



10-Year Assessment

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

2017

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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 \$ 1.4 billion over the 10-year plan horizon.

State of Existing Facilities

ATC operates 784 lines with a total of 9540 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.

Due in large part to our asset management efforts, our reliability has remained best-in-class in several industry benchmarking studies. For 2016, we scored in the top decile for 69-kV and 100-kV to 161-kV performance and 1st quartile for 345- to 500-kV performance with our peer transmission operators.

ATC operates a fleet of 223 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 operates a fleet of 9440 protective relays. 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 2190 circuit breakers in service. Of these, 1773 use sulfur hexafluoride (SF₆) as an arc quenching and insulating medium. There are 416 oil circuit breakers and 1 vacuum circuit breaker. Asset Renewal, as applied to circuit breakers will target units that have specific reliability and performance concerns and SF₆ circuit breakers with environmental concerns.



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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 a multi-year assessment program to verify the actual field conditions match design assumptions for line and substation facilities. Aerial surveys and other engineering analysis means were used to evaluate line facility ratings.

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 an 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.



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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).

Cable Type	69-kV Mileage	115,138 & 161-kV Mileage
High Pressure Fluid Filled (HPFF)	24.7	53.8
High Pressure Gas Filled (HPGF)	0	3.4
Solid Dielectric (SD)	10.4	7.0
Self-Contained Fluid Filled (SCFF), Submarine	0.3	8.2
Total Miles	35.3	72.0

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 in conjunction with other capital work at the station.

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



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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 which 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.

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

Approximately 9440 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 50-60 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 2190 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.



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Power Transformer Asset Renewal and Sparing Strategy

The intent of the ATC power transformer asset renewal program is to make a risk 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, or a proactive 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 operational impact and prioritization.

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.

Control Buildings

Control buildings contain the protective relaying and control components of the substation including relays, SCADA, AC/DC sources and batteries. Life cycle of a building is estimated at 50 years. Consideration of replacement is given at times of major work in the control building. Major work may include relay renewal or substation expansion. Economies are gained if the control building is



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replaced when new relaying or a building expansion is required. The new building design may also be a cost effective upgrade to physical security at the site.

Please refer to [Table AR-7](#) for details.

Remote Terminal Units (RTUs)

The RTUs provide the interface between the substation equipment and the Energy Management System (EMS) for remote monitoring and control of ATC substation facilities. The RTUs provide a communication link between all intelligent electronic devices in the substation and the EMS. Thus allowing the Operators to monitor all data in the substation. These equipment data links are also important to the Asset Management group by providing real time equipment data like; dissolved gas, GIC values, harmonic values and other equipment data. This data allows the Operators and Asset Management to operate the system and monitor performance of important substation assets.

The RTU asset renewal program is prioritized by replacing the older least reliable RTUs with modern equipment that can meet ATC's ever increasing communication and security needs. The program will replace the obsolete hardware followed by replacing hardware with slow speed processors. With the upgrades, the station alarms will be modified to meet the current ATC standard.

ATC plans to renew about 18 RTUs panels per year in the 10 year horizon.

Please refer to [Table AR-8](#) for details.

Physical Security

ATC has developed a risk based physical security program to address the risk of physical attack. The program is designed to provide increased resiliency for intentional attacks and weather events. Substations and facilities have been prioritized and evaluated for importance to the bulk electric system. Implementation has begun and build out will take place over the next ten years.