



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 at the lowest 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 lowest whole life cycle cost and reliable performance of the ATC transmission system. ATC's Asset Renewal plan calls for an estimated spend of \$1.1 billion over the 10-year plan horizon.

State of Existing Facilities

ATC operates 2392 lines with a total of 9426 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 24 transmission operators across the United States. This sample comprises 44.4 percent of the United States/Canadian transmission grid based upon NERC bulk power line mileage. ATC lines operating at 115, 138, and 345kV were top 10 percent for reliability performance in 2011. ATC 69-kV transmission lines were top 25 percent for reliability performance in 2011. As evidenced by reliability data, our lines are performing well. However, targeted investment will be required to maintain reliability.

ATC operates a fleet of 196 in service transformers, with approximately 45 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 an ongoing routine 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 1962 circuit breakers in service. Of these, 1368 use sulfur hexafluoride (SF₆) as an arc quenching and insulating medium. There are 590 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 SF₆ circuit breakers with environmental concerns.

Transmission Line Asset Renewal

Overhead Transmission Line Facilities



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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 is in a three year program to verify the actual field conditions match design assumptions for line facilities rated 115kV and above. Aerial surveys and other engineering analysis means are being 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 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 whole life cost means of obtaining the desired reliability.

Details of the line asset renewal plan are shown in Table AR-1. The estimated cost of the plan over the 10 year horizon is \$ 523 million.

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), solid dielectric cable (SD) systems and self-contained fluid filled system (SCFF).

Cable Type	69-kV Mileage	138-kV Mileage
High Pressure Fluid Filled (HPFF)	24.7	56.3
High Pressure Gas Filled (HPGF)	0	3.4
Solid Dielectric (SD)	10.3	4.7



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Self-Contained Fluid Filled (SCFF)	0.4	8.2
Total Miles	35.4	72.6

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. The self-contained fluid filled cables located in the Straits of Mackinac that connect Upper and Lower Michigan are expected to reach end of life near the end of the 10-year horizon.

Details of the line asset renewal plan are shown in Table AR-2. The estimated cost of the plan over the 10 year horizon is \$ 150 million.

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 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 poor operational history are targeted for replacement. .

The cost estimate for this program over the 10 year horizon is \$51 million. 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



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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.

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

Approximately 11,000 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 to spend approximately \$ 106 million for relay renewal in the 10 year horizon. This equates to about 50 relay panels per year. 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 1962 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, reducing SF₆ emissions, and reducing the number of unplanned outages. ATC plans to spend approximately \$ 61 million on the circuit breaker fleet over the 10 year horizon. Please refer to Table AR-5 for details.

Power Transformer Asset Renewal

The intent of the ATC power transformer asset renewal program is to make an assessment of each transformer in the fleet based upon condition, operational importance and the probability of failure based on age. 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 of the aged transformer. ATC has a spare transformer plan where 20 ATC owned units are available. ATC 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 regardless of age.



10-Year Assessment

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

2012

2012 10-Year Assessment www.atc10yearplan.com

- Healthy units with low importance will be backed up with a system wide spare regardless of age.
- Units in poor health and low importance will be backed up with system spares regardless of age.

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.

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.

A fleet approach has been taken to estimate the investment in the 10-year horizon and for consideration in determining the number of system spares. The fleet approach uses a curve that represents 50 percent of transformers will fail by age 50 years. A probability of failure for each unit is determined from the curve and aggregated for each year in the 10-year horizon. The expected investment to maintain this existing level of 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. The cost estimate for this program over the 10 year horizon is \$127 million. 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. Please refer to Table AR-6 for details.

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

System Additions	Projected In-Service Year	Planning Zone	Need Category
Re-insulate Winneconne - Berlin 69-kV line Y-80	2013	1	Improve condition and increase reliability performance of existing line
Rebuild North Point - Rocky Run 115-kV line T-20	2016	1	Improve condition and increase reliability performance of existing line.
Rebuild Wautoma - Montello 69-kV line Y17	2017	1	Improve condition and increase reliability performance of existing line
Rebuild Whiting Avenue-Plover 115-kV line B-106	2019	1	Improve condition and increase reliability performance of existing line
Partial rebuild Coyne - Saratoga 115-kV line T-72	2020	1	Improve condition and increase reliability performance of existing line
Partial rebuild Petenwell - Saratoga 138-kV line X-43	2020	1	Improve condition and increase reliability performance of existing line
Partial rebuild Coyne - Plover 115-kV line J-114	2020	1	Improve condition and increase reliability performance of existing line
Partial rebuild Roberts - 9 Mile 69-kV line 6952	2012	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	2012	2	Improve condition and increase reliability performance of existing line
Partial rebuild Munising-Gwinn 69-kV line (Autrain line) – Single circuit portion	2013	2	Improve condition and increase reliability performance of existing line
Rebuild Atlantic - M38 69-kV line (Atlantic 69 line)	2013	2	Improve condition and increase reliability performance of existing line
Re-insulate Portage - 9 Mile 69-kV lines 6901/6902	2014	2	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
Partial rebuild Rexton-Hiawatha 69-kV line ESE_6908	2015	2	Improve condition and increase reliability performance of existing line

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

System Additions	Projected In-Service Year	Planning Zone	Need Category
Partial rebuild Blaney Park-Munising 69-kV line (Inland line)	2016	2	Improve condition and increase reliability performance of existing line
Partial rebuild Conover-Mass 69-kV line 6530	2018	2	Improve condition and increase reliability performance of existing line
Partial rebuild Powers-Chalk Hill 69-kV line 6910	2018	2	Improve condition and increase reliability performance of existing line
Rebuild Doylestown - Rio Pumping station 69-kV line Y20	2013	3	Improve condition and increase reliability performance of existing line
Rebuild Russell - McCue 138kV X-22	2013	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 Darlington - Hillman 138-kV X-14	2016	3	Improve condition and increase reliability performance of existing line
Rebuild Portage - Dam Heights 69-kV line Y16	2016	3	Improve condition and increase reliability performance of existing line
Rebuild Eden - Hillman 69-kV line Y105	2018	3	Improve condition and increase reliability performance of existing line
Rebuild Boscobel - Lone Rock 69-kV line Y-124	2018	3	Improve condition and increase reliability performance of existing line
Rebuild Colley Road – Brick Church 69-kV line Y-32	2022	3	Improve condition and increase reliability performance of existing line
Shield wire replacement Stiles - Pulliam 138-kV lines KK64441-64451	2013	4	Improve condition and increase reliability performance of existing line

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

System Additions	Projected In-Service Year	Planning Zone	Need Category
Partial Rebuild North Appleton – Butte des Morts 345kV R-304	2015	4	Improve condition and increase reliability performance of existing line
Rebuild Sawyer - Dykesville 69-kV line DYKY21	2016	4	Improve condition and increase reliability performance of existing line
Rebuild Pioneer - Sobieski 69-kV line E-83 Tap	2018	4	Improve condition and increase reliability performance of existing line
Rebuild Sobieski - Bayport 69-kV line T-98	2018	4	Improve condition and increase reliability performance of existing line
Rebuild Highway V - Oak Street 69-kV line Z-26	2018	4	Improve condition and increase reliability performance of existing line
Rebuild Danz - Finger Road 69-kV line L-64	2018	4	Improve condition and increase reliability performance of existing line
Rebuild Finger Road - Highway V 69-kV line U-47	2018	4	Improve condition and increase reliability performance of existing line
Rebuild Custer - New Holstein 69-kV line P-68	2019	4	Improve condition and increase reliability performance of existing line
Rebuild Goodman - Caldron Falls 69-kV line J-88	2019	4	Improve condition and increase reliability performance of existing line
Partial rebuild Howard - Pulliam 138-kV line D-82	2019	4	Improve condition and increase reliability performance of existing line
Rebuild Neevin - Butte Des Morts 138-kV line 43021	2020	4	Improve condition and increase reliability performance of existing line
Rebuild Manrap - Wesmark 69-kV line R-44	2020	4	Improve condition and increase reliability performance of existing line
Rebuild Sunset Point-Mears-Woodenshoe-Neevin 138-kV lines A-79, MCRG21 and 80952	2020	4	Improve condition and increase reliability performance of existing line
Rebuild Butte des Morts - North Appleton 138-kV line 6853	2020	4	Improve condition and increase reliability performance of existing line
Rebuild Finger Road – Canal 69-kV line J-10	2020	4	Improve condition and increase reliability performance of existing line

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

System Additions	Projected In-Service Year	Planning Zone	Need Category
Shield wire replacement Tosa - Butler 138-kV line 5061	2013	5	Improve condition and increase reliability performance of existing line
Shield wire replacement Tosa - Bluemound 138-kV line 5041	2013	5	Improve condition and increase reliability performance of existing line
Shield wire replacement Butler - Tower#4291 138kV line 3443	2013	5	Improve condition and increase reliability performance of existing line
Rebuild Hartford - St. Lawrence 138-kV line 8031	2014	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 Merrill Hills - Waukesha 138-kV line 7021	2015	5	Improve condition and increase reliability performance of existing line
Rebuild Albers - Paris 138-kV line 3124	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
Partial rebuild Summit - Merrill Hills 138-kV line 3551	2017	5	Improve condition and increase reliability performance of existing line
Rebuild Oak Creek SW YD – Hayes 138-kV line 811	2019	5	Improve condition and increase reliability performance of existing line
Rebuild Summit -Cooney 138-kV line 6431	2021	5	Improve condition and increase reliability performance of existing line
Rebuild Paris – Burlington 138-kV line 8962	2021	5	Improve condition and increase reliability performance of existing line
Rebuild St. Lawrence – Barton 138-kV line 8032	2022	5	Improve condition and increase reliability performance of existing line

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

System Additions	Projected In-Service Year	Planning Zone	Need Category
Rebuild Barton – Auburn 138-kV line 9752	2022	5	Improve condition and increase reliability performance of existing line

*Table AR-2
Asset Renewal Underground Line Work*

System Additions	Projected In-Service Year	Planning Zone	Need Category
Nine Mile – Three Mile line ESE6903	2015	2	Improve condition and increase reliability performance of existing line
Straits – Mc Gulpin line 9901	2020	2	Improve condition and increase reliability performance of existing line
Straits – Mc Gulpin line 9903	2020	2	Improve condition and increase reliability performance of existing line
West Middleton – Stage Coach line 6927	2019	3	Improve condition and increase reliability performance of existing line
Redwood – First Ave line T-46	2015	4	Improve condition and increase reliability performance of existing line
Danz Ave – University (WPS) line O-15	2017	4	Improve condition and increase reliability performance of existing line
Lodestar – Erdman line X-48	2019	4	Improve condition and increase reliability performance of existing line
Edgewater – Erdman line Y-31	2021	4	Improve condition and increase reliability performance of existing line

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

System Upgrade	Projected In-Service Year	Voltage	Planning Zone	Need Category
Replace Instrument Transformers and Arresters	2012	various	various	Improve condition, reliability
Replace Instrument Transformers and Arresters	2013	various	various	Improve condition, reliability
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

*Table AR-4
Asset Renewal Relay Replacements*

System Upgrade	Projected In-Service Year	Voltage	Planning Zone	Need Category
Replace 40 Relay Panels	2012	various	various	Improve condition, reliability
Replace 66 Relay Panels	2013	various	various	Improve condition, reliability
Replace 67 Relay Panels	2014	various	various	Improve condition, reliability
Replace 65 Relay Panels	2015	various	various	Improve condition, reliability
Replace 65 Relay Panels	2016	various	various	Improve condition, reliability
Replace 65 Relay Panels	2017	various	various	Improve condition, reliability
Replace 65 Relay Panels	2018	various	various	Improve condition, reliability
Replace 65 Relay Panels	2019	various	various	Improve condition, reliability
Replace 65 Relay Panels	2020	various	various	Improve condition, reliability
Replace 65 Relay Panels	2021	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	2012	Various	End of life, parts obsolescence (4 units) 69 kV
Circuit breaker replacements	2012	Various	Type U bushings (37 units) 69 kV
Circuit breaker replacements	2012	Various	Ratings (6 units) 69 kV
Circuit breaker replacements	2012	Various	Mechanism design issues (1 units) 69kV
Circuit breaker replacements	2012	Various	Type U Bushings (9 units) 138kV
Circuit breaker replacements	2012	Various	Planning stability issues (3 units) 138 KV
Circuit breaker replacements	2012	Various	Ratings (3 units) 138kV
Circuit breaker replacements	2013	Various	Type U Bushings (12 units) 69kV
Circuit breaker replacements	2013	Various	Planning stability issues (1 units) 69 KV
Circuit breaker replacements	2013	Various	Type S bushings (1 unit) 69 kV
Circuit breaker replacements	2013	Various	Type U Bushings (4 units) 138kV

*Table AR-5
Transmission System Additions – Asset Renewal Circuit Breakers (continued)*

System Additions	Projected In-Service Year	Planning Zone	Need Category
Circuit breaker replacements	2013	Various	End of life, part obsolescence (6 units) 138 kV
Circuit breaker replacements	2013	Various	EPA SF6 emission reduction (7units) 345 kV
Circuit breaker replacements	2014	Various	End of life, parts obsolescence (7 units) 138 kV
Circuit breaker replacements	2014	Various	Mechanism design issues (11 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	2015	4	Mechanism design issues (7 units) 69 kV
Circuit breaker replacements	2015	4	End of life, parts obsolescence (1 units) 69 kV
Circuit breaker replacements	2015	Various	End of life, parts obsolescence (6 units) 138 kV
Circuit breaker replacements	2015	4	Bushing flange oil leak (4 units) 345 kV

*Table AR-5
Transmission System Additions – Asset Renewal Circuit Breakers (continued)*

System Additions	Projected In-Service Year	Planning Zone	Need Category
Circuit breaker replacements	2016-2021	Various	Mechanism design issues (23 units) 69 kV
Circuit breaker replacements	2016-2021	Various	End of life, parts obsolescence (6 units) 69 kV
Circuit breaker replacements	2016-2021	Various	Mechanism design issues (3 units) 138 kV
Circuit breaker replacements	2016-2021	Various	End of life, parts obsolescence (7 units) 138 kV
Circuit breaker replacements	2016-2021	Various	Bushing flange oil leak (21 units) 345 kV
Circuit breaker replacements	2016-2021	Various	End of life, parts obsolescence (8 units) 345 kV

*Table AR-6
Asset Renewal Transformer Replacements*

System Upgrade	Projected In-Service Year	Voltage	Planning Zone	Need Category
Bluemound T1	2012	230/138-kV	5	Improve condition, reliability
Edgewater T31 and T32	2013	138/69-kV	4	Improve condition, reliability
Atlantic T1	2013	138/69-kV	2	Improve condition, reliability
Plains T8 and T9	2014	138/69-kV	2	Improve condition, reliability
Lancaster T31	2015	138/69-kV	3	Improve condition, reliability
Replace one transformer	2015	138/69-kV	various	Improve condition, reliability
Arnott T31	2015	138/69-kV	1	Improve condition, reliability
Replace two transformers	2016	138/69-kV	various	Improve condition, reliability
Highway V T1 and T2	2017	138/69-kV	4	Improve condition, reliability
North Appleton T3	2017	345/138-kV	4	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