

Reclosers - Vacuum							
Component Classification Categories							
Criticality	I	X				DC, SS, TDC, TSS locations that serve O'Hare & Midway Airports	
	II		X			Locations exclusive of Criticality I, DC locations and ≤34kV ESS locations	
	III			X		DC locations	
	IV				X	≤34kV ESS 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	N/A	N/A	N/A	N/A		
	Spare	N/A	N/A	N/A	N/A		
Condition Monitoring Tasks							
	Task Frequencies				Failure Codes		Comments
Visual Inspection	5W	10W	3M	6M	1d-h, 2d-h, 3f-h, 4a, 5b-c, 6a-e		
Check Contact Erosion Wear Indicator	3Y	3Y	3Y	3Y	1d, 2d, 3f, 4a		3 phase recloser only
Inspect Operator Mechanism	3Y	3Y	3Y	3Y	1a, 1e-f, 2a, 2e-f, 6f		3 phase recloser only
Inspect Recloser Control Cabinet	3Y	3Y	3Y	3Y	1b, 2b, 6e		3 phase recloser only
Contact Resistance (Ductor) Test	3Y	3Y	3Y	3Y	1d, 2d, 3f, 4a		3 phase recloser only
Time Directed							
	Task Frequencies				Failure Codes		Comments
Mechanism Lubrication	3Y	3Y	3Y	3Y	1c, 2c, 3e		3 phase recloser only
Control Battery Replacement	3Y	3Y	3Y	3Y	1g, 2g		
Failure Finding Tasks							
	Task Frequencies				Failure Codes		Comments
Check Cabinet Heaters	5W	10W	3M	6M	1b, 1f, 2b, 2f, 3d		3 phase recloser only
Thermography	1Y	1Y	1Y	4Y	4a-b		
Functional Operations Check	3Y	3Y	3Y	3Y	1a, 1c, 1e-f, 2a-c, 2e-f, 3c, 3e, 3g		3 phase recloser only
Condition Directed Tasks							
	Task Frequencies				Failure Codes		Comments
None	N/A	N/A	N/A	N/A			

Reclosers - Oil							
Component Classification Categories							
Criticality	I	X					DC, SS, TDC, TSS locations that serve O'Hare & Midway Airports
	II		X				Locations exclusive of Criticality I, DC locations and ≤34kV ESS locations
	III			X			DC locations
	IV				X		≤34kV ESS 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	N/A	N/A	N/A	N/A		
	Spare	N/A	N/A	N/A	N/A		
Condition Monitoring Tasks		Task Frequencies				Failure Codes	Comments
Visual Inspection		5W	10W	3M	6M	1d-h, 2d-h, 3f-h, 4a, 5b-c, 6a-e	
Inspect Operator Mechanism		3Y	3Y	3Y	3Y	1a, 1e-f, 2a, 2e-f, 6f	
Inspect Recloser Control Cabinet		3Y	3Y	3Y	3Y	1b, 2b, 6e	
Oil Dielectric Test		3Y	3Y	3Y	3Y	5d	
Contact Resistance (Ductor) Test		3Y	3Y	3Y	3Y	1d, 2d, 3f, 4a	
Time Directed		Task Frequencies				Failure Codes	Comments
Mechanism Lubrication		3Y	3Y	3Y	3Y	1c, 2c, 3e	
Control Battery Replacement		3Y	3Y	3Y	3Y	1g, 2g	
Failure Finding Tasks		Task Frequencies				Failure Codes	Comments
Check Cabinet Heaters		5W	10W	3M	6M	1b, 1f, 2b, 2f, 3d	
Thermography		1Y	1Y	1Y	4Y	4a-b	
Functional Operations Check		3Y	3Y	3Y	3Y	1a, 1c, 1e-f, 2a-c, 2e-f, 3c, 3e, 3g	
Condition Directed Tasks		Task Frequencies				Failure Codes	Comments
None		N/A	N/A	N/A	N/A		

RECLOSER FAILURE MODES

FAILURE MODE	FAILURE CAUSES	MAINTENANCE TASKS
1. Fails to Close	1a. Close Coil Failure	Functional Operations Check
1. Fails to Close	1a. Close Coil Failure	Inspect Operator Mechanism
1. Fails to Close	1b. Control Circuit Failure	Check Cabinet Heaters
1. Fails to Close	1b. Control Circuit Failure	Inspect Recloser Control Cabinet
1. Fails to Close	1c. Lack of Lubrication	Functional Operations Check
1. Fails to Close	1c. Lack of Lubrication	Mechanism Lubrication
1. Fails to Close	1d. Interrupter Failure	Check Contact Erosion Wear Indicator
1. Fails to Close	1d. Interrupter Failure	Contact Resistance (Ductor) Test
1. Fails to Close	1d. Interrupter Failure	Visual Inspection
1. Fails to Close	1e. Mechanical/Linkage Failure	Functional Operations Check
1. Fails to Close	1e. Mechanical/Linkage Failure	Inspect Operator Mechanism
1. Fails to Close	1e. Mechanical/Linkage Failure	Visual Inspection
1. Fails to Close	1f. Stored Energy Failure	Check Cabinet Heaters
1. Fails to Close	1f. Stored Energy Failure	Functional Operations Check
1. Fails to Close	1f. Stored Energy Failure	Inspect Operator Mechanism
1. Fails to Close	1f. Stored Energy Failure	Visual Inspection
1. Fails to Close	1g. Dead Battery	Visual Inspection
1. Fails to Close	1g. Dead Battery	Control Battery Replacement
1. Fails to Close	1h. Charger Failure	Visual Inspection
2. Fails to Open	2a. Open Coil Failure	Functional Operations Check
2. Fails to Open	2a. Open Coil Failure	Inspect Operator Mechanism
2. Fails to Open	2b. Control Circuit Failure	Check Cabinet Heaters
2. Fails to Open	2b. Control Circuit Failure	Functional Operations Check
2. Fails to Open	2b. Control Circuit Failure	Inspect Recloser Control Cabinet
2. Fails to Open	2c. Lack of Lubrication	Functional Operations Check
2. Fails to Open	2c. Lack of Lubrication	Mechanism Lubrication
2. Fails to Open	2d. Interrupter Failure	Check Contact Erosion Wear Indicator
2. Fails to Open	2d. Interrupter Failure	Contact Resistance (Ductor) Test
2. Fails to Open	2d. Interrupter Failure	Visual Inspection
2. Fails to Open	2e. Mechanical/Linkage Failure	Functional Operations Check
2. Fails to Open	2e. Mechanical/Linkage Failure	Inspect Operator Mechanism
2. Fails to Open	2e. Mechanical/Linkage Failure	Visual Inspection
2. Fails to Open	2f. Stored Energy Failure	Check Cabinet Heaters
2. Fails to Open	2f. Stored Energy Failure	Functional Operations Check
2. Fails to Open	2f. Stored Energy Failure	Inspect Operator Mechanism
2. Fails to Open	2f. Stored Energy Failure	Visual Inspection
2. Fails to Open	2g. Dead Battery	Control Battery Replacement
2. Fails to Open	2g. Dead Battery	Visual Inspection
2. Fails to Open	2h. Charger Failure	Visual Inspection
3. Fails to Interrupt	3c. Open Coil Failure	Functional Operations Check
3. Fails to Interrupt	3d. Control Circuit Failure	Check Cabinet Heaters
3. Fails to Interrupt	3e. Lack of Lubrication	Functional Operations Check
3. Fails to Interrupt	3e. Lack of Lubrication	Mechanism Lubrication
3. Fails to Interrupt	3f. Interrupter Failure	Check Contact Erosion Wear Indicator
3. Fails to Interrupt	3f. Interrupter Failure	Contact Resistance (Ductor) Test
3. Fails to Interrupt	3f. Interrupter Failure	Visual Inspection
3. Fails to Interrupt	3g. Mechanical/Linkage Failure	Functional Operations Check
3. Fails to Interrupt	3g. Mechanical/Linkage Failure	Visual Inspection
3. Fails to Interrupt	3h. Stored Energy Failure	Visual Inspection
4. Fails to Provide Conduction Path	4a. Contacts High Resistance	Check Contact Erosion Wear Indicator
4. Fails to Provide Conduction Path	4a. Contacts High Resistance	Contact Resistance (Ductor) Test
4. Fails to Provide Conduction Path	4a. Contacts High Resistance	Visual Inspection
4. Fails to Provide Conduction Path	4a. Contacts High Resistance	Thermography
4. Fails to Provide Conduction Path	4b. Bus Connections Failure	Thermography
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	5d. Poor Oil Quality	Oil Dielectric Test
6. Fails to Maintain Boundary Integrity	6a. Gasket Failure	Visual Inspection

RECLOSER FAILURE MODES

FAILURE MODE	FAILURE CAUSES	MAINTENANCE TASKS
6. Fails to Maintain Boundary Integrity	6b. Weld Failure	Visual Inspection
6. Fails to Maintain Boundary Integrity	6c. Tank Corrosion	Visual Inspection
6. Fails to Maintain Boundary Integrity	6d. Loose Connections	Visual Inspection
6. Fails to Maintain Boundary Integrity	6e. Control Cabinet Contamination	Inspect Recloser Control Cabinet
6. Fails to Maintain Boundary Integrity	6e. Control Cabinet Contamination	Visual Inspection
6. Fails to Maintain Boundary Integrity	6f. Mechanism Contamination	Inspect Operator Mechanism

RECLOSER MAINTENANCE TASK DEFINITION

TASK	DEFINITION
Check Cabinet Heaters	Perform check of cabinet heater system, including verification of thermostat operation, if so equipped. This should include control, mechanism cabinet, and Interrupter Enclosure heaters. If heaters are not accessible record heater feed amps.
Check Contact Erosion Wear Indicator	On units with contact wear indicators, check indication and replace vacuum interrupters when indication reaches the OEM recommended level for replacement.
Contact Resistance (Ductor) Test	Apply DC current (100 Amps DC) between terminals of equipment under test to measure current path resistance.
Control Battery Replacement	Replace the control battery.
Functional Operations Check	Operate the recloser through the proper sequence to lockout. Reset - ensure the rest and rest-time for the recloser operates as intended.
Inspect Recloser Control Cabinet	Check interior of control cabinet for accumulation of dust and dirt; clean as necessary. Check door gasket for effective seal, repair or replace as required. Check for broken or loose wiring terminals. Visually inspect circuit boards for burnt or damage components.
Inspect Operator Mechanism	Check interior of operator mechanism cabinet for accumulation of dust and dirt; clean as necessary. Check door gasket for effective seal, repair or replace as required. Check for broken or loose wiring terminals. Check the motor brushes for excessive wear and burning; replace as needed. Close and trip recloser manually several times to check mechanical operation.
Mechanism Lubrication	Apply approved lubricants to bearings and other specified areas on mechanism, including linkage wear points.
Oil Dielectric Test	Sample and analyze oil for dielectric strength and visually inspect for excessive water and particulate. Perform Dielectric Strength Lab Analysis per ASTM D877.
Thermography	Infrared inspection of equipment.
Visual Inspection	Scope includes: -- External visual inspection of components. -- Check for broken or cracked bushings, check for paint scratches and other mechanical damage; touch up to inhibit corrosion. -- For oil reclosers, check for signs of oil leaks and check oil level. -- Record recloser operations counter. This may include both a mechanical counter and/or a digital counter integral to the recloser controls. -- Record recloser battery voltage. Replace if below OEM recommended levels. -- Perform battery load test as recommended in recloser instruction manual. -- Verify that the closing springs are charged.

RECLOSER MAINTENANCE BASIS

Recloser 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:

ANSI C37.60, "Requirements for Automatic Circuit Reclosers for Alternating-Current Systems"
ANSI C37.61, "Guide for the Application, Operation and Maintenance of Automatic Circuit
IEEE C57.152-2013 "IEEE Guide for Diagnostic Field Testing of Fluid-filled Power Transformers, Regulators and Reactors"
Cooper Power Systems Service Information S280-77-1, "Kyle Form 4C Microprocessor-Based Recloser Control Installation and Operation Instructions"
Cooper Power Systems Service Information S280-16-2, "Type VXE-15 and VXE-27 Single-Phase Maintenance Instructions"
Cooper Power Systems Service Information S280-45-5, "Type VSA-12, VSA-16 and VSA-20/800 Three-Phase Recloser Maintenance Instructions"

Boundary Definition

The boundary of a substation recloser for the purpose of this document is defined to include the recloser tank, bushings, interrupters, insulating oil, operating mechanism, and controls that are integral with the recloser.

Excluded from this treatment are: The associated secondary equipment that interfaces with the recloser controller such as the scada controls. Also excluded are distribution pole-top reclosers.

Failure Experiences

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

Disposition of Vendor Recommendations

Recommendations were incorporated into the template as appropriate based on operating

RECLOSER MAINTENANCE BASIS

Basis for Template Tasks

Check Cabinet Heaters: Operation of the heaters assures that recloser will operate.

Check Contact Erosion Wear Indicator: During detailed inspection of recloser check contact erosion wear indicator as specified by the OEM.

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.

Control Battery Replacement: Ensure proper operation of recloser and controls.

Functional Operations Check: Determine that the recloser trips/resets as designed.

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

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

Mechanism Lubrication: The mechanism is composed of multiple bearing and sliding surfaces that require periodic re-lubrication due to minimum movement of parts during operation.

Oil Dielectric Test: Ensure that the insulating oil has not become contaminated. Refer to IEEE C57.152, ASTM D877.

Thermography: A primary tool for detection of connection issues and bushing issues.

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

RECLOSER TEMPLATE DEVELOPMENT HISTORY

Revision 0		Date 01/12/2007
Writer	Chris Stefanski (Strategic Programs)	
Reviewer(s)		
Approver(s)	Kathy McHugh (FAM Maintenance Planning)	
Reason Written	To document the maintenance program tasks, frequencies, failure modes, and maintenance basis	

Revision 1		Date 11/30/2010
Writer	Chris Stefanski	
Reviewer(s)	Ken Wendt (Mgr. Material Condition)	
Approver(s)	Bill Fluhler , Bill Gannon, Nitin Patel, Jim Crane, Bill Sullivan	
Reason Written	Added note to ensure template changes are communicated to affected work groups.	

Revision 2		Date 04/29/2011
Writer	Chris Stefanski (Material Condition)	
Reviewer(s)	Ken Wendt, Drew Reindel, Jim Crane	
Approver(s)	Bill Fluhler (ComEd)	
Reason Written	Modified criticality definitions and incorporated 10-week, 3-month and 6-month inspection task frequencies. Created separate tabs for Vacuum and Oil.	

Revision 3		Date 03/19/2014
Writer	Suneetha Parupalli (Material Condition)	
Reviewer(s)	Nitin Patel (Mgr. T&S Equipment Standards), Ken Wendt (Mgr. Material Condition), William Bradley (Sr. Engineer, T&S Equipment Standards)	
Approver(s)	Mike Moy (UFAM ComEd)	
Reason Written	3 year review, reformat document, add 3 phase note to vacuum reclosers	

Revision 4		Date 02/06/2015
Writer	Chris Stefanski (Exelon Utilities)	
Reviewer(s)	Ken Wendt, Suneetha Parupalli	
Approver(s)	Mike Moy (UFAM ComEd)	

RECLOSER TEMPLATE DEVELOPMENT HISTORY

Reason Written	Revised criticality definitions and modified document to serve as the ComEd maintenance standard. Corrected thermography frequency at ESS locations \leq 34 kV from 1 year to 4 years.
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Revision 5		Date 01/26/2018
Writer	Hugo Castaneda (Material Condition)	
Reviewer(s)	Dale Player (Mgr. Material Condition), Doug Mason (T&S Equipment Stds)	
Approver(s)	Mike Moy (UFAM ComEd)	
Reason Written	3 year review. Added reference to IEEE and ASTM standards in task definition and maintenance basis for Oil Dielectric Test.	