

**LINE SWITCH, AIR BREAK TYPES [1] [2]**

Component Classification Categories						
Criticality	I	X			All 345 kV Line Switches	
	II		X		All 115 kV through 230 kV Line Switches	
	III			X	All 69 kV Line Switches	
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 Tasks		Task Frequencies		Failure Codes	Comments	
Thermography		4Y	4Y	4Y	4b	
Time Directed Tasks				Failure Codes	Comments	
Switch Mech & Lube		4Y	4Y	4Y	1a-1i, 2a-2h, 3a,3b 4a	Mech & Lubes performed in conjunction with FEG equipment outages. Line switches for nuclear station lines with 24 month refuel cycles shall have maintenance performed every refuel outage.
Failure Finding Tasks				Failure Codes	Comments	
Visual Inspection - Comprehensive Aerial		4Y	4Y	4Y	1a,1e,1g 3a,3b	
External Visual Inspection (Operator Rounds)		AR	AR	AR	1a, 1c, 1d, 1e, 1g, 2a, 2c, 2e, 2g, 2h	Operator rounds as dictated by switching needs
MOD Heater Element Inspection		1Y	1Y	N/A	5a	
Condition Directed Tasks				Failure Codes	Comments	
None		N/A	N/A	N/A		

Notes:

- [1] Air Break type switches include: Vertical Break, Center Break, Side Break, Double Break and V-Switch.
- [2] Air Break switches may be installed with or without MOD's (motor operated disconnects)

*This document is intended to depict maintenance activities for ComEd and is consistent with the North Star maintenance guidelines for Exelon Utilities. It is not intended to be used as "Evidence of Compliance" for regulatory audits or in support of regulatory Readiness Evaluations. Evidence of Compliance documents shall be owned and maintained at the individual OpCo level.*

LINE SWITCH, CIRCUIT SWITCHER [1] [2]			
Component Classification Categories			
Criticality	I	X	All Line Switches 69 kV and above
Duty Cycle	Heavy Load	N/A	
	Normal Load	N/A	
Service Condition	In Service	X	
	Spare	N/A	
<b>Condition Monitoring Tasks</b>			
Thermography	4Y	4b	
<b>Time Directed Tasks</b>			
Mech & Lube [3]	4Y	1a-1i, 2a-2d, 3a,3b 4a	
MOD Heater Element Inspection [4]	1Y	5a	
<b>Condition Directed Tasks</b>			
None	N/A		
<b>Failure Finding Tasks</b>			
Visual Inspection - Comprehensive Aerial	4Y	1a, 1e,1g 3a,3b	
External Visual Inspection (Operator Rounds)	AR	1a, 1c, 1d, 1e, 1g, 2a, 2c, 2e	Operator rounds as dictated by switching needs

Notes:

[1] Circuit Switcher types include: S&C Mark II, Mark III, Mark IV, Mark V Vertical and Center Break types

[2] Circuit Switchers may be installed with or without MOD's (motor operated disconnects)

[3] Mech & Lubes performed in conjunction with FEG equipment outages. Line switches for nuclear station lines with 24 month refuel cycles shall have maintenance performed every refuel outag

[4] MOD Heater Element Inspections are performed prior to summer weather each year.

FAILURE MODE

- 1. Fails to Close
- 1. Fails to Close
- 1. Fails to Close

- 1. Fails to Close
- 1. Fails to Close

- 1. Fails to Close
- 1. Fails to Close
- 1. Fails to Close

- 1. Fails to Close
- 1. Fails to Close
- 1. Fails to Close

- 1. Fails to Close
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- 1. Fails to Close
- 1. Fails to Close

- 1. Fails to Close
- 1. Fails to Close

- 2. Fails to Open
- 2. Fails to Open

- 2. Fails to Open
- 2. Fails to Open
- 2. Fails to Open

- 2. Fails to Open
- 2. Fails to Open

- 2. Fails to Open
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- 2. Fails to Open

FAILURE CAUSES:

- 1a. Blade Fails to Roll-in Completely
- 1a. Blade Fails to Roll-in Completely
- 1a. Blade Fails to Roll-in Completely

- 1b. Corroded Hinge Pivot Point
- 1c. Improper Blade Alignment

- 1c. Improper Blade Alignment
- 1d. Coupling/Linkage Failure
- 1d. Coupling/Linkage Failure

- 1e. Structure/Foundation Alignment
- 1e. Structure/Foundation Alignment
- 1e. Structure/Foundation Alignment

- 1f. Stop Failure/Alignment
- 1g. Animal Intrusion (Bird Nest)
- 1g. Animal Intrusion (Bird Nest)
- 1g. Animal Intrusion (Bird Nest)

- 1h. Seized Bearing Assembly
- 1i. Failed Control Unit

- 2a. Blade Fails to Roll
- 2a. Blade Fails to Roll

- 2b. Corroded Hinge Pivot Point
- 2c. Coupling/Linkage Failure
- 2c. Coupling/Linkage Failure

- 2d. Stop Failure/Alignment
- 2e. Animal Intrusion (Bird Nest)

- 2e. Animal Intrusion (Bird Nest)
- 2f. Seized Bearing Assembly
- 2g. Inoperable- Linkage Bound/Locked

- 2g. Inoperable- Linkage Bound/Locked

MAINTENANCE TASKS:

- Switch Mech & Lube
- Visual Inspection - Comprehensive Aerial
- External Visual Inspection (Operator Rounds)

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- Switch Mech & Lube
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- External Visual Inspection (Operator Rounds)

- Switch Mech & Lube

FAILURE MODE

2. Fails to Open

2. Fails to Open

2. Fails to Open

2. Fails to Open

3. Fails to Insulate

3. Fails to Insulate

3. Fails to Insulate

3. Fails to Insulate

4. Fails to Provide Conduction Path

5. False Open/Close Operation

FAILURE CAUSES:

2h. Gear Operator Failure

2h. Gear Operator Failure

2i. Interrupter Targets remain Yellow

2i. Interrupter Targets remain Yellow

3a. External Contamination

3a. External Contamination

3b. Cracked/Broken Insulator

3b. Cracked/Broken Insulator

4a. High Contact Resistance

4b. Hotspot

5a. Control Cabinet Contact Corrosion

MAINTENANCE TASKS:

External Visual Inspection (Operator Rounds)

Switch Mech & Lube

External Visual Inspection (Operator Rounds)

Switch Mech & Lube

Switch Mech & Lube

Visual Inspection - Comprehensive Aerial

Switch Mech & Lube

Visual Inspection - Comprehensive Aerial

Switch Mech & Lube

Thermography

MOD Heater Element Inspection

TASK	DEFINITION
Switch Mech & Lube	<p>Performed in conjunction with associated FEG equipment outages. This task consists of the following:</p> <ol style="list-style-type: none"> <li>1. Operate the switch to identify any problems with the linkage/motor operator mechanism, and to clean the contact surfaces.</li> <li>2. The inspection portion consists of a visual verification of proper alignment, engagement, adjustment, and travel. It is also intended to identify broken or missing parts, contamination or deterioration. Inspect and clean motor operator mechanism compartment and perform operational check of cabinet heater system (if present).</li> <li>3. Lubricate linkage and motor operator mechanism where applicable with approved lubricants.</li> <li>4. Apply approved contact grease to all contact surfaces.</li> </ol>
MOD Heater Element Inspection	<p>This task is performed prior to the summer months and consists of the following:</p> <ol style="list-style-type: none"> <li>1. The inspection consists of a visual verification of proper heater element operation.</li> </ol>
Visual Inspection - Comprehensive Aerial	<p>Inspection performed aerially where accessible by helicopter. Inspection includes; all structure components, detailed inspection of hardware assemblies, detailed inspection of structural connections, detailed spacer analysis and detailed review of conductor/shield wire spans between structures. The speed of inspection averages 1.5 mph.</p>
External Visual Inspection (Operator Rounds)	<p>Visual assessment of equipment condition during hands on operation / operator rounds. Inspection includes visual inspection of all major structural and electrical components as well as verification of proper operation.</p>
Thermography	<p>Inspection performed aerially or from ground level. Inspection should include identification location of the hot spots and the temperature rise exceeding 5F on:</p> <ul style="list-style-type: none"> <li>- Identification of Hot Spots on transmission line switch and associated connections</li> </ul>

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## **OHT LINE SWITCH Template Summary**

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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.

The tasks included apply to OHT Line Switches installed along transmission lines with maintenance responsibilities designated to OHT field crews. This maintenance template is the result of good industry practices and industry experience, IEEE Standards, EPRI guidance and manufacturer recommendations. These tasks represent the minimum scope for effective performance monitoring and assure the switch will perform adequately and provide sufficient indication of an adverse condition to allow timely corrective actions to be taken.

### **References:**

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1. Internal reports and operating experience
2. Interviews with OHT personnel
3. OEM Maintenance Manuals and Interviews

### **Boundary Definition**

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The tasks included apply to OHT Line Switches installed along transmission lines with maintenance responsibilities designated to OHT field crews. This maintenance template is the result of good industry practices and industry experience, IEEE Standards, EPRI guidance and manufacturer recommendations. These tasks represent the minimum scope for effective performance monitoring and assure the switch will perform adequately and provide sufficient indication of an adverse condition to allow timely corrective actions to be taken.

The boundary of a Line Switch is defined to include Air Break Type Switches and Circuit Switchers. All type switches can be installed both with or without MOD (Motor Operated Disconnects). Air Break type switches include: Vertical Break, Center Break, Side Break, Double Break and V-Switch. Circuit Switcher types include: S&C Mark II, Mark III, Mark IV, Mark V, Vertical and Center Break types.

The boundary shall include the main switch, switch linkage, switch contacts, switch operator, arcing whips and wire and bus terminations. For purposes of this document the boundary does not include the switch structure. The establishment of the boundary for the switch was based on the functional relationship between the components that comprise the equipment. No equipment or components outside of the boundaries were considered in the analysis.

## **Failure Experience**

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

## **Vendor Recommendations**

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OHT, Line Switch OEM's recommend to exercise and operate switches every 12 months. FEG outage schedule extends exercise period to 4 years. Recommendation is to perform Mech & Lube task to identify operability issues, wear or damage to switch components and to repair or replace components found to be defective or out of specifications.

## **Disposition of Vendor Recommendations**

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NA

## **Basis For Template Tasks**

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**External Visual Inspection (Operator Rounds):** This inspection approximates real-time condition monitoring that can detect developing problems and degradation, and provides condition data used to initiate corrective actions. Performed as part of routine substation/switchyard operator inspections and includes the following tasks:

1. Check overall switch and operating mechanism including condition and proper position of all linkages, operating rods, blades (properly seated and fully rolled-in), contacts, horn latches, arcing horns, and whips.
2. Check insulators for cracks, chips, or burns.
3. Verify all insulators are properly aligned and parallel between top and bottom and in line with all three phases.
4. Check switch and motor operator to be properly coupled (MOD only).
5. Check condition of grounding cables, braids, straps and connections.

**Switch Mech & Lube:** Performed in conjunction with associated FEG equipment outages. Vendor recommendations suggest that switches be periodically operated. The routine maintenance task consists of the following:

1. Operate switch to identify any problems with the linkage/mechanism, and to wipe the contact surfaces.
2. Check for synchronized closing of blades and proper contact in closed position (properly seated and fully rolled-in)
3. Check switch for alignment, contact pressure, erosion, corrosion, or mechanical malfunction.
4. Check blade lock or latch for adjustment.
5. Check all contacts and current carrying parts.
6. Check plating on all contact surfaces.

7. Check arcing horns for signs of excessive arc damage.
8. Inspect live parts for scarring, gouging, or sharp points.
9. Replace contacts and current carrying parts found to have insufficient contact surface or plating material.
  
10. Clean and lubricate all contact parts.
11. Inspect insulators for cracks, chips, or burns.
12. Check corona balls and rings for damage.
13. Inspect inter-phase linkages, operating rods, and levers to ensure adjustments correct.
14. Lubricate all linkage where applicable with approved lubricants.
15. Check gearboxes for moisture or corrosion and re-grease if necessary.
16. Inspect grounding flexible braids for broken strands and slip rings for corrosion.
17. Replace and/or adjust any component found to be defective or out of calibration.

For motor operator mechanism:

1. Check operator motor, linkage, and bearings.
2. Check all solenoids, contacts, cams, limit switches.
3. Check all heaters, bolts, nuts, washers, cotter pins, terminals, fuses, and fuse blocks.
4. Inspect and check safety interlocks.
  
5. Operate switch and check for proper functioning.

**External Visual Inspection (Aerial Inspection ):** A visual inspection (condition monitoring) is used to detect damaged insulators, major components including wires and accessories. Condition data generated during Visual Inspection is used to initiate corrective actions. The items to be checked/recorded are:

1. Identify locations with broken or flashed insulators
2. Identify locations with structure damage or deterioration ( wood structures)
3. Identify locations with damage to accessories or linkage
4. Identify locations with non standard attachments and non standard bolted connections.

**MOD Heater Element Inspection:** This task is performed prior to the summer months and consists of the the inspection and visual verification of proper heater element operation.

**Thermography:** Inspection performed aerially or from ground level. Inspection should include identification location of the hot spots and the temperature rise exceeding 5F on transmission line switch and associated connections

#### **Maintenance Gaps Identified**

TBD

#### **Equipment Criticality**

Criticality 1 – All 345 kV Line Switches

Criticality 2 – All 115 kV through 230 kV Line Switches

Criticality 3 – All 69 kV Line Switches

<b>Revision 0</b>		<b>Date 06/17/2005</b>
Writer	Howard Murray (Transmission Line Engineering)	
Reviewer(s)	1/28/05 Template Challenge Session Attendees	
Approver(s)	Kathy McHugh (FAM Maintenance Planning)	
Reason Written	To document the maintenance program tasks, frequencies, failure modes, and maintenance basis	

<b>Revision 1</b>		<b>Date 11/30/2010</b>
Writer	Chuck Priebe	
Reviewer(s)	Ken Wendt (Mgr. Material Condition), Drew Reindel (Mgr. T&S Engineering)	
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.	

<b>Revision 2</b>		<b>Date 11/24/2014</b>
Writer	Robert Munley, Stephen Dasovich, Howard Murray	
Reviewer(s)	George Leinhauser, Ken Wendt, Ken Braerman	
Approver(s)	J. Coffman, Cory Sommerson, Mike Moy	
Reason Written	Updated to align across BGE, ComEd, and PECO with incorporation of best practices.	

<b>Revision 3</b>		<b>Date 2/2/2018</b>
Writer	Howard Murray	
Reviewer(s)	Angelo DeAngelis (Material Condition)	
Approver(s)	Mike Moy (UFAM ComEd)	
Reason Written	3 year review, no content change.	