

<b>Cathodic Protection Equipment, Underground Transmission</b>				
Component Classification Categories				
Criticality	I	X		Rectifier Locations with Remote Monitoring
	II		X	Rectifier Locations without Remote Monitoring
Duty Cycle	Heavy Load	N/A	N/A	
	Normal Load	N/A	N/A	
Service Condition	In Service	X	X	
	Spare	N/A	N/A	
<b>Condition Monitoring Tasks</b>				
	<b>Task Frequencies</b>	<b>Task Frequencies</b>	<b>Failure Codes</b>	<b>Comments</b>
<b>Rectifier Readings</b>	NA	6M	1a,1c,1d	
<b>Anode Current Readings</b>	1Y	1Y	1b,1c	Done in conjunction with Cathodic Protection Calibration
<b>Structure Current Readings</b>	1Y	1Y	1c	Done in conjunction with Cathodic Protection Calibration
<b>Time Directed Tasks</b>				
	<b>Task Frequencies</b>	<b>Task Frequencies</b>	<b>Failure Codes</b>	<b>Comments</b>
<b>ISP Insitu Testing</b>	1Y	1Y	2a-b	Used where test terminals are installed. For units without test terminals, other tests are conducted
<b>Cathodic Protection Calibration</b>	1Y	1Y	1a-d	
<b>Failure Finding</b>				
	<b>Task Frequencies</b>	<b>Task Frequencies</b>	<b>Failure Codes</b>	<b>Comments</b>
<b>Manhole Pipe Voltage Recording</b>	5Y	5Y	2b,3a-b,4	
<b>Condition Directed Tasks</b>				
	<b>Task Frequencies</b>	<b>Task Frequencies</b>	<b>Failure Codes</b>	<b>Comments</b>
<b>Coating Defects Locating</b>	5Y	5Y	3a-b,4	The 5 year frequency will continue until all lines have been surveyed and based on findings frequency will change to align with EU template

**FAILURE MODE**

- 1. Fails to Provide DC Current
  
- 2. Fails to Provide DC Electrical Insulation
- 2. Fails to Provide DC Electrical Insulation
  
- 3. Fails to Meet -0.850 V Criteria
- 3. Fails to Meet -0.850 V Criteria
  
- 4. Fails to Maintain Mechanical Integrity

**FAILURE CAUSES**

- 1a. Rectifier Failure
- 1a. Rectifier Failure
- 1b. Anode Depleted
- 1c. Header Cable Failure
- 1c. Header Cable Failure
- 1d. Negative Dist. Box Failure
  
- 2a. Isolator Failure
- 2b. ISP Switch Closed, where applicable
  
- 3a. Pipe Shorted
- 3b. Pipe Coating Failure
  
- 4. Pipe Corrosion

**MAINTENANCE TASKS**

- Rectifier Readings
- Cathodic Protection Calibration
- Anode Current Readings
- Rectifier Readings
- Structure Current Readings
- Rectifier Readings
  
- ISP Insitu Testing
- Manhole Pipe Voltage Recording
  
- Manhole Pipe Voltage Recording/ Coating Defects Locating
- Manhole Pipe Voltage Recording/ Coating Defects Locating
  
- Coating Defects Locating

<b>TASK</b>	<b>DEFINITION</b>
Rectifier Readings	Record Rectifier's Volts and Amps output and the rectifier tapping. Data should be compared to previous readings. Any changes in readings should be investigated.
Cathodic Protection Calibration	Detailed inspection to ensure the cathodic protection system (rectifier, anode, and associated equipment) is working properly and has no burned or damaged internal components.
Anode Current Readings	Record individual anode current at Anode bed and compare with previous readings.
Structure Current Readings	Record individual current return for each structure at the negative termination and compare with previous readings.
ISP Insitu Testing	At locations where test terminals are installed, complete insitu testing of the internal component of the ISP to ensure the unit integrity. In case the units are not fitted with test terminals or the tester is unavailable, AC & DC voltage across the unit terminal shall be obtained, in addition to the AC current magnitude on the ground side through the use of a clamp measuring device. All obtained readings shall be recorded.
Manhole Pipe Voltage Recording	Pipe-to-reference cell voltage readings should be made in manholes and compared with previous readings. The readings should be taken with a recording voltmeter for a predetermined time period (min 2 hrs and max 24 hrs) and the mean voltage calculated. For ComEd, these readings should be taken in all manholes on any given line for two consecutive cycles or until such time as the worst manhole can be determined, at which point the readings should be discontinued in all but the worst manhole and the frequency of inspection changed to a more appropriate interval based on the results and engineering judgment. (Manhole voltages at PECO have been analyzed and determined to justify a 1-yr frequency for recoding readings in 1 (historically worst) manhole per line.)
Coating Defects Locating	Task involves walking the line end to end, using the MH as marking/point of reference. Two guys each with a sensor connected to measuring equipment measuring the voltage gradient between the two sensors.

## **Cathodic Protection of Underground Transmission 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.

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### **References:**

NACE Standard RP0169-2013  
NACE Standard TM0497-2012  
NACE Standard TM0102-2002

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### **Boundary Definition**

The boundary of Transmission Cathodic Protection systems are defined as all equipment required to ensure corrosion protection including:

- Rectifiers
- Anode Beds
- Isolating Surge Protectors

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### **Failure Experiences**

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

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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.

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## **Basis For Template Tasks**

**Anode Current Readings** : Comparison / trending of readings is used to indicate need for Anode replacement.

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**Structure Current Readings**: Comparison of readings is used to determine need for additional protective current. It will also indicate the need to survey the line to investigate the reason for the sudden change in the return current magnitude.

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**Cathodic Protection Calibration** : Ensure that the rectifier, anode, and associated equipment is working properly and has no burned or damaged internal components.

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**ISP Insitu Testing**: The Insitu tester provides a component check for the ISP units . It also provide a snapshot of the voltage and current passing through unit at the time of testing. This test is applicable in locations where test terminals are installed. In case the units are not fitted with test terminals or the tester is unavailable, AC & DC voltage across the unit terminal shall be obtained, in addition to the AC current magnitude on the ground side through the use of a clamp measuring device. All obtained readings shall be recorded.

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**Manhole Pipe Voltage Readings**: The practice is to record the structure-to-soil potential vs a CuSO<sub>4</sub> reference cell to determine the effect of stray current. It is used to assess the effect of corrosion control methods and the structure condition under the influence of mitigating processes.

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**Rectifier Readings**: Monitor the performance of the rectifier unit. Trending rectifier output over time will indicate factors affecting the output or reveals break down in the unit or system.

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**Coating Defects Locating**: The process utilizes surveying the entire length of the structure to identify coating defects. Coating defects vary in their sizes and can lead to metal perforation. Pipe Current, where applicable, can be used to narrow down the area of survey.

<b>Revision 0</b>		<b>Date 06/17/05</b>
Writer	George Leinhauser (Strategic Programs)	
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 11/06/2006</b>
Writer	George Leinhauser (Strategic Programs)	
Reviewer(s)		
Approver(s)	Kathy McHugh (FAM Maintenance Planning)	
Reason Written	General template scrub and incorporate lessons learned from initial implementation of Rev 0	

<b>Revision 2</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 3</b>		<b>Date 06/30/2011</b>
Writer	Chuck Priebe (ComEd Mat'l. Condition), Joseph Hay (PECO Transmission Eng.)	
Reviewer(s)	Ken Wendt (ComEd Mgr. Mat'l. Condition), Youssef Tabib (ComEd Corrosion Control Eng.), Frank Frentzas (ComEd Trans. Eng.), Rob Fournie (ComEd Mgr. Trans. Eng.), Alex Bilicki (PECO Corrosion Control Tech.)	
Approver(s)	Bill Fluhler (ComEd FAM Maintenance Planning), Drew Davis (PECO FAM Maintenance Planning)	
Reason Written	Revised Tasks and Frequencies to align with material condition improvement, equipment changes, and operating experience.	

<b>Revision CE 0</b>		<b>Date 02/03/2015</b>
Writer	Frank Frentzas (ComEd Trans. Eng.)	
Reviewer(s)	Youssef Tabib (ComEd Corrosion Control Eng.), Angelo DeAngelis (Mat'l Condition)	
Approver(s)	Mike Moy (ComEd FAM Maintenance Planning)	
Reason Written	Revised Tasks and Frequencies to align with EU PM Alignment initiative.	

<b>Revision CE1</b>		<b>Date 02/01/2018</b>
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Writer	Youssef Tabib (ComEd Corrosion Control Eng.)
Reviewer(s)	Angelo DeAngelis (Mat'l Condition)
Approver(s)	Mike Moy (UFAM ComEd)
Reason Written	3 year review, revised NACE reference documents to latest issue, no other content change.