



## **Asset Renewal**

The Asset Management Department is focused on the life cycle management of ATC's transmission assets. The objective is to ensure assets perform the required function in a sustainable manner while managing life cycle cost.

Coordination of design, commissioning, operation, maintenance and replacement strategy is crucial to achieve this objective. Asset Renewal is the "replacement strategy" piece of the asset life cycle. Asset Renewal is driven by public and worker safety, regulatory compliance, reliability and operational performance.

The ATC Asset Renewal plan captures the balance between life cycle cost and reliable performance of the ATC transmission system. ATC's Asset Renewal plan calls for an estimated spend of \$1.2 billion over the 10-year plan horizon.

## **State of Existing Facilities**

ATC operates 769 lines with a total of 9494 circuit miles. A number of facilities have been identified as nearing end of life or having components at end of life during the 10 year assessment period.

ATC benchmarks its transmission line performance with 14 transmission operators across the United States. This sample comprises 30 percent of the United States/Canadian transmission grid based upon NERC bulk power line mileage. ATC line reliability remained a top performer in 2013 Transmission Reliability Composite Score (TACS) highlighted by "Best in Class" for 100-161kV, "Top Decile" for 345-500kV and "Top Quartile" for 69kV voltage classes. The TACS computation contains 5 years of age-weighted outage data, with approximately 80% of weight on the most recent 2 years. As evidenced by reliability data, our lines are performing well. However, targeted investment will be required to maintain reliability.

ATC operates a fleet of 186 in service transformers, with approximately 40 percent of these being more than 35 years old. Fortunately, ATC has not experienced a high failure rate of these aging transformers but the assessment anticipates that ongoing investment is required to maintain reliability and manage operational and financial risk.

ATC's protective relay systems are critical to the safe and reliable operation of the transmission system. The plan is to modernize the relay systems to meet compliance requirements, improve reliability, minimize inadvertent operation, and provide additional information to ATC System Operations to improve restoration time when an outage does occur.

ATC has a fleet of 2065 circuit breakers in service. Of these, 1554 use sulfur hexafluoride (SF<sub>6</sub>) as an arc quenching and insulating medium. There are 507 oil circuit breakers and 4 vacuum circuit breakers. Asset Renewal, as applied to circuit breakers will target units that have specific reliability and performance concerns and SF<sub>6</sub> circuit breakers with environmental concerns.



## **Transmission Line Asset Renewal**

### ***Overhead Transmission Line Facilities***

The Asset Maintenance group of ATC monitors the overhead line facilities through a maintenance and inspection program designed to assess the condition of line facilities. Aerial and ground inspections of ATC facilities are performed periodically to identify issues for repair. The goal is to maintain reliable performance as well as public and worker safety. ATC System Operations and Asset Management personnel monitor performance and track the reliability of all ATC lines. Particular attention is paid to lightning withstand performance and improvements that can be targeted at poor performing lines. The inspection and reliability performance programs are considered the initial drivers for asset renewal upgrades to a facility. The line design is further analyzed by Asset Management for structural and clearance-related issues to complete the list of possible drivers.

ATC has responded to the NERC Alert for Facilities Ratings and has completed a three year assessment program to verify the actual field conditions match design assumptions for line facilities rated 115kV and above. Aerial surveys and other engineering analysis means were used to evaluate line facility ratings. Beyond the NERC Alert, ATC is planning to confirm as-built conditions of the 69kV system and the Bulk Electric Facilities not included in the NERC Alert.

Transmission line facilities categorized to have inadequate condition or poor operational performance history are brought to ATC Planning for consideration. Planning may have specific system reliability needs for the line or geographic area. If Planning and Asset Management both have drivers for a project, a primary need driver is agreed upon and the project progresses as either a network (Planning driven) or asset renewal (Asset Management driven) project. The scope of the Asset Renewal project can vary from complete rebuilds to replacements of problematic components such as poles, cross arms or insulators. The extent of renewal driven work may be further impacted by importance of the line to the end customer. Net present value (NPV) analysis is used to evaluate various options and determine the least cost means of obtaining the desired reliability.

Details of the line asset renewal plan are shown in Table AR-1.

### ***Underground Transmission Line Asset Renewal***

Our underground transmission system consists of high pressure fluid filled cable systems (HPFF), High Pressure Gas Filled cable systems (HPGF), XLPE or EPR insulated solid dielectric cable (SD) systems and self-contained fluid filled system (SCFF).

<b>Cable Type</b>	<b>69-kV Mileage</b>	<b>115 &amp; 138-kV Mileage</b>
High Pressure Fluid Filled (HPFF)	24.7	53.75
High Pressure Gas Filled (HPGF)	0	3.4
Solid Dielectric (SD)	10.3	4.8



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Self-Contained Fluid Filled (SCFF), Submarine	0.3	8.2
Total Miles	35.4	70.2

The condition of high pressure fluid and high pressure gas filled systems is such that no investment is expected in the 10-year horizon. Several of the solid dielectric cable installations are approaching end of life and will require replacement over the 10 year horizon.

Details of the line asset renewal plan are shown in Table AR-2.

### **Instrument Transformer and Surge Arrester Renewal**

Instrument transformers used for monitoring voltages and currents on the ATC system are key to reliable performance. The goal of asset renewal efforts is to manage maintenance costs and avoid end of life failures on the ATC system. Instrument transformers at end of life or with poor operational history are targeted for replacement.

Arresters are installed to prevent outages and protect equipment from lightning and over voltage surges. The goal of asset renewal efforts is to manage maintenance costs and avoid end of life failures on the ATC system. Arresters at end of life or with poor operational history are targeted for replacement.

Please refer to Table AR-3 for details.

### **Relay Asset Renewal**

Relays are the cornerstone of a reliable transmission system. The goal of the ATC relay asset renewal effort is to improve relay performance, provide information for Operations, and reduce maintenance cost. ATC is able to improve line and equipment capabilities with microprocessor based relays by eliminating over-reaching misoperations and increasing capacity load limits. The improved performance of the microprocessor relays allows ATC to address stability issues and increase system reliability and security with the use of carrier and fiber optic communication systems. The new technology has additional benefits of better factory support, improved spare part availability, software upgrades and technical support to ATC staff.

Microprocessor based relays offer valuable information for ATC Operations. New relay systems are able to be used to direct field resources to the problem area and verify what component of the transmission system has failed. Additionally, fault location information is used with the geographic lightning detection network to correlate lightning strikes with line outages. This enables ATC to historically track performance of specific sections of the line to aid in determining transmission line Asset Renewal prioritization.

Relay renewals are being made to satisfy NERC reliability standard requirements and recommendations from the Florida blackout.



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The self-check and remote monitoring capabilities of microprocessor based relays allow longer maintenance cycles and reduce maintenance costs.

Approximately 10,735 in service relays protect the ATC network. The asset renewal program is prioritized by replacing the least reliable relays by type, relays at end-of-life and, relays with schemes that have a history of inadvertent operations. This includes single relays that require remote back-up and electromechanical relays that do not provide fault location or self-alarm.

ATC plans renew about 50 relay panels per year in the 10 year horizon. Please refer to Table AR-4 for details.

### **Circuit Breaker Asset Renewal**

Circuit breakers are essential to the reliability and safety of the network. ATC has a fleet of 2065 gas, oil, and vacuum circuit breakers. The goal of the circuit breaker renewal program is to improve reliability and environmental performance. This includes reducing maintenance outage requirements and reducing the number of unplanned outages. Please refer to Table AR-5 for details.

### **Power Transformer Asset Renewal and Sparing Strategy**

The intent of the ATC power transformer asset renewal program is to make an assessment of each transformer in the fleet based upon health, operational importance and the probability of failure. This assessment is used to determine a spare or renewal strategy. The strategy options are either an on-site spare, system wide spare that can be relocated to replace the failed transformer, or renewal replacement for the subject transformer. ATC has a spare transformer plan and also participates in an industry spare equipment program.

- Healthy units with high importance and high probabilities of failure based on age may warrant an on-site spare or a system spare in the general area to minimize transport times.
- Units in poor health with high importance are candidates for renewal.
- Healthy units with low importance will be backed up with a system wide spare.
- Units in poor health and low importance will be backed up with a system wide spare.

The operational importance of a particular transformer to the transmission network is based upon a series of planning studies that look at the severity of the contingencies following the failure of the specific transformer. Given the high cost, specialty design and logistical challenges of moving a large power transformer, double-contingency studies provide guidance for the operation impact and prioritization.



# 10-Year Assessment

An annual report summarizing proposed additions and expansions to ensure electric system reliability.

2014

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Power transformer condition is monitored as part of the asset maintenance program through off-line electrical tests, visual inspection and tracking of maintenance history. On line tests include dissolved-gas-analysis-oil tests, infrared inspection, vibration analysis and partial discharge condition assessment.

The expected investment to maintain reliability will require replacement of approximately two 138/69-kV transformers per year and one 345/138-kV transformer every two years in the 10-year horizon. Actual replacement of a specific transformer in the fleet will be based on the results of the ATC condition monitoring program and assessments of importance captured in the ATC Transformer Health Index. Please refer to Table AR-6 for details.

*Table AR-1*  
*Transmission System Additions – Asset Renewal Line Work*

<b>System Additions</b>	<b>Projected In-Service Year</b>	<b>Planning Zone</b>	<b>Need Category</b>
Partial Rebuild Castle Rock - Hilltop (ALTE) 69kV Y39	2014	1	Improve condition and increase reliability performance of existing line
Rebuild Wautoma - Montello 69-kV line Y17	2016	1	Improve condition and increase reliability performance of existing line
Rebuild North Point - Rocky Run 115-kV line T-20	2019 (P)	1	Improve condition and increase reliability performance of existing line
Rebuild Whiting Avenue-Plover 115-kV line B-106	2019 (P)	1	Improve condition and increase reliability performance of existing line
Rebuild Wautoma - Harrison 69-kV line Y19	2020 (P)	1	Improve condition and increase reliability performance of existing line
Partial rebuild Coyne - Saratoga 115-kV line T-72	2020 (P)	1	Improve condition and increase reliability performance of existing line
Partial rebuild Petenwell - Saratoga 138-kV line X-43	2020 (P)	1	Improve condition and increase reliability performance of existing line
Partial rebuild Coyne - Plover 115-kV line J-114	2020 (P)	1	Improve condition and increase reliability performance of existing line
Rebuild Lincoln Pump Sta. - Chaffee Creek 69-kV line Y18	2021 (P)	1	Improve condition and increase reliability performance of existing line
Rebuild West Wisconsin Rapids – Sigel 69-kV line Y45	2021 (P)	1	Improve condition and increase reliability performance of existing line
Rebuild Wautoma – Chaffee Creek 69-kV line Y49	2021 (P)	1	Improve condition and increase reliability performance of existing line
Rebuild Lincoln Pump Sta. - McKenna 69-kV line Y145	2023 (P)	1	Improve condition and increase reliability performance of existing line
Rebuild McKenna - Castle Rock 69-kV line Y47	2023 (P)	1	Improve condition and increase reliability performance of existing line
Re-insulate Sawyer - Gwinn 69-kV line (Sawyer line)	2014	2	Improve condition and increase reliability performance of existing line
Re-insulate Munising - Gwinn 69-kV line (Autrain line) – Double circuited portion with Munising 138	2015	2	Improve condition and increase reliability performance of existing line
Partial rebuild Pine River-Hiawatha 69-kV line ESE_6908	2015	2	Improve condition and increase reliability performance of existing line
Partial rebuild Munising-Gwinn 69-kV line (Autrain line) – Single circuit portion	2017	2	Improve condition and increase reliability performance of existing line



*Table AR-1  
Transmission System Additions – Asset Renewal Line Work (Continued)*

<b>System Additions</b>	<b>Projected In-Service Year</b>	<b>Planning Zone</b>	<b>Need Category</b>
Re-insulate Portage - 9 Mile 69-kV lines 6901/6902	2023 (P)	2	Improve condition and increase reliability performance of existing lines
Partial rebuild Conover-Mass 69-kV line 6530	2023 (P)	2	Improve condition and increase reliability performance of existing line
Partial rebuild Powers-Chalk Hill 69-kV line 6910	2023 (P)	2	Improve condition and increase reliability performance of existing line
Rebuild Paddock – Shaw 69kV 69-kV line Y54	2014	3	Improve condition and increase reliability performance of existing line
Rebuild Eden - Hillman 69-kV line Y105	2015	3	Improve condition and increase reliability performance of existing line
Re-route/Rebuild Prairie du Sac Dam Crossing, Dam Heights - Dane 69-kV line Y8	2015	3	Improve condition and increase reliability performance of existing line
Rebuild Rubicon - Concord 138-kV line 9061	2016	3	Improve condition and increase reliability performance of existing line
Rebuild Rubicon - Butler Ridge 138-kV line RUBG11	2016	3	Improve condition and increase reliability performance of existing line
Rebuild Butler Ridge - Hartford 138-kV line HTFG51	2016	3	Improve condition and increase reliability performance of existing line
Rebuild Portage - Dam Heights 69-kV line Y16	2017	3	Improve condition and increase reliability performance of existing line
Rebuild Boscobel - Lone Rock 69-kV line Y124	2018	3	Improve condition and increase reliability performance of existing line
Rebuild South Beaver Dam - Horicon 69-kV line Y134	2020 (P)	3	Improve condition and increase reliability performance of existing line
Rebuild Darlington – Hillman 138-kV line X14	2023 (P)	3	Improve condition and increase reliability performance of existing line
Rebuild South Fond Du Lac SW YD – Spring Brook Road 69-kV line Y133	2023 (P)	3	Improve condition and increase reliability performance of existing line
Rebuild Sheepskin – Stoughton 69-kV line Y12	2023 (P)	3	Improve condition and increase reliability performance of existing line
Rebuild Academy – Columbus 69-kV line Y21	2023 (P)	3	Improve condition and increase reliability performance of existing line

*Table AR-1  
Transmission System Additions – Asset Renewal Line Work (Continued)*

<b>System Additions</b>	<b>Projected In-Service Year</b>	<b>Planning Zone</b>	<b>Need Category</b>
Rebuild Lost Dauphin – Glenview 69-kV line F-6	2014	4	Improve condition and increase reliability performance of existing line
Partial Rebuild North Appleton – Kewaunee SW YD 345kV R-304	2015	4	Improve condition and increase reliability performance of existing line
Rebuild Sawyer - Dyckesville 69-kV line DYKY21	2016	4	Improve condition and increase reliability performance of existing line
Rebuild Butte des Morts - North Appleton 138-kV line 6853	2017	4	Improve condition and increase reliability performance of existing line
Rebuild Goodman - Caldron Falls 69-kV line J-88	2019 (P)	4	Improve condition and increase reliability performance of existing line
Partial rebuild Howard - Pulliam 138-kV line D-82	2019 (P)	4	Improve condition and increase reliability performance of existing line
Rebuild Neevin - Butte Des Morts 138-kV line 43021	2021 (P)	4	Improve condition and increase reliability performance of existing line
Rebuild Pioneer - Sobieski 69-kV line E-83 Tap	2021 (P)	4	Improve condition and increase reliability performance of existing line
Rebuild Sobieski - Bayport 69-kV line T-98	2021 (P)	4	Improve condition and increase reliability performance of existing line
Rebuild Sunset Point-Mears - Woodenshoe - Neevin 138-kV lines A-79, MCRG21 and 80952	2021 (P)	4	Improve condition and increase reliability performance of existing line
Rebuild Danz - Finger Road 69-kV line L-64	2022 (P)	4	Improve condition and increase reliability performance of existing line
Rebuild Finger Road - Highway V 69-kV line U-47	2022 (P)	4	Improve condition and increase reliability performance of existing line
Rebuild Highway V - Oak Street 69-kV line Z-26	2022 (P)	4	Improve condition and increase reliability performance of existing line
Rebuild Custer - New Holstein 69-kV line P-68	2022 (P)	4	Improve condition and increase reliability performance of existing line
Rebuild Manrap - Wesmark 69-kV line R-44	2022 (P)	4	Improve condition and increase reliability performance of existing line



*Table AR-1*  
*Transmission System Additions – Asset Renewal Line Work (Continued)*

<b>System Additions</b>	<b>Projected In-Service Year</b>	<b>Planning Zone</b>	<b>Need Category</b>
Rebuild Finger Road SW STA – Wesmark 69-kV line FIRY11	2022 (P)	4	Improve condition and increase reliability performance of existing line
Rebuild Finger Road – Canal 69-kV line J-10	2023 (P)	4	Improve condition and increase reliability performance of existing line
Rebuild Albers - Paris 138-kV line 3124	2015	5	Improve condition and increase reliability performance of existing line
Rebuild Cooney - Concord 138-kV line 9042	2015	5	Improve condition and increase reliability performance of existing line
Partial rebuild Summit - Merrill Hills 138-kV line 3551	2015	5	Improve condition and increase reliability performance of existing line
Partial rebuild Merrill Hills - Waukesha 138-kV line 7021	2016	5	Improve condition and increase reliability performance of existing line
Rebuild Hartford - St. Lawrence 138-kV line 8031	2016	5	Improve condition and increase reliability performance of existing line
Rebuild St. Martins - Edgewood 138-kV line 3013	2017	5	Improve condition and increase reliability performance of existing line
Rebuild and add breaker on Edgewood - Mukwonago 138-kV line 671K61	2017	5	Improve condition and increase reliability performance of existing line
Rebuild Oak Creek SW YD – Hayes 138-kV line 811	2019 (P)	5	Improve condition and increase reliability performance of existing line
Rebuild Summit -Cooney 138-kV line 6431	2021 (P)	5	Improve condition and increase reliability performance of existing line
Rebuild Paris – Burlington 138-kV line 8962	2021 (P)	5	Improve condition and increase reliability performance of existing line
Rebuild St. Lawrence – Barton 138-kV line 8032	2022 (P)	5	Improve condition and increase reliability performance of existing line
Rebuild Barton – Auburn 138-kV line 9752	2022 (P)	5	Improve condition and increase reliability performance of existing line

(P) – indicates the project is Provisional in status

*Table AR-2*  
*Asset Renewal Underground Line Work*

<b>System Additions</b>	<b>Projected In-Service Year</b>	<b>Planning Zone</b>	<b>Need Category</b>
West Middleton – Stage Coach line 6927	2020	3	Improve condition and increase reliability performance of existing line
Redwood – First Ave line T-46	2020	4	Improve condition and increase reliability performance of existing line
Danz Ave – University (WPS) line O-15	2023	4	Improve condition and increase reliability performance of existing line
Lodestar – Erdman line X-48	2021	4	Improve condition and increase reliability performance of existing line
Edgewater – Erdman line Y-31	2022	4	Improve condition and increase reliability performance of existing line

*Table AR-3*  
*Asset Renewal Instrument Transformer and Arrester Replacements*

<b>System Upgrade</b>	<b>Projected In-Service Year</b>	<b>Voltage</b>	<b>Planning Zone</b>	<b>Need Category</b>
Replace Instrument Transformers and Arresters	2014	various	various	Improve condition, reliability
Replace Instrument Transformers and Arresters	2015	various	various	Improve condition, reliability
Replace Instrument Transformers and Arresters	2016	various	various	Improve condition, reliability
Replace Instrument Transformers and Arresters	2017	various	various	Improve condition, reliability
Replace Instrument Transformers and Arresters	2018	various	various	Improve condition, reliability
Replace Instrument Transformers and Arresters	2019	various	various	Improve condition, reliability
Replace Instrument Transformers and Arresters	2020	various	various	Improve condition, reliability
Replace Instrument Transformers and Arresters	2021	various	various	Improve condition, reliability
Replace Instrument Transformers and Arresters	2022	various	various	Improve condition, reliability
Replace Instrument Transformers and Arresters	2023	various	various	Improve condition, reliability

*Table AR-4*  
*Asset Renewal Relay Replacements*

<b>System Upgrade</b>	<b>Projected In-Service Year</b>	<b>Voltage</b>	<b>Planning Zone</b>	<b>Need Category</b>
Replace 67 Relay Panels	2014	various	various	Improve condition, reliability
Replace 65 Relay Panels	2015	various	various	Improve condition, reliability
Replace 60 Relay Panels	2016	various	various	Improve condition, reliability
Replace 60 Relay Panels	2017	various	various	Improve condition, reliability
Replace 50 Relay Panels	2018	various	various	Improve condition, reliability
Replace 50 Relay Panels	2019	various	various	Improve condition, reliability
Replace 50 Relay Panels	2020	various	various	Improve condition, reliability
Replace 50 Relay Panels	2021	various	various	Improve condition, reliability
Replace 50 Relay Panels	2022	various	various	Improve condition, reliability
Replace 50 Relay Panels	2023	various	various	Improve condition, reliability

*Table AR-5  
Asset Renewal Circuit Breakers*

System Additions	Projected In-Service Year	Planning Zone	Need Category
Circuit breaker replacements	2014	Various	End of life, parts obsolescence (6 units) 138 kV
Circuit breaker replacements	2014	Various	Mechanism design issues (9 units) 69 kV
Circuit breaker replacements	2014	Various	Type U Bushings (4 units) 138kV
Circuit breaker replacements	2014	3	Type U Bushings (1 unit) 69kV
Circuit breaker replacements	2014	5	Over duty rating (1 unit) 138 kV
Circuit breaker replacements	2014	5	Thermal rating (1 unit) 138 kV
Circuit breaker replacements	2015	Various	Mechanism design issues (7 units) 69 kV
Circuit breaker replacements	2015	Various	End of life, parts obsolescence (10 units) 69 kV
Circuit breaker replacements	2015	Various	Type U Bushings (2 units) 69kV
Circuit breaker replacements	2015	Various	End of life, parts obsolescence (11 units) 138 kV
Circuit breaker replacements	2015	4	Type U Bushings (3 units) 138kV

*Table AR-5  
Asset Renewal Circuit Breakers (continued)*

<b>System Additions</b>	<b>Projected In-Service Year</b>	<b>Planning Zone</b>	<b>Need Category</b>
Circuit breaker replacements	2015	4	Bushing flange oil leak (4 units) 345 kV
Circuit breaker replacements	2016	Various	Mechanism design issues (9 units) 69 kV
Circuit breaker replacements	2016	Various	End of life, parts obsolescence (3 units) 69 kV
Circuit breaker replacements	2016	Various	End of life, parts obsolescence (3 units) 138 kV
Circuit breaker replacements	2016	3	Bushing flange oil leak (3 units) 345 kV
Circuit breaker replacements	2017	Various	Mechanism design issues (7 units) 69 kV
Circuit breaker replacements	2017	Various	End of life, parts obsolescence (6 units) 69 kV
Circuit breaker replacements	2017	Various	End of life, parts obsolescence (9 units) 138 kV
Circuit breaker replacements	2018-2023	Various	Mechanism design issues (12 units) 69 kV
Circuit breaker replacements	2018-2023	Various	End of life, parts obsolescence (38 units) 69 kV
Circuit breaker replacements	2018-2023	Various	Mechanism design issues (3 units) 138 kV



*Table AR-5*  
*Asset Renewal Circuit Breakers (continued)*

<b>System Additions</b>	<b>Projected In-Service Year</b>	<b>Planning Zone</b>	<b>Need Category</b>
Circuit breaker replacements	2018-2023	Various	End of life, parts obsolescence (37 units) 138 kV
Circuit breaker replacements	2018-2023	Various	Bushing flange oil leak (13 units) 345 kV
Circuit breaker replacements	2018-2023	Various	End of life, parts obsolescence (7 units) 345 kV

*Table AR-6  
Asset Renewal Transformer Replacements*

<b>System Upgrade</b>	<b>Projected In-Service Year</b>	<b>Voltage</b>	<b>Planning Zone</b>	<b>Need Category</b>
Plains T8 and T9	2014-5	138/69-kV	2	Improve condition, reliability
Arnett T31	2016	138/69-kV	1	Improve condition, reliability
Sunset Point T1	2016	138/69-kV	4	Improve condition, reliability
Replace two transformers	2017	138/69-kV	various	Improve condition, reliability
Replace one transformer	2017	345/138-kV	various	Improve condition, reliability
Replace two transformers	2018	138/69-kV	various	Improve condition, reliability
Replace two transformers	2019	138/69-kV	various	Improve condition, reliability
Replace one transformer	2019	345/138-kV	various	Improve condition, reliability
Replace two transformers	2020	138/69-kV	various	Improve condition, reliability
Replace two transformer	2021	138/69-kV	various	Improve condition, reliability
Replace one transformer	2021	345/138-kV	various	Improve condition, reliability
Replace two transformer	2022	138/69-kV	various	Improve condition, reliability
Replace two transformer	2023	138/69-kV	various	Improve condition, reliability
Replace one transformer	2023	345/138-kV	various	Improve condition, reliability