of Follow Up work orders which proactively address substation conditions have risen over time while Trouble Maintenance has fallen.

2. D. 2. Substation Flooding

Distribution substations are largely safe and adequate for seasonality and moderate storm events. Record-breaking events throughout the United States continue to underscore the importance of protecting infrastructure from flooding. A decade or more ago, National Grid experienced extreme flooding at several substations. Since that timeframe, historical event information and Federal Emergency Management Agency

[1] Substation count is now derived from FERC classification, which has resulted in an increase of the number of distribution substations.

(FEMA) data has used as the basis to develop an on-going flood risk and management program and complete mitigation projects.

Capital projects have been completed to retire and relocate substations entirely out of flood zones, construct impermeable concrete floodwalls, raise vulnerable equipment, reinforce river-bank barriers, and other resiliency initiatives. All stations that have been affected by flooding have had, at a minimum, some degree of mitigation completed. In addition to the resiliency hardening already completed, Union Falls station is slated for relocation and retirement.

FEMA Flood Insurance Rate Maps are examined at the planning stages of every project to assess the latest data, risk, and reasonable feasibility of avoiding flood risk. For new FEMA maps, these data have been developed from detailed hydraulic analysis based from extreme storm events and provide “Base Flood Elevations,” *i.e.*, theoretical water levels to protect infrastructure against. Certain challenges exist such as a lack of elevation data on older effective FEMA maps and certain regions in the state are unmapped entirely. These data also may not take into account the possibility of factors such as dam breaks, ice river jams, debris blocked bridges/culverts, and storm events in excess of the theoretical rainfall of 1 in 100 years. The American Society of Civil Engineers “Flood Resistant Design and Construction” Standard is utilized for mitigation and new construction projects. National Grid classifies stations as Flood Design Class 4, the most stringent and flood protective category.

In addition to targeted capital projects, an extensive amount of emergency response flood mitigation materials have been purchased and strategically located throughout New York State. National Grid field workforces have been trained on the equipment and the team of engineers and field crews are prepared to respond via notification from the Emergency Planning Department.

2. D. 3. Substation Equipment Assessments and Asset Condition Codes

The Company classifies substations by condition and impact codes as shown in Table 2D-2.

Table 2D-2
Substation Condition Codes

Code	Classification/Condition	Implication
1 Proactive	Asset expected to operate as designed for more than 10 years.	Appropriate maintenance performed; regular inspections performed.
2 Proactive	Some asset deterioration or known type/design issues. Obsolescence of equipment such that spares/replacement parts are not available.	Asset likely to be replaced or re-furbished in 5-10 years; increased resources may be required to

Code	Classification/Condition	Implication
	System may require a different capability at asset location.	maintain/operate assets.
3 Proactive	Asset condition is such that there is an increased risk of failure. Test and assessment identifies definite deterioration which is on going.	Asset likely to be replaced or refurbished in less than 5 years; increased resources may be required to maintain/operate assets.
4 Reactive	Asset has sudden and unexpected change in condition such that it is of immediate concern; this may be detected through routine diagnostics, including inspections, annual testing, maintenance or following an event.	Testing and assessment required to determine whether the asset may be returned to service or may be allowed to continue in service. Following Engineering analysis the asset will be either recoded to 1-2-3 or removed from the system.

Condition codes are used to summarize the status of the asset type population.

2. D. 4. Indoor Substations

Indoor substations were generally built in the 1920s through 1940s and are considered obsolete. The outmoded design of most of the stations does not meet accepted safety practices, and the protection and control systems have been superseded by new technology. Some indoor substation equipment is also in poor and/or overloaded condition. There are 34 indoor substations in Buffalo, five in Niagara Falls, one in Albany and one in Gloversville. In addition there are two newer indoor substations in Buffalo, built after 1949. These stations will need replacement at the end of the program.

By law, the City of Buffalo has limited the distribution voltage in most areas to 4.16kV. Distribution within the City is often backyard construction. Given the local requirements and cost of conversion, converting the load is not a preferred option. The Niagara Falls indoor substations are supplied from an underground 12kV system. That system and the substations that supply it are of the same vintage and poor condition as the indoor substations. Several 115-13.2kV substations and feeders have been constructed in the area, so building smaller outdoor stations and limited conversion is an option being considered.

2. D. 4. 1. Condition and Performance Issues

Key safety issues associated with the obsolete Buffalo style indoor substation design are:

- The 23kV Condit oil switches do not have the appropriate fault interrupting capability.
- The operation of the 23kV Condit oil switch and the 4.16kV oil circuit breakers require the operator to stand next to the switch or breaker.
- The protective relay scheme does not provide detection for certain faults, and has inappropriate blocking, which may lead to equipment failure.
- The obsolete equipment does not meet current requirements for fault interrupting capability, operating interfaces and personnel safety.
- Breakers have no provision for proper safety grounding.

Key reliability and customer issues associated with the obsolete Buffalo style indoor substations are:

- The existing protection scheme has limited the ability to connect some customer loads, cannot be upgraded, and must be replaced.
- Wear of 4.16kV breaker operating mechanisms has resulted in misoperations.
- In some locations, transformer banks are overloaded and poor ventilation in transformer bays has led to transformer overheating.
- The 23kV substation supply is overloaded on contingency.
- Given the obsolete protection scheme and equipment, equipment failures can escalate leading to extended customer outages.

2. D. 4. 2. Remedial Actions Performed

Between July 1, 2016 and June 30, 2017, the Buffalo #37 substation construction was on-going and the Buffalo Station #59 construction was in its early stages. The indoor portion of the Brighton Ave. substation in Syracuse was retired as well, as load was transferred to Rock Cut Road substation.

2. D. 5. Metal-Clad Switchgear

Metal-clad equipment is prone to water and animal ingress which leads to failures. V&O surveys help detect such degradation, but do not identify poorly performing electrical equipment unless there is significant deterioration or failure. Such identification is more likely with electro-acoustic detection techniques. An initial review using this technique identified a number of locations for further review. For example, the North Troy substation metal-clad swichgear was recently replaced after being identified using this technique.

2. D. 5. 1. Condition and Performance Issues

A further selection of metal-clad switchgear was assessed using a criticality ranking that led to the identification of deterioration at Hopkins Road, which is presently in engineering. Emmet Street Station 256, McCrea Street Station 272, Chrisler Avenue Station 257, Market Hill Station 324, Station 162, Tuller Hill Station 246 and Avenue A Station 291 are in conceptual engineering. A number of other metal-clad switchgear stations that have been assessed and identified for replacement or retirement based on review of performance and risk mitigation are listed in Table 2D-3.

Table 2D-3
Metal-Clad Substations with Performance Issues

Divison	Station Name	Status
Substation - NY East	AVENUE A 291 METALCLAD REPLACEMENT	Conceptual
Substation - NY Central	HOPKINS 253 - REPLACE METALCLAD GEA	In-progress
Substation - NY East	JOHNSON RD - REPLACE METALCLAD GEAR	Planning
Substation - NY East	MCKNOWNVILLE 327 METALCLAD REPLACEM	Planning
Substation - NY Central	PINE GROVE METALCLAD REPLACEMENT	Planning
Substation - NY East	PINEBUSH - REPLACE METALCLAD GEAR	Planning
Substation - NY West	STATION 162 METALCLAD REPLACEMENT	Conceptual
Substation - NY West	STATION 61 - METALCLAD REPLACEMENT	Planning
Substation - NY Central	TULLER HILL 246 UNIT METALCLAD REPL	Conceptual

The Company continues to evaluate metal-clad equipment via V&O inspections and Infrared Thermovision to provide base line information. Electrical partial discharge surveys are performed as needed for individual cases involving suspect assets.

2. D. 5. 2. Remedial Actions Performed

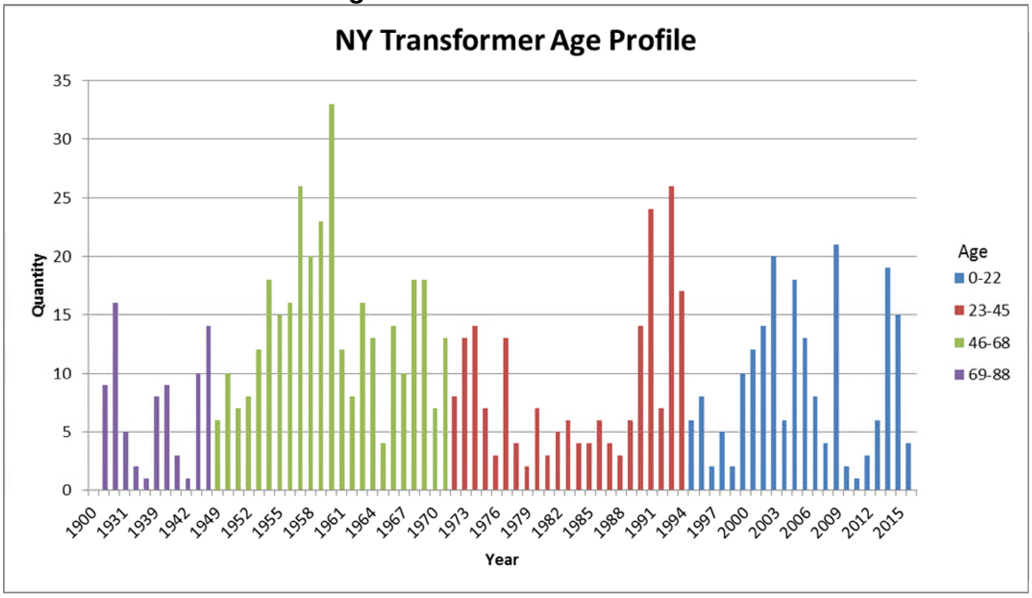
The plan to replace the Emmett Street metal-clad was re-evaluated based on recent capacity requirements in the area. Chrisler Ave metal-clad will be replaced and the station will be expanded to allow the 4 kV metal-clad at Emmett Street to eventually be retired. There is a plan to retire Market Hill Station and replace it with a new 115-13.2kV station on Maple Ave.

2. D. 6. Power Transformers

National Grid has 804 distribution power transformers plus 59 spares with primary voltages 69kV and below. The population of power transformers is generally sound, with some exceptions discussed in this section. Most power transformers range in size from less than 1MVA to about 20MVA and may have several MVA ratings depending on available cooling options.

The average age of the distribution power transformer population is 44 years, which is displayed in Figure 2D-4. There are 302 power transformers greater than 50 years of age based on stored nameplate data. However, 4 percent of the total population of transformers have no year of manufacture indicated in the Cascade database, which implies that there may be an additional 35 units greater than 50 years of age.

Figure 2D-4
Age Profile of Transformers



Power transformer age is a helpful indicator of which transformers may be less able to perform their function due to accumulated deterioration. Power transformer paper insulation deteriorates with time and thermal loading history. The deterioration is cumulative and irreversible and thus cannot be addressed via maintenance. As the paper degrades, the ability of the insulation to withstand mechanical forces is reduced and the mechanical integrity of the transformer is compromised when subjected to through faults or internal faults. In addition, the paper deterioration may lead to shrinkage of the winding packs thereby, reducing the mechanical stability of the transformer.

Given the possible substantial impact of power transformer failures on the distribution system, and the extensive lead times and disruption to normal operations, National Grid pursues a comprehensive approach to risk management of transformers. This includes thorough and regular reviews of the population, procuring an appropriate number of spare units, and the generation of a 'watch list' of suspect and higher impact transformers for more frequent observation and review. National Grid also reviews each transformer individually to determine both condition and likely risks to the system before making a determination regarding replacement or refurbishment requirements.

2. D. 6. 1. Condition and Performance Issues

National Grid's maintenance practice is to perform a Dissolved Gas Analysis (DGA) on distribution power transformers rated 2.5MVA to 15MVA every two years and units rated above 15MVA annually. In addition, DGA may be performed more frequently on suspect units to monitor the condition more closely. Sampling and analysis may be quarterly, monthly or more often; and this information is used to determine the current condition of the transformers and the likely degradation over time.

Table 2D-5 provides condition codes for 2016 and 2017 year-to-date based on this review. In 2017, two transformers remain as condition code 4 due to elevated gasses, poor insulation test results, inadequate thermal capability, contaminated windings and no known available spares. In addition, these units are mature in age and may be better addressed by replacement rather than maintenance or repair.

Table 2D-5
Condition Code of Transformers

Year	Code	1	2	3	4	Grand Total
2016	TRF	676	32	15	3	726
2017	TRF	754	31	17	2	804

A transformer with condition code 4 is not automatically replaced. The transformer may receive more frequent DGA sampling and review. Most code 4 units will be revised to a lower condition code following a review, but it is possible that they will be replaced.

2. D. 6. 2. Remedial Actions Performed

The transformer watch list is based on condition and operational information. The watch list is used to monitor transformers of concern to assess how their condition develops and, if need be, plan for rapid replacement of the unit. For example, transformers that are subject to a through fault, as may be initiated by a lightning strike, may:

- fail instantaneously as a result of internal stresses generated by the through fault;
- start to deteriorate from through faults weakening the transformer over time; or
- generate diagnostic gasses which are measured to determine degradation and which may subsequently stabilize.

There are 44 transformers on the Company's transformer "watch list." The issues associated with these units are as follows:

- Twenty units have deteriorated winding insulation. In addition, two of the 20 are overheating, while three show signs of contamination in the oil and windings. Ten of the 20 units are more than 69 years old.
- Sixteen of the units have elevated combustible gasses. One of the units is highly utilized, and three have contaminated windings. One unit has issues with the Load Tap Changer (LTC). Five are over 69 years old.
- Eight units have elevated hydrogen. Hydrogen is an indicator of partial discharge or excessive moisture in the transformer. Four of the seven units also contain moisture and contaminated windings. Three units are over 69 years old.

A review of possible transformer spares and mobile capability has been performed and documented for the transformers on the list. In addition, the ability to perform field ties and operate units as an open delta on single-bank units with delta high side windings[2] is reviewed as a possible solution if a problem arises. Furthermore, an increase in DGA sampling will occur, where needed, to monitor the transformer condition.

Table 2D-6 provides the current list of transformers on the "watch list".

Table 2D-6
"Watch" List of Distribution and Sub-Transmission Transformers

Station Location	FERC	Region	Equipment Description	MVA	Voltage	Age
Antwerp Station 801	D	NYCD	1 LTC TRF	5.25	23-4.8 kV, 3.75/4.2/5.25 MVA	56
Chrisler Avenue Station 257	D	NYED	2 LTC TRF	3.65	34.5-4.16 kV 3/3.65 MVA	61
Cuyler Station 24	D	NYCD	1 TRF A	0.2	34.5-4.16 kV .2 MVA	88
Cuyler Station 24	D	NYCD	1 TRF B	0.2	34.5-4.16 kV .2 MVA	88
Cuyler Station 24	D	NYCD	1 TRF C	0.2	34.5-4.16 kV .2 MVA	88
Cuyler Station 24	D	NYCD	2 TRF A	0.2	34.5-4.16 kV .2 MVA	88
Cuyler Station 24	D	NYCD	2 TRF B	0.2	34.5-4.16 kV .2 MVA	88
Cuyler Station 24	D	NYCD	2 TRF C	0.2	34.5-4.16 kV .2 MVA	88
Eagle Bay	D	NYCD	1 TRF A	1.25	46-4.8 kV, 1.25 MVA	60
Eagle Bay	D	NYCD	1 TRF B	1.25	46-4.8 kV, 1.25 MVA	60
Eagle Bay	D	NYCD	1 TRF C	1.25	46-4.8 kV, 1.25 MVA	60
East Syracuse	D	NYCD	1 LTC TRF	6.3	34.5-4.16 kV 5/6.3 MVA	59
Elm Street Station 898	D	NYCD	STEP REG 1			66
Glens Falls Hospital Station 414	D	NYED	2 TRF	3.2	34.5-4.16 kV 2.83/3.2 MVA	43
Glenwood Station 227	D	NYCD	1 LTC TRF	6.25	34.5-4.16 kV 5/6.25 MVA	57
Hudson Falls Station 88	D	NYED	2 TRF	5	34.5-13.8 kV 5 MVA	27

[2] The three high voltage windings are connected in a delta formation rather than a grounded wye formation.

Station Location	FERC	Region	Equipment Description	MVA	Voltage	Age
Karner Station 317	D	NYED	2 LTC TRF	6.25	34.5-4.16 kV 5/6.25 MVA	83
Karner Station 317	D	NYED	1 LTC TRF	6.25	34.5-4.16 kV 5/6.25 MVA	58
Lima Station	D	NYWD	1 TRF	2.5	34.5-4.8 kV 2.5 MVA	57
Machias Station 13	T	NYWD	2 LTC TRF	3.75	34.5-4.8 kV, 3.75 MVA	26
McCrea Street Station 272	D	NYED	1 LTC TRF	3.75	34.5-4.8 kV 3/3.75 MVA	67
Mill Street Station 748	T	NYCD	2 LTC TRF	6.25	23-4.8 kV 5/6.25 MVA	62
Mill Street Station 748	T	NYCD	3 LTC TRF	6.25	23-4.8 kV 5/6.25 MVA	62
Mill Street Station 748	T	NYCD	1 LTC TRF	6.25	23-4.8 kV 5/6.25 MVA	62
Miller Street Station 117	D	NYCD	1 TRF A	3.1	34.5-4.8 kV 2.5/3.1 MVA	77
Miller Street Station 118	D	NYCD	1 TRF B	3.1	34.5-4.8 kV 2.5/3.1 MVA	77
Miller Street Station 119	D	NYCD	1 TRF C	3.1	34.5-4.8 kV 2.5/3.1 MVA	77
Newtonville Station 305	D	NYED	2 LTC TRF	5.6	34.5-4.16 kV 5/5.6 MVA	54
Petrolia Station 19	D	NYWD	1 TRF C	1	34.5-4.8kV, 1 MVA	
Petrolia Station 19	D	NYWD	1 TRF B	1	34.5-4.8kV, 1 MVA	
Phoenix Station 51	D	NYCD	1 LTC TRF	7	34.5-4.8 kV 5/6.25/7 MVA	48
Rock City Station 623	D	NYCD	1 LTC TRF	7	46-4.16 kV 5.6/7 MVA	63
Shore Road Station 281	D	NYED	1 LTC TRF	6.3	34.5-4.8 kV 5/6.25 MVA	60
State Street Station 954	D	NYCD	1 LTC TRF	3.75	23-4.8 kV 3/3.75 MVA	
State Street Station 954	D	NYCD	2 LTC TRF	3.75	23-4.8 kV 3/3.75 MVA	
Station 025	D	NYWD	2 TRF	2.5	23-4.16 kV 2.5 MVA	
Station 034	D	NYWD	1 TRF	2.5	23-4.16 kV 2.5 MVA	87
Station 037	D	NYWD	2 TRF	2.5	23-4.16 kV 2.5 MVA	87
Station 037	D	NYWD	4 TRF	2.5	23-4.16 kV 2.5 MVA	87
Station 038	D	NYWD	4 TRF	2.5	23-4.16 kV 2.5 MVA	87

Station Location	FERC	Region	Equipment Description	MVA	Voltage	Age
Station 040	D	NYWD	1 LTC TRF	4.8	23-4.16 kV 3.75/4.8 MVA	40
Station 056	D	NYWD	4 LTC TRF	3.1	23-4.16 kV 2.5/3.1 MVA	50
Station 057	D	NYWD	2 LTC TRF	5.3	23-4.16 kV 3.75/4.2/4.7/5 MVA	44
Station 059	D	NYWD	3 TRF	2.5	23-4.16 kV 2.5/3.13 MVA	60
Station 083 - Welch Ave	D	NYWD	1 TRF	3.5	12-4.16 kV, 3.5 MVA	
Station 085 - Stephenson Ave	D	NYWD	1 TRF	3.5	12-4.8 kV, 3.5 MVA	49
Station 124 - Almeda Ave	D	NYWD	2 LTC TRF	5.25	34.5-4.16 kV 5.25 MVA	62
Station 124 - Almeda Ave	D	NYWD	1 LTC TRF	4.687	34.5-4.16 kV 4.687 MVA	62
Station 124 - Almeda Ave	D	NYWD	4 LTC TRF	3.75	34.5-4.16 kV 3.75 MVA	52
Stow Station 52	D	NYWD	1 TRF	2.5	34.5-4.18 kV, 2.5 MVA	
Summit Station 347	D	NYED	1 TRF	10.5	69-4.8 kV 7.5/8.4/10.5 MVA	48
Third Street Station 216	D	NYCD	1 TRF	4.69	34.5-4.8 kV, 3.75/4.69 MVA	60

Programs are in place to replace substation power transformers. Of the transformers identified to be watched, all have been prioritized for future replacement or retirement based on condition and risk. Table 2D-7 describes transformers that will be addressed within five years.

Table 2D-7
Transformers to be Replaced or Retired within Five Years

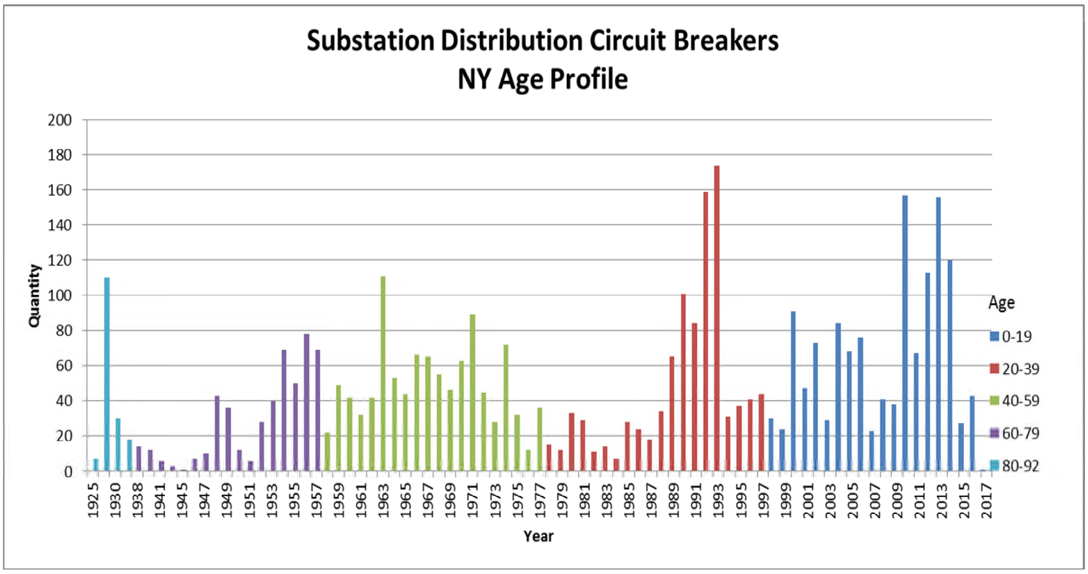
Station Location	MVA	Status
Chrisler Ave Station 257	3	Conceptual
Cuyler Station 24 (qty 6)	1.5	Final Engineering
Rock City Station 623	**7**	**Conceptual**
State Street Station 954	**3.75**	**Planning**
Station 056 (qty 4)	**3.13**	**Final Engineering**
Station 124 - Almeda Ave (qty 4)	3.75	Conceptual
Station 040	4.8	Planning
Stow Station 52	2.5	Planning

Although transformer replacements are based on condition and risk, a cautious approach is used to determine the appropriate number of transformers needing replacement per year.

2. D. 7. Circuit Breakers

National Grid has 3,922 circuit breakers and 142 spares on the distribution system, with an average age of 38 years as shown in Figure 2D-8. The substation circuit breaker population is generally sound and reliable; however, there are certain units which will be addressed as described below.

Figure 2D-8
Age Profile of Circuit Breakers



2. D. 7. 1. Condition and Performance Issues

There are relatively few gas circuit breakers (GCB) in the breaker population, but similar numbers of Air Magnetic Circuit Breakers (AMCB) and Oil Circuit Breakers (OCB) with an increasing amount of Vacuum Circuit Breakers (VCB) as shown in Table 2D-9. This analysis includes breakers and reclosers.

Table 2D-9
Breakers Types

Breaker Type	Percentage of Total Population 2016	Percentage of Total Population 2017
AMCB	17%	19%
GCB	4%	6%
OCB	26%	25%
VCB	53%	50%

Older breakers, though not inherently less reliable, are more difficult to maintain, may not meet the specifications needed for modern electrical systems and may not be supported in terms of replacements or spare parts.

Breaker condition coding was based on engineering experience and supported by discussion with local operations staff and Subject Matter Experts (SMEs). Condition codes have been applied to the operating population as shown in Table 2D-10.

Table 2D-10
Condition Code of Circuit Breakers

Condition Code	1	2	3	4	Grand Total
2016	2692	1263	59	0	4,014
2017	2530	1310	72	10	3,922

2. D. 7. 2. Remedial Actions Performed

Approximately 52 breakers have been replaced since the last report. Of the 52, three failed unexpectedly and were replaced with system spares. Seven breakers represent new substation installations.

Certain types of breakers with condition codes 2 and 3 are targeted for replacement/refurbishment over the next ten years due to either obsolescence or poor performance, and are listed in Table 2D-11. Since there are many General Electric Type AM breakers of various condition codes, these breakers are reviewed annually for replacement.

Occasionally other breakers outside of the targeted family are identified for replacement due to obsolescence, excessive maintenance or poor performance. The quantities have been updated in the below table.

Table 2D-11
Circuit Breakers to be Replaced/Refurbished

Type of Family	Quantity	Average Age (Years)
Federal Pacific (Code 3)	8	58
General Electric Type AM (Code 2)	3	51
General Electric Type VIR (Code 2)	1	42
ITE Type HK (Code 2)	58	45
ITE Type KS (Code 2)	46	47
McGraw Edison (Code 2)	2	36
Westinghouse DHP (Code 2)	30	49
Other (Code 3)	59	53

Type of Family	Quantity	Average Age (Years)
Federal Pacific (Code 3)	8	58
General Electric Type AM (Code 2)	3	51
General Electric Type VIR (Code 2)	1	42
ITE Type HK (Code 2)	58	45
ITE Type KS (Code 2)	46	47
McGraw Edison (Code 2)	2	36
Westinghouse DHP (Code 2)	30	49
Other (Code 3)	59	53

Replacements are prioritized based upon potential impact from failure. Therefore, some breakers with condition code 2 may be replaced prior to some with condition code 3 due to the higher impact associated with the failure of the code 2 assets.

2. D. 8. Protection and Controls

The following table indicates the number and type of relays currently installed in distribution substations.

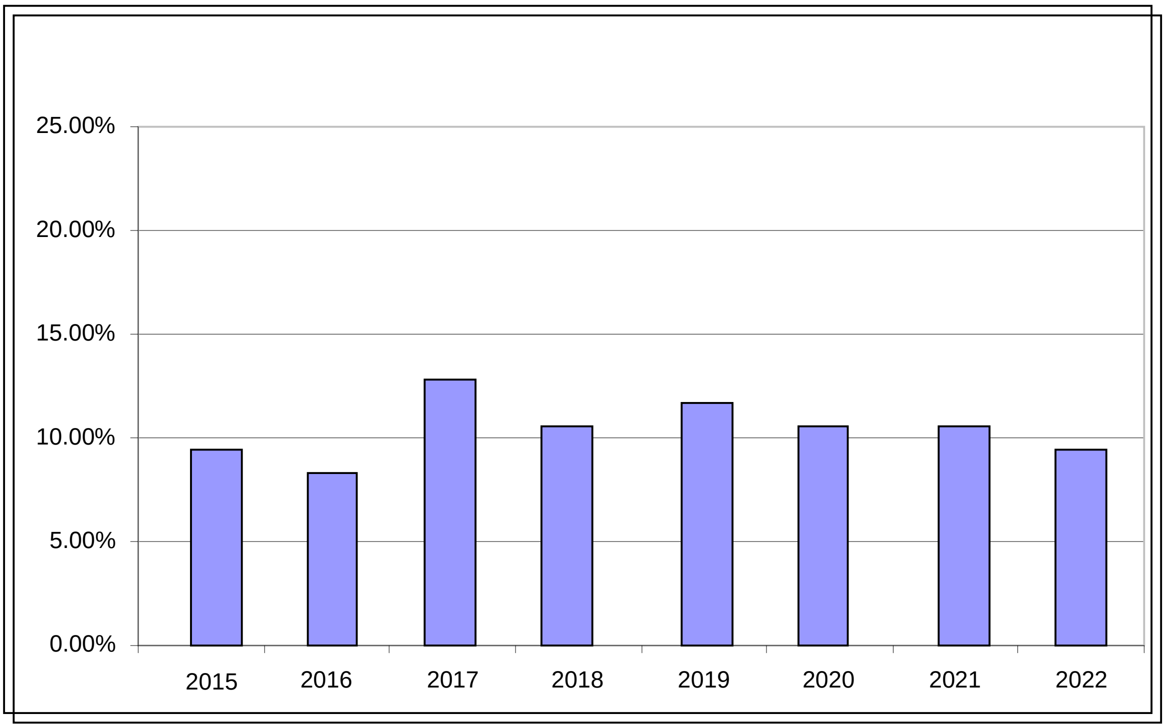
Table 2D-12
Distribution Relay Inventory

Class	Distribution
Electro-mechanical	31,721
Microprocessor	4,711

2. D. 8. 1. Condition and Performance Issues

The Company is testing between 8 and 15 percent of the relay population annually. The year on year variation occurs because of operational requirements. For example, a relay package may be tested earlier than its due date because of new installations/removals/substation rebuilds, or relay settings are changed. Each time a change is made to the relay setting, the relay is re-calibrated and the calibration date is automatically reset. When a relay is tested and fails, it will either be repaired or replaced.

Figure 2D-13
Forecast Percent of relay population to be tested (by Year)



2. D. 8. 2. Remedial Actions Performed

Following an assessment of protective relaying and substation control systems considered critical, a replacement program strategy was approved in 2010 and the project is currently underway.

National Grid will continue to assess the relay protection systems on the distribution and sub-transmission systems and adjust, upgrade, and/or replace protection and control systems as needed to provide safe and adequate operation of the network. The assessment will occur annually as part of a comprehensive annual asset health review. The recommendations of next year's relay replacement plans will take into account any new issues.

With the advent of digital technologies, facilities can be upgraded to gain greater capability and increased reliability. As substation projects are engineered and designed, the electromechanical and solid state relays are being upgraded to modern microprocessor-based relays.

Microprocessor-based relays are an ideal choice for a cost-effective method to implement distribution system protection. The upgrading of old protection systems with digital systems can offer the following features and benefits:

- Improved quality and high availability;
- Improved sensitivity of monitoring equipment;
- A Digital relay can replace multiple discrete relays resulting in reduced CT secondary burdens;
- Greater protection and control functionality, self monitoring and the ability to record oscillographic information and Sequence of Events;
- Lower maintenance costs; and
- Easy integration to the Distributed Control System via network communications.

2. D. 9. Installation of Remote Terminal Units (RTUs)

Currently, 33 percent of the 526 New York distribution substations have SCADA. The total number of additional stations that need SCADA is estimated to be 137. Two RTU installations have been completed at the following substations since the last report:

- Milton Avenue
- Trenton Falls

Engineering has been completed, and installations planned to install RTUs, wiring, control, and data acquisition capability at the substations listed below:

- Rock City
- Niles

- Madison
- Levitt
- Chadwicks
- Buckley Corners
- Harris Road
- Station 129 - Brompton
- Bremen
- Corinth
- Port Henry
- Nassau
- Station 139 – Martin Road
- Station 154 – George
- Shawnee
- Mill Street
- West Hamlin
- Station 056

In addition to the RTU specifc projects listed above, RTU installations and expansions are also incorporated into the workscope of larger substation projects.

2. D. 10. Obsolete Remote Terminal Units (RTUs)

There are approximately 678 operating RTUs under the Company's control, of which 158 transmission and distribution units are being replaced under an ongoing RTU replacement strategy (SG002).

See Chapter 2A (Transmission) for more information on RTUs.

2. D. 11. Batteries and Chargers

2. D. 11. 1. Condition and Performance Issues

The current population of batteries is in sound condition. If a battery system has reached the end of its expected life, it undergoes a condition assessment and a decision is made on replacement of the unit.

Table 2D-14 provides current condition codes for the battery and charger population.

Table 2D-14
Condition of Battery and Charger Population

COND	1	2	3	4	Grand Total
2016	312	16	4	0	332
2017	598	54	35	5	692

Note: 2017 count includes batteries and chargers and 2016 count includes only batteries.

2. D. 11. 2. Remedial Actions Performed

Three station batteries and chargers have been replaced since the last report. National Grid's policy is to replace battery sets that are 20 years old, or sooner if warranted based on battery condition determined through testing and inspection per National Grid Substation Maintenance standards. The 20 year asset life is based on industry best practice and experience in managing battery systems. Where needed, the battery charger is replaced at the same time as the battery system.

2. D. 11. Other Substation Assets

Assets described here would be addressed individually should their condition dictate a rapid response, or while addressing maintenance, replacement or refurbishment ongoing at the same station. Information about other substation assets is generated through V&O Inspections and through feedback from Company personnel when they visit the site.

2. D. 11. 1. Substation Structures and Foundations

Generally substation structures are sound, but some significant issues at particular stations may be identified and require remedial action.

2. D. 11. 2. Surge Arresters

There are no significant issues with relation to surge arresters in distribution substations.

2. D. 11. 3. Cap-Pin Insulators

Cap and pin insulators have a history of failure especially when they are used as an insulator for hook-stick type disconnect switches. Insulators are replaced when they are identified as a risk, or as part of on going work at a particular substation.

2. D. 11. 4. Sensing Devices

The term sensing devices is used to identify current transformers (CTs) and Voltage Transformers (VTs) / Potential Transformers (PTs). As indicated in Table 2D-15 below, the population of sensing devices has remained relatively stable and they are generally in good condition.

Table 2D-15
Condition Codes of Sensing Devices

TYPE	1	2	3	4	Grand Total
2016	1837	126	137	0	2,120
2017	1903	135	141	0	2,179

Sensing devices are inspected regularly as part of V&O checks and through annual Infra-Red (IR) inspections. Replacement focuses on any sensing device regardless of manufacturer which appears to be weeping or has external cracks, as these conditions can lead to moisture ingress, potentially resulting in failure of the device.

GE Type Butyl PTs that are more than 30 years old are replaced when the opportunity arises as they are known to be less reliable than the general population. GE Type Butyl PTs rated 46 kV, 34.5kV and 23kV have been identified and prioritized for replacement due to recent failures. There are 137 identified GE Type Butyl PTs at these voltage ratings.

2. D. 11. 5. Capacitor Banks and Switches

Table 2D-16 provides the distribution capacitor bank population, showing that the bulk of the population is in good condition.

Table 2D-16
Capacitor Bank Condition Code

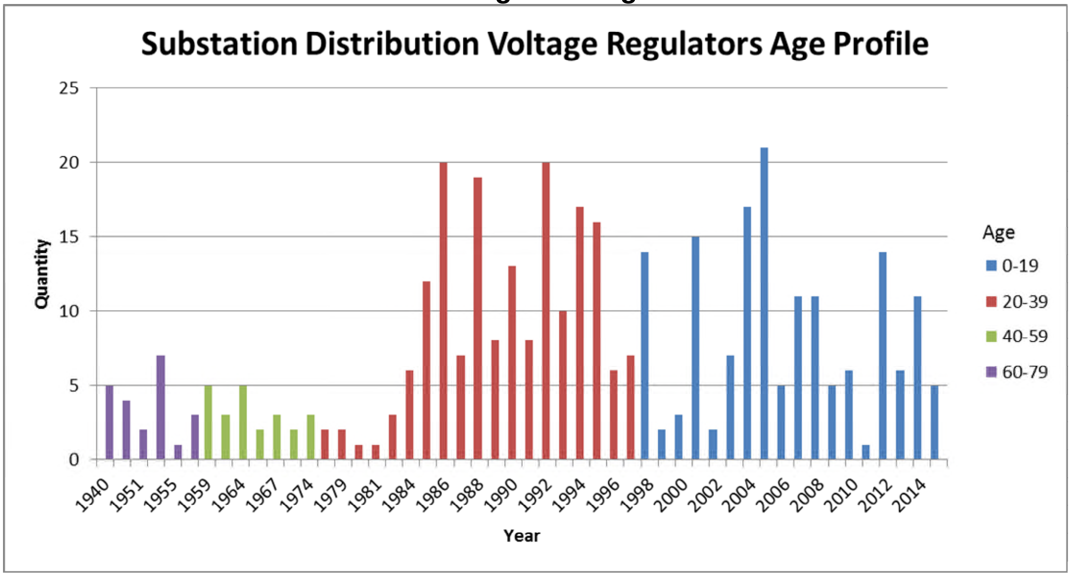
TYPE	1	2	3	4	Grand Total
2016	73	0	0	0	73
2017	69	0	0	0	69

The capacitor bank voltage circuit switchers were replaced at Woodard and Schuyler substations due to asset condition issues.

2. D. 11. 6. Reactors and Regulators

Regulators and reactors provide voltage control and power flow management capability. There are approximately 516 regulators in operation, and 14 spares in distribution substations. The average age of the operating regulator population is 24 years, however 34% do not have age data, and therefore the average age may be older. The regulator age profile is shown in Figure 2D-17 below.

Figure 2D-17
New York Regulator Age Profile



There are approximately 8 air-core reactors at one substation that are 10 years old. The remaining reactors are older, but are missing age data information due to the fact that manufacturers did not provide manufacture dates on their nameplates on older units.

2. D. 11. 6. 1. Condition and Performance Issues

Regulators of specific manufacturer and design that are considered to be less reliable are listed in Table 2D-18. There has been a high failure rate of Siemens JFR regulators purchased between 1988 and 1993. The most common failure mode is burning and failure of the moveable or stationary contacts. The General Electric IRS and IRT Induction regulators and the Westinghouse IRT regulators also have known switching problems, obsolete parts, and are less likely to sustain a through fault when compared to more modern type regulators.

Voltage regulators are monitored via V&O inspections and infrared surveys. Other problematic regulators may be identified from these inspections and Substation Equipment Replacement Request (SERR) submission.

Table 2D-18
Voltage Regulator Types

Manufacturer	Type	Count
2016 Siemens	JFR	12
2016 GE	IRS/IRT	57[4]
2017 Siemens	JFR	19
2017GE	IRS/IRT	87[4]

Table 2D-19
Condition Code of Regulators and Reactors

TYPE	1	2	3	4	Grand Total
2016 VREG	366	69	0	0	435
2016 REAC	8	0	0	0	8
2017 VREG	424	671	0	0	495
2017 REAC	21	0	0	0	21

2. D. 11. 6. 2. Remedial Actions Performed

All voltage regulators receive regular maintenance per Company standards. In addition, there is an approved strategy in effect to replace Siemens JFR and GE IRS/IRT Voltage Regulators.

A Reactor (Non-transformer) Strategy has also been approved. As part of the strategy, 9 air core reactors located at Seneca substation have been replaced. The units have concrete frames that were deteriorating and breaking apart. Since the coils are wound around the frame, this weakens their condition and may cause a problem if a system disturbance occurs.

Chapter 3. Exhibits

The following contains exhibits referenced in the Report.

Exhibit 1 – Electric Assets by Transmission Study Area

A. Northeast Study Area

Electrical Facilities			
Substations			
Amsterdam 326	Clinton 366	Knapp Road 432	Schenevus 261
Ashley 331	Cobleskill 214	Luther Forrest	Schoharie 234
Ballston 12	Comstock 48	Malta 443	Schroon Lake 429
Battenkill 342	Corinth 285	Market Hill 324	Schuylerville 39
Bay Street 233	Crown Point 249	Marshville 299	Scofield Rd. 450
Bennett Switching St	Delanson 269	Mayfield 356	Sharon 363
Birch Ave. 322	East Worcester 60	McCrea St. 272	Smith Bridge 464
Bolton 284	EJ West 38	Meco 318	South St. 297
Brook Rd. 369	Ephratah 18	Middleburg 390	Spier Falls
Burgoyne 337	Farnan Rd. 476	Mohican 247	St Johnsville 335
Butler 362	Fort Gage 319	North Creek 122	Stoner 358
Cambridge 29	French Mountain	North River	Summit 347
Canajoharie 31	Gilmantown Rd 154	Northville	Ticonderoga 163
Carboy Switching St	Glens Falls 75	Ogden Brook 423	Union St 376
Caroga 219	Grand Street 433	Otten 412	Vail Mills 392
Cedar 453	Guy Park 239	Pallette Stone 385	Warrensburg 321
Cement Mt 455	Hague Rd. 418	Port Henry 385	Weibel Ave. 415
Center Street 379	Hastings Switching St 439	Pottersville 424	Wells 208
Charley Lake 254	Henry St. 316	Queensbury 295	West Milton
Charlton 222	Hill 311	Randall Road 463	Whitehall 187
Cherry Valley 41	Hudson Falls 88	Riparius 293	Wilton 329
Chestertown 42	Indian Lake 310	Rock City Falls 404	Worcester 189
Church Street 43	Johnstown 61	Saratoga 142	

Transmission Lines			
Circuit ID	**Circuit Name**	**Main Line / Tap Name**	**Voltage (kV)**
T5100	Clinton - Marshville #12	main line	115
T5240	Inghams - East Springfield #7	main line	115
T5250	Inghams - Meco #15	main line	115
T5250-1 Tap	Inghams - Meco #15	I-M#15 - Clinton Tap	115
T5260	Inghams - St. Johnsville #6	main line	115
T5260-1 Tap	Inghams - St. Johnsville #6	I-SJ #6 - Beardslee Tap	115
T5270	Inghams - Stoner #9	main line	115
T5270-1 Tap	Inghams - Stoner #9	I-S #9 - Center Street Tap	115
T5270-2 Tap	Inghams - Stoner #9	I-S #9 - Fage Dairy Tap	115
T5430	Mohican - Battenkill #15	main line	115
T5430-1 Tap	Mohican - Battenkill #15	M-B #15 - Irving Tissue Tap	115
T5440	Mohican - Butler #18	main line	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T5440-1 Tap	Mohican - Butler #18	M-B #18 - GF Cement Tap	115
T5440-2 Tap	Mohican - Butler #18	M-B #18 - Finch Pruyn Tap	115
T5440-3 Tap	Mohican - Butler #18	M-B #18 - S. Glens Falls Energy Tap	115
T5710	Spier - Butler #4	main line	115
T5730	Spier - Queensbury #5	main line	115
T5730-1 Tap	Spier - Queensbury #5	S-Q #5 - Ogden Brook Tap	115
T5740	Spier - Queensbury #17	main line	115
T5740-1 Tap	Spier - Queensbury #17	S-Q #17 Sherman Island Tap	115
T5740-2 Tap	Spier - Queensbury #17	S-Q #17 Ogden Brook Tap	115
T5750-1 Tap	Spier - Rotterdam #1	S-R #1 - Weibel Ave Tap	115
T5750-2 Tap	Spier - Rotterdam #1	S-R #1 - Smith Bridge Tap	115
T5750-3 Tap	Spier - Rotterdam #1	S-R #1 - Brook Road Tap	115
T5750-4 Tap	Spier - Rotterdam #1	S-R #1 - West Milton Tap	115
T5750-5 Tap	Spier - Rotterdam #1	S-R #1 - Ballston Tap	115
T5750-6 Tap	Spier - Rotterdam #1	S-R #1 - Malta Sub Tap	115
T5760-1 Tap	Spier - Rotterdam #2	S-R #2 - Weibel Ave Tap	115
T5760-2 Tap	Spier - Rotterdam #2	S-R #2 - Smith Bridge Tap	115
T5760-3 Tap	Spier - Rotterdam #2	S-R #2 - Brook Road Tap	115
T5760-4 Tap	Spier - Rotterdam #2	S-R #2 - Ballston Tap	115
T5760-5 Tap	Spier - Rotterdam #2	S-R #2 - Malta Sub Tap	115
T5770	Spier - West #9	main line	115
T5770-1 Tap	Spier - West #9	S-W #9 - IP Corinth Tap	115
T5770-2 Tap	Spier - West #9	S-W #9 - Stewart's Bridge Tap	115
T5770-3 Tap	Spier - West #9	S-W #9 - Scofield Road Tap	115
T5770-4 Tap	Spier - West #9	S-W #9 - Palmer Curtis Tap	115
T5780	St. Johnsville - Marshville #11	main line	115
T5810	Ticonderoga - Republic #2	main line	115
T5810-1 Tap	Ticonderoga - Republic #2	R-T #2 - Hague Road Sub Tap	115
T5810-2 Tap	Ticonderoga - Republic #2	R-T #2 - Lachute Hydro Tap	115
T5810-3 Tap	Ticonderoga - Republic #2	R-T #2 - IP Ticonderoga Tap	115
T5810-4 Tap	Ticonderoga - Republic #2	R-T #2 - Crown Point Tap	115
T5810-5 Tap	Ticonderoga - Republic #2	R-T #2 - Port Henry Tap	115
T5820	Ticonderoga - Hague Road #4	main line	115
T5830	Ticonderoga - Whitehall #3	main line	115
T5830-1 Tap	Ticonderoga - Whitehall #3	T-W #3 - Otten Tap	115
T5870	Warrensburg - North Creek #5	main line	115
T5880	Warrensburg - Scofield Road #10	main line	115
T5890	Whitehall - Blissville #7	main line	115
T5900	Whitehall - Mohican #13	main line	115
T5900-1 Tap	Whitehall - Mohican #13	W-M #13 - Comstock (NYSEG) Tap	115
T5900-2 Tap	Whitehall - Mohican #13	W-M #13 - Comstock Tap	115
T5900-3 Tap	Whitehall - Mohican #13	W-M #13 - Burgoyne Tap	115
T5900-4 Tap	Whitehall - Mohican #13	W-M #13 - Adirondack Resources Tap	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T5910	Whitehall - Cedar #6	main line	115
T5910-1 Tap	Whitehall - Cedar #6	W-C #6 - Great Meadow Tap	115
T5910-2 Tap	Whitehall - Cedar #6	W-C #6 - Burgoyne Tap	115
T5950	Indeck Corinth - Spier #18	main line	115
T5970	Queensbury - Cedar #10	main line	115
T6070	Spier - Mohican #7	main line	115
T6410R	Ticonderoga - Sanford Lake (retired)	main line	115
T6480-1 Tap	Mohican - Luther Forest #3	M-NT #3 - Hemstreet Tap	115
T6480-2 Tap	Mohican - Luther Forest #3	M-NT #3 - Mulberry (NYSEG) Tap	115
T6580	Global Foundries - Luther Forest #111	main line	115
T6590	Global Foundries - Luther Forest #222	main line	115
T6480	Mohican - Luther Forest #3	main line	115

The following transmission lines have portions in both the Northeast and Capital-Hudson Valley study areas:

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T5750	Spier - Rotterdam #1	main line	115
T5760	Spier - Rotterdam #2	main line	115
T6060R	Mohican - North Troy #3	main line	115
T6490	Luther Forest - North Troy #308	main line	115

Sub-Transmission Lines			
Circuit ID	From	To	Voltage (kV)
1	Dahowa	Cement Mountain	34.5
1	North Creek	Indian Lake	34.5
1	Mohican	Hudson Falls	34.5
2	Cement Mountain	Cambridge	34.5
2	Chestertown	North Creek	34.5
2	Fort Gage	Queensbury	34.5
3	Hoosick	Cambridge	34.5
3	Chestertown	Schroon	34.5
3	Fort Edwards	Hudson Falls	34.5
3	Glens Falls	Henry St.	34.5
3	Spier	Brook Rd.	34.5
4	Adirondack Hydro Hudson Falls	Mohican	34.5
5	Glens Falls	Ashley	34.5
5	Cement Mountain	Battenkill	34.5

Sub-Transmission Lines			
Circuit ID	**From**	**To**	**Voltage (kV)**
6	Ballston	Mechanicville	34.5
6	Schuylerville	Battenkill	34.5
6	Spier	Corinth	34.5
6	Warrensburg	Chestertown	34.5
7	AHDC Middle Falls	Cement Mountain	34.5
7	Chestertown	North Creek	34.5
7	Queensbury	Bay St.	34.5
8	Ballston	Shore Rd.	34.5
8	Hoosick	Clay Hill	34.5
8	Spier	Glens Falls	34.5
8	Glens Falls	Spier	34.5
8	Warrensburg	Fort Gage	34.5
9	Queensbury	Warrensburg	34.5
9	Warrensburg	Queensbury	34.5
9	West Milton	Ballston	34.5
10	Glens Falls	Bay St.	34.5
10	Saratoga	Ballston	34.5
11	Brook Rd.	Ballston	34.5
11	Mohican	Glens Falls	34.5
11	Glens Falls	Mohican	34.5
12	Glens Falls	Mohican	34.5
12	Mohican	Glens Falls	34.5
12	Spier	Saratoga	34.5
14	Queensbury	Henry St.	34.5
17	Hudson Falls	McCrea St.	34.5

B. Capital and Hudson Valley Study Area

Electrical Facilities			
Substations			
Albany Steam		Leeds 377	Rosa Rd. 137
Alps 417		Liberty St. 94	Rotterdam 138
Altamont 283	East Schodack 447	Long Lane 504	Russell Rd 228
Amsterdam 326	East Springfield 477	Lynn St 320	Ruth Rd. 381
Athens	East Worcester 60	Maplewood 307	Sand Creek Rd. 452
Avenue A 291	Eastover Road	Market Hill 324	Schenevus 261
Ballston 12	Elnora 344	Marshville 299	Schodack 451
Bennington Paperboard	Elnora 442	Mayfield 356	Schoharie 234
Bethlehem 21	Elsmere 407	McClellan St. 304	School St.
Blue Stores 303	Emmet 256	McKownville 327	Scotia 255
Boyntonville 333	Ephratah 18	Mechanicville 971	Selkirk 149
Brunswick 264	Everett Rd. 420	MECO 318	Seminole 339
Buckley Corners 454	Feura Bush 503	Menands 101	Seventh Ave. 244
Burdeck St 265	Fire House Rd. 449	Menands-Partridge St	Sharon 363
Campus 1	Forts Ferry 459	Middleburg 390	Shore Rd. 281
Campus 2	Front St. 360	Nassau 113	St. Johnsville 335
Canajoharie 31	Genesee St	New Scotland	Stoner 358
Caroga Lake 219	Gilmantown Rd 154	New Krumkill 421	Stuyvesant 35
Castleton 36	Gloversville 72	Newark St. 300	Summit 347
Central Ave. 235	Grand St 433	Newtonville 305	Swaggertown Rd. 364
Center St. 379	Greenbush 78	North Troy #123	Sycaway 372
Charlton 222	Grooms Rd. 345	Northville 332	Tibbets Ave. 292
Charley Lake 41	Guy Park 239	Old Krumkill	Trinity Riser 404
Chrisler Ave. 257	Hemstreet 328	Oathout 402	Trinity 164
Clay Hill 251	Hill St. 311	Partridge St. 128	Unionville 276
Church St. 43	Hoag 221	Patroon 323	Vail Mills 392
Clinton 366	Hoosick 314	Pinebush 371	Valkin 427
Cobleskill 214	Hudson 87	Prospect Hill 413	Voorheesville 178
Colvin Ave. 313	Inman Rd. 370	Quail Hollow 457	Watt St. 230
Commerce Ave. 434	Johnson Rd. 352	Randall Rd. 463	Weaver St. 245
Corliss Park 338	Johnstown 61	Rensselaer 132	West Milton
Curry Rd. 365	Juniper 446	Reynolds Rd. 334	Wells 208
Delanson 269	Karner 317	Rifle Range 458	Wolf Rd. 344
Delaware Ave. 330	Lansingburg 93	River Rd. 444	Woodlawn 188

Delmar 279	Latham 282	Riverside 288	Worcester 189
Depot 425		Rock City Falls 404	

Transmission Lines

Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T5000	Arsenal - Reynolds Road #31	main line	115
T5000-1 Tap	Arsenal - Reynolds Road #31	A-RR #31 - Rensselaer Waste Water tap	115
T5000-2 Tap	Arsenal - Reynolds Road #31	A-RR #31 - GE Healthcare tap	115
T5010	Albany - Greenbush #1	main line	115
T5020	Albany - Greenbush #2	main line	115
T5030	Alps - Berkshire #393	main line	345
T5040	Altamont - New Scotland #20	main line	115
T5040-1 Tap	Altamont - New Scotland #20	A-NS #20 - Voorheesville Tap	115
T5060	Battenkill - North Troy #10	main line	115
T5060-1 Tap	Battenkill - North Troy #10	B-NT #10 - Mulberry (NYSEG) Tap	115
T5070	Bethlehem - Albany #18	main line	115
T5080	LaFarge Building Materials - Pleasant Valley #8	main line	115
T5080-1 Tap	LaFarge Building Materials - Pleasant Valley #8	LBM-PV #8 - Buckley Corners	115
T5080-2 Tap	LaFarge Building Materials - Pleasant Valley #8	LBM-PV #8 - Blue Stores Tap	115
T5090	Churchtown - Pleasant Valley #13	main line	115
T5090-1 Tap	Churchtown - Pleasant Valley #13	C-PV #13 - Blue Stores Tap	115
T5110	Curry Road - Wolf Road #8	main line	115
T5110-1 Tap	Curry Road - Wolf Road #8	CR-WR #8 - Ruth Road Tap	115
T5110-2 Tap	Curry Road - Wolf Road #8	CR-WR #8 - Sand Creek Tap	115
T5120	Firehouse Road - North Troy #15	main line	115
T5120-1 Tap	Firehouse Road - North Troy #16	FR-NT #15 - GE Silicone Tap	115
T5120-2 Tap	Firehouse Road - North Troy #15	FR-NT #15 - Prospect Hill Tap	115
T5130	Front St. - Rosa Road #11	main line	115
T5140	G.E. R&D - Inman Road #20	main line	115
T5140-1 Tap	G.E. R&D - Inman Road #20	GERD-IR #20 - Elnora Tap	115
T5170	Schodack - Churchtown #14	main line	115
T5170-1 Tap	Schodack - Churchtown #14	S-C #14 - Valkin Tap	115
T5180	Greenbush - Hudson #15	main line	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T5180-1 Tap	Greenbush - Hudson #15	G-H #15 - Trans Canada Tap	115
T5180-2 Tap	Greenbush - Hudson #15	G-H #15 - ValkinTap	115
T5190	Greenbush - Stephentown #993	main line	115
T5200	Grooms Road - Inman Road #15	main line	115
T5220	Hoosick - Bennington #6	main line	115
T5230	Hudson - Pleasant Valley #12	main line	115
T5230-1 Tap	Hudson - Pleasant Valley #12	H-PV #12 - Adm Milling Tap	115
T5280	Long Lane - LaFarge Building Materials #6	main line	115
T5290	Johnson Road- Maplewood #12	main line	115
T5300	Krumkill - Albany #7	main line	115
T5310	Leeds - Hurley Avenue #301	main line	345
T5320	Athens - Pleasant Valley #91	main line	345
T5330	Leeds - Pleasant Valley #92	main line	345
T5340	Maplewood - Arsenal #15	main line	115
T5350	Maplewood - Menands #19	main line	115
T5370	McKownville - Krumkill #8	main line	115
T5390	Meco - Rotterdam #10	main line	115
T5390-1 Tap	Meco - Rotterdam #10	M-R #10 - Center St. Tap	115
T5390-2 Tap	Meco - Rotterdam #10	M-R #10 - Church St. Tap	115
T5390-3 Tap	Meco - Rotterdam #10	M-R #10 - Amsterdam Tap	115
T5400	Menands - Reynolds Road #2	main line	115
T5400-1 Tap	Menands - Reynolds Road #2	M-RR#2 - GE Healthcare tap	115
T5410	Menands - Riverside #3	main line	115
T5410-1 Tap	Menands - Riverside #3	M-R #3 - Albany County Waste Tap	115
T5420	Milan - Pleasant Valley #10	main line	115
T5450	New Scotland - Alps #2	main line	345
T5460	New Scotland - Bethlehem #4	main line	115
T5470	New Scotland - Long Lane #7	main line	115
T5470-1 Tap	New Scotland - Long Lane #7	NS-LL#7 - Owens Corning Tap	115
T5470-2 Tap	New Scotland - Long Lane #7	NS-LL#7 - MG Industries Tap	115
T5470-3 Tap	New Scotland - Long Lane #7	NS-LL#7 - BOC GasTap	115
T5470-4 Tap	New Scotland - Long Lane #7	NS-LL#7 - GE Plastics Tap	115
T5480	New Scotland - Leeds #93	main line	345
T5490	New Scotland - Leeds #94	main line	345
T5500	New Scotland - Feura Bush #9	main line	115
T5500-1 Tap	New Scotland - Feura Bush #9	NS-FB #9 - Owens Corning Tap	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T5500-2 Tap	New Scotland - Feura Bush #9	NS-FB #9 - MG Industries Tap	115
T5500-3 Tap	New Scotland - Feura Bush #9	NS-FB #9 - GE Plastics Tap	115
T5520	North Catskill - Milan #T7	main line	115
T5530	North Troy - Hoosick #5	main line	115
T5530-1 Tap	North Troy - Hoosick #5	NT-H #5 - Boyntonville Tap	115
T5540	North Troy - Reynolds Road #16	main line	115
T5540-1 Tap	North Troy - Reynolds Road #16	NT-RR #16 - Sycaway Tap	115
T5550	North Troy - Wynantskill #14	main line	115
T5550-1 Tap	North Troy - Wynantskill #14	NT-W #14 - Sycaway Tap	115
T5560	Reynolds Road - Alps #1	main line	345
T5570	Reynolds Road - Greenbush #9	main line	115
T5580	Riverside - Reynolds Road #4	main line	115
T5580-1 Tap	Riverside - Reynolds Road #4	R-R #4 - Greenbush Tap	115
T5590	Riverside - Trinity #18	main line	115
T5600	Riverside - Trinity #19	main line	115
T5610	Rosa Road - G.E.(R&D) #14	main line	115
T5620	Rotterdam - Altamont #17	main line	115
T5620-1 Tap	Rotterdam - Altamont #17	R-A #17 - Burdeck St. Tap	115
T5630	Rotterdam-Bear Swamp E205	main line	230
T5640	Rotterdam - Curry Road #11	main line	115
T5650	Rotterdam - Front St. #16	main line	115
T5660	Rotterdam - G.E. #14	main line	115
T5670	Rotterdam - G.E. #15	main line	115
T5680	Rotterdam - New Scotland #13	main line	115
T5690	Rotterdam - New Scotland #19	main line	115
T5690-1 Tap	Rotterdam - New Scotland #19	R-NS #19 - Burdeck St. Tap	115
T5690-2 Tap	Rotterdam - New Scotland #19	R-NS #19 - Voorheesville Tap	115
T5700	Rotterdam - Woodlawn #35	main line	115
T5700-1 Tap	Rotterdam - Woodlawn #35	R-W #35 - Pinebush Tap	115
T5750-7 Tap	Spier - Rotterdam #1	S-R #1 - Swaggertown Tap	115
T5760-6 Tap	Spier - Rotterdam #2	S-R #2 - Swaggertown Tap	115
T5790	State Campus - Menands #15	main line	115
T5790-1 Tap	State Campus - Menands #15	SC-M #15 - Patroon Tap	115
T5790-2 Tap	State Campus - Menands #15	SC-M #15 - Everett Tap	115
T5800	Stoner - Rotterdam #12	main line	115
T5800-1 Tap	Stoner - Rotterdam #12	S-R #12 - Vail Mills Tap	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T5800-2 Tap	Stoner - Rotterdam #12	S-R #12 – Church St. Tap	115
T5800-3 Tap	Stoner - Rotterdam #12	S-R #12 - Amsterdam Tap	115
T5840	Trinity - Albany #5	main line	115
T5850	Trinity - Albany #9	main line	115
T5920	Woodlawn - State Campus #12	main line	115
T5920-1 Tap	Woodlawn - State Campus #12	W-SC #12 - Pinebush Tap	115
T5920-2 Tap	Woodlawn - State Campus #12	W-SC #12 - Ruth Road Tap	115
T5920-3 Tap	Woodlawn - State Campus #12	W-SC #12 - Sand Creek Tap	115
T5930	Wynantskill - Reynolds Road #13	main line	115
T5940	Feura Bush - North Catskill #2	main line	115
T5940-1 Tap	Feura Bush - North Catskill #2	FB-NC #2 - BOC GAS Tap	115
T5960	Coastal Technology - Greenbush #16	main line	115
T5980	New Scotland - Albany #8	main line	115
T5980-1 Tap	New Scotland - Albany #8	NS-A #8 - Air Products Tap	115
T5990	New Scotland - Feura Bush #3	main line	115
T6000	Reynolds Road - Feura Bush #17	main line	115
T6010	Wolf Road - Menands #10	main line	115
T6010-1 Tap	Wolf Road - Menands #10	WR-M #10 - Everett Tap	115
T6090	Greenbush - Schodack #13	main line	115
T6160	Leeds - Athens #95	main line	345
T6360	Grooms Road - Forts Ferry #13	main line	115
T6360-1 Tap	Grooms Road - Forts Ferry #13	GR-FF #13 - Fire House Tap	115
T6370	Forts Ferry - Johnson Rd #14	main line	115
T6380	CESTM - Patroon #6	main line	115
T6390	McKownville - CESTM #2	main line	115
T6490-1Tap	Luther Forest - North Troy #308	LT-NT #308 - Mullberry (NYSEG) Tap	115

The following lines have portions in both the Capital Hudson Valley and Utica Rome transmission study areas:

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T4070	Edic - New Scotland #14	main line	345
T4130	Marcy - New Scotland #18	main line	345
T4200	Porter-Rotterdam #30	main line	230
T4210	Porter-Rotterdam #31	main line	230

The following transmission lines have portions in both the Capital Hudson Valley and Northeast transmission study areas:

Transmission Lines			
Circuit ID	**Circuit Name**	**Main Line / Tap Name**	**Voltage (kV)**
T5750	Spier - Rotterdam #1	main line	115
T5760	Spier - Rotterdam #2	main line	115
T6060R	Mohican - North Troy #3	main line	115
T6490	Luther Forest - North Troy #308	main line	115

Sub-Transmission Lines			
Circuit ID	**From**	**To**	**Voltage (kV)**
10	Emmet	McCellan St	34.5
13	Emmet	Woodlawn	34.5
5	Karner	Patroon	34.5
5	Knolls	Vischer	34.5
1	Lynn St	Woodlawn	34.5
11	McCellan St	Bevis Hill	34.5
1	Rosa Rd	Knolls	34.5
2	Rosa Rd.	Bevis Hill	34.5
32	Rotterdam	Scotia	34.5
34	Rotterdam	Lynn St	34.5
36	Rotterdam	Weaver	34.5
6	Scotia	Rosa Rd.	34.5
3	Vischer	Woodlawn	34.5
9	Weaver St.	Emmet	34.5
14	Woodlawn	Karner	34.5
5	Cobleskill	Summit	69
6	Cobleskill	Schoharie	69
16	Marshville	Sharon	69
18	Rotterdam	Schoharie	69
3	Schenevus	Summit	23
17	Sharon	Cobleskill	69
3	Amsterdam	Schenectady International	69
7	Amsterdam	Ephratah	69
8	Canajoharie	Marshville	69
3	Gloversville	Hill St.	69
6	Gloversville	Canajoharie	69
4	Hill St.	Meco	69
8	Johnstown	Market Hill	69
11	Market Hill	Amsterdam	69

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Sub-Transmission Lines			
Circuit ID	From	To	Voltage (kV)
7	Mayfield	Meco	69
9	Mayfield	Vail Mills	69
12	Meco	Johnstown	69
8	Northville	Mayfield	69
4	Schenectady International	Rotterdam	69
2	Ephratah	Caroga	23
1	Northville	Wells	23
2	Wells	Gilmantown Rd.	23
7	Central Ave	Patroon	34.5
11	Latham	Newtonville	34.5
2	Maplewood	Liberty St	34.5
5	Maplewood	Norton	34.5
9	Maplewood	Latham	34.5
13	Maplewood	Liberty St	34.5
18	Maplewood	Menands	34.5
16	Newtonville	Patroon	34.5
3	Patroon	Krumkill	34.5
4	Patroon	Colvin Ave	34.5
5	Shore	Rosa	34.5
17	Crescent	School St	34.5
20	Crescent	North Troy	34.5
5	Greenbush	Castleton	34.5
6	Greenbush	Nassau	34.5
8	Greenbush	Snyders Lake	34.5
8	Hoosick	Clay Hill	34.5
4	Lansingburg	Seventh Ave	34.5
8	Liberty	Tibbits	34.5
5	Liberty	Seventh Ave	
9	Nassau	Hudson	34.5
1	North Troy	Lansingburg	34.5
2	North Troy	Tibbits	34.5
7	North Troy	Tibbits	
19	North Troy	School St	34.5
20	North Troy	Crescent	
10	Rensselaer	Greenbush	34.5
11	Rensselaer	Greenbush	34.5
2	Tibbits	North Troy	34.5
7	Tibbits	North Troy	34.5
8	Tibbits	Liberty St	34.5
10	RPI	Tibbits	34.5

Sub-Transmission Lines			
Circuit ID	From	To	Voltage (kV)
5	Seventh Ave	Liberty	34.5
2	Altamont	Voorheesville	34.5
10	Bethlehem	Avenue A	34.5
13	Bethlehem	Rensselaer	34.5
5	Bethlehem	Selkirk	34.5
1	Bethlehem	Voorheesville	34.5
2	Colvin Ave	Partridge St	34.5
9	Colvin Ave	Seminole	34.5
14	Delaware	Bethlehem	34.5
37	Delaware	South Mall	34.5
6	Delmar	Bethlehem	34.5
9	Krumkill	Delmar	34.5
8	Menands	Central Ave	34.5
32	Menands	Genesee	34.5
9	Menands	Liberty St	34.5
27	Menands	Riverside	34.5
36	Menands	South Mall	34.5
6	Newark	Maplewood	34.5
17	Norton	Menands	34.5
5	Partridge	Avenue A	34.5
9	Partridge	Riverside	34.5
39	Partridge	Riverside	34.5
16	Riverside	Albany Medical Center	34.5
36	Riverside	Albany Medical Center	34.5
10	Riverside	Dewitt Apts	34.5
35	Riverside	South Mall	34.5
38	Riverside	South Mall	34.5
8	Riverside	Times Union Center	34.5
14	Riverside	Times Union Center	34.5
8	School	Newark	34.5

C. Northern Study Area

Electrical Facilities			
Substations			
Akwesasne 825	Dennison 960	Lisbon 963	Ogdensburg 938
Antwerp	Dexter 726	Little River 955	Parishville 939
Ausable Forks 846	E. Norfolk 913	Loon Lake 837	Paul Smith's 834
Balmat 904	E. Oswegatchie 982	Lowville 733	Piercefield 829
Battle Hill	E. Watertown 817	Lyme 733	Port Leyden
Black River	Edwards 916	Malone 895	Portage St. 754
Bloomingdale 841	Elm St. 898	McAdoo 914	Raybrook 839
Bombay 897	Emeryville	McIntyre	Riverview 847
Brady 957	Fine	Merrillville 838	S. Philadelphia 764
Brasher 851	Fort Covington 896	Mill St. 748	Sewalls Island 766
Bremen 815	Franklin Falls 843	Mine Rd.	Silver Lake 845
Brier Hill 953	Gabriels 835	Moira 859	Spencers Corner 863
Brown Falls	Gilpin Bay 956	Morristown 933	St. Regis 977
Carthage 717	Hammond 370	N. Bangor 864	Star Lake
Chasm Falls 852	Heuvelton	N. Carthage 816	State St. 954
Coffeen 760	Higley 924	N. Governeur 983	Sunday Creek 876
Collinsville 716	Hogansburg 855	N. Lawrence 861	Taylorville
Colony	Indian River 323	Newton Falls	Thousand Islands 814
Colton 909	Lake Clear 833	Nicholville 860	Tupper Lake 830
Corning	Lake Colby 927	Norfolk	Union 844
David 979	Lawrence Ave. 976	North Ogdensburg 878	W. Adams 875
Dekalb 984	Leray 813	Norwood 936	Westville 885

Transmission Lines			
Circuit ID	**Circuit Name**	**Main Line / Tap Name**	**Voltage (kV)**
T3000	Alcoa - Dennison #12	main line	115
T3020	Battle Hill - Balmat #5	main line	115
T3020-1 Tap	Battle Hill - Balmat #5	BH-B #5 - Zinco Tap	115
T3020-2 Tap	Battle Hill - Balmat #5	BH-B #5 - Gouverneur Talc Co. Tap	115
T3030	Colton - Battle Hill #7	main line	115
T3030-1 Tap	Colton - Battle Hill #7	C-BH #7 Little River Tap	115
T3030-2 Tap	Colton - Battle Hill #7	C-BH #7 Pyrites Tap	115
T3030-3 Tap	Colton - Battle Hill #7	C-BH #7 Dekalb Tap	115
T3050	Black River - North Carthage #1	main line	115
T3050-1 Tap	Black River - North Carthage #1	BR-NC #1 - Kamine-Carthage Co-Gen Tap	115
T3050-2 Tap	Black River - North Carthage #1	BR-NC#1 - Climax Co-Gen Tap	115
T3060	Black River - Taylorville #2	main line	115
T3060-1 Tap	Black River - Taylorville #2	BR-T #2 - Fort Drum Co-Gen Tap	115
T3060-2 Tap	Black River - Taylorville #2	BR-T #2 - Fort Drum #1 Tap	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T3060-3 Tap	Black River - Taylorville #2	BR-T #2 - Deferiet Paper Tap	115
T3060-4 Tap	Black River - Taylorville #2	BR-T #2 - North Carthage Tap	115
T3070	Browns Falls - Newton Falls Pap. Co. #6	main line	115
T3080	Browns Falls - Taylorville #3	main line	115
T3090	Browns Falls - Taylorville #4	main line	115
T3100	Boundary Road - Dennison #1	main line	115
T3100-1 Tap	Boundary Road - Dennison #1	BR-D #1 - Rosemount Tap (CE)	115
T3100-2 Tap	Boundary Road - Dennison #1	BR-D #1 - McConnell Tap (CE)	115
T3100-3 Tap	Boundary Road - Dennison #1	BR-D #1 - Aldophus Tap (CE)	115
T3100-4 Tap	Boundary Road - Dennison #1	BR-D #1 - Courtaulds Tap (CE)	115
T3100-5 Tap	Boundary Road - Dennison #1	BR-D #1 - Loyalist Tap (CE)	115
T3110	Boundary Road - Dennison #2	main line	115
T3110-1 Tap	Boundary Road - Dennison #2	BR-D #2 - Rosemount Tap (CE)	115
T3110-2 Tap	Boundary Road - Dennison #2	BR-D #2 - McConnell Tap (CE)	115
T3110-3 Tap	Boundary Road - Dennison #2	BR-D #2 - Aldophus Tap (CE)	115
T3110-4 Tap	Boundary Road - Dennison #2	BR-D #2 - Courtaulds Tap (CE)	115
T3110-5 Tap	Boundary Road - Dennison #2	BR-D #2 - Loyalist Tap (CE)	115
T3110-6 Tap	Boundary Road - Dennison #2	BR-D #2 - ICI Plant Tap (CE)	115
T3120	Coffeen - Black River #3	main line	115
T3120-1 Tap	Coffeen - Black River #3	C-BR #3 - Glen Park Hydro Tap	115
T3120-2 Tap	Coffeen - Black River #3	C-BR #3 - Air Brake Tap	115
T3130	Coffeen - West Adams #2	main line	115
T3140	Colton - Browns Falls #1	main line	115
T3150	Colton - Browns Falls #2	main line	115
T3160	Colton - Carry (Stark) #9	main line	115
T3160-1 Tap	Colton - Townline #9	C-T #9 - South Colton Hydro Tap	115
T3160-2 Tap	Colton - Townline #9	C-T #9 - Five Falls Hydro Tap	115
T3160-3 Tap	Colton - Townline #9	C-T #9 - Rainbow Hydro Tap	115
T3160-4 Tap	Colton - Townline #9	C-T #9 - Blake Hydro Tap	115
T3160-5 Tap	Colton - Townline #9	C-T #9 - Carry Tap	115
T3170	Colton - Malone #3	main line	115
T3170-1 Tap	Colton - Malone #3	C-M #3 - Allens Falls Hydro Tap	115
T3170-2 Tap	Colton - Malone #3	C-M #3 - Nicholville Tap	115
T3180	Dennison - Colton #4	main line	115
T3180-1 Tap	Dennison - Colton #4	D-C #4 - Norfolk Tap	115
T3180-2 Tap	Dennison - Colton #4	D-C #4 - Mead Paper Tap	115
T3180-3 Tap	Dennison - Colton #4	D-C #4 - Lawrence Ave. Tap	115
T3180-4 Tap	Dennison - Colton #4	D-C #4 - Sugar Island Hydro Tap	115
T3180-5 Tap	Dennison - Colton #4	D-C #4 - Unionville / Hewittville Hydros Tap	115
T3190	Dennison - Colton #5	main line	115
T3190-1 Tap	Dennison - Colton #5	D-C #5 - Lawrence Ave Tap	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T3190-2 Tap	Dennison - Colton #5	D-C #5 - Hannawa Falls Tap	115
T3200	Fort Drum - Black River #9	Not a tap (main line)	115
T3200-1 Tap	Fort Drum - Black River #9	FD-BR #3 - Indian River Tap	115
T3210	Lake Colby - Lake Placid #3	main line	115
T3210-1 Tap	Lake Colby - Lake Placid #3	LC-LP #3 - Ray Brook Tap	115
T3230	Malone - Lake Colby #5	main line	115
T3250	McIntyre - Corning #6	main line	115
T3270	M.E.F. - Alcoa #3	main line	115
T3280	McIntyre - Colton #8	main line	115
T3280-1 Tap	McIntyre - Colton #8	M-C #8 - Ogdensburg Tap	115
T3280-2 Tap	McIntyre - Colton #8	M-C #8 - McAdoo Sub Tap	115
T3280-3 Tap	McIntyre - Colton #8	M-C #8 - Little River Tap	115
T3290	North Gouverneur - Battle Hill #8	main line	115
T3300	Ogdensburg - McIntyre #2	main line	115
T3320	Taylorville - Boonville #5	main line	115
T3330	Taylorville - Boonville #6	main line	115
T3330-1 Tap	Taylorville - Boonville #6	T-B #6 - Northbrook Energy Tap	115
T3330-2 Tap	Taylorville - Boonville #6	T-B #6 - Moose River Hydro Tap	115
T3330-3 Tap	Taylorville - Boonville #6	T-B #6 - Lyonsdale Hydro/ Burrows Tap	115
T3330-4 Tap	Taylorville - Boonville #6	T-B #6 - Lyonsdale Co-Gen Tap	115
T3340	Taylorville - Moshier #7	main line	115
T3340-1 Tap	Taylorville - Moshier #7	T-M #7 - Eagle Tap	115
T3340-2 Tap	Taylorville - Moshier #7	T-M #7 - Sunday Creek Tap	115
T3350	Thousand Islands - Coffeen #4	main line	115
T3350-1 Tap	Thousand Islands - Coffeen #4	TI-C #4 - Lyme Tap	115
T3360	Willis - Malone #1	main line	115
T3380	Alcoa - North Ogdensburg #13	main line	115
T3390	East Oswegatchie - North Gouverneur #1	main line	115
T3400	North Ogdensburg - McIntyre #9	main line	115
T3410	O.E.F. - North Ogdensburg #1	main line	115
T6180	Corning - Battle Hill #4	main line	115
T6180-1 Tap	Corning - Battle Hill #4	C-B #4 - McAdoo Tap	115
T6180-2 Tap	Corning - Battle Hill #4	C-B #4 - Dekalb Tap	115
T6210	Raymondville - Norfolk #1	main line	115
T6210-1 Tap	Raymondville - Norfolk #1	R-N #1 - APC Paper Tap	115
T6270	North Carthage - Taylorville #8	main line	115
T6340	Adirondack-Chases Lake #13	main line	230
TNYPA-1 Tap	Moses-Reynolds-GM MRG1 (NYPA)	M-R-G MRG1 (NYPA) - Akwesasne Tap	115

The following transmission line has portions in both the Northern and Central transmission study areas:

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T2120	Coffeen - Black River - Lighthouse Hill #5	main line	115
T3040	Black River - Lighthouse Hill #6	main line	115

The following transmission line has portions in both the Northern and Mohawk transmission study areas:

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T4010	Adirondack-Porter #12	main line	230
T6350	Chases Lake-Porter #11	main line	230

Sub-Transmission Lines			
Circuit ID	From	To	Voltage (kV)
21	Nicholville	North Bangor	34.5
22	Spencer Corners	Bombay	34.5
23	Nicholville	Bombay	34.5
23	Malone	Chasm Falls	34.5
24	Malone	Spencer Corners	34.5
26	Malone	Spencer Corners	34.5
26	Akwesasne	Fort Convington	34.5
23	Akwesasne	Nicholville	34.5
30	Lake Clear	Lake Colby	46
31	Lake Colby	Franklin	46
34	Union Falls	Franklin	46
35	Union Falls	Lake Clear	46
36	Union Falls	Ausable Forks	46
37	High Falls	Union Falls	46
38	Lake Clear	Tupper Lake	46
39	Piercefield	Tupper Lake	46
21	Colony	Browns Falls	34.5
22	Browns Falls	Newton Falls	34.5
22	Colony	South Edwards	34.5
2	Emeryville	Gouverneur Talc. Co.	23
21	McIntyre	David	23
21	Norfolk	Norwood	23

Sub-Transmission Lines			
Circuit ID	From	To	Voltage (kV)
23	Emeryville	Mine Rd.	23
23	McIntyre	Heuvelton	23
24	Balmat	Emeryville	23
24	McIntyre	Hammond	23
25	Lisbon	Heuvelton	23
26	State St.	Little River	23
27	Balmat	Fowler	23
28	Mine Rd.	Colony	23
21	Old Forge	Raquette Lake	46
22	Boonville	Alder Creek	46
23	Alder Creek	Old Forge	46
21	Carthage	High Falls	23
21	Mill St.	Black River	23
21	South Philadelphia	Theresa	23
22	Black River	Black River Hydro	23
22	Carthage	Taylorville	23
22	Lowville	Boonville	23
23	Beaver Falls	Taylorville	23
24	Carthage	North Carthage	23
24	Leray	Black River	23
24	South Philadelphia	Antwerp	23
24	Taylorville	Effley	23
25	Belfort	Taylorville	23
25	Coffeen	Dexter	23
25	South Philadelphia	Indian River	23
26	Carthage	Copenhagen	23
26	Coffeen	Mill St.	23
26	High Falls	Taylorville	23
27	Deferiet	Herrings	23
28	Herring	Carthage	23
29	Deferiet	North Carthage	23

D. Syracuse Oswego Cortland Study Area

Electrical Facilities			
Substations			
Ash St. 223	Drumlins 132	Labrador 230	Sandy Creek 66
Baily 313	Duguid 265	Lafayette 301	Scriba 319
Ballina 221	E. Fulton 100	Lake Rd. Two 299	Seneca Hill 206
Bartell 325	E. Molloy Rd. 151	Lords Hill 66	Sentinel Heights 128
Belmont 260	E. Pulaski 324	Lorings 276	Seventh North 231
Brewerton 07	E. Syracuse 27	Lysander 297	Solvay 57
Bridge St. 295	E. Conklin 314	Mallory 125	Sorrell Hill 269
Bridgeport 168	Elbridge 312	McGraw 228	South Bay 60
Brighton Ave. 08	Euclid 267	Messina 42	South Oswego 254
Bristol Hill 109	Fabius 55	Mexico 43	Southwood 244
Buckabee Mears 300	Fairdale 135	Midler 145	Springfield 167
Buckley 140	Fairmount 118	Miller St. 117	Starr Rd. 334
Butternut 255	Fay Street 103	Milton Ave. 266	Stiles 58
Camillus 10	Fayette St. 28	Minoa 44	Teall Ave. 72
Cardiff 13	Fayetteville 14	Nestle Company 245	Temple St. 243
Carr 387	Fisher Ave. 270	New Haven 256	Third St. 216
Carrier 268	Fly Rd. 261	Niles 294	Truxton 74
Cazenovia 220	FMR Carlyle 268	Oswego Steam	Tuller Hill 246
Central Square 15	Galeville 213	Paloma 254	Tully Center 278
Chittenango 16	Geres Lock 30	Parish 49	Varick 207
Cicero 17	Gilbert Mills 247	Park Street 144	Volney 296
Clay 229	Glenwood 227	Peat Street 250	W. Monroe 274
Cleveland 11	Granby Center 293	Pebble Hill 290	W. Cleveland 326
Colosse 321	Hancock #2 138	Perryville 50	West Oswego 209
Constantia 19	Hancock 137	Phoenix 51	Westvale 133
Cortland 502	Harris Road 235	Pine Grove 59	Whitaker 296
Crouse Hinds 239	Headson 146	Pompey 120	Wine Creek 283
Curtis St 224	Hinsdale 218	Pulaski 68	Woodard 233
Cuyler 24	Homer 129	Rathburn 160	
Delphi 262	Hopkins 253	Ridge Rd. 219	
Dewitt 241	Jamesville Recloser 152	Rock Cut 286	
Dorwin 26	Jewett 291	Sand Rd. 131	

The transmission lines located in the Central transmission study area are provided in the table below.

Transmission Lines			
Circuit ID	**Circuit Name**	**Main Line / Tap Name**	**Voltage (kV)**
T2000	Ash - Teall #7	main line	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T2010	Ash - Teall #8	main line	115
T2020	Ash - Temple #9	main line	115
T2030	Auburn (State St.) - Elbridge #5	main line	115
T2040	Clay - Dewitt #3	main line	115
T2040-1 Tap	Clay - Dewitt #3	C-D #3 - Bartell Tap	115
T2040-2 Tap	Clay - Dewitt #3	C-D #3 - Pine Grove Tap	115
T2040-3 Tap	Clay - Dewitt #3	C-D #3 - New Venture Gear Tap	115
T2040-4 Tap	Clay - Dewitt #3	C-D #3 - Fly Road Tap	115
T2040-5 Tap	Clay - Dewitt #3	C-D #3 - Butternut Tap	115
T2050	Clay - Dewitt #5	main line	115
T2050-1 Tap	Clay - Dewitt #5	C-D #5 - Duguid Tap	115
T2060	Clay - DeWitt #13	main line	345
T2090	Clay - Teall #10	main line	115
T2090-1 Tap	Clay - Teall #10	C-T #10 - Bartell / Pine Grove Tap	115
T2090-2 Tap	Clay - Teall #10	C-T #10 - E. Malloy	115
T2100	Clay - Teall #11	main line	115
T2100-1 Tap	Clay - Teall #11	C-T #11 - Euclid Tap	115
T2100-2 Tap	Clay - Teall #11	C-T #11 - Hopkins Tap	115
T2110	Clay - Woodard #17	main line	115
T2110-1 Tap	Clay - Woodard #17	C-W #17 - Euclid Tap	115
T2110-2 Tap	Clay - Woodard #17	C-W #17 - OCWA Tap	115
T2130	Cortland - Lapeer #1	main line	115
T2130-1 Tap	Cortland - Lapeer #1	C-L #1 - Tuller Hill Tap	115
T2140	Curtis Street - Teall #13	main line	115
T2140-1 Tap	Curtis Street - Teall #13	CS-T #13 - Lysander Tap	115
T2140-2 Tap	Curtis Street - Teall #13	CS-T #13 - Anheuser Busch Tap	115
T2140-3 Tap	Curtis Street - Teall #13	CS-T #13 - Belmont Tap	115
T2140-4 Tap	Curtis Street - Teall #13	CS-T #13 - Sorrell Hill Tap	115
T2140-5 Tap	Curtis Street - Teall #13	CS-T #13 - Crouse Hinds Tap	115
T2140-6 Tap	Curtis Street - Teall #13	CS-T #13 - Hopkins Tap	115
T2150	DeWitt - LaFayette #22	main line	345
T2160	Dewitt - Tilden #19	main line	115
T2170	Elbridge - Geres Lock #3	main line	115
T2180	Elbridge - Geres Lock #18	main line	115
T2180-1 Tap	Elbridge - Geres Lock #18	E-GL #18 - Milton Tap	115
T2190	Elbridge - Geres Lock #19	main line	115
T2190-1 Tap	Elbridge - Geres Lock #19	E-GL #19 - Milton Tap	115
T2200	Elbridge - Woodard #4	main line	115
T2200-1 Tap	Elbridge - Woodard #4	-W #4 - Belmont Tap	115
T2220	FitzPatrick - Lighthouse Hill #3	main line	115
T2220-1 Tap	FitzPatrick - Lighthouse Hill #3	F-LH #3 - Scriba Tap	115
T2220-2 Tap	FitzPatrick - Lighthouse Hill #3	F-LH #3 - New Haven Tap	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T2230R	Fulton Co-Gen - Clay #4	main line	115
T2240	General Electric - Geres Lock #8	main line	115
T2240-1 Tap	GE (Electronics Park) - Geres Lock #8	GE-GL #8 - Solvay Muni. Bridge St. Tap	115
T2240-2 Tap	GE (Electronics Park) - Geres Lock #8	GE-GL #8 - Solvay Muni. Matthews Ave. Tap	115
T2260	Geneva (Border City) - Elbridge #15	main line	115
T2260-1 Tap	Geneva (Border City) - Elbridge #15	G-E #15 - Hyatt Road Tap	115
T2270	Geres Lock - Solvay #2	main line	115
T2270-1 Tap	Geres Lock - Solvay #2	GL-S #2 - Solvay Muni. Matthews Ave. Tap	115
T2270-2 Tap	Geres Lock - Solvay #2	GL-S #2 - Crucible Steel	115
T2280	Geres Lock - Solvay #14	main line	115
T2280-1 Tap	Geres Lock - Solvay #14	GL-S #14 - Solvay Muni. Bridge St. Tap	115
T2280-2 Tap	Geres Lock - Solvay #14	GL-S #14 - TriGen Tap	115
T2280-3 Tap	Geres Lock - Solvay #14	GL-S #14 - Crucible Steel	115
T2290	Geres Lock - Tilden #16	main line	115
T2300	Indeck Oswego - Lighthouse Hill #2	main line	115
T2300-1 Tap	Indeck Oswego - Lighthouse Hill #2	IO-LHH #2 Wine Creek Tap	115
T2300-2 Tap	Indeck Oswego - Lighthouse Hill #2	IO-LHH #2 Alcan Tap	115
T2300-3 Tap	Indeck Oswego - Lighthouse Hill #2	IO-LHH #2 Scriba Tap	115
T2300-4 Tap	Indeck Oswego - Lighthouse Hill #2	IO-LHH #2 New Haven Tap	115
T2300-5 Tap	Indeck Oswego - Lighthouse Hill #2	IO-LHH #2 Schoeller Paper / E Pulaski Tap	115
T2310R	LaFayette - Oakdale #4 (36)	main line	345
T2320	Lighthouse Hill - Clay #7	main line	115
T2350	Nine Mile Point Unit One - Clay #8	main line	345
T2360	Nine Mile Pt. #1 - FitzPatrick #4	main line	115
T2370	Nine Mile Point Unit One - Scriba #9	main line	345
T2380	Nine Mile Pt. #2 - Scriba #5	main line	115
T2390	Nine Mile Pt. #2 - Scriba #6	main line	115
T2410-1 Tap	Oneida - Fenner #8	O-F #8 - Whitman Tap	115
T2420	Oswego - LaFayette #17	main line	345
T2430	Oswego - South Oswego #3	main line	115
T2440	Oswego - South Oswego #5	main line	115
T2450	Oswego - South Oswego #8	main line	115
T2470	Oswego - Volney #11	main line	345
T2480	Oswego - Volney #12	main line	345
T2520	Peat - Dewitt #7	main line	115
T2520-1 Tap	Peat - Dewitt #7	P-D #7 - Bridge St. Tap	115
T2520-2 Tap	Peat - Dewitt #7	P-D #7 - Headson Tap	115
T2540	Scriba - Volney #20	main line	345
T2550	Scriba - Volney #21	main line	345

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T2560	Sleight Road - Auburn (State St.) #3	main line	115
T2580	South Oswego - Curtis St. #10	main line	115
T2590R	South Oswego - Fulton Co-Gen #7	main line	115
T2600	South Oswego - Geres Lock #9	main line	115
T2600-1 Tap	South Oswego - Geres Lock #9	SO-GL #9 - Clear water pump Tap	115
T2600-2 Tap	South Oswego - Geres Lock #9	SO-GL #9 - Anheuser Busch Tap	115
T2600-3 Tap	South Oswego - Geres Lock #9	SO-GL #9 - Lysander Tap	115
T2600-4 Tap	South Oswego - Geres Lock #9	SO-GL #9 - Sorrell Hill Tap	115
T2610	South Oswego - Indeck(Oswego) #6	main line	115
T2610-1 Tap	South Oswego - Indeck(Oswego) #6	SO- I #6 - Paloma Tap	115
T2610-2 Tap	South Oswego - Indeck(Oswego) #6	SO- I #6 - Wine Creek Tap	115
T2610-3 Tap	South Oswego - Indeck(Oswego) #6	SO- I #6 – Hammermill Tap	115
T2630	South Oswego - Nine Mile Pt.#1 #1	main line	115
T2630-1 Tap	South Oswego - Nine Mile Pt.#1 #1	SO-NMP1 #1 - ALCAN Tap	115
T2630-2 Tap	South Oswego - Nine Mile Pt.#1 #1	SO-NMP1 #1 - Paloma Tap	115
T2630-3 Tap	South Oswego - Nine Mile Pt.#1 #1	SO-NMP1 #1 - Lake Road #2 Tap	115
T2640	SUNY Cortland - Cortland #2	Not a tap (main line)	115
T2640-1 Tap	SUNY Cortland - Cortland #2	C-SC #2 - Buckbee Mears Tap	115
T2640-2 Tap	SUNY Cortland - Cortland #2	C-SC #2 - Borg Warner Tap	115
T2650	Teall - Dewitt #4	main line	115
T2650-1 Tap	Teall - Dewitt #4	T-D #4 - East Malloy Tap	115
T2650-2 Tap	Teall - Dewitt #4	T-D #4 - New Venture Gear / Coolidge Ventures Tap	115
T2650-3 Tap	Teall - Dewitt #4	T-D #4 - Butternut Tap	115
T2650-4 Tap	Teall - Dewitt #4	T-D #4 - Fly Road Tap	115
T2660	Teall - Carr Street #6	main line	115
T2660-1 Tap	Teall - Carr Street #6	T-CS #6 - Carrier Tap	115
T2660-2 Tap	Teall - Carr Street #6	T-CS #6 - Bristol Myers Squibb #1 Tap	115
T2660-3 Tap	Teall - Carr Street #6	T-CS #6 - Bristol Myers Squibb #2 Tap	115
T2670	Teall - Oneida #2	main line	115
T2680	Teall - Oneida #5	main line	115
T2680-1 Tap	Teall - Oneida #5	T-O #5 - Bridgeport Tap	115
T2690	Temple - Dewitt #10	main line	115
T2690-1 Tap	Temple - Dewitt #10	T-D #10 Bridge St. Tap	115
T2690-2 Tap	Temple - Dewitt #10	T-D #10 Headson Tap	115
T2700	Temple - SU/Gas #11	main line	115
T2710	Tilden - Cortland #18	main line	115
T2720	Volney - Clay #6	main line	345
T2740	Carr Street - Dewitt #15	main line	115
T2740-1 Tap	Carr Street - Dewitt #15	CS-D #15 - Bristol-Myers Squibb #1 Tap	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T2740-2 Tap	Carr Street - Dewitt #15	CS-D #15 - Bristol-Myers Squibb #2 Tap	115
T2750	Clay - General Electric (Electronics Park) #14	main line	115
T2760	Independence - Scriba #25	main line	345
T2770	O.C.R.R.A. - Tilden #15	main line	115
T2770-1 Tap	O.C.R.R.A. - Tilden #15	O-T #15 – Rock Cut Rd Tap	115
T6030	Independence - Clay #26	main line	345
T6120	Geres Lock - Onondaga Co-Gen #12	main line	115
T6130	Geres Lock - WPS Empire State Co-Gen #11	main line	115
T6140	Fenner - Cortland #3	main line	115
T6140-1 Tap	Fenner - Cortland #3	F-C #3 - Fenner Oneida Co-Op (NYPA) Tap	115
T6140-2 Tap	Fenner - Cortland #3	F-C #3 - Labrador Tap	115
T6150	Hook Road - Elbridge #7	main line	115
T6150-1 Tap	Hook Road - Elbridge #7	HR - E #7 – Farmington Tap (NYSEG)	115
T6150-2 Tap	Hook Road - Elbridge #7	HR - E #7 - Hamilton Road Tap (NYSEG)	115
T6400	South Oswego - Clay #4	main line	115
T6400-1 Tap	South Oswego - Clay #4	SO-C #4 NY Chocolate Tap	115
T6400-2 Tap	South Oswego - Clay #4	SO-C #4 - NE Biofuels Tap	115
T6400-3 Tap	South Oswego - Clay #4	SO-C #4 - Owens Illinois Tap	115
T6400-4 Tap	South Oswego - Clay #4	SO-C #4 - Sealright Tap	115
T6470	Lafayette - Clarks Corners #4 (46)	main line	345

The following transmission line has portions in both the Central and Genesee Regions:

Transmission Lines			
Circuit ID	Circuit Trunk Name	Main Line / Tap Name	Voltage (kV)
T1570	Mortimer - Elbridge #2	main line	115

The following transmission line has portions in both the Central and Mohawk transmission study areas:

Transmission Lines			
Circuit ID	Circuit Trunk Name	Main Line / Tap Name	Voltage (kV)
T4280	Volney - Marcy #19	**Not a tap (main line)**	345

The following transmission line has portions in both the Central and Northern transmission study areas:

Transmission Lines			
Circuit ID	**Circuit Trunk Name**	**Main Line / Tap Name**	**Voltage (kV)**
T2120	Coffeen - Black River - Lighthouse Hill #5	main line	115
T3040	Black River - Lighthouse Hill #6	main line	115

Sub-Transmission Lines			
Circuit ID	**From**	**To**	**Voltage (kV)**
30	From	To	34.5
33	Ash St.	Burnet	34.5
25	Ash St.	Burnet	34.5
29	Ash St.	Carousel	34.5
24	Ash St.	Carousel	34.5
23	Ash St.	McBride	34.5
28	Ash St.	McBride	34.5
37	Ash St.	Solvay	34.5
38	Brighton	Tilden	34.5
39	Brighton	Tilden	34.5
38	Fayette	Ash St.	34.5
36	Fayette	Ash St.	34.5
37	Fayette	Solvay	34.5
20	Fayette	Solvay	34.5
22	McBride	Brighton	34.5
25	McBride	Brighton	34.5
33	McBride	University	34.5
26	McBride	University	34.5
27	Solvay		34.5
23	Solvay		34.5
25	Teall		34.5
28	Teall	Ley Creek Treat Plant	34.5
22	Teall	Syracuse China	34.5
33	Solvay		34.5
24	Mallory	Cicero	34.5
28	Woodard		34.5
29	Woodard		34.5
26	Woodard	Baldwinsville	34.5
32	Woodard	Crouse Hinds	34.5
32	Woodard	Teall	34.5
27	Teall		34.5

Sub-Transmission Lines			
Circuit ID	**From**	**To**	**Voltage (kV)**
27	Woodard	Ash St.	34.5
28	Pebble Hill	Rathbun	34.5
38	Minoa	Whitman	34.5
33	Headson	Tilden	34.5
26	Headson	Minoa	34.5
28	Headson	Pebble Hill	34.5
34	Minoa	Whitman	34.5
29	Burnet Ave.	Headson	34.5
31	Teall		34.5
30	Teall	Headson	34.5
31	Elbridge	Marcellus	34.5
509	Elbridge	Jewett	34.5
33	Niles Tap		34.5
21	Harris Rd.	Tilden	34.5
20	Harris Rd.	Tilden	34.5
34	Solvay	Harris Rd	34.5
35	Solvay	Harris Rd	34.5
22	Solvay		34.5
20	Solvay		34.5
21	Cortland	Cortland	34.5
23	Cortland	Cortland	34.5
39	Cortland	Cortland	34.5
32	Labrador	Rathbun	34.5
24	Pebble Hill	Tilden-Tully Tap	34.5
30	Tilden	Tully Tap	34.5

E. Utica Rome Study Area

Electrical Facilities			
Substations			
Alder Creek 701	Inghams 20	Poland 621	Turin 653
Arnold 656	Lehigh 669	Porter 657	Turning Stone 640
Boonville 707	Lenox 513	Raquette Lake 398	Valley 594
Cavanaugh Rd. 616	Lighthouse Hill 61	Rock City 623	Voorhees 83
Chadwicks 668	Levitt 665	Rome 762	Walesville 331
Clinton 604	Madison 654	Salisbury 678	Watkins Road 528
Conkling 652	Middleville 666	Schuyler 663	West Herkimer 676
Debalso 684	Old Forge 383	Sherman 333	Whitman 671
Deerfield 606	Oneida 501	So. Washington 614	White Lake 399
Eagle Bay 382	Oriskany 648	Stittville 670	Whitesboro 632
Edic 662	Peterboro 514	Terminal 651	Yahnundasis 646
Frankfort 677	Pleasant 664	Trenton 627	

Transmission Lines			
Circuit ID	**Circuit Name**	**Main Line / Tap Name**	**Voltage (kV)**
T2800	Watkins Road - Inghams #2	main line	115
T2800-1 Tap	Watkins Road - Inghams #2	WR-I #2 - Salisbury Tap	115
T4020	Boonville - Porter #1	main line	115
T4020-1 Tap	Boonville - Porter #1	B-P #1 - Stittville Tap	115
T4030	Boonville - Porter #2	main line	115
T4030-1 Tap	Boonville - Porter #2	B-P #2 - Stittville Tap	115
T4030-2 Tap	Boonville - Porter #2	B-P #2 - Boonville Muni. Tap	115
T4040	Boonville - Rome #4	main line	115
T4040-1 Tap	Boonville - Rome #4	B-R #4 - Madison Tap	115
T4040-2 Tap	Boonville - Rome #4	B-R #4 - Revere Copper & Brass Tap	115
T4060	Boonville - Rome #3	main line	115
T4060-1 Tap	Boonville - Rome #3	B-R #3 - Griffis AVA Tap	115
T4060-2 Tap	Boonville - Rome #3	B-R #3 - Madison Tap	115
T4080	Edic - Porter #10	main line	115
T4090	Edic-Porter #17	main line	230
T4100	Edic - Porter #20	main line	115
T4110	Levitt - Rome #8	main line	115
T4110-1 Tap	Levitt - Rome #8	L-R #8 - Lehigh Tap	115
T4110-2 Tap	Levitt - Rome #8	L-R #8 - Camden Wire Tap	115
T4110-3 Tap	Levitt - Rome #8	L-R #8 - Voorhees Ave Tap	115
T4110-4 Tap	Levitt - Rome #8	L-R #8 - Rome Cable Tap	115
T4140	Oneida - Oneida Energy (Sterling) #4	main line	115
T4150	Oneida - Porter #7	main line	115
T4150-1 Tap	Oneida - Porter #7	O-P #7 - Cavanaugh Road Tap	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T4150-2 Tap	Oneida - Porter #7	O-P #7 - Walesville Tap	115
T4160	Oneida - Yahnundasis #6	main line	115
T4160-1 Tap	Oneida - Yahnundasis #6	O-Y #6 - Sherrill Power & Light Tap	115
T4170	Porter - Deerfield #8	main line	115
T4180	Porter - Deerfield #9	main line	115
T4190	Porter - Watkins Road #5	main line	115
T4190-1 Tap	Porter - Watkins Road #5	P-WR #5 - Deerfield Tap	115
T4220	Porter - Schuyler #13	main line	115
T4230	Porter - Terminal #6	main line	115
T4230-1 Tap	Porter - Terminal #6	P-T #6 - Utica Convertors Tap	115
T4240	Porter - Valley #4	main line	115
T4250	Rome - Oneida #1	main line	115
T4260	Terminal - Schuyler #7	main line	115
T4270R	Valley - Inghams #3	main line	115
T4290	Yahnundasis - Chadwicks #1	main line	115
T4290-1 Tap	Yahnundasis - Chadwicks #1	Y-C #1 - Special Metals Tap	115
T4300	Yahnundasis - Porter #3	main line	115
T4300-1 Tap	Yahnundasis - Porter #3	Y-P #3 - Utica Corp (Halsley) Tap	115
T4300-2 Tap	Yahnundasis - Porter #3	Y-P #3 - Walesville Tap	115
T4300-3 Tap	Yahnundasis - Porter #3	Y-P #3 - Debalso Tap	115
T4300-4 Tap	Yahnundasis - Porter #3	Y-P #3 - Conmed Tap	115
T6050	Watkins Road - Ilion Municipal Co-Gen #8	main line	115
T6050-1 Tap	Watkins Road - Ilion Municipal Co-Gen #8	WR-I #8 - Murphy Station Co-Gen Tap	115
T6560	Valley - Fairfield #12	main line	115
T6570	Fairfield - Inghams #3	main line	115
T6570-1 Tap	Fairfield - Inghams #3	F-I #3 - Salisbury Tap	115

The following line has portions in both the Utica/Rome and Syracuse/Oswego/Cortland transmission study areas:

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T2410	Oneida - Fenner #8	main line	115

The following lines have portions in both the Utica/Rome and Capital Hudson Valley transmission study areas:

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)

T4070	Edic - New Scotland #14	main line	345
T4130	Marcy - New Scotland #18	main line	345
T4200	Porter-Rotterdam #30	main line	230
T4210	Porter-Rotterdam #31	main line	230

Sub-Transmission Lines			
Circuit ID	**From**	**To**	**Voltage (kV)**
22	Deerfield	Schuyler	46
26	Deerfield	Whitesboro	46
26	Pleasant	Schuyler	46
21	Schuyler	Valley	46
24	Schuyler	Valley	46
21	Trenton	Deerfield	46
27	Trenton	Deerfield	46
24	Trenton	Middleville	46
23	Trenton	Prospect	46
25	Trenton	Whitesboro	46
26	Valley	Inghams	46
27	Valley	Inghams	46
29	Whitesboro	Schuyler	46
29	Whitesboro	Homogenous Metals Tap	46
27	Yahnundasis	Clinton	46
25	Yahnundasis	Pleasant	46
24	Yahnundasis	Westmoreland	46
23	Yahnundasis	Whitesboro	46

F. Genesee Study Area

Electrical Facilities			
Substations			
Albion 80	E. Golah 51	Livonia 37	Sheppard 29
Attica 12	E. Newstead 6	Lyndonville 95	Sourssprings Switch
Avon 43	Eagle Harbor 92	Medina	South Newfane #71
Barker 78	Elba 20	Middleport 77	Southland 84
Basom 15	Gasport 90	Mortimer	Station 197
Batavia 01	Geneseo 55	Mumford 50	Telegraph Road
Brockport 74	Golah	N. Akron	University #81
Burt #171	Groveland 41	N. Leroy 04	Waterport 73
Butts Road 72	Hemlock 38	Newfane 170	West Albion 79
Byron 18	Industry 47	North Lakeville	West Hamlin 82
Caledonia 44	Iroquois Rock	Oakfield 03	Wethersfield 23
Canawagus	Knapp Rd. 226	Orangeville 19	Willow Specialties 24
Conesus 52	Lakeville 40	Richmond 32	York Center 53
Corfu 22	Lapp 26	Royalton 98	
Darien 16	Lima 36	Rush 34	
Dolomite 9	Linden 21	SE Batavia	
E. Batavia 28	Livingston 130	Shelby 76	

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T1000	Brunner - Sour Springs 118	main line	115
T1000-1 Tap	Brunner - Sour Springs #118	B-SS #118 - Shelby Tap	115
T1040	Alabama - Telegraph 115	main line	115
T1050	Batavia - Southeast Batavia 117	main line	115
T1050-1 Tap	Batavia - Southeast Batavia #117	B-SEB #117 Oatka Dairy Tap	115
T1320	Golah - North Lakeville #116	main line	115
T1320-1 Tap	Golah - North Lakeville #116	G-NL #116 - E. Golah Tap	115
T1320-2 Tap	Golah - North Lakeville #116	G-NL #116 - Kraft Foods Tap	115
T1490	Lockport - Batavia #107	main line	115
T1490-1 Tap	Lockport - Batavia #107	L-B #107 - Alabama Switch Struc. Tap	115
T1490-2 Tap	Lockport - Batavia #107	L-B #107 - Akron Village Tap	115
T1490-3 Tap	Lockport - Batavia #107	L-B #107 - East Batavia Tap	115
T1500	Lockport - Batavia #108	main line	115
T1500-1 Tap	Lockport - Batavia #108	L-B #108 - North Akron Tap	115
T1510	Lockport - Batavia #112	main line	115
T1510-1 Tap	Lockport - Batavia #112	L-B #112 - Oakfield Tap	115
T1520	Lockport - Hinman #100	main line	115
T1530	Lockport - Mortimer #111	main line	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T1530-1 Tap	Lockport - Mortimer #111	L-M #111 - Alabama Switch Tap	115
T1530-2 Tap	Lockport - Mortimer #111	L-M #111 - Sour Springs Switch Tap	115
T1530-3 Tap	Lockport - Mortimer #111	L-M #111 - University Sta. 81 Tap	115
T1530-4 Tap	Lockport - Mortimer #111	L-M #111 - Brockport Tap	115
T1530-5 Tap	Lockport - Mortimer #111	L-M #111 - West Hamlin Tap	115
T1540	Lockport - Mortimer #113	main line	115
T1540-1 Tap	Lockport - Mortimer #113	L-M #113 - Sour Springs Switch Tap	115
T1540-2 Tap	Lockport - Mortimer #113	L-M #113 - University Sta. 81 Tap	115
T1540-3 Tap	Lockport - Mortimer #113	L-M #113 - Brockport Tap	115
T1540-4 Tap	Lockport - Mortimer #113	L-M #113 - West Hamlin Tap	115
T1550	Lockport - Mortimer #114	main line	115
T1550-1 Tap	Lockport - Mortimer #114	L-M #114 - Sheldon/ Telegraph Road Tap	115
T1550-2 Tap	Lockport - Mortimer #114	L-M #114 - Sour Springs Switch Tap	115
T1560	Mortimer - Hook Road #1	main line	115
T1560-1 Tap	Mortimer - Hook Road #2	M-HR #1 - Lawler Tap (NYPA)	115
T1560-2 Tap	Mortimer - Hook Road #3	M-HR #1 - Hogan Road Tap (NYPA)	115
T1570-1 Tap	Mortimer - Elbridge #2	M-E #2 - Lawler Tap (NYPA)	115
T1570-2 Tap	Mortimer - Elbridge #2	M-E #2 - Hogan Road Tap (NYPA)	115
T1580	Mortimer - Golah #110	main line	115
T1590	Mortimer - Pannell Road #24	main line	115
T1590-1 Tap	Mortimer - Pannell Road #24	M-P #24 - Pittsford Tap	115
T1600	Mortimer - Pannell Road #25	main line	115
T1600-1 Tap	Mortimer - Pannell Road #25	M-P #25 - Pittsford Tap	115
T1610	Mortimer(Sta.82) - Quaker(Sta.121) #23	main line	115
T1610-1 Tap	Mortimer(Sta.82) - Quaker(Sta.121) #23	M-Q #23 - Pittsford Tap	115
T1860	Pannell(Sta.122) -Geneva(Border City) #4	main line	115
T1860-1 Tap	Pannell(Sta.122) -Geneva(Border City) #4	P-G #4 - Farmington Tap	115
T1870	Quaker Road(Sta.121) - Sleight Road #13	main line	115
T1890	Southeast Batavia - Golah #119	main line	115
T1890-1 Tap	Southeast Batavia - Golah #119	SB-G #119 - East Batavia Tap	115
T1930	Mortimer - Sta.23 & Sta.33 #901	main line	115

The following transmission lines have portions in both the Genesee and Frontier study areas:

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)

Transmission Lines			
T1440	Huntley - Lockport #36	main line	115
T1450	Huntley - Lockport #37	main line	115
T1620	Mountain - Lockport #103	main line	115
T1690	Niagara - Lockport #101	main line	115
T1700	Niagara - Lockport #102	main line	115

The following transmission line has portions in both the Genesee and Central study areas:

Transmission Lines			
Circuit ID	**Circuit Name**	**Main Line / Tap Name**	**Voltage (kV)**
T1570	Mortimer - Elbridge #2	main line	115

Sub-Transmission Lines			
Circuit ID	**From**	**To**	**Voltage (kV)**
301	Phillips Road	Medina	34.5
302	Telegraph Road	Medina	34.5
303	Telegraph Road	Medina	34.5
304	Phillips Road	Telegraph Road	34.5
305	Medina	Albion	34.5
306	Waterport	Albion	34.5
307	Waterport	Brockport	34.5
308	Albion	Brockport	34.5
310	Brockport	Owens Illinois	34.5
312	Gasport	Telegraph Road	34.5
213	Caledonia	Golah	34.5
203	North Leroy	Caledonia	34.5
209	Attica	Wethersfield	34.5
208	North Leroy	Attica	34.5
206	Batavia	Attica	34.5
225	North Akron	Attica	34.5
223	Batavia	North Leroy	34.5
219	Oakfield	Batavia	34.5
201	Oakfield	Caledonia	34.5
227	North Akron	Oakfield	34.5
204	I2R Element	North Akron	34.5
205	I2R Element	North Akron	34.5
218	N. Lakeville	Ridge	34.5

224	N. Lakeville	Hemlock	34.5
226	N. Lakeville	Richmond	34.5
217	Golah	N. Lakeville	34.5
216	Golah	N. Lakeville	34.5
109	Mortimer	Golah	69
853	Golah	S. Perry	69

G. Frontier Study Area

Electrical Facilities			
Substations			
Alameda Ave 124	Main Street	Buffalo St 161	Buffalo St 46
Amherst	Maple Road 140	Buffalo St 162	Buffalo St 47
Ayer Rd 211	Martin Road 139	Buffalo St 201	Buffalo St 48
Beech Ave 81	Military Road 210	Buffalo St 202	Buffalo St 49
Brompton Rd 129	Milpine 96	Buffalo St 203	Buffalo St 51
Buffalo Ave 215	Mountain	Buffalo St 204	Buffalo St 52
Burt 171	Mountain Switching Str	Buffalo St 208	Buffalo St 53
Col Ward Pump 50	New Gardenville	Buffalo St 21	Buffalo St 56
Dale Rd 213	New Walden	Buffalo St 22	Buffalo St 57
Delaware Rd 127	Newfane 170	Buffalo St 23	Buffalo St 59
Dupont 133	Niagara Falls Blvd 130	Buffalo St 24	Buffalo St 63
E Cambria 100	Oakwood Ave 138	Buffalo St 24a	Buffalo St 66
Eight Ave 80	Oakwood 232	Buffalo St 25	Buffalo St 67
Electric Ave 55	Old Gardenville	Buffalo St 26	Buffalo St 68
Eleventh St 82	Packard	Buffalo St 27	Buffalo St 74
Elm	Phillips Rd Switching St	Buffalo St 28	Buffalo St 77
Galleria Switching St	Park Club Lane 219	Buffalo St 29	Buffalo St 78
George Urban 154	Ransomville 89	Buffalo St 30	Buffalo St 79
Getzville 60	Ridge 142	Buffalo St 31	Buffalo St 157
Gibson 106	Roberts 155	Buffalo St 32	Stephenson Ave 84
Grand Island 64	South Newfane 71	Buffalo St 33	Summit Park 97
Harbor Front 212	Sanborn	Buffalo St 34	Swann Rd 105
Harlem Rd 58	Sawyer Ave	Buffalo St 35	Sweet Home Rd 224
Harper	Seneca Shops 207	Buffalo St 36	Tonawanda Creek 206
Huntley	Seneca Terminal 447	Buffalo St 37	Walck Rd
Huth Rd 61	Shawnee Rd 76	Buffalo St 38	Walmore Rd 217
Kenmore Terminal	Buffalo St 121	Buffalo St 39	Waterfront 205
Kensington Terminal	Buffalo St 122	Buffalo St 40	Welch Ave 83
Lewiston Hts 86	Buffalo St 126	Buffalo St 41	Wilson 93
Lewiston 87	Buffalo St 132	Buffalo St 42	Young Street 214
Lockport Rd 216	Buffalo St 146	Buffalo St 43	Youngman 1
Lockport	Buffalo St 157	Buffalo St 44	Youngstown 88
Long Rd 209	Buffalo St 160	Buffalo St 45	

The transmission lines located in the Frontier transmission study area are provided in the table below:

Transmission Lines			
Circuit ID	**Circuit Name**	**Main Line / Tap Name**	**Voltage (kV)**

nationalgrid

Transmission Lines			
Circuit ID	**Circuit Name**	**Main Line / Tap Name**	**Voltage (kV)**
T1010	Adams - Packard 187	main line	115
T1010-1 Tap	Adams - Packard #187	A-P #187 Niagara Falls Wastewater Tap	115
T1010-2 Tap	Adams - Packard #187	A-P #187 Carbo-Wash. Mills Tap	115
T1010-3 Tap	Adams - Packard #187	A-P #187 Occidental Chemical Tap	115
T1010-4 Tap	Adams - Packard #187	A-P #187 Great Lakes Carbon Tap	115
T1010-5 Tap	Adams - Packard #187	A-P #187 Pyron Tap	115
T1010-6 Tap	Adams - Packard #187	A-P #187 Dupont Tap	115
T1010-7 Tap	Adams - Packard #187	A-P #187 Buffalo Av. 215 Tap	115
T1020	Adams - Packard 188	main line	115
T1020-1 Tap	Adams - Packard #188	A-P #188 Niagara Falls Wastewater Tap	115
T1020-2 Tap	Adams - Packard #188	A-P #188 Carbo-Wash. Mills Tap	115
T1020-3 Tap	Adams - Packard #188	A-P #188 Occidental Chemical Tap	115
T1020-4 Tap	Adams - Packard #188	A-P #188 Great Lakes Carbon Tap	115
T1020-5 Tap	Adams - Packard #188	A-P #188 Pyron Tap	115
T1020-6 Tap	Adams - Packard #188	A-P #188 Dupont Tap	115
T1020-7 Tap	Adams - Packard #188	A-P #188 Buffalo Av. 215 Tap	115
T1030	Airco - Buffalo River 147	main line	115
T1030-1 Tap	Airco - Buffalo River #147	A-BR #147 Co-Steel Recycling Tap	115
T1060	Beck - Lockport 104	main line	115
T1060-1 Tap	Beck - Lockport #104	B-L #104 - Mountain Switch Struc. Tap	115
T1060-2 Tap	Beck - Lockport #104	B-L #104 - Swann Road 105 Tap	115
T1070	Beck-Packard 76	main line	230
T1120	DuPont - Packard #183	main line	115
T1120-1 Tap	DuPont - Packard #183	D-P #183 - Carbon Graphite Tap	115
T1120-2 Tap	DuPont - Packard #183	D-P #183 - Harper Tap	115
T1120-3 Tap	DuPont - Packard #183	D-P #183 - Olin (NYPA) Tap	115
T1130	DuPont - Packard #184	main line	115
T1130-1 Tap	DuPont - Packard #184	D-P #184 - Carbon Graphite Tap	115
T1130-2 Tap	DuPont - Packard #184	D-P #184 - CH Resources Co-Gen Tap	115
T1130-3 Tap	DuPont - Packard #184	D-P #184 - Harper Tap	115
T1130-4 Tap	DuPont - Packard #184	D-P #184 - Olin (NYPA) Tap	115
T1140	Elm Street-Gardenville #71	main line	230
T1150	Elm Street-Gardenville #72	main line	230
T1190	Gardenville - Bethlehem #149	main line	115
T1190-1 Tap	Gardenville - Bethlehem #149	G-B #149 Harbor Front 212 Tap	115
T1190-2 Tap	Gardenville - Bethlehem #149	G-B #149 Ford Tap	115
T1190-3 Tap	Gardenville - Bethlehem #149	G-B #149 Bethlehem SWS	115
T1200	Gardenville - Bethlehem #150	main line	115
T1200-1 Tap	Gardenville - Bethlehem #150	G-B #150 Bethlehem SWS	115
T1200-2 Tap	Gardenville - Bethlehem #150	G-B #150 Harbor Front 212 Tap	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T1210	Gardenville - Buffalo River Switch #145	main line	115
T1210-1 Tap	Gardenville - Buffalo River Switch #145	G-B #145 St Lawrence Cement Tap	115
T1210-3 Tap	Gardenville - Buffalo River Switch #145	G-B #145 Ridge Station 142 Tap	115
T1210-4 Tap	Gardenville - Buffalo River Switch #145	G-B #145 Great Lakes MDF	115
T1220	Gardenville - Buffalo River Switch #146	main line	115
T1220-1 Tap	Gardenville - Buffalo River Switch #146	G-B #146 Ridge Station 142 Tap	115
T1230	Gardenville - Depew #54	main line	115
T1230-1 Tap	Gardenville - Depew #54	G-D #54 - American Standard Tap	115
T1230-2 Tap	Gardenville - Depew #54	G-D #54 - Walden (NYSEG) Tap	115
T1230-3 Tap	Gardenville - Depew #54	G-D #54 - Walden Station 69 Tap	115
T1230-4 Tap	Gardenville - Depew #54	G-D #54 - Cooper Industries Tap	115
T1230-5 Tap	Gardenville - Depew #54	G-D #54 - Veridian (Calspan) Tap	115
T1230-6 Tap	Gardenville - Depew #54	G-D #54 - Buffalo Tungsten Tap	115
T1290	Gardenville - Seneca #81	main line	115
T1300	Gardenville - Seneca #82	main line	115
T1300-1 Tap	Gardenville - Seneca #82	G-S #82 Station 155 Tap	115
T1370	Huntley-Elm Street #70	main line	230
T1380	Huntley - Gardenville #38	main line	115
T1380-1 Tap	Huntley - Gardenville #38	H-G #38 Station 129 Tap	115
T1380-2 Tap	Huntley - Gardenville #38	H-G #38 Amherst Term Station Tap	115
T1380-3 Tap	Huntley - Gardenville #38	H-G #38 Maple Station 140 Tap	115
T1380-4 Tap	Huntley - Gardenville #38	H-G #38 Station 54 Tap	115
T1380-5 Tap	Huntley - Gardenville #38	H-G #38 Station 61 Tap	115
T1380-6 Tap	Huntley - Gardenville #38	H-G #38 Urban Station 154 Tap	115
T1380-7 Tap	Huntley - Gardenville #38	H-G #38 Walden Station Tap	115
T1380-8 Tap	Huntley - Gardenville #38	H-G #38 Dale Road Station 213 Tap	115
T1390	Huntley - Gardenville #39	main line	115
T1390-1 Tap	Huntley - Gardenville #39	H-G #39 FMC Tap	115
T1390-2 Tap	Huntley - Gardenville #39	H-G #39 Station 129 Tap	115
T1390-3 Tap	Huntley - Gardenville #39	H-G #39 Amherst Term Station Tap	115
T1390-4 Tap	Huntley - Gardenville #39	H-G #39 Maple Station 140 Tap	115
T1390-5 Tap	Huntley - Gardenville #39	H-G #39 Station 54 Tap	115
T1390-6 Tap	Huntley - Gardenville #39	H-G #39 Station 61 Tap	115
T1390-7 Tap	Huntley - Gardenville #39	H-G #39 Urban Station 154 Tap	115
T1390-8 Tap	Huntley - Gardenville #39	H-G #39 Dale Road Station 213 Tap	115
T1400	Huntley-Gardenville #79	main line	230
T1400-1 Tap	Huntley-Gardenville #79	H-G #79 Amherst Station SUNY Tap	230
T1400-2 Tap	Huntley-Gardenville #79	H-G #79 Sawyer Avenue Tap	230

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T1410	Huntley-Gardenville #80	main line	230
T1410-1 Tap	Huntley-Gardenville #80	H-G #80 Amherst Station SUNY Tap	230
T1410-2 Tap	Huntley-Gardenville #80	H-G #80 Sawyer Avenue Tap	230
T1420	Huntley - Praxair #46	main line	115
T1420-1 Tap	Huntley - Praxair #46	H-L#46 - FMC Tap	115
T1420-2 Tap	Huntley - Praxair #46	H-L#46 - Dunlop Tire Tap	115
T1420-3 Tap	Huntley - Praxair #46	H-L#46 - Dupont Tap	115
T1420-4 Tap	Huntley - Praxair #46	H-L#46 - Chevy Tap	115
T1420-5 Tap	Huntley - Praxair #46	H-L#46 - Kenmore Term Station Tap	115
T1420-6 Tap	Huntley - Praxair #46	H-L#46 – American Brass Tap	115
T1420-7 Tap	Huntley - Praxair #46	H-L#46 - Encogen Tap	115
T1420-8 Tap	Huntley - Praxair #46	H-L#46 - CNP Station 18 Tap	115
T1420-9 Tap	Huntley - Praxair #46	H-L#46 - Buffalo Sewer Auth. Tap	115
T1430	Huntley - Praxair #47	main line	115
T1430-1 Tap	Huntley - Praxair #47	H-L#47 - Dunlop Tire Tap	115
T1430-2 Tap	Huntley - Praxair #47	H-L#47 - Dupont Tap	115
T1430-3 Tap	Huntley - Praxair #47	H-L#47 - Chevy Tap	115
T1430-4 Tap	Huntley - Praxair #47	H-L#47 - Kenmore Term Station Tap	115
T1430-5 Tap	Huntley - Praxair #47	H-L#47 – American Brass Tap	115
T1430-6 Tap	Huntley - Praxair #47	H-L#47 - Encogen Tap	115
T1430-7 Tap	Huntley - Praxair #47	H-L#47 - Buffalo Sewer Auth. Tap	115
T1440-1 Tap	Huntley - Lockport #36	H-L #36 - Station 138 Tap	115
T1440-2 Tap	Huntley - Lockport #36	H-L #36 - Station 206 Tap	115
T1440-3 Tap	Huntley - Lockport #36	H-L #36 - Ayer Rd Station 211 Tap	115
T1440-4 Tap	Huntley - Lockport #36	H-L #36 - Young Station 214 Tap	115
T1440-5 Tap	Huntley - Lockport #36	H-L #36 - Sweethome Station 224 Tap	115
T1450-1 Tap	Huntley - Lockport #37	H-L #37 - Station 138 Tap	115
T1450-2 Tap	Huntley - Lockport #37	H-L #37 - Station 206 Tap	115
T1450-3 Tap	Huntley - Lockport #37	H-L #37 - Ayer Rd Station 211 Tap	115
T1450-4 Tap	Huntley - Lockport #37	H-L #37 - Sweethome Station 224 Tap	115
T1470	Kensington - Gardenville #44	main line	115
T1470-1 Tap	Kensington - Gardenville #44	K-G #44 American Axle Tap	115
T1480	Kensington - Gardenville #45	main line	115
T1480-1 Tap	Kensington - Gardenville #45	K-G #45 American Axle Tap	115
T1620-1 Tap	Mountain - Lockport #103	M-L #103 Swann Road 105 Tap	115
T1620-2 Tap	Mountain - Lockport #103	M-L #103 Shawnee Station 76 Tap	115
T1630	Mountain - Niagara #120	main line	115
T1640	Mountain - Niagara #121	main line	115
T1650	Mountain - Niagara #122	main line	115
T1660	Niagara - Gardenville #180	main line	115
T1660-1 Tap	Niagara - Gardenville #180	N-G #180 - Long Road Station 209 Tap	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T1670	Niagara - Gibson #197	main line	115
T1670-1 Tap	Niagara - Gibson #197	N-G #197 - Ferro Electronics Tap	115
T1670-2 Tap	Niagara - Gibson #197	N-G #197 - Global Metals Tap	115
T1670-3 Tap	Niagara - Gibson #197	N-G #197 - UCAR Carbon Tap	115
T1670-4 Tap	Niagara - Gibson #197	N-G #197 - Lockport Road 216 Tap	115
T1680	Niagara - Gibson #198	main line	115
T1680-1 Tap	Niagara - Gibson #198	N-G #198 - Ferro Electronics Tap	115
T1680-2 Tap	Niagara - Gibson #198	N-G #198 - Global Metals Tap	115
T1680-3 Tap	Niagara - Gibson #198	N-G #198 - UCAR Carbon Tap	115
T1680-4 Tap	Niagara - Gibson #198	N-G #198 - Lockport Road 216 Tap	115
T1690-1 Tap	Niagara - Lockport #101	N-L #101Sanborn Station Tap	115
T1700-1 Tap	Niagara - Lockport #102	N-L #102 Sanborn Station Tap	115
T1700-2 Tap	Niagara - Lockport #102	N-L #102 Shawnee Station 76 Tap	115
T1710	Niagara-Packard #61	main line	230
T1720	Niagara-Packard #62	main line	230
T1730	Niagara - Packard #191	main line	115
T1740	Niagara - Packard #192	main line	115
T1750	Niagara - Packard #193	main line	115
T1760	Niagara - Packard #194	main line	115
T1770	Niagara - Packard #195	main line	115
T1780	Packard - Gardenville #182	main line	115
T1780-1 Tap	Packard - Gardenville #182	P-G #182 - Long Road 209 Tap	115
T1780-2 Tap	Packard - Gardenville #182	P-G #182 - Niagara Falls Blvd. Station 130 Tap	115
T1780-3 Tap	Packard - Gardenville #182	P-G #182 - ECWA RF Ball Pump Tap	115
T1780-4 Tap	Packard - Gardenville #182	P-G #182 - Youngmann Term Tap	115
T1780-5 Tap	Packard - Gardenville #182	P-G #182 - Park Club Lane 219Tap	115
T1780-6 Tap	Packard - Gardenville #182	P-G #182 - Walden Sun Tap	115
T1780-7 Tap	Packard - Gardenville #182	P-G #182 - American Standard Tap	115
T1790	Packard-Huntley #77	main line	230
T1800	Packard-Huntley #78	main line	230
T1810	Packard - Walck Road #129	main line	115
T1810-1 Tap	Packard - Walck Road #129	P-W #129 - Military Rd. Sta. 210 Tap	115
T1810-2 Tap	Packard - Walck Road #129	P-W #129 - Milpine Sta. 96 Tap	115
T1810-3 Tap	Packard - Walck Road #129	P-W #129 - Summit Park Sta. 97 Tap	115
T1810-4 Tap	Packard - Walck Road #129	P-W #129 - Bergholtz Switch Str. Tap	115
T1820	Packard - Huntley #130	main line	115
T1820-1 Tap	Packard - Huntley #130	P-H #130 - Military R. Sta. 210 Tap	115
T1820-2 Tap	Packard - Huntley #130	P-H #130 - Milpine Sta. 96 Tap	115
T1820-3 Tap	Packard - Huntley #130	P-H #130 - Summit Park Sta. 97 Tap	115
T1820-4 Tap	Packard - Huntley #130	P-H #130 - Bergholtz Switch Str. Tap	115
T1820-5 Tap	Packard - Huntley #130	P-H #130 - Sta. 78 Tap	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T1830	Packard - Union Carbide Met. (Linde) #185	main line	115
T1830-1 Tap	Packard - Union Carbide Met. (Linde) #185	P-U #185 - Cascades NF Inc Tap	115
T1830-2 Tap	Packard - Union Carbide Met. (Linde) #185	P-U #185 - American Refuel Tap	115
T1830-3 Tap	Packard - Union Carbide Met. (Linde) #185	P-U #185 - Occidental Chemical Tap	115
T1840	Packard - Union Carbide Met. (Linde) #186	main line	115
T1840-1 Tap	Packard - Union Carbide Met. (Linde) #186	P-U #186 - Cascades NF Inc Tap	115
T1840-2 Tap	Packard - Union Carbide Met. (Linde) #186	P-U #186 - American Refuel Tap	115
T1840-3 Tap	Packard - Union Carbide Met. (Linde) #186	P-U #186 - Occidental Chemical Tap	115
T1850	Packard - Urban(Erie St.) #181	main line	115
T1850-1 Tap	Packard - Urban(Erie St.) #181	P-U #181 - Niagara Falls Blvd Station 130 Tap	115
T1850-2 Tap	Packard - Urban(Erie St.) #181	P-U #181 - ECWA RF Ball Pump Tap	115
T1850-3 Tap	Packard - Urban(Erie St.) #181	P-U #181 - Youngman Term Tap	115
T6020	Walck Road - Huntley #133	main line	115
T6020-1 Tap	Walck Road - Huntley #133	W-H #133 Youngs Station 214 Tap	115
T6020-2 Tap	Walck Road - Huntley #133	W-H #133 Station 78 Tap	115
T6260	Bell Aero - Bergholtz #99	main line	115
T6260-1 Tap	Bell Aero - Bergholtz #99	B-B #99 Carborundum Tap	115
T6260-2 Tap	Bell Aero - Bergholtz #99	B-B #99 Walmore Rd Tap	115
TNYSEG-1 Tap	Urban-Erie 922 (NYSEG)	U-E 922(NYSEG) - Veridian Tap	115

The following transmission lines have portions in both the Frontier and Genesee transmission study areas:

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T1440	Huntley - Lockport #36	main line	115
T1450	Huntley - Lockport #37	main line	115
T1620	Mountain - Lockport #103	main line	115
T1690	Niagara - Lockport #101	main line	115
T1700	Niagara - Lockport #102	main line	115

The following transmission lines have portions in both the Frontier and Southwestern transmission study areas:

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T1240	Gardenville-Dunkirk #73	main line	230
T1250	Gardenville-Dunkirk #74	main line	230
T1260	Gardenville - Dunkirk #141	main line	115
T1270	Gardenville - Dunkirk #142	main line	115
T1280	Gardenville - Homer Hill #152	main line	115
T1950	Gardenville - Homer Hill #151	main line	115

The sub-transmission lines located in the Frontier transmission study area are provided in the table below:

Sub-Transmission Lines			
Circuit ID	From	To	Voltage (kV)
605	Youngmann Terminal	Buffalo Station 58 Tap	34.5
605	Buffalo Station 58 Tap	Buffalo Station 124	34.5
605	Buffalo Station 58 Tap	Buffalo Station 58	34.5
606	Youngmann Terminal	Buffalo Station 58 Tap	34.5
606	Buffalo Station 58 Tap	Buffalo Station 124	34.5
606	Buffalo Station 58 Tap	Buffalo Station 58	34.5
701	Aero Commerce Park	Buffalo Station 67	34.5
701	Walden	Amherst	34.5
702	Walden	Ledyard Sw. Struct.	34.5
703	Walden	Galleria	34.5
1-E	Elm Station	Emerg. Hosp	23
2-E	Elm Station	Dunn Tire Park	23
3-E	Elm Station	--------	23
4-E	Elm Station	Station 48	23
5-E	Elm Station	Station 38	23
6-E	Elm Station	Station 38	23
7-E	Elm Station	Station 41	23
8-E	Elm Station	Station 41	23
9-E	Elm Station	Station 41	23
10-E	Elm Station	Dunn Tire Park	23
16-E	Elm Station	Station 34	23
17-E	Elm Station	Station 34	23
18-E	Elm Station	Station 34	23
23-E	Elm Station	Station 38	23
27-E	Elm Station	Station 34	23

Sub-Transmission Lines			
Circuit ID	**From**	**To**	**Voltage (kV)**
35-E	Elm Station	Station 41	23
1-K	Kensington Station	Station 68	23
2-K	Kensington Station	Station 68	23
3-K	Kensington Station	Station 68	23
4-K	Kensington Station	Station 68	23
5-K	Kensington Station	SUNY Buffalo	23
6-K	Kensington Station	SUNY Buffalo	23
7-K	Kensington Station	Clearing Niagara	23
8-K	Kensington Station	Meyer Memorial Hosp	23
9-K	Kensington Station	Station 32	23
9-K	Station 32	Station 157	23
10-K	Kensington Station	Station 26	23
11-K	Kensington Station	Station 26	23
12-K	Kensington Station	Station 26	23
13-K	Kensington Station	Station 32	23
13-K	Station 32	Station 28	23
14-K	Kensington Station	Station 26	23
15-K	Kensington Station	Station 26	23
21-K	Kensington Station	Station 22	23
22-K	Kensington Station	Station 22	23
23-K	Kensington Station	Station 22	23
33-K	Kensington Station	Station 22	23
401	Youngstown 88	Lewiston 87	34.5
401	Lewiston 87	Mountain	34.5
402	Ransomville 89	Wilson 93	34.5
402	Wilson 93	Burt 171	34.5
402	Burt 171	Phillips Rd	34.5
403	Youngstown 88	Model City Landfill Tap	34.5
403	Model City Landfill Tap	Ransomville 89	34.5
403	Ransomville 89	Sanborn	34.5
404	Mountain	Lewiston Heights 86	34.5
404	Lewiston Heights	Niagara Stone Tap	34.5
404	Niagara Stone Tap	Graph Tap	34.5
404	Graph Tap	Graph	34.5
404	Graph Tap	Sanborn	34.5
405	Lewiston Heights	Mountain	34.5
52	Harper	Welch Ave 83	12.0
53	Harper	Welch Ave 83	12.0
54	Harper	Welch Ave 83	12.0
55	Harper	Welch Ave 83	12.0

Sub-Transmission Lines			
Circuit ID	**From**	**To**	**Voltage (kV)**
60	Harper	Eighth Street 80	12.0
61	Harper	Eighth Street 80	12.0
62	Harper	Welch Ave 83	12.0
63	Harper	Welch Ave 83	12.0
65	Harper	Eighth Street 80	12.0
653	Harper	Stephenson Ave 85	12.0
654	Harper	Stephenson Ave 85	12.0
655	Harper	Stephenson Ave 85	12.0
71	Gibson	P24	12.0
71	P24	P31	12.0
71	P31	General Abrasive	12.0
71	P31	Titanium	12.0
73	Gibson	Globar	12.0
73	Globar	Beech Street 81	12.0
1-H	Sawyer	Station 22	23
2-H	Sawyer	Station 22	23
3-H	Sawyer	Station 22	23
4-H	Sawyer	Station 201	23
5-H	Sawyer	Station 201	23
6-H	Sawyer	Station 37	23
7-H	Sawyer	Station 48A	23
8-H	Sawyer	Station 48A	23
9-H	Sawyer	Station 33	23
10-H	Sawyer	Station 26	23
11-H	Sawyer	Station 26	23
12-H	Sawyer	Station 26	23
13-H	Sawyer	Station 22	23
14-H	Sawyer	Station 26	23
15-H	Sawyer	Station 26	23
16-H	Sawyer	Station 160	23
17-H	Sawyer	Station 160	23
18-H	Sawyer	Station 160	23
19-H	Sawyer	Station 37	23
20-H	Sawyer	Station 33	23
21-H	Sawyer	TOPS	23
22-H	Sawyer	Station 48A	23
26-H	Sawyer	Station 56	23
26-H	Station 56	Kenmore Mercy Hosp	23
27-H	Sawyer	Station 161	23
28-H	Sawyer	Station 56	23

Sub-Transmission Lines			
Circuit ID	**From**	**To**	**Voltage (kV)**
28-H	Station 56	Kenmore Mercy Hosp	23
29-H	Sawyer	Station 48	23
33-H	Sawyer	Station 126	23
34-H	Sawyer	Station 126	23
35-H	Sawyer	Station 33	23
35-H	Station 33	Station 204	23
36-H	Sawyer	Switch 578	23
1-S	Seneca Station	Station 46	23
2-S	Seneca Station	Station 46	23
3-S	Seneca Station	Station 46	23
19-S	Seneca Station	OLV Hosp.	23
31-S	Seneca Station	Station 46	23
31-S	Station 46	OLV Hosp.	23
4-S	Seneca Station	Station 48	23
5-S	Seneca Station	Station 48	23
6-S	Seneca Station	Station 38	23
23-S	Seneca Station	Station 38	23
7-S	Seneca Station	Station 42	23
8-S	Seneca Station	Station 42	23
9-S	Seneca Station	Station 42	23
13-S	Seneca Station	Buffalo Color	23
14-S	Seneca Station	Buffalo Color	23
30-S	Seneca Station	Station 41	23
32-S	Seneca Station	Scrap Property	23
33-S	Seneca Station	Scrap Property	23
10-S	Kensington Station	Seneca Station	23
11-S	Kensington Station	Seneca Station	23
12-S	Kensington Station	Seneca Station	23
15-S	Kensington Station	Seneca Station	23
16-S	Seneca Station	Station 34	23
17-S	Seneca Station	Station 34	23
18-S	Seneca Station	Station 34	23
27-S	Seneca Station	Station 34	23
601	Buffalo Station 78	Buffalo Station 77 Tap	23
601	Buffalo Station 78	Buffalo Station 77 Tap	23
601	Buffalo Station 77 Tap	Buffalo Station 77	23
601	Buffalo Station 77 Tap	Buffalo Station 74 Tap	23
601	Buffalo Station 74 Tap	Buffalo Station 74	23
601	Buffalo Station 74 Tap	Buffalo Station 57	23
601	Buffalo Station 57	Buffalo Station 127 Tap	23

Sub-Transmission Lines			
Circuit ID	From	To	Voltage (kV)
601	Buffalo Station 127 Tap	Buffalo Station 127	23
601	Buffalo Station 127 Tap	Buffalo Station 63	23
602	Buffalo Station 78	Buffalo Station 77 Tap	23
602	Buffalo Station 78	Buffalo Station 77 Tap	23
602	Buffalo Station 77 Tap	Buffalo Station 77	23
602	Buffalo Station 77 Tap	Buffalo Station 74 Tap	23
602	Buffalo Station 74 Tap	Buffalo Station 74	23
602	Buffalo Station 74 Tap	Buffalo Station 57	23
602	Buffalo Station 57	Buffalo Station 127 Tap	23
602	Buffalo Station 127 Tap	Buffalo Station 127	23
602	Buffalo Station 127 Tap	Buffalo Station 63	23
603	Buffalo Station 78	Buffalo Station 77 Tap	23
603	Buffalo Station 78	Buffalo Station 77 Tap	23
603	Buffalo Station 77 Tap	Buffalo Station 77	23
603	Buffalo Station 77 Tap	Buffalo Station 74 Tap	23
603	Buffalo Station 74 Tap	Buffalo Station 74	23
603	Buffalo Station 74 Tap	Buffalo Station 57	23
603	Buffalo Station 57	Buffalo Station 127 Tap	23
603	Buffalo Station 127 Tap	Buffalo Station 127	23
603	Buffalo Station 127 Tap	Buffalo Station 63	23
604	Buffalo Station 77 Tap	Buffalo Station 77	23
604	Buffalo Station 77 Tap	COLORFORMS Inc.	23
622	Buffalo Station 78	Buffalo Station 122 Tap	23
622	Buffalo Station 122 Tap	Buffalo Station 79	23
622	Buffalo Station 122 Tap	Buffalo Station 122	23
623	Buffalo Station 78	Buffalo Station 122 Tap	23
623	Buffalo Station 122 Tap	Buffalo Station 79	23
623	Buffalo Station 122 Tap	Buffalo Station 122	23
624	Buffalo Station 78	Waste Water Tap	23
624	Waste Water Tap	Buffalo Station 79	23
624	Waste Water Tap	Waste Water	23

H. Southwest Study Area

Electrical Facilities			
Substations			
Andover 09	Delameter Rd. 93	Ischua Switching St.	Reservoir
Angola Switch St	Delevan 11	Knights Creek 06	Ridge 142
Ashville Switch St	Dugan Rd. 22	Lakeview Rd.182	Ripley 53
Baker St.	Dunkirk	Langford 180	Roberts Rd. 154
Bemus Point	E. Dunkirk 63	Levant 98	Shaleton
Bennett Rd. 99	E. Otto 28	Machias 13	Sherman 54
Berry Rd. 153	Eden Center 88	Maplehurst 04	Sinclairville 72
Brigham Rd	Eden Switching St	N. Angola	South Dow
Buffalo Station 139	Ellicott 65	N. Ashford 36	South Randolph
Buffalo Station 149	Falconer	N. Chautauqua 78	South Wellsville 23
Busti 68	Farmersville 27	N. Collins 92	Steamburg 17
Cassadaga 61	Findley Lake 71	N. Eden 82	Stow 52
Cattaraugus 15	Finley Rd Switching St	N. Olean 30	Valley 44
Chautauqua 05	Five Mile Road	New Road Switching St	Vandalia 104
Cloverbank 91	Franklinville 24	Niles	W. Olean 33
Clymer 55	French Creek	Oak Hill 62	W. Portland 151
Collins 83	Frewsburg 69	Panama 70	W. Salamanca 16
Cuba 05	Greenhurst 60	Petrolia 19	W. Valley 25
Cuba Lake 37	Harborfront 212	Poland 66	West Perrysburg 181
Dake Hill Switching St	Hartfield 79	Price Corners	Whitesville 101
	Homer Hill		

Transmission Lines			
Circuit ID	**Circuit Name**	**Main Line / Tap Name**	**Voltage (kV)**
T1080	Dunkirk - Falconer 160	main line	115
T1080-1 Tap	Dunkirk - Falconer #160	D-F #160 – Westfield Village Tap	115
T1080-2 Tap	Dunkirk - Falconer #160	D-F #160 - Columbia Gas Tap	115
T1080-3 Tap	Dunkirk - Falconer #160	D-F #160 - Cummins Tap	115
T1090	Dunkirk - Falconer 161	main line	115
T1090-1 Tap	Dunkirk - Falconer #161	D-F #161 - Willowbrook Switch Tap	115
T1090-2 Tap	Dunkirk - Falconer #161	D-F #161 - Special Metals Tap	115
T1090-3 Tap	Dunkirk - Falconer #161	D-F #161 - Ludlum Tap	115
T1090-4 Tap	Dunkirk - Falconer #161	D-F #161 – Roberts Road Tap	115
T1090-5 Tap	Dunkirk - Falconer #161	D-F #161 - East Dunkirk Tap	115
T1100	Dunkirk - Falconer #162	main line	115
T1100-1 Tap	Dunkirk - Falconer #162	D-F #162 - Willowbrook Switch Tap	115
T1100-2 Tap	Dunkirk - Falconer #162	D-F #162 - Ludlum Tap	115
T1100-3 Tap	Dunkirk - Falconer #162	D-F #162 – Bennett Road Tap	115
T1100-4 Tap	Dunkirk - Falconer #162	D-F #162 – Roberts Road Tap	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T1100-5 Tap	Dunkirk - Falconer #162	D-F #162 - East Dunkirk Tap	115
T1110	Dunkirk-South Ripley #68	main line	230
T1160	Falconer - Homer Hill #153	main line	115
T1160-1 Tap	Falconer - Homer Hill #153	F-HH #153 - South Dow Street Tap	115
T1160-2 Tap	Falconer - Homer Hill #153	F-HH #153 - Carrs Corner Switch Tap (NYSEG)	115
T1160-3 Tap	Falconer - Homer Hill #153	F-HH #153 - Salamanca-Frank St. Tap	115
T1160-4 Tap	Falconer - Homer Hill #153	F-HH #153 - Salamanca-Rochester Tap	115
T1170	Falconer - Homer Hill #154	main line	115
T1170-1 Tap	Falconer - Homer Hill #154	F-HH #154 - South Dow Street Tap	115
T1170-2 Tap	Falconer - Homer Hill #154	F-HH #154 - Carrs Corners Switch Tap (NYSEG)	115
T1170-3 Tap	Falconer - Homer Hill #154	F-HH #154 – Salamanca-Frank St. Tap	115
T1170-4 Tap	Falconer - Homer Hill #154	F-HH #154 – Salamanca-Rochester Tap	115
T1180	South Ripley-Erie #69	main line	230
T1260-1 Tap	Gardenville - Dunkirk #141	G-D #141 Martin Road Station 139 Tap	115
T1260-2 Tap	Gardenville - Dunkirk #141	G-D #141 Station 55 Tap	115
T1260-3 Tap	Gardenville - Dunkirk #141	G-D #141 Cloverbank Station 91Tap	115
T1260-4 Tap	Gardenville - Dunkirk #141	G-D #141 Shaleton Station 81 Tap	115
T1260-5 Tap	Gardenville - Dunkirk #141	G-D #141 Delameter Station 93 Tap	115
T1260-6 Tap	Gardenville - Dunkirk #141	G-D #141 North Angola Tap	115
T1260-7 Tap	Gardenville - Dunkirk #141	G-D #141 Silver Creek (NYSEG) Tap	115
T1270-1 Tap	Gardenville - Dunkirk #142	G-D #142 Martin Road Station 139 Tap	115
T1270-2 Tap	Gardenville - Dunkirk #142	G-D #142 Station 55 Tap	115
T1270-3 Tap	Gardenville - Dunkirk #142	G-D #142 Ford Tap	115
T1270-4 Tap	Gardenville - Dunkirk #142	G-D #142 Cloverbank Station 91Tap	115
T1270-5 Tap	Gardenville - Dunkirk #142	G-D #142 Delameter Station 93 Tap	115
T1270-6 Tap	Gardenville - Dunkirk #142	G-D #142 Bennett Road Station 99 Tap	115
T1270-7 Tap	Gardenville - Dunkirk #142	G-D #142 North Angola Tap	115
T1270-8 Tap	Gardenville - Dunkirk #142	G-D #142 Silver Creek (NYSEG) Tap	115
T1280-1 Tap	Gardenville - Homer Hill #152	G-HH #152 Springville Station Tap	115
T1280-2 Tap	Gardenville - Homer Hill #152	G-HH #152 Cobble Hill Tap	115
T1280-3 Tap	Gardenville - Homer Hill #152	G-HH #152 Machias Tap	115
T1280-4 Tap	Gardenville - Homer Hill #152	G-HH #152 Ischua Switch Tap	115
T1330	Hartfield - Moons Switches #159	main line	115
T1340	Homer Hill - Bennett Road #157	main line	115
T1340-1 Tap	Hartfield - Moons Switches #159	HH-BR #157 - Dugan Road Tap	115
T1340-2 Tap	Homer Hill - Bennett Road #157	HH-BR #157 - Wellsville Tap	115
T1350	Homer Hill - Dugan Road #155	main line	115
T1350-1 Tap	Homer Hill - Dugan Road #155	HH-DR #155 - West Olean Tap	115
T1350-2 Tap	Homer Hill - Dugan Road #155	HH-DR #155 - Cooper-Power Sys. Tap	115
T1360	Homer Hill - West Olean #156	main line	115

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T1360-1 Tap	Homer Hill - West Olean #156	HH-WO #156 - Dresser Tap	115
T1460	Homer Hill - Indeck Olean #166	main line	115
T1900	Valley (Station 44) - Ischua Switch #158	main line	115
T1910	Willowbrook Switch - Brigham #164	main line	115
T1950-1 Tap	Gardenville - Homer Hill #151	G-HH #151 Springville Station Tap	115
T1950-2 Tap	Gardenville - Homer Hill #151	G-HH #151 Cobble Hill Tap	115
T1950-3 Tap	Gardenville - Homer Hill #151	G-HH #151 Arcade Village (Muni) Tap	115
T1950-4 Tap	Gardenville - Homer Hill #151	G-HH #151 Machias Tap	115
T1950-5 Tap	Gardenville - Homer Hill #151	G-HH #151 Ischua Switch Tap	115
T6080	Falconer - Warren #171	main line	115
T6110	Homer City - Stolle Road#37	main line	345
T6450	Archade - Homer Hill #167	main line	115

The following transmission lines have portions in both the Southwestern and Frontier transmission study areas:

Transmission Lines			
Circuit ID	Circuit Name	Main Line / Tap Name	Voltage (kV)
T1240	Gardenville-Dunkirk #73	main line	230
T1250	Gardenville-Dunkirk #74	main line	230
T1260	Gardenville - Dunkirk #141	main line	115
T1270	Gardenville - Dunkirk #142	main line	115
T1280	Gardenville - Homer Hill #152	main line	115
T1950	Gardenville - Homer Hill #151	main line	115

Sub-Transmission Lines			
Circuit ID	From	To	Voltage (kV)
803	Dake Hill	Machias	34.5
801	Delvan	Machias	34.5
816	Dake Hill	West Salamanca	34.5
804	Cold Spring	West Salamanca	34.5
802	Machias	Maplehurst	34.5
817	North Ashford	Nuclear Fuels	34.5
815	Bagdad	Dake Hill	34.5
856	Shaleton	North Angola	34.5
857	North Angola	Bagdad	34.5
862	North Angola	Bagdad	34.5

861	North Angola	North Ashford	34.5
851	Dunkirk	West Portland	34.5
852	Dunkirk	Hartfield	34.5
866	West Portland	Hartfield	34.5
859	Hartfield	South Dow	34.5
867	West Portland	Sherman	34.5
855	Hartfield	Sherman	34.5
863	Sherman	Ashville	34.5
854	Hartfield	Ashville	34.5
865	South Dow	Poland	34.5
860	North Eden	Eden	34.5
805	West Salamanca	Homer Hill	34.5
809	Homer Hill	Ceres	34.5
811	Homer Hill	Nile	34.5
541	Andover	South Wellsville	34.5
812	Nile	South Wellsville	34.5

Exhibit 2 - Transmission Inspection and Maintenance Report
Calendar Years 2014 – 2016

Summary of Deficiencies and Repair Activity Resulting from the Inspection Process - Transmission

Transmission Facilities	2014				2015				2016			
Priority Level	I	II	III	Temp Repairs	I	II	III	Temp Repairs	I	II	III	Temp Repairs
Repair Expected	Within 1 week	Within 1 year	Within 3 years	Within 90 days	Within 1 week	Within 1 year	Within 3 years	Within 90 days	Within 1 week	Within 1 year	Within 3 years	Within 90 days
Towers/Poles												
Steel Towers												
Number of Deficiencies	0	18	123	0	0	2	100	0	1	3	75	0
Repaired in Time Frame	0	9	26	0	0	1	3	0	0	0	0	0
Repaired - Overdue	0	8	0	0	0	0	0	0	1	0	0	0
Not Repaired - Not Due	0	0	97	0	0	0	97	0	0	3	75	0
Not Repaired - Overdue	0	1	0	0	0	1	0	0	0	0	0	0
Poles												
Number of Deficiencies	0	326	1360	1	5	211	1593	0	3	110	1753	4
Repaired in Time Frame	0	226	175	1	5	138	113	0	3	35	9	0
Repaired - Overdue	0	84	0	0	0	13	0	0	0	0	0	0
Not Repaired - Not Due	0	0	1185	0	0	0	1480	0	0	75	1744	4
Not Repaired - Overdue	0	16	0	0	0	60	0	0	0	0	0	0
Anchors/Guy Wire												
Number of Deficiencies	0	18	223	0	1	17	228	0	0	20	331	0
Repaired in Time Frame	0	10	47	0	1	10	11	0	0	2	6	0
Repaired - Overdue	0	8	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	176	0	0	0	217	0	0	18	325	0
Not Repaired - Overdue	0	0	0	0	0	7	0	0	0	0	0	0
Crossarm/Brace												
Number of Deficiencies	1	21	135	0	1	15	127	1	1	18	213	0
Repaired in Time Frame	1	15	27	0	1	10	17	0	1	2	1	0
Repaired - Overdue	0	6	0	0	0	1	0	0	0	0	0	0
Not Repaired - Not Due	0	0	108	0	0	0	110	0	0	16	212	0
Not Repaired - Overdue	0	0	0	0	0	4	0	1	0	0	0	0
Grounding System												
Number of Deficiencies	0	15	394	0	2	91	432	0	0	16	309	0
Repaired in Time Frame	0	9	201	0	1	91	137	0	0	12	0	0
Repaired - Overdue	0	6	0	0	1	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	193	0	0	0	295	0	0	4	309	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Conductors												
Cable												
Number of Deficiencies	0	1	4	1	1	3	5	0	0	1	68	0
Repaired in Time Frame	0	1	0	1	0	2	0	0	0	1	0	0
Repaired - Overdue	0	0	0	0	1	1	0	0	0	0	0	0
Not Repaired - Not Due	0	0	4	0	0	0	5	0	0	0	68	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Static/Neutral												
Number of Deficiencies	0	8	22	1	0	2	9	0	0	6	19	0
Repaired in Time Frame	0	5	4	1	0	0	2	0	0	0	1	0
Repaired - Overdue	0	1	0	0	0	2	0	0	0	0	0	0
Not Repaired - Not Due	0	0	18	0	0	0	7	0	0	6	18	0
Not Repaired - Overdue	0	2	0	0	0	0	0	0	0	0	0	0
Insulators												
Number of Deficiencies	2	4	164	0	3	6	106	4	2	15	102	0
Repaired in Time Frame	2	1	24	0	3	3	2	4	0	1	0	0
Repaired - Overdue	0	3	0	0	0	1	0	0	2	0	0	0
Not Repaired - Not Due	0	0	140	0	0	0	104	0	0	14	102	0
Not Repaired - Overdue	0	0	0	0	0	2	0	0	0	0	0	0
Miscellaneous												
Right of Way Condition												
Number of Deficiencies	0	0	0	0	0	0	0	0	0	0	0	0
Repaired in Time Frame	0	0	0	0	0	0	0	0	0	0	0	0
Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Temporary Repairs												
Number of Temp Repairs	0	0	0	0	0	0	0	0	0	0	0	0
Repaired in Time Frame	0	0	0	0	0	0	0	0	0	0	0	0
Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Other												
Number of Deficiencies	7	76	31	0	2	9	64	2	0	14	39	0
Repaired in Time Frame	7	55	2	0	2	7	4	1	0	4	1	0
Repaired - Overdue	0	20	0	0	0	1	0	0	0	0	0	0
Not Repaired - Not Due	0	0	29	0	0	0	60	0	0	10	38	0
Not Repaired - Overdue	0	1	0	0	0	1	0	1	0	0	0	0

Transmission FacilitiesTotal												
Total												
Number of Deficiencies	10	487	2456	3	15	356	2664	7	7	203	2909	4
Repaired in Time Frame	10	331	519	3	13	262	298	6	4	58	20	0
Repaired - Overdue	0	136	0	0	2	21	0	0	3	0	0	0
Not Repaired - Not Due	0	0	1935	0	0	0	2366	0	0	139	2889	4
Not Repaired - Overdue	0	20	2	0	0	73	0	1	0	6	0	0

Exhibit 3 - Distribution Inspection and Maintenance Report
Calendar Years 2014 –2016

Summary of Deficiencies and Repair Activity Resulting from the Inspection Process - Distribution

Overhead Facilities	2014				2015				2016			
Priority Level	I	II	III	Temp Repairs	I	II	III	Temp Repairs	I	II	III	Temp Repairs
Repair Expected	Within 1 week	Within 1 year	Within 3 years	Within 90 days	Within 1 week	Within 1 year	Within 3 years	Within 90 days	Within 1 week	Within 1 year	Within 3 years	Within 90 days
Poles												
Pole Condition												
Number of Deficiencies	149	4195	4440	72	225	1717	7744	60	301	958	7903	41
Repaired in Time Frame	148	3915	1273	69	212	1626	966	51	287	255	147	29
Repaired - Overdue	1	252	0	3	13	72	0	6	14	0	0	8
Not Repaired - Not Due	0	0	3167	0	0	0	6778	0	0	703	7756	1
Not Repaired - Overdue	0	28	0	0	0	19	0	3	0	0	0	3
Grounding System												
Number of Deficiencies	72	7642	3383	1	243	3758	26985	49	344	4446	10618	0
Repaired in Time Frame	70	7248	2130	1	220	3666	9831	49	340	1268	1705	0
Repaired - Overdue	2	359	0	0	23	63	0	0	4	0	0	0
Not Repaired - Not Due	0	0	1253	0	0	0	17154	0	0	3178	8913	0
Not Repaired - Overdue	0	35	0	0	0	29	0	0	0	0	0	0
Anchors/Guy Wire												
Number of Deficiencies	8	1241	16970	34	2	405	13892	30	4	0	17759	20
Repaired in Time Frame	8	1024	6333	33	2	374	1421	26	4	0	270	14
Repaired - Overdue	0	209	0	1	0	30	0	3	0	0	0	0
Not Repaired - Not Due	0	0	10637	0	0	0	12471	0	0	0	17489	1
Not Repaired - Overdue	0	8	0	0	0	1	0	1	0	0	0	5
Cross Arm/Bracing												
Number of Deficiencies	41	491	188	8	48	417	811	15	87	0	2223	2
Repaired in Time Frame	40	478	62	8	48	413	174	13	87	0	194	1
Repaired - Overdue	1	11	0	0	0	4	0	2	0	0	0	1
Not Repaired - Not Due	0	0	126	0	0	0	637	0	0	0	2029	0
Not Repaired - Overdue	0	2	0	0	0	0	0	0	0	0	0	0
Riser												
Number of Deficiencies	4	3131	1072	7	5	1484	3324	1	14	0	5302	1
Repaired in Time Frame	4	2958	516	6	5	1428	325	0	14	0	98	1
Repaired - Overdue	0	158	0	0	0	47	0	1	0	0	0	0
Not Repaired - Not Due	0	0	556	0	0	0	2999	0	0	0	5204	0
Not Repaired - Overdue	0	15	0	1	0	9	0	0	0	0	0	0
Conductors												
Primary Wire/Broken Ties												
Number of Deficiencies	51	106	59	2	37	122	68	5	37	155	47	2
Repaired in Time Frame	51	93	23	2	37	118	6	3	37	55	1	1
Repaired - Overdue	0	12	0	0	0	2	0	1	0	0	0	0
Not Repaired - Not Due	0	0	36	0	0	0	62	0	0	100	46	1
Not Repaired - Overdue	0	1	0	0	0	2	0	1	0	0	0	0
Secondary Wire												
Number of Deficiencies	50	297	389	18	32	116	288	10	21	0	518	3
Repaired in Time Frame	50	285	189	18	29	103	33	8	21	0	3	2
Repaired - Overdue	0	9	0	0	3	7	0	1	0	0	0	1
Not Repaired - Not Due	0	0	200	0	0	0	255	0	0	0	515	0
Not Repaired - Overdue	0	3	0	0	0	6	0	1	0	0	0	0
Neutral												
Number of Deficiencies	0	0	0	0	0	0	0	0	0	0	0	0
Repaired in Time Frame	0	0	0	0	0	0	0	0	0	0	0	0
Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Insulators												
Number of Deficiencies	13	213	9	1	15	356	8	4	12	357	24	3
Repaired in Time Frame	12	206	2	1	15	350	0	3	12	140	1	0
Repaired - Overdue	1	6	0	0	0	4	0	0	0	0	0	1
Not Repaired - Not Due	0	0	7	0	0	0	8	0	0	217	23	0
Not Repaired - Overdue	0	1	0	0	0	2	0	1	0	0	0	2

Pole Equipment												
Transformers												
Number of Deficiencies	7	2575	2008	0	6	1890	3947	0	18	36	5833	0
Repaired in Time Frame	7	2373	928	0	6	1527	459	0	18	15	165	0
Repaired - Overdue	0	194	0	0	0	357	0	0	0	0	0	0
Not Repaired - Not Due	0	0	1080	0	0	0	3488	0	0	21	5668	0
Not Repaired - Overdue	0	8	0	0	0	6	0	0	0	0	0	0
Cutouts												
Number of Deficiencies	0	473	173	0	5	234	385	0	4	84	353	0
Repaired in Time Frame	0	453	51	0	5	217	36	0	4	19	12	0
Repaired - Overdue	0	13	0	0	0	10	0	0	0	0	0	0
Not Repaired - Not Due	0	0	122	0	0	0	349	0	0	65	341	0
Not Repaired - Overdue	0	7	0	0	0	7	0	0	0	0	0	0
Lightning Arrestors												
Number of Deficiencies	0	118	1997	0	0	266	1081	0	0	545	1578	0
Repaired in Time Frame	0	115	642	0	0	251	238	0	0	231	18	0
Repaired - Overdue	0	3	0	0	0	11	0	0	0	0	0	0
Not Repaired - Not Due	0	0	1355	0	0	0	843	0	0	314	1560	0
Not Repaired - Overdue	0	0	0	0	0	4	0	0	0	0	0	0
Other Equipment												
Number of Deficiencies	2	2217	1073	1	4	669	1961	1	4	154	3966	0
Repaired in Time Frame	2	2007	464	1	3	645	177	1	4	48	88	0
Repaired - Overdue	0	190	0	0	1	16	0	0	0	0	0	0
Not Repaired - Not Due	0	0	609	0	0	0	1784	0	0	106	3878	0
Not Repaired - Overdue	0	20	0	0	0	8	0	0	0	0	0	0
Miscellaneous												
Trimming Related												
Number of Deficiencies	16	0	0	0	118	0	0	0	67	0	0	0
Repaired in Time Frame	16	0	0	0	118	0	0	0	66	0	0	0
Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	1	0	0	0
Temporary Repairs												
Number of Temp Repairs	0	0	0	0	0	0	0	0	0	0	0	0
Repaired in Time Frame	0	0	0	0	0	0	0	0	0	0	0	0
Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Other												
Number of Deficiencies	0	1	0	0	0	0	0	0	0	0	0	0
Repaired in Time Frame	0	0	0	0	0	0	0	0	0	0	0	0
Repaired - Overdue	0	1	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Overhead Facilities Total												
Total												
Number of Deficiencies	413	22700	31758	143	740	11434	60494	174	913	6737	56181	72
Repaired in Time Frame	408	21155	13451	139	700	10718	14266	157	894	2432	2924	52
Repaired - Overdue	5	1417	0	4	40	623	0	17	19	0	0	11
Not Repaired - Not Due	0	0	18307	0	0	0	46228	0	0	4297	53257	1
Not Repaired - Overdue	0	128	0	0	0	93	0	0	0	8	0	8

Summary of Deficiencies and Repair Activity Resulting from the Inspection Process - Pad Mount Transformers												
Pad Mount Transformers	**2014**				**2015**				**2016**			
Priority Level	**I**	**II**	**III**	**Temp Repairs**	**I**	**II**	**III**	**Temp Repairs**	**I**	**II**	**III**	**Temp Repairs**
Repair Expected	**Within 1 week**	**Within 1 year**	**Within 3 years**	**Within 90 days**	**Within 1 week**	**Within 1 year**	**Within 3 years**	**Within 90 days**	**Within 1 week**	**Within 1 year**	**Within 3 years**	**Within 90 days**
Pad Mount Tansformers												
Damaged Structure												
Number of Deficiencies	9	167	0	0	17	129	0	0	17	245	0	0
Repaired in Time Frame	9	166	0	0	17	124	0	0	16	84	0	0
Repaired - Overdue	0	1	0	0	0	2	0	0	1	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	161	0	0
Not Repaired - Overdue	0	0	0	0	0	3	0	0	0	0	0	0
Damaged Equipment												
Number of Deficiencies	0	0	0	0	0	0	0	0	0	0	0	0
Repaired in Time Frame	0	0	0	0	0	0	0	0	0	0	0	0
Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Cable Condition												
Number of Deficiencies	0	0	0	0	0	0	0	0	0	0	0	0
Repaired in Time Frame	0	0	0	0	0	0	0	0	0	0	0	0
Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Oil Leak												
Number of Deficiencies	6	124	0	0	5	123	0	0	13	93	0	1
Repaired in Time Frame	6	120	0	0	5	120	0	0	12	21	0	1
Repaired - Overdue	0	2	0	0	0	1	0	0	1	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	72	0	0
Not Repaired - Overdue	0	2	0	0	0	2	0	0	0	0	0	0
Off Pad												
Number of Deficiencies	21	154	0	8	25	184	0	0	17	181	0	0
Repaired in Time Frame	21	152	0	8	25	175	0	0	17	72	0	0
Repaired - Overdue	0	1	0	0	0	7	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	109	0	0
Not Repaired - Overdue	0	1	0	0	0	2	0	0	0	0	0	0
Lock/Latch/Penta												
Number of Deficiencies	0	0	0	0	0	0	0	0	0	0	0	0
Repaired in Time Frame	0	0	0	0	0	0	0	0	0	0	0	0
Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous												
Temporary Repairs												
Number of Temp Repairs	0	0	0	0	0	0	0	0	0	0	0	0
Repaired in Time Frame	0	0	0	0	0	0	0	0	0	0	0	0
Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Other												
Number of Deficiencies	0	0	0	0	0	0	0	0	0	0	0	0
Repaired in Time Frame	0	0	0	0	0	0	0	0	0	0	0	0
Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Pad Mount Total												
Total												
Number of Deficiencies	36	445	0	8	47	436	0	0	47	519	0	1
Repaired in Time Frame	36	438	0	8	47	419	0	0	45	242	0	1
Repaired - Overdue	0	4	0	0	0	10	0	0	2	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	277	0	0
Not Repaired - Overdue	0	3	0	0	0	7	0	0	0	0	0	0

Summary of Deficiencies and Repair Activity Resulting from the Inspection Process - Streetlights												
Overhead Facilities	**2014**				**2015**				**2016**			
Priority Level	I	II	III	Temp Repairs	I	II	III	Temp Repairs	I	II	III	Temp Repairs
Repair Expected	Within 1 week	Within 1 year	Within 3 years	Within 90 days	Within 1 week	Within 1 year	Within 3 years	Within 90 days	Within 1 week	Within 1 year	Within 3 years	Within 90 days
Streetlight												
Base/Standard/Light												
Number of Deficiencies	0	132	7	0	4	204	2	0	0	124	0	0
Repaired in Time Frame	0	131	0	0	2	193	0	0	0	4	0	0
Repaired - Overdue	0	1	0	0	2	7	0	0	0	0	0	0
Not Repaired - Not Due	0	0	7	0	0	0	2	0	0	120	0	0
Not Repaired - Overdue	0	0	0	0	0	4	0	0	0	0	0	0
Handhole/Service Box												
Number of Deficiencies	0	0	0	0	0	0	0	0	0	0	0	0
Repaired in Time Frame	0	0	0	0	0	0	0	0	0	0	0	0
Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Service/Internal Wiring												
Number of Deficiencies	0	0	0	0	5	1	0	0	0	0	0	0
Repaired in Time Frame	0	0	0	0	0	0	0	0	0	0	0	0
Repaired - Overdue	0	0	0	0	5	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Overdue	0	0	0	0	0	1	0	0	0	0	0	0
Access Cover												
Number of Deficiencies	0	0	11	0	0	0	17	0	0	0	33	0
Repaired in Time Frame	0	0	0	0	0	0	1	0	0	0	0	0
Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	11	0	0	0	16	0	0	0	33	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous												
Temporary Repairs												
Number of Temp Repairs	0	0	0	0	0	0	0	0	0	0	0	0
Repaired in Time Frame	0	0	0	0	0	0	0	0	0	0	0	0
Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Other												
Number of Deficiencies	0	8	0	0	0	9	0	0	0	32	0	0
Repaired in Time Frame	0	4	0	0	0	1	0	0	0	0	0	0
Repaired - Overdue	0	0	0	0	0	0	0	0	0	0	0	0
Not Repaired - Not Due	0	0	0	0	0	0	0	0	0	32	0	0
Not Repaired - Overdue	0	4	0	0	0	8	0	0	0	0	0	0
Streetlight Total												
Total												
Number of Deficiencies	0	140	18	0	9	214	19	0	0	156	33	0
Repaired in Time Frame	0	135	0	0	2	194	1	0	0	4	0	0
Repaired - Overdue	0	1	0	0	7	7	0	0	0	0	0	0
Not Repaired - Not Due	0	0	18	0	0	0	18	0	0	152	33	0
Not Repaired - Overdue	0	4	0	0	0	13	0	0	0	0	0	0