

CIRCUIT SWITCHER								
Component Classification Categories								
Criticality	I	X					Nuclear switchyards	
	II		X				DC, SS, TDC, TSS locations that serve O'Hare & Midway Airports	
	III			X			Locations exclusive of Criticality I & II locations, DC locations 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		
<b>Condition Monitoring Tasks</b>								
		<b>Task Frequencies</b>				<b>Failure Codes</b>		<b>Comments</b>
Visual Inspection		5W	5W	10W	3M	6M	1a, 2a, 3a, 5a	
Thermography		1Y	1Y	1Y	1Y	4Y	4a-b	
Contact Resistance (Ductor) Test		4Y	8Y	8Y	8Y	8Y	3c, 4a, 4c	
<b>Time Directed Tasks</b>								
		<b>Task Frequencies</b>				<b>Failure Codes</b>		<b>Comments</b>
Operate/Inspect/Lubricate		4Y	8Y	8Y	8Y	8Y	1a-b, 2a-c, 3b, 3d, 6a	
<b>Failure Finding Tasks</b>								
		<b>Task Frequencies</b>				<b>Failure Codes</b>		<b>Comments</b>
Check Cabinet Heaters		5W	5W	10W	3M	6M	1a, 2a, 3b	
<b>Condition Directed Tasks</b>								
		<b>Task Frequencies</b>				<b>Failure Codes</b>		<b>Comments</b>
None		N/A	N/A	N/A	N/A	N/A		

## CIRCUIT SWITCHER FAILURE MODES

FAILURE MODE	FAILURE CAUSES	MAINTENANCE TASKS
1.Fails to Close	1a. Control Circuit Failure	Visual Inspection
1.Fails to Close	1a. Control Circuit Failure	Operate/Inspect/Lubricate
1.Fails to Close	1a. Control Circuit Failure	Check Cabinet Heaters
1.Fails to Close	1b. Mechanical/Linkage Failure	Operate/Inspect/Lubricate
2. Fails to Open	2a. Control Circuit Failure	Visual Inspection
2. Fails to Open	2a. Control Circuit Failure	Operate/Inspect/Lubricate
2. Fails to Open	2a. Control Circuit Failure	Check Cabinet Heaters
2. Fails to Open	2b. Mechanical/Linkage Failure	Operate/Inspect/Lubricate
2. Fails to Open	2c. Blade Fails to Open	Operate/Inspect/Lubricate
3. Fails to Interrupt	3a. Loss of SF6	Visual Inspection
3. Fails to Interrupt	3b. Control Circuit Failure	Operate/Inspect/Lubricate
3. Fails to Interrupt	3b. Control Circuit Failure	Check Cabinet Heaters
3. Fails to Interrupt	3c. Interrupter Contact Failure	Contact Resistance (Ductor) Test
3. Fails to Interrupt	3d. Mechanical Linkage Failure	Operate/Inspect/Lubricate
4. Fails to Provide Conduction Path	4a. Contacts High Resistance	Contact Resistance (Ductor) Test
4. Fails to Provide Conduction Path	4a. Contacts High Resistance	Thermography
4. Fails to Provide Conduction Path	4b. Bus Connection Failure	Thermography
4. Fails to Provide Conduction Path	4c. Interrupter Contact Failure	Contact Resistance (Ductor) Test
5. Fails to Provide Adequate Insulation Level	5a. Cracked/Broken Insulator	Visual Inspection
6. Fails to Provide Adequate Grounding	6a. Grounding Switch Failure	Operate/Inspect/Lubricate

## CIRCUIT SWITCHERS MAINTENANCE TASK DEFINITION

TASK	DEFINITION
Check Cabinet Heaters	Verify cabinet heaters are operational, where installed.
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 circuit switcher and operating mechanism.</p> <ul style="list-style-type: none"> <li>-- Check general condition of motor operator cabinet. Inspect door gaskets and check for evidence of moisture. Check for broken or damaged parts, loose wires and that conduits are sealed. Check proper functioning of indicator lamps, operations counter and convenience lamp.</li> <li>-- Check linkages, couplings and connection hardware for damage or corrosion.</li> <li>-- Check electrical operation, coupled and de-coupled, by using local trip and close pushbuttons. Check proper operation of brake.</li> <li>-- Check disconnect condition, position of beaver tails and verify that all blades are fully rolled-in</li> <li>-- Check switch operator, power train, brain, shunt-trip device and disconnect live parts for evidence of damage, excessive corrosion or wear.</li> <li>-- Check power train and brain for proper operation during slow, manual cranking.</li> <li>-- Wipe off old lubricants and lubricate using approved products.</li> <li>-- Hand crank the unit to verify ease of operation and proper tripping of interrupters.</li> <li>-- Check for evidence of deterioration of the "lovejoy" coupling</li> <li>-- Check ground strap connection</li> <li>-- If installed, verify resistance of pre-insertion resistor is within specifications and not damaged. Check that pressure plug is present and is properly aligned with opening in resistor mounting bracket or adapter.</li> <li>-- Check bolted connections are tight. Check arcing arm assemblies for proper setting and for evidence of corrosion, damage, or excessive wear.</li> <li>-- Check proper SF6 pressure.</li> <li>-- If installed, check remote gas density monitor. Check replacement date of transmitter batteries and replace as necessary.</li> <li>-- If present, check grounding switch for evidence of damage, excessive corrosion or wear.</li> </ul> <p>Check bolted connections are tight. Wipe off old lubricants and lubricate using approved products. Manually operate the switch to verify ease of operation and proper alignment of contacts.</p>
Thermography	Infrared inspection of electrical equipment and power path components
Visual Inspection	<p>Visual assessment of the condition of the equipment. Items to check include:</p> <ul style="list-style-type: none"> <li>-- Check disconnect condition, position of beaver tails and verify that all blades are fully rolled-in</li> <li>-- Check insulators for chips and cracks</li> <li>-- Check for white or red targets, indicating misoperation or loss of gas pressure</li> <li>-- Inspect door gaskets for proper seal</li> <li>-- Check ground strap connection</li> <li>-- Check that conduit openings are sealed</li> </ul>

# CIRCUIT SWITCHERS MAINTENANCE BASIS

## Circuit Switcher 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

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### Boundary Definition

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

- Linkages
- Contacts
- Arc Horns/Whips
- Interrupters
- Insulators
- Operating Mechanism

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

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### Failure Experiences

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

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### Vendor Recommendations

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

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### Disposition of Vendor Recommendations

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

# CIRCUIT SWITCHERS MAINTENANCE BASIS

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## Basis For Template Tasks

**Check Cabinet Heaters:** Verifying proper operation of cabinet heaters decreases possibility of corrosion especially on components of the control circuit and operating mechanism.

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**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.

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**Operate/Inspect/Lubricate:** Vendor recommendations suggest that circuit switchers be periodically operated, inspected and lubricated.

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

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**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.

## CIRCUIT SWITCHER TEMPLATE DEVELOPMENT HISTORY

<b>Revision 0</b>		<b>Date 06/29/2015</b>
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. Changed Contact Resistance and Operate/Inspect/Lubricate task frequencies from 3Y to 4Y and from 6Y to 8Y to align with 4-year FEG schedules.	

  

<b>Revision 1</b>		<b>Date 06/26/2018</b>
Writer	Hugo Castaneda (Material Condition)	
Reviewer(s)	Dale Player Mgr Material Condition	
Approver(s)	Michael Moy (UFAM ComEd)	
Reason Written	3 yr review. Added Circuit Switcher maintenance at DC locations for future coverage. No other major changes.	