

Pole Top Capacitors						
Component Classification Categories						
Criticality	I	X				Banks with DA Control (Switched or Fixed). Includes VO equip.
	II		X			Switched bank with a Controller
	III			X		Fixed bank without a Controller
	IV				X	Fixed bank with a Controller
Duty Cycle	Heavy Load	N/A				
	Normal Load	N/A				
Service Condition	In Service	N/A				
	Spare	N/A				
<b>Condition Monitoring Tasks</b>						
		<b>Task Frequencies</b>			<b>Failure Codes</b>	<b>Comments</b>
Amp Balance Test	1Y	1Y	1Y	1Y	1a	
Visual Inspection	4Y/2Y	1Y	1Y	1Y	1a-d, 2a-b, 3a-b	4yr for taps, 2 yr for mainline
		<b>Task Frequencies</b>			<b>Failure Codes</b>	<b>Comments</b>
Thermography	2Y	2Y	2Y	2Y	1b, 1d, 3b	Applicable for Mainline Capacitors Only
Functional Test	1Y	1Y	1Y	1Y	2a-b	
		<b>Task Frequencies</b>			<b>Failure Codes</b>	<b>Comments</b>
None	N/A			N/A		
		<b>Task Frequencies</b>			<b>Failure Codes</b>	<b>Comments</b>
None	N/A			N/A		

### FAILURE MODES

- 1. Fails to Provide Volt-Amperes Reactive (VARs)
  
- 2. Fails to Switch On/Off
  
- 3. Fails to Provide Adequate Insulation
- 3. Fails to Provide Adequate Insulation
- 3. Fails to Provide Adequate Insulation

### FAILURE CAUSES

- 1a. Loss of Individual Cans
- 1a. Loss of Individual Cans
- 1b. Loose Connections
- 1b. Loose Connections
- 1c. Blown Fuse
- 1d. Failed Cutout
- 1d. Failed Cutout
  
- 2a. Control Circuit Failure
- 2a. Control Circuit Failure
- 2b. Oil Switch Failure
- 2b. Oil Switch Failure
  
- 3a. External Contamination
- 3b. Cracked/Broken Bushing
- 3b. Cracked/Broken Bushing

### MAINTENANCE TASKS

- Visual Inspection
- Amp Balance Test
- Visual Inspection
- Thermography
- Visual Inspection
- Visual Inspection
- Thermography
  
- Visual Inspection
- Functional Test
- Visual Inspection
- Functional Test
  
- Visual Inspection
- Visual Inspection
- Thermography

## **TASK**

Amp Balance Test

## **DEFINITION**

Take current readings on each phase using an 'amprobe' or 'ampstick'. Typical current readings include: @40 amps/phase for 4kV - 100 kVAR per phase, @55 amps/phase for 13kV - 400 kVAR per phase, @ 40 amps/phase for 34kV - 800 kVAR per phase. Current readings will vary in direct proportion to the circuit voltage at the site. Variations of up to 10% would be acceptable. Where current readings do not fall within these guidelines, steps should be taken to identify which tanks need to be replaced. Where VO equipment allows for remote testing, and as applicable, confirm with Standards the corresponding threshold values which align with the values above. Confirmation should be made based on equipment type/model and the reading being taken remotely.

Functional Test

Thermography

Obtain load readings.

Infrared inspection of electrical equipment and power path components to identify any hot spots that may exist.

Visual Inspection

Visual inspection of equipment and miscellaneous hardware that identifies broken / degraded components. Items inspected are documented via procedures posted to the Management Model under control element Conduct of Maintenance.

## **Pole Top Capacitor Template Summary**

The Preventive Maintenance program is documented via Performance Centered Maintenance (PCM) templates. Templates have been developed that address all transmission, substation, and distribution equipment that is owned, and / or, maintained by EED. 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 PCM templates are the result of good industry practices, industry experience, and manufacturer recommendations.

### **References:**

Internal reports and operating experience

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### **Boundary Definition**

Boundaries includes the pole top capacitor unit.

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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**

N/A

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### **Disposition of Vendor Recommendations**

N/A

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## **Basis For Template Tasks**

**AMP Balance Test:** Check current reading variances to ensure proper tank balance.

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**Functional Test:** Obtain load readings and evaluate to ensure proper functionality of device.

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**Thermography:** A primary tool for detection of hot spots and 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.

<b>Revision 0</b>		<b>Date 12/29/2006</b>
Writer	Larry Griess (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	

<b>Revision 1</b>		<b>Date 11/30/2010</b>
Writer	Chuck Priebe	
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.	

<b>Revision 2</b>		<b>Date 08/17/2011</b>
Writer	Rodolfo Patriarca	
Reviewer(s)	Pete Yan, Ken Wendt, Chris Stefanski, Ron Riley	
Approver(s)	Bill Fluhler	
Reason Written	Deleted time directed task "Oil Switch Replacement" to align template with Capacitor Inspection Procedure. Task is not required since switched capacitors are inspected every year for Summer Preparedness and about 30 oil switches are replaced annually.	

<b>Revision 3</b>		<b>Date 08/01/2014</b>
Writer	Suneetha Parupalli, Material Condition	
Reviewer(s)	Ken Wendt (Mgr. Material Condition), Peter Yan (Sr. Engineer, Reliability Programs)	
Approver(s)	Mike Moy(UFAM)	
Reason Written	3 year review, reformat document, no content change	

<b>Revision 0 (AM-CE-P034-R3009 previous version)</b>		<b>Date 11/20/2015</b>
Writer	Suneetha Parupalli, Material Condition	
Reviewer(s)	Ken Wendt (Mgr. Material Condition), Peter Yan (Sr. Engineer, Reliability Programs)	
Approver(s)	Mike Moy(UFAM)	
Reason Written	Align with current practice of same maintenance frequency for fixed and switched banks.	

<b>Revision 1</b>		<b>Date 08/17/2016</b>
Writer	Suneetha Parupalli, Material Condition	
Reviewer(s)	Dale Player (Mgr. Material Condition), Peter Yan (Sr. Engineer, Reliability Programs), Anil Dhawan (Sr. Engineer, Distribution Standards)	
Approver(s)	Mike Moy(UFAM)	
Reason Written	Modified criticality section to align with EU template	

<b>Revision 2</b>		<b>Date 08/31/2019</b>
Writer	Jimi Conway (Sr. Engineer, Material Condition)	
Reviewer(s)	Suneetha Parupalli (Mgr. Material Condition), Lucy Ballesteros (Sr. Engineer, Reliability Programs), Rudy Patriarca (Sr. Engineer, Material Condition), Jimi Conway (Sr. Engineer, Material Condition), Manisha Bandyopadhyay (Mgr. AESCnT), Krystof Sudol (Mgr. Voltage Optimization), Keith Frost (Mgr. Reliability Programs), Merle Turner (Mgr. Maintenance Inspections)	
Approver(s)	Mike Moy (UFAM)	
Reason Written	3-yr review. Updated to reflect Voltage Optimization remote monitoring and testing capabilities. Adjusted visual inspection frequencies to align with circuit inspection frequencies and EU requirement. Updated Criticality I to include wording for VO equipment. Updated Amp Balance Test to include provisions for confirming corresponding values to be confirmed by standards based on the reading being taken by the specific make/model of the equipment.	