

Switch, Motor Operated (MOD) or Manual or Ground Disconnect - ≥345kV						
Component Classification Categories						
	I	X			Nuclear Switchyards ≥ 220kV as defined in the respective Nuclear Plant Interface Requirements (NPIRs).	
	II		X		Next Terminal Out [Equipment 220kV & Up] from Nuclear Switchyards (as defined in the respective NPIRs)	
	III			X	345kV and 765kV disconnects exclusive of Criticality I & II locations	
Duty Cycle	Heavy Load	N/A	N/A	N/A		
	Normal Load	N/A	N/A	N/A		
Service Condition	In Service	X	X	X		
	Spare	N/A	N/A	N/A		
Condition Monitoring Task		Task Frequencies			Failure Codes	Comments
Visual Inspection		5W	10W	10W	1a, 1d-e, 1g, 2c, 2e, 3a-b, 5a	
Thermography		1Y	1Y	1Y	1a-c, 1g, 3a, 4a-b	At nuclear switchyards thermography is performed in the Spring and Fall. Additionally, during the summer months of June, July, and August all disconnects in the switchyard are IR scanned during high temperature periods once each month. Thermography is also used to check disconnects within 3 days after they have been reclosed to assure they are fully seated and operating properly. The above additional surveillance is performed by Nuclear Generation personnel.
Time Directed Tasks		Task Frequencies			Failure Codes	Comments
Operate/Inspect/Lubricate		4Y	4Y	8Y	1a-i, 2a-d, 2f-g, 3a-b, 4a, 5a	At the Nuclear switchyards, these tasks for the Main Power Transformer disconnect switches and the disconnect switches on the generating unit side of the Unit Output circuit breakers are to be performed at a 3-year frequency.
Contact Resistance (Ductor) Test		4Y	4Y	8Y	1b, 2b, 4a-b	
Blade and Hinge Assembly Maintenance		12Y	12Y	AR	1a-d, 2a-c	
TTR 6 / TTR 6U Switches only						
Failure Finding Tasks		Task Frequencies			Failure Codes	Comments
Check Cabinet Heaters		5W	10W	10W	1i, 2g, 5a	
Condition Directed Tasks		Task Frequencies			Failure Codes	Comments
None		N/A	N/A	N/A		

Switch, Motor Operated (MOD) or Manual or Ground Disconnect - ≥69kV to ≤138kV						
Component Classification Categories						
I	X				DC, SS, TDC, TSS locations that serve O'Hare & Midway Airports	
II		X			Critical Transmission Interconnections	
III			X		Critical Equipment / Locations per ComEd AM-CE-P034-R0001 (Equipment / Locations exclusive of Criticality I & II locations)	
IV				X	All other 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	X	
	Spare	N/A	N/A	N/A	N/A	
Condition Monitoring Task						
	Task Frequencies				Failure Codes	Comments
Visual Inspection	5W	10W	10W	10W	1a, 1d-e, 1g, 2c, 2e, 3a-b, 5a	
Thermography	1Y	1Y	1Y	1Y	1a-c, 1g, 3a, 4a-b	
Time Directed Tasks						
	Task Frequencies				Failure Codes	Comments
Operate/Inspect/Lubricate	8Y	8Y	8Y	AR	1a-i, 2a-d, 2f-g, 3a-b, 4a, 5a	
Contact Resistance (Ductor) Test	8Y	8Y	8Y	AR	1b, 2b, 4a-b	
Blade and Hinge Assembly Maintenance	AR	AR	AR	AR	1a-d, 2a-c	TTR 6 / TTR 6U Switches only
Failure Finding Tasks						
	Task Frequencies				Failure Codes	Comments
Check Cabinet Heaters	5W	10W	10W	10W	1i, 2g, 5a	
Condition Directed Tasks						
	Task Frequencies				Failure Codes	Comments
None	N/A	N/A	N/A	N/A		

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Switch, Motor Operated (MOD) or Manual or Ground Disconnect ≤34kV								
Component Classification Categories								
Criticality	I	X					DC, SS, TDC, TSS locations that serve O'Hare & Midway Airports	
	II		X				Critical Equipment / Locations per ComEd AM-CE-P034-R0001 (Equipment / Locations Exclusive of Criticality I)	
	III			X			Locations exclusive of Criticality I & II, DC and ≤34kV ESS locations	
	IV				X		DC locations	
	V					X	≤ 34kV ESS locations	
Duty Cycle	Heavy Load	N/A	N/A	N/A	N/A	N/A		
	Normal Load	N/A	N/A	N/A	N/A	N/A		
Service Condition	In Service	X	X	X	X	X		
	Spare	N/A	N/A	N/A	N/A	N/A		
Condition Monitoring Task							Failure Codes	Comments
Visual Inspection		5W	10W	10W	3M	6M	1a, 1d-e, 1g, 2c, 2e, 3a-b, 5a	
Thermography		1Y	1Y	1Y	1Y	4Y	1a-c, 1g, 3a, 4a-b	
Time Directed Tasks							Failure Codes	Comments
Operate/Inspect/Lubricate		16Y	16Y	AR	AR	AR	1a-i, 2a-d, 2f-g, 3a-b, 4a, 5a	
Failure Finding Tasks							Failure Codes	Comments
Contact Resistance (Ductor) Test		AR	AR	AR	AR	AR	1b, 2b, 4a-b	For switches ≤ 34kV, perform maintenance based on thermography or visual inspection.
Check Cabinet Heaters		5W	10W	10W	3M	6M	1i, 2g, 5a	Where applicable
Condition Directed Tasks							Failure Codes	Comments
Operate/Inspect/Lubricate		AR	AR	AR	AR	AR	1a-i, 2a-d, 2f-g, 3a-b, 4a, 5a	For switches ≤ 34kV, perform maintenance based on thermography or visual inspection.

SWITCH FAILURE MODES

FAILURE MODES	FAILURE CAUSES	MAINTENANCE TASKS
1. Fails to Close	1a. Blade Fails to Roll-in Completely	Operate/Inspect/Lubricate
1. Fails to Close	1a. Blade Fails to Roll-in Completely	Visual Inspection
1. Fails to Close	1a. Blade Fails to Roll-in Completely	Thermography
1. Fails to Close	1a. Blade Fails to Roll-in Completely	Blade and Hinge Assembly Maintenance
1. Fails to Close	1b. Corroded Hinge Pivot Point	Operate/Inspect/Lubricate
1. Fails to Close	1b. Corroded Hinge Pivot Point	Thermography
1. Fails to Close	1b. Corroded Hinge Pivot Point	Contact Resistance (Ductor) Test
1. Fails to Close	1b. Corroded Hinge Pivot Point	Blade and Hinge Assembly Maintenance
1. Fails to Close	1c. Improper Blade Alignment	Operate/Inspect/Lubricate
1. Fails to Close	1c. Improper Blade Alignment	Thermography
1. Fails to Close	1c. Improper Blade Alignment	Blade and Hinge Assembly Maintenance
1. Fails to Close	1d. Coupling/Linkage Failure	Operate/Inspect/Lubricate
1. Fails to Close	1d. Coupling/Linkage Failure	Visual Inspection
1. Fails to Close	1d. Coupling/Linkage Failure	Blade and Hinge Assembly Maintenance
1. Fails to Close	1e. Structure/Foundation Alignment	Operate/Inspect/Lubricate
1. Fails to Close	1e. Structure/Foundation Alignment	Visual Inspection
1. Fails to Close	1f. Stop Failure/Alignment	Operate/Inspect/Lubricate
1. Fails to Close	1g. Animal Intrusion	Operate/Inspect/Lubricate
1. Fails to Close	1g. Animal Intrusion	Visual Inspection
1. Fails to Close	1g. Animal Intrusion	Thermography
1. Fails to Close	1h. Motor Failure	Operate/Inspect/Lubricate
1. Fails to Close	1i. Motor Control Circuit Failure	Operate/Inspect/Lubricate
1. Fails to Close	1i. Motor Control Circuit Failure	Check Cabinet Heaters
2. Fails to Open	2a. Blade Fails to Roll	Operate/Inspect/Lubricate
2. Fails to Open	2a. Blade Fails to Roll	Blade and Hinge Assembly Maintenance
2. Fails to Open	2b. Corroded Hinge Pivot Point	Operate/Inspect/Lubricate
2. Fails to Open	2b. Corroded Hinge Pivot Point	Contact Resistance (Ductor) Test
2. Fails to Open	2b. Corroded Hinge Pivot Point	Blade and Hinge Assembly Maintenance
2. Fails to Open	2c. Coupling/Linkage Failure	Operate/Inspect/Lubricate
2. Fails to Open	2c. Coupling/Linkage Failure	Visual Inspection

SWITCH FAILURE MODES

FAILURE MODES	FAILURE CAUSES	MAINTENANCE TASKS
2. Fails to Open	2c. Coupling/Linkage Failure	Blade and Hinge Assembly Maintenance
2. Fails to Open	2d. Stop Failure/Alignment	Operate/Inspect/Lubricate
2. Fails to Open	2e. Animal Intrusion	Visual Inspection
2. Fails to Open	2f. Motor Failure	Operate/Inspect/Lubricate
2. Fails to Open	2g. Motor Control Circuit Failure	Operate/Inspect/Lubricate
2. Fails to Open	2g. Motor Control Circuit Failure	Check Cabinet Heaters
3. Fails to Insulate	3a. External Contamination	Operate/Inspect/Lubricate
3. Fails to Insulate	3a. External Contamination	Visual Inspection
3. Fails to Insulate	3a. External Contamination	Thermography
3. Fails to Insulate	3b. Cracked/Broken Insulator	Operate/Inspect/Lubricate
3. Fails to Insulate	3b. Cracked/Broken Insulator	Visual Inspection
4. Fails to Provide Conductive Path	4a. High Resistance Connection	Thermography
4. Fails to Provide Conductive Path	4a. High Resistance Connection	Contact Resistance (Ductor) Test
4. Fails to Provide Conductive Path	4a. High Resistance Connection	Operate/Inspect/Lubricate
4. Fails to Provide Conductive Path	4b. Bus Connection Failure	Thermography
4. Fails to Provide Conductive Path	4b. Bus Connection Failure	Contact Resistance (Ductor) Test
5. Fails to Provide Position Indication	5a. Aux contact failure	Operate/Inspect/Lubricate
5. Fails to Provide Position Indication	5a. Aux contact failure	Visual Inspection
5. Fails to Provide Position Indication	5a. Aux contact failure	Check Cabinet Heaters

SWITCH MAINTENANCE TASK DEFINITION

TASK	DEFINITION
Blade and Hinge Assembly Maintenance	Perform the Hinge Assembly Maintenance procedure and replace live parts as outlined in the Pascor TTR6 Extended Life Maintenance Plan.
Check Cabinet Heaters	Visual / physical verification that cabinet heaters are operational.
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.
Operate/Inspect/Lubricate	<p>Perform off-line detailed inspection and lubrication of the switch and operating mechanism. Perform Blade and Hinge Assembly maintenance and replace live parts as required based on following criteria.</p> <ul style="list-style-type: none"> -- Operate switch to identify any problems with the linkage / mechanism and to wipe the contact surfaces. -- Clean corroded hinge pivot points. Reapply grease. Lubricate all linkage where applicable with approved lubricants. Check gearboxes for moisture or corrosion and re-grease if necessary. -- Check for synchronized closing of blades and proper contact in closed position (properly seated and fully rolled-in). Check switch for alignment, contact pressure, erosion, corrosion, or mechanical malfunction. Check blade lock or latch for adjustment. -- Check contacts and current carrying parts for signs of scarring, gouging or presence of sharp points. Check condition of plating on contact surfaces. Clean and lubricate all contact parts. -- Check arcing horns for signs of excessive arc damage. Check corona balls and rings for damage. <p>-- Inspect flexible grounding braids for broken strands and slip rings for corrosion. -- Inspect insulators for cracks, chips, or burns. -- Check tightness of bolted connections and perform Visual Inspection of the bus. -- Inspect auxiliary contacts (where applicable) for degradation, pitting and corrosion. Additionally, visually Inspect for obvious contact mis-alignment. -- for motor operated mechanisms, Check operator motor, linkage, and bearings. Check all solenoids, contacts, cams and limit switches. Check heaters, bolts, nuts, washers, cotter pins, terminals, fuses, and fuse blocks. Inspect and Check safety interlocks. Operate switch and Check for proper operation.</p>
Thermography	Infrared inspection of electrical equipment and power path components to identify any hot spots that may exist either in the contacts or bus connections. Comparisons should be made between phases to determine excessive contact heating.
Visual Inspection	<p>Visually assess condition of the equipment. Items to check include:</p> <ul style="list-style-type: none"> -- Check condition of all components including couplings, whips, horn latches, arcing horns, finger contacts, and grounding. Check condition and position of beaver tails and verify that all blades are fully rolled-in. -- Verify whips are in proper position and of proper length. -- Verify insulators are properly aligned and parallel between top and bottom, and in line with all three phases. -- Check insulators for chips and cracks. -- Verify that closed disconnect is fully seated and contacts are engaged

SWITCH MAINTENANCE BASIS

Switch 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:

Standard 62 IEEE Guide for Diagnostic Field Testing of Electric Power Apparatus
Internal reports and operating experience
OEM Maintenance Manuals and Interviews
Pascor "Maintenance Guidelines for Type TTR6 Air Disconnect Switches"
EPRI 1001779 Guidelines for the Life Extension of Substations

Boundary Definition

The boundary of a switch is defined to be from powerpath terminal to powerpath terminal, including:

- switch linkage, switch contacts and switch insulators
- motor operator mechanism (MOD only)
- motor (MOD only)
- arc horns / whips
- wire and bus terminations

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

SWITCH MAINTENANCE BASIS

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

Basis For Template Tasks

Blade and Hinge Assembly Maintenance: Pascor recommends blade and hinge assembly maintenance be performed every 10-12 years per the "TTR6 Extended Life Maintenance Plan" for TTR6 switches that are operated infrequently and are more than 9 years old.

Check Cabinet Heaters: Continuous heater operation mitigates corrosion of components in the operating mechanism cabinet.

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 at bolted or spring-loaded connections.

Operate/Inspect/Lubricate: Vendor recommendations suggest that switches be periodically operated, inspected and lubricated. Additionally, experience with auxiliary position indicating contacts has indicated need for inspection and verification of contact alignment.

Thermography: IEEE Standard 62 identifies thermography as a primary tool for detection of connection 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 actions.

SWITCH TEMPLATE DEVELOPMENT HISTORY

Revision 0		Date 07/17/2015
Writer	Chris Stefanski (Exelon Utilities)	
Reviewer(s)	Ken Wendt, Sal Salazar	
Approver(s)	Michael Moy (UFAM ComEd)	
Reason Written	Created to document the ComEd maintenance program tasks, frequencies, failure modes, and maintenance basis.	
Revision 1		Date 3/31/2016
Writer	Hugo Castaneda (Material Condition)	
Reviewer(s)	Ken Wendt, Nitin Patel, Doug Mason, Greg Hitzke, Elizabeth Jakosz	
Approver(s)	Mike Moy (UFAM ComEd)	
Reason Written	Introduced 69kV to 138kV Switch Disconnect maintenance at sites determined by Engineering. In addition, added 16Y mainenance for ≤ 34 kV Switch Disconnects at Critical and target sites.	
Revision 2		Date 9/22/2017
Writer	Hugo Castaneda (ComEd Material Condition)	
Reviewer(s)	Dale Player (ComEd Material Condition Manager), Nitin Patel (ComEd T&S Equipment Stds Manager), Greg Hitzke (ComEd T&S Equipment Stds), Elizabeth Spolarich (ComEd T&S Equipment Stds), Richard Bellino (ComEd T&S Equipment Stds), Lonnie Grote (ComEd T&S Equipment Stds), 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)	Mike Moy (UFAM ComEd)	
Reason Written	Revised Criticalities to reflect AM-CE-P034-R0001 categories and revised Blade and Hinge Assembly task detail to replace live parts.	