

Circuit Breaker, Oil, 66 kV and Above							
Component Classification Categories							
Criticality	I	X				Nuclear Switchyards ≥ 220kV as defined in the respective Nuclear Plant Interface Requirements (NPIRs).	
	III		X				DC, SS, TDC, TSS locations that serve O'Hare & Midway Airports
	IV			X			All other 66kV and above locations
Duty Cycle	Heavy Load	N/A	N/A	N/A	N/A		
	Normal Load	N/A	N/A	N/A	N/A		
Service Condition	In Service	X	X	X	N/A		
	Spare	N/A	N/A	N/A	X	Designated spare equipment*	
Condition Monitoring Tasks				Failure Codes		Comments	
Check Red (Closed) Indicating Lamp	5W	5W	10W	N/A	2a-b		
Monitor Compressor Run Time	5W	5W	10W	N/A	1f	Where meters installed	
Visual Inspection	5W	5W	10W	10W	1e-f, 2e-f, 3a, 3g-h, 5b-c, 6a-e, 7b		
Oil Quality Test	1Y	3Y	3Y	3Y	3b, 5d	Applicable to designated spare breakers, if stored outdoors in substation yards.	
Thermography	1Y	1Y	1Y	N/A	4a-b		
Contact Resistance (Ductor) Test	4Y	4Y	4Y	N/A	1d, 4a		
Power Factor Test	4Y	4Y	4Y	N/A	5a-b, 5e, 5g		
Travel Test	4Y	4Y	4Y	N/A	1e, 2e, 3g		
Time Directed Tasks				Failure Codes		Comments	
Drain Air Receiver Moisture	5W	5W	10W	N/A	1f, 2f, 3h		
Compressor Maintenance	2Y	2Y	2Y	N/A	1f, 2f, 3h		
Exercise Mechanism	4Y	4Y	4Y	N/A	1a, 1e, 2a-c, 2e, 3c, 3g		
Mechanism Lubrication / Maintenance	4Y	4Y	4Y	N/A	1a-c, 1e-f, 2a-c, 2e-f, 3c-e, 3g-h, 7b		
Pressurized Vessel Inspection	3Y	AR	AR	N/A	6b, 6c	Schedule driven by Certificate renewal date for each breaker.	
Internal Inspection	12Y	AR	AR	N/A	1d-e, 2d-e, 3f-g, 4a, 5e, 5g	Nuclear Switchyards ONLY- NEIL Standard 2.2.4.14.1.5 requires a complete internal inspection, as defined by the OEM, not to exceed a 12-year interval for oil breakers associated with GSU, aux and start-up transformers. For GSU, it applies to the first breaker(s) out from the transformer to the switchyard. For aux and start-up transformers it applies to the last breaker to the transformer from the switchyard. The cost differential for performing this work on the shorter frequency will be borne by Nuclear Generation.	
Pilot and Control Valve Refurbishment	12Y	AR	AR	AR	1f, 2f, 3h		
Mechanism Refurbishment	24Y	AR	AR	AR	1e, 2e		
Bushing Test Tap Assembly Replacement	24Y	AR	AR	AR	5b, 5c	Applicable to Westinghouse Circuit Breakers with Type O Bushings only.	
Failure Finding Tasks				Failure Codes		Comments	
Check Control Cabinet Heaters	5W	5W	10W	10W	1b, 1f, 2b, 2f, 3d, 3h, 7b-c	Applicable to designated spare breakers, if stored outdoors in substation yards.	
Check of Gauges and Pressure Switches	4Y	4Y	4Y	N/A	1f, 2f, 3h, 7a		
Functional Alarm Test	4Y	4Y	4Y	N/A	7a-d		
Textolite Sleeve Bearing Wear	4Y	4Y	4Y	N/A	1e, 2e	GE Type FK only; as applicable	
Condition Directed Tasks				Failure Codes		Comments	
None	N/A	N/A	N/A	N/A			

* **Designated Spare Equipment** that is covered by this PM program is defined as circuit breakers placed in long-term, outdoor storage in substation yards and designated for use as replacements for breakers in previously defined applications or positions. Examples of equipment excluded from this PM program are: breakers stored for ongoing or future projects or installations, breakers removed from service and retired on-site, and breakers stored temporarily to be re-delivered to other locations.

Circuit Breaker, Oil, 34 kV						
Component Classification Categories						
Duty Cycle	I	X				DC, SS, TDC, TSS locations that serve O'Hare & Midway Airports
	II		X			Locations exclusive of Cricatality I, DC and ≤34kV ESS locations
	III			X		DC locations
	IV				X	≤34kV ESS locations
	Heavy Load	N/A	N/A	N/A	N/A	
Service Condition	Normal Load	N/A	N/A	N/A	N/A	
	In Service	X	X	X	X	
Condition Monitoring Tasks		Failure Codes				Comments
Check Red (Closed) Indicating Lamp	5W	10W	3M	6M	2a-b	
Monitor Compressor Run Time	5W	10W	3M	6M	1f	Where meters installed
Visual Inspection	5W	10W	3M	6M	1e-f, 2e-f, 3a, 3g-h, 5b-c, 6a-e, 7b	
Oil Quality Test	3Y	3Y	3Y	3Y	3b, 5d	
Thermography	1Y	1Y	1Y	4Y	4a-b	
Contact Resistance (Ductor) Test	3Y	3Y	3Y	3Y	1d, 4a	
Power Factor Test	3Y	3Y	3Y	3Y	5a-b, 5e, 5g	
Travel Test	3Y	3Y	3Y	3Y	1e, 2e, 3g	
Time Directed Tasks		Failure Codes				Comments
Drain Air Receiver Moisture	5W	10W	3M	6M	1f, 2f, 3h	
Compressor Maintenance	2Y	2Y	2Y	2Y	1f, 2f, 3h	
Exercise Mechanism	3Y	3Y	3Y	3Y	1a, 1e, 2a-c, 2e, 3c, 3g	
Mechanism Lubrication / Maintenance	3Y	3Y	3Y	3Y	1a-c, 1e-f, 2a-c, 2e-f, 3c-e, 3g-h, 7b	
Pressurized Vessel Inspection	3Y	AR	AR	AR	6b, 6c	Schedule driven by Certificate renewal date for each breaker.
Internal Inspection	AR	AR	AR	AR	1d-e, 2d-e, 3f-g, 4a, 5e, 5g	
Failure Finding Tasks		Failure Codes				Comments
Check Control Cabinet Heaters	5W	10W	3M	6M	1b, 1f, 2b, 2f, 3d, 3h, 7b-c	
Check of Gauges and Pressure Switches	3Y	3Y	3Y	3Y	1f, 2f, 3h, 7a	
Functional Alarm Test	3Y	3Y	3Y	3Y	7a-d	
Condition Directed Tasks		Failure Codes				Comments
None	N/A	N/A	N/A	N/A		

OIL BREAKER FAILURE MODES

FAILURE MODE	FAILURE CAUSES	MAINTENANCE TASKS
1. Fails to Close	1a. Close Coil Failure	Exercise Mechanism
1. Fails to Close	1a. Close Coil Failure	Mechanism Lubrication / Maintenance
1. Fails to Close	1b. Control Circuit Failure	Check Control Cabinet Heaters
1. Fails to Close	1b. Control Circuit Failure	Mechanism Lubrication / Maintenance
1. Fails to Close	1c. Lack of Lubrication	Mechanism Lubrication / Maintenance
1. Fails to Close	1d. Interrupter Failure	Contact Resistance (Ductor) Test
1. Fails to Close	1d. Interrupter Failure	Internal Inspection
1. Fails to Close	1e. Mechanical/Linkage Failure	Travel Test
1. Fails to Close	1e. Mechanical/Linkage Failure	Visual Inspection
1. Fails to Close	1e. Mechanical/Linkage Failure	Mechanism Refurbishment
1. Fails to Close	1e. Mechanical/Linkage Failure	Textolite Sleeve Bearing Wear
1. Fails to Close	1e. Mechanical/Linkage Failure	Exercise Mechanism
1. Fails to Close	1e. Mechanical/Linkage Failure	Mechanism Lubrication / Maintenance
1. Fails to Close	1e. Mechanical/Linkage Failure	Internal Inspection
1. Fails to Close	1f. Stored Energy Failure	Visual Inspection
1. Fails to Close	1f. Stored Energy Failure	Monitor Compressor Run Time
1. Fails to Close	1f. Stored Energy Failure	Check of Gauges and Pressure Switches
1. Fails to Close	1f. Stored Energy Failure	Drain Air Receiver Moisture
1. Fails to Close	1f. Stored Energy Failure	Compressor Maintenance
1. Fails to Close	1f. Stored Energy Failure	Check Control Cabinet Heaters
1. Fails to Close	1f. Stored Energy Failure	Pilot / Control Valve Refurbishment
1. Fails to Close	1f. Stored Energy Failure	Mechanism Lubrication / Maintenance
2. Fails to Open	2a. Open Coil Failure	Check Red (Closed) Indication Lamp
2. Fails to Open	2a. Open Coil Failure	Exercise Mechanism
2. Fails to Open	2a. Open Coil Failure	Mechanism Lubrication / Maintenance
2. Fails to Open	2b. Control Circuit Failure	Check Control Cabinet Heaters
2. Fails to Open	2b. Control Circuit Failure	Check Red (Closed) Indication Lamp
2. Fails to Open	2b. Control Circuit Failure	Exercise Mechanism
2. Fails to Open	2b. Control Circuit Failure	Mechanism Lubrication / Maintenance
2. Fails to Open	2c. Lack of Lubrication	Mechanism Lubrication / Maintenance
2. Fails to Open	2c. Lack of Lubrication	Exercise Mechanism
2. Fails to Open	2d. Interrupter Failure	Internal Inspection
2. Fails to Open	2e. Mechanical/Linkage Failure	Travel Test
2. Fails to Open	2e. Mechanical/Linkage Failure	Mechanism Refurbishment
2. Fails to Open	2e. Mechanical/Linkage Failure	Visual Inspection
2. Fails to Open	2e. Mechanical/Linkage Failure	Textolite Sleeve Bearing Wear
2. Fails to Open	2e. Mechanical/Linkage Failure	Exercise Mechanism

OIL BREAKER FAILURE MODES

FAILURE MODE	FAILURE CAUSES	MAINTENANCE TASKS
2. Fails to Open	2e. Mechanical/Linkage Failure	Mechanism Lubrication / Maintenance
2. Fails to Open	2e. Mechanical/Linkage Failure	Internal Inspection
2. Fails to Open	2f. Stored Energy Failure	Visual Inspection
2. Fails to Open	2f. Stored Energy Failure	Check of Gauges and Pressure Switches
2. Fails to Open	2f. Stored Energy Failure	Drain Air Receiver Moisture
2. Fails to Open	2f. Stored Energy Failure	Compressor Maintenance
2. Fails to Open	2f. Stored Energy Failure	Check Control Cabinet Heaters
2. Fails to Open	2f. Stored Energy Failure	Pilot / Control Valve Refurbishment
2. Fails to Open	2f. Stored Energy Failure	Mechanism Lubrication / Maintenance
3. Fails to Interrupt	3a. Loss of Oil	Visual Inspection
3. Fails to Interrupt	3b. Poor Oil Quality	Oil Quality Test
3. Fails to Interrupt	3c. Open Coil Failure	Profile Breaker Operation
3. Fails to Interrupt	3c. Open Coil Failure	Exercise Mechanism
3. Fails to Interrupt	3c. Open Coil Failure	Mechanism Lubrication / Maintenance
3. Fails to Interrupt	3d. Control Circuit Failure	Check Control Cabinet Heaters
3. Fails to Interrupt	3d. Control Circuit Failure	Mechanism Lubrication / Maintenance
3. Fails to Interrupt	3e. Lack of Lubrication	Mechanism Lubrication / Maintenance
3. Fails to Interrupt	3f. Interrupter Failure	Internal Inspection
3. Fails to Interrupt	3g. Mechanical/Linkage Failure	Visual Inspection
3. Fails to Interrupt	3g. Mechanical/Linkage Failure	Travel Test
3. Fails to Interrupt	3g. Mechanical/Linkage Failure	Exercise Mechanism
3. Fails to Interrupt	3g. Mechanical/Linkage Failure	Mechanism Lubrication / Maintenance
3. Fails to Interrupt	3g. Mechanical/Linkage Failure	Internal Inspection
3. Fails to Interrupt	3h. Stored Energy Failure	Visual Inspection
3. Fails to Interrupt	3h. Stored Energy Failure	Check of Gauges and Pressure Switches
3. Fails to Interrupt	3h. Stored Energy Failure	Drain Air Receiver Moisture
3. Fails to Interrupt	3h. Stored Energy Failure	Compressor Maintenance
3. Fails to Interrupt	3h. Stored Energy Failure	Pilot / Control Valve Refurbishment
3. Fails to Interrupt	3h. Stored Energy Failure	Check Control Cabinet Heaters
3. Fails to Interrupt	3h. Stored Energy Failure	Mechanism Lubrication / Maintenance
4. Fails to Provide Conductive Path	4a. High Resistance Connection	Contact Resistance (Ductor) Test
4. Fails to Provide Conductive Path	4a. High Resistance Connection	Internal Inspection
4. Fails to Provide Conductive Path	4a. High Resistance Connection	Thermography
4. Fails to Provide Conductive Path	4b. Bus Connections Failure	Thermography
5. Fails to Provide Adequate Insulation Level	5a. External Contamination	Power Factor Test

OIL BREAKER FAILURE MODES

FAILURE MODE	FAILURE CAUSES	MAINTENANCE TASKS
5. Fails to Provide Adequate Insulation Level	5b. Cracked/Broken Bushing	Power Factor Test
5. Fails to Provide Adequate Insulation Level	5b. Cracked/Broken Bushing	Bushing Test Tap Assembly Replacement
5. Fails to Provide Adequate Insulation Level	5b. Cracked / Broken Bushing	Visual Inspection
5. Fails to Provide Adequate Insulation Level	5c. Loss of Oil	Visual Inspection
5. Fails to Provide Adequate Insulation Level	5c. Loss of Oil	Bushing Test Tap Assembly Replacement
5. Fails to Provide Adequate Insulation Level	5d. Poor Oil Quality	Oil Quality Test
5. Fails to Provide Adequate Insulation Level	5e. Solid Dielectric Failure	Power Factor Test
5. Fails to Provide Adequate Insulation Level	5e. Solid Dielectric Failure	Internal Inspection
5. Fails to Provide Adequate Insulation Level	5g. Electrical Tracking of Operating Rod	Internal Inspection
5. Fails to Provide Adequate Insulation Level	5g. Electrical Tracking of Operating Rod	Power Factor Test
6. Fails to Maintain Boundary Integrity	6a. Gasket Failure	Visual Inspection
6. Fails to Maintain Boundary Integrity	6b. Weld Failure	Visual Inspection
6. Fails to Maintain Boundary Integrity	6b. Weld Failure	Pressurized Vessel Inspection
6. Fails to Maintain Boundary Integrity	6c. Tank Corrosion	Visual Inspection
6. Fails to Maintain Boundary Integrity	6c. Tank Corrosion	Pressurized Vessel Inspection
6. Fails to Maintain Boundary Integrity	6d. Loose Connections	Visual Inspection
6. Fails to Maintain Boundary Integrity	6e. Control Cabinet Contamination	Visual Inspection
6. Fails to Maintain Boundary Integrity	6f. Pressure Relief Valve Failure	Pressurized Vessel Inspection
7. Fails to Alarm	7a. Gauge / Pressure Switch Failure	Check of Gauges and Pressure Switches
7. Fails to Alarm	7a. Gauge / Pressure Switch Failure	Functional Alarm Test
7. Fails to Alarm	7b. Control Circuit Failure	Check Control Cabinet Heaters
7. Fails to Alarm	7b. Control Circuit Failure	Functional Alarm Test
7. Fails to Alarm	7b. Control Circuit Failure	Visual Inspection
7. Fails to Alarm	7b. Control Circuit Failure	Mechanism Lubrication / Maintenance
7. Fails to Alarm	7c. Aux Relay Failure	Check Control Cabinet Heaters
7. Fails to Alarm	7c. Aux Relay Failure	Functional Alarm Test
7. Fails to Alarm	7d. Scada Failure	Functional Alarm Test

OIL BREAKER MAINTENANCE TASK DEFINITIONS

TASK	DEFINITION
Bushing Test Tap Assembly Replacement	Replacement of Bushing Test Tap Assembly with associated seals on Westinghouse Circuit Breakers with Type O Bushings. The task is also performed As Required if evidence exists of the following at the Bushing Tap Assembly: arcing, excessive heating, degraded wear, oil leaking, and/or poor Bushing Power Factor (C2) results.
Check Control Cabinet Heaters	Visual / physical verification that cabinet heaters are operational.
Check of Gauges and Pressure Switches	Perform functional test of pressure switch pick up and drop out using the pressure gauge in the breaker control cabinet.
Check Red (Closed) Indicating Lamp	Verify red indicating lamp is lit on all closed breakers to ensure trip circuit continuity and control fuses.
Compressor Maintenance	Change compressor oil, replace air filter, check condition of belt and if needed replace, check alignment of motor and pulley. Drain air receiver down to verify compressor pick up and shut down. Measure and record time required for compressor to go from low limit to shut off.
Contact Resistance (Ductor) Test	Apply DC current (100 Amps DC) between terminals of equipment under test to measure current path resistance. Contact resistance testing is done prior to performing maintenance and after completion of maintenance. The as-found and as-left resistance values are used to verify maintenance effectiveness.
Drain Air Receiver Moisture	Purge condensed moisture from air compressor tank unless ambient temperature is below 40 deg F.
Exercise Mechanism	Open and close breaker electrically.
Functional Alarm Test	Verify alarm at breaker is sent to the substation control house and system operations. Test should be performed by bringing up an alarm at the equipment and verifying it is received in the substation control house and system operations.
Internal Inspection	Interrupting chamber inspection and refurbishment of contact and interrupting assemblies. Replacement of components, as required. Scope includes: -- Measure contact resistance across bushing terminals -- Measure contact engagement by performing a slow-close operation -- Measure resistance of voltage dividing resistors -- Check oil dashpots, over-travel stop clearances, pole unit lever system settings -- Check for loose or worn components -- Check for implementation of modifications based on OEM advisories Recommended spare parts should be obtained prior to inspections.
Mechanism Lubrication / Maintenance	Off-line detailed inspection of the operating mechanism. Checks include: -- Operate breaker from local and remote control -- Trip from manual trip device and check electrical interlocks -- Check solenoids, limit switches, dash pots, position indicators and counter for proper operation -- Verify all clearance dimensions (stops, latches, rollers, switches and links) -- Check wiring terminal blocks for tightness -- Check closing control and pilot valves for leaks -- Check for leaks in the operator -- Wipe and clean accessible linkages and wear points -- Apply approved lubricants to bearings and other specified areas on mechanism, including linkage wear points. Lubrication should not be added to sealed bearings.
Mechanism Refurbishment	Replacement of sealed bearings; cleaning and re-lubrication of other bearings. Detailed inspection of the mechanism for worn or damaged components. Check for implementation of modifications based on OEM advisories. Check for continuity across all operating switches and interlock switches. Check for continuity of all operating coils.
Monitor Compressor Run Time	If meter installed, observe and record cumulative compressor run time hours.

OIL BREAKER MAINTENANCE TASK DEFINITIONS

TASK	DEFINITION
Oil Quality Test	Take 1 jar sample for voltage class < 220 kV. Take 2 jar samples for voltage class >= 220 kV. Oil Quality Lab Analysis: The scope of testing includes Dielectric Strength (ASTM D877), Interfacial Tension (ASTM D971), Color (ASTM D1500), Sediment (ASTM D1698), Moisture Content (ASTM D1553) and Acid Number (ASTM D974). For Circuit Breakers outside of the Nuclear Switchyard: Interfacial Tension, Acid Number and Color are not required.
Pilot and Control Valve Refurbishment	Rebuild control pilot valve using available rebuild kit. Replace pilot valve if required.
Power Factor Test	Electrical loss measurement, usually performed using Doble power factor equipment, which helps to prove the insulating level of the device.
Pressurized Vessel Inspection	Periodic inspection and re-certification of operating pressure vessels, conducted by the State certified inspector at most substations or IDNS (IEMA) at nuclear sites in Illinois. Includes calibration or replacement of relief valve(s). Outside of Nuclear, performance of this task is driven by the State certified inspector's schedule and identified substation personnel are used to only provide escort.
Textolite Sleeve Bearing Wear	Inspection for excessive wear in the support and connecting sleeve bearings of the drive linkage from the operating mechanism to the individual phase lift rods. This should be checked using the maintenance closing device and a pry bar.
Thermography	Infrared inspection of electrical equipment and power path components to identify any hot spots that may exist either in the contacts, bus connections or within control cabinets. Comparisons should be made phase to phase or on tank walls to determine if contact heating can be found or to determine oil levels within all tanks and verify level gauge.
Travel Test	Measure and record the speed, timing, contact velocity and acceleration, contact penetration, contact rebound and sequence of operation during open, close and trip-free operations.
Visual Inspection	Visual assessment of the condition of the equipment. Items to check include: -- Check oil levels and air pressures are within specification -- Check/record operations counter -- Listen for air leakage or excessive compressor run time -- Verify mechanical position indicator for correct position and check operations counter -- Check mechanism cabinet for general cleanliness, evidence of moisture and signs of wildlife or insect infestation -- Check for signs of loose or worn parts in mechanism -- Check compressor oil level -- Check compressor belts for wear, tension and alignment -- Check cabinet door for degradation of the door seal and for proper operation of the door latch. Check interior components, wiring terminals and fuse holders for rust or corrosion. -- Check for proper grounding on breaker tank(s) and control cabinet(s) -- Ensure alarm cutouts are in proper configuration -- Check closing and trip solenoid coils for evidence of heating. Check closing contactors for cleanliness and heating or burning of contacts. -- Check for fluid leaks on hydraulic mechanisms.

OIL BREAKER MAINTENANCE BASIS

Oil Circuit Breaker Template Summary

The Preventive Maintenance program is documented via maintenance templates. Templates have been developed that address transmission, substation, and distribution equipment that is owned and maintained by Exelon Utilities. Each template documents the program tasks, frequencies, failure modes, and maintenance basis for the associated equipment. Tasks and associated frequencies are designed to address known failure modes of the equipment covered by the template. In general, the tasks included in the maintenance templates are the result of good industry practices, industry experience, and manufacturer recommendations.

References:

Internal reports and operating experience
OEM Maintenance Manuals and Interviews
EPRI 1001779 Guidelines for the Life Extension of Substations

Boundary Definition

The boundary of an oil circuit breaker is defined from bushing terminal to bushing terminal, including:

- Live parts and bushings
- Drive mechanism
- Compressor
- Control cabinet

Excluded from this treatment are: protective relays, DC supply, AC supply.

Failure Experience

Failures are subject to ACE/RCI investigation. Findings/recommended corrective actions are incorporated into the template as required.

Vendor Recommendations

OEM manuals were referenced and interviews conducted during the development of this template.

Disposition of Vendor Recommendations

Recommendations were incorporated into the template as appropriate based on operating experience.

OIL BREAKER MAINTENANCE BASIS

Basis For Template Tasks

Bushing Test Tap Assembly Replacement: Experience with Westinghouse Circuit Breaker with Type O Bushings shows a gradual wear of the internal seals of the Bushing Test Tap Assembly and the test tap itself, eventually leading to insulation breakdown. Replacement of the test tap assembly mitigates insulation breakdown within the receptacle.

Check Control Cabinet Heaters: Operation of the heaters assures that pilot valve, compressor and other components of the air handling system will operate even in sub-zero weather

Check of Gauges and Pressure Switches: Perform functional test as a tool for identifying problems with the various controls and indicators.

Check Red (Closed) Indicating Lamp: The red light is in series with the trip coil and when lit, indicates integrity of the trip circuit.

Compressor Maintenance: Routine maintenance of the compressor, per OEM recommendations, will ensure extended life of the machine. Failure of the compressor may adversely affect the pressure reduction fill valve when called upon to operate excessively.

Contact Resistance (Ductor) Test: Performed bushing terminal to bushing terminal. Measures increased resistance at connection points along the current conduction path. Used to diagnose, or determine, problems internal to the breaker that would require an inspection.

Drain Air Receiver Moisture: This task serves the dual purpose of maintaining dry air supply to the breaker air system as well as reducing internal corrosion of the air receiver tank walls.

Exercise Mechanism: This redistributes the lubricants in bearings and on other surfaces and prevents bearing set at pressure points.

Functional Alarm Test: Intent of this task is to verify that any alarm initiated by a device or sensor at the equipment results in a notification at the control building and/or at the control / operations center. Timely and appropriate response to abnormal equipment conditions is contingent on proper operation of the alarm systems.

OIL BREAKER MAINTENANCE BASIS

Internal Inspection: This task is intended to identify internal problems that may be developing and not identified through diagnostic testing.

Mechanism Lubrication / Maintenance: The mechanism of a circuit breaker is composed of multiple bearing and sliding surfaces that require periodic re-lubrication due to minimum movement of parts during breaker operation. CIGRE studies have concluded that the dominant failure mode of older style breakers is mechanism failure.

Mechanism Refurbishment: Task intended to rebuild mechanism to factory specifications.

Monitor Compressor Run Time: Applicable where run-time meters are installed. Run-time monitoring will enable early detection and proactive repair of air system leaks.

Oil Quality Test: IEEE Standard 62 C57.152 identifies oil quality tests as a tool for monitoring aging and condition of the insulating system. Oil quality tests provide indication of oil condition. The scope of testing includes: Dielectric Strength, Interfacial Tension, Color, Appearance (visual check for presence of sediment / contaminants), and moisture content, Acid Number. It is important to obtain the temperature of the equipment at the time of the sample to ensure accurate calculation of H₂O saturation. Outside of the Nuclear Switchyard: Interfacial Tension, and Color are not required as they're not prescribed by the Manufacturer.

Pilot / Control Valve Refurbishment: These devices contain "o" rings that have a finite life. Air leaks and misoperation due to "gumming up" of moveable parts are the frequent causes of emergent corrective maintenance for oil breakers on the Exelon system.

Power Factor Test: Power Factor test provides indication of insulation degradation and, in some instances, component failure. Scope of test should include bushings, capacitance tap, grading capacitors, operating rods and insulating oil. The test is intended to be performed as one overall system test of the circuit breaker with separate measurements performed on the bushings. The test is best applied as a trending tool.

Pressurized Vessel Inspection: Periodic inspection and re-certification of operating pressure vessels is required by state code. Calibration of the relief valve is required on breakers in nuclear switchyards in Illinois. It has been determined that it can be more cost effective and less risky to replace the in-service valve with a pre-calibrated valve.

OIL BREAKER MAINTENANCE BASIS

Textolite Sleeve Bearing Wear: Per vendor service advisory this applies to GE Type FK circuit breakers only.

Thermography: IEEE Standard 62 identifies thermography as a primary tool for detection of connection issues, bushing issues, and issues with the cooling systems.

Travel Test: Circuit breaker timing and travel test measures the speed and acceleration of breaker movable parts during open, close and trip-free operations. The test addresses failure modes associated with excessive unlatching friction, mechanism binding or contact friction, inadequate lubrication, improper spring adjustments, improper stop adjustments, worn contacts, malfunctioning shock absorbers or dashpots, excessive rebound or improper velocity through the arcing zone of operation.

Visual Inspection: This inspection approximates real-time condition monitoring that can detect developing problems and degradation, and provides condition data used to initiate corrective actions.

OIL BREAKER 34 kV and ABOVE TEMPLATE DEVELOPMENT HISTORY

Revision 0		Date 07/28/2015
Writer	Chris Stefanski (Exelon Utilities)	
Reviewer(s)	Ken Wendt, Greg Hitzke	
Approver(s)	Michael Moy (UFAM ComEd)	
Reason Written	Revised criticality definitions and modified document to serve as the ComEd maintenance standard.	

Revision 1		Date 11/04/2016
Writer	Hugo Castaneda (Material Condition)	
Reviewer(s)	Dale Player, Greg Hitzke, Tu Liang, Nitin Patel, Doug Mason	
Approver(s)	Michael Moy (UFAM ComEd)	
Reason Written	Updated document to reflect recommended changes from the EU Substation Breaker Process Assessment/Productivity Review. In addition, based on ComEd OE, added a time directed task to replace the Bushing Tap Assy, model specific, on Nuclear Switchyard Oil Circuit Breakers.	

Revision 2		Date 10/27/2017
Writer	Hugo Castaneda (ComEd Material Condition)	
Reviewer(s)	Dale Player (ComEd), Greg Hitzke (ComEd), Tu Liang (ComEd), Nitin Patel (ComEd), Ismael Rivera Jr (Dresden Nuclear Station Systems Engineer), Travis Greene (Byron Nuclear Station Systems Engineer), Sachin Shukla (Braidwood Nuclear Station Systems Engineer), Aaron Kulow (Quad Cities Nuclear Station Systems Engineer), Kent Nelson (LaSalle Nuclear Station Systems Engineer)	
Approver(s)	Michael Moy (UFAM ComEd)	
Reason Written	Revised to include new criticalities as defined in AM-CE-P034-R0001. In addition, the Oil Quality task detail and basis were updated to reflect manufacturer recommendation.	

Revision 3		Date 8/21/2019
Writer	Kevin Chamberlain (ComEd Material Condition)	
Reviewer(s)	Greg Hitzke, Tu Liang, Nitin Patel, Doug Mason, Richard Bellino, and Elizabeth Spolarich	
Approver(s)	Michael Moy (UFAM ComEd)	

OIL BREAKER 34 kV and ABOVE TEMPLATE DEVELOPMENT HISTORY

Reason Written	Revised to align with the updated revision of AM-EU-P034-R1006. Added Internal Inspection requirements for 34kV oil breakers. Updated Pilot and Control Valve refurbishment Task Definitions.
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