Revisions to this document shall be communicated in accordance with program document AM-EU-P034 R2005 to ensure alignment between maintenance templates and field work procedures.

INSULATORS - OVERHEAD TRANSMISSION				
Component Classification Categories				
Criticality	I	X		Lines 69 kV and above
Duty Cycle	Heavy Load	N/A		
	Normal Load	N/A		
Service Condition	In Service	X		
	Spare	N/A		

Condition Monitoring Tasks	**Task Frequencies**	**Failure Codes**	**Comments**
None	N/A		
Time Directed Tasks		**Failure Codes**	**Comments**
Visual Inspection - Roadway Salt Contaminated	1M	1b	Identified vulnerable locations* between December 1 and March 1, every 1st day of month
Failure Finding Tasks		**Failure Codes**	**Comments**
Visual Inspection - Comprehensive Aerial	4Y	1a-b, 2a-e	Cycle aligns with 4 year FEG
Visual Inspection - Standard Aerial	1Y	1a-b, 2a-c	
Visual Inspection - Ground Patrol	1Y	1a-b, 2a-e	Lines/structures not accessible for *Visual Inspection - Standard Aerial* . inspection of insulators for circuits which engineering has determined to be difficult to identify during the comprehensive aerial visual inspection. Ground patrol inspections shall be on a staggered cycle with respect to the comprehensive aerial inspection. The cycle should be aligned with the vegetation management cycle as much as possible.
Condition Directed Tasks		**Failure Codes**	**Comments**
Visual Inspection - Roadway Salt Contaminated	AR	1b	Identified vulnerable locations* for each snow event where roads are plowed and salted

* - Location have been identified by ComEd

FAILURE MODE		MAINTENANCE TASKS
1. Fails to insulate	1a. Damaged Assembly	Visual Inspection - Standard Aerial
1. Fails to insulate	1a. Damaged Assembly	Visual Inspection - Comprehensive Aerial
1. Fails to insulate	1a. Damaged Assembly	Visual Inspection - Ground Patrol
1. Fails to insulate	1b. Contamination	Visual Inspection - Standard Aerial
1. Fails to insulate	1b. Contamination	Visual Inspection - Comprehensive Aerial
1. Fails to insulate	1b. Contamination	Visual Inspection - Ground Patrol
1. Fails to insulate	1b. Contamination	Visual Inspection - Standard Aerial
1. Fails to insulate	1b. Contamination	Visual Inspection - Roadway Salt Contaminated
2. Mechanical Failure	2a. Broken Bell (Entire Skirt Gone) - Porcelain Assembly	Visual Inspection - Standard Aerial
2. Mechanical Failure	2a. Broken Bell (Entire Skirt Gone) - Porcelain Assembly	Visual Inspection - Comprehensive Aerial
2. Mechanical Failure	2a. Broken Bell (Entire Skirt Gone) - Porcelain Assembly	Visual Inspection - Ground Patrol
2. Mechanical Failure	2b. Exposed Fiberglass Rod - Polymer Assembly	Visual Inspection - Standard Aerial
2. Mechanical Failure	2b. Exposed Fiberglass Rod - Polymer Assembly	Visual Inspection - Comprehensive Aerial
2. Mechanical Failure	2b. Exposed Fiberglass Rod - Polymer Assembly	Visual Inspection - Ground Patrol
2. Mechanical Failure	2c. High Fault Current Flashover - Polymer Components Damaged	Visual Inspection - Standard Aerial
2. Mechanical Failure	2c. High Fault Current Flashover - Polymer Components Damaged	Visual Inspection - Comprehensive Aerial
2. Mechanical Failure	2c. High Fault Current Flashover - Polymer Components Damaged	Visual Inspection - Ground Patrol
2. Mechanical Failure	2d. Inadequate Design (9" Insulator Bells @ 345kV - ComEd)	Visual Inspection - Comprehensive Aerial
2. Mechanical Failure	2d. Inadequate Design (9" Insulator Bells @ 345kV - ComEd)	Visual Inspection - Ground Patrol
2. Mechanical Failure	2e. Worn hardware and fittings (>25% worn)	Visual Inspection - Comprehensive Aerial
2. Mechanical Failure	2e. Worn hardware and fittings (>25% worn)	Visual Inspection - Ground Patrol

TASK	
Visual Inspection - Comprehensive Aerial	Inspection performed aerially where accessible by helicopter. The speed of inspection averages 1.5 mph. Scope includes: -- Identify broken porcelain Insulators, including number bells broken -- Identify polymer insulators with evidence flash damage or tracking -- Identify porcelain insulators with corona damage -- Identify flashed porcelain insulators -- Identify contaminated insulators -- Indentify worn hardware and fittings (>25% worn)
Visual Inspection - Ground Patrol	Inspection performed from ground level due to inaccessibility by helicopter. Additional structures may be inspected on a 5 year cycle (staggered with the Comprehensive Aerial cycle) where the aerial inspections are unable to identify defects at the ground line of the structure due to vegetation. Scope includes: -- Identify broken porcelain Insulators, including number bells broken -- Identify polymer insulators with evidence flash damage or tracking -- Identify porcelain insulators with corona damage -- Identify flashed porcelain insulators -- Identify contaminated insulators -- Indentify worn hardware and fittings (>25% worn)
Visual Inspection - Roadway Salt Contaminated	Inspection of insulators identified at ComEd locations where road salting/snow plowing is know to cause contamination. Identify signs of contamination. (Per ComEd OP-CE-P066.)

TASK	
Visual Inspection - Standard Aerial	Inspection performed aerially where accessible by helicopter. The speed of inspection averages 6 mph. (Reference speed =10-20 knots). [When performed with Thermography, the speed of inspection averages 14 mph. Reference speed = 30-40 knots]. Inspection include: -- Identify broken porcelain Insulators -- Identify polymer insulators with evidence flash damage or tracking -- Identify flashed porcelain insulators -- Identify contaminated insulators

OHT INSULATOR 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

interviews with OHT personnel

Assessing the Integrity and Remaining Service Life of Vintage High Voltage Ceramic Insulators **,** paper by Mark Ostendorp, PhD, EPRIsolutions, Inc., published by IEEE, 2003.

Assessment of Pollution Severity and Evaluation of Pollution Monitors, Final Report **,** EPRI RP3684-01, Insulator Research Project, Volume III of VI, prepared by Will Lanes, College of Engineering, University of New Orleans, February, 1996.

Composite Suspension Insulators for Overhead Transmission Lines – Tests **,** ANSI C29.11, latest edition.

Condition Assessment of Polymer Insulators **,** by Ravi S. Gorur, Department of Electrical Engineering, Arizona State University, USA.

Design Manual for High Voltage Transmission Lines , REA Bulletin 1724E-200**,** United States Department of Agriculture, Rural Utilities Service, latest edition.

IEEE Task Force Report: Brittle Fracture in Non-Ceramic Insulators **,** J.T. Burnham, et al, IEEE Transactions on Power Delivery, Vol. 17, No. 3, July 2002.

Insulators - Composites - Suspension Type **,** ANSI C29.12, latest edition.

Laboratory Analysis of Naturally Aged Silicon Rubber Polymer Insulators from Contaminated Environments, 138 to 765kV **,** by R.J. Hill, Institute of Electrical and Electronic Engineers, Inc, April 1994.

National Electrical Safety Code, ANSI C2- (NESC) **,** 2002 Edition, Institute of Electrical and Electronic Engineers, Inc., latest edition.

Review of Current Knowledge: Polluted Insulators **,** CIGRE WG –33-04, Task Force 01, August 27, 1998.

Test Methods for Electrical Power Insulators **,** ANSI C29.1, latest edition.

Transmission Line Reference Book, 345kV and Above **,** Electric Power Research Institute, second edition.

Worldwide Service Experience with HV Composite Insulators **,** CIGRE WG 22.03, Electra 2000

Zinc-Coating (Hot-Dip) on Iron and Steel Hardware , A-153, American society for Testing and Material (ASTM).

Boundary Definition

The boundary of the "insulator" for the purpose of this document is defined to include all complete insulator assemblies including individualt insulator units (bells), and attachement hardware. This includes both suspension, strain, and line line posts of both the ceramic and non-ceramic materials.

Attachment Hardware (shackles, shoes, clamps, clevises, etc.) at both hot and cold ends is included with the definition.

Failure Experience

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

Vendor Recommendations

N/A

Disposition of Vendor Recommendations
N/A

Basis For Template Tasks

Visual Inspection - Comprehensive Aerial: This inspection approximates real-time condition monitoring that can detect developing problems and degradation, and provides condition data used to initiate corrective actions. The comprehensive aerial inspection is performed at a slower fly speed to allow for more detailed visual inspection.

Visual Inspection - Ground Patrol: This inspection approximates real-time condition monitoring that can detect developing problems and degradation, and provides condition data used to initiate corrective actions. Performed at locations not accessible by helicopter for standard aerial analysis.

Visual Inspection - Roadway Salt Contaminated: This inspection is performed at locations where roadway contaminants associated with salting and plowing are prone to cause problems. The inspection is performed on both a time directed (during the winter snow months) and condition directed basis. The level of contamination will determine the need for follow up corrective action.

Visual Inspection - Standard Aerial: This inspection approximates real-time condition monitoring that can detect developing problems and degradation, and provides condition data used to initiate corrective actions.

	Revision 0
Writer	Howard Murray (Transmission Line Engineering)
Reviewer(s)	
Approver(s)	Kathy McHugh (FAM Maintenance Planning)
Reason Written	To document the maintenance program tasks, frequencies, failure modes, and maintenance basis

	Revision 1	Date 11/30/2010
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.	

	Revision 2	Date 01/27/2014
Writer	Suneetha Parupalli, Sr Engineer, Material Condition	
Reviewer(s)	Ken Wendt (Mgr. Material Condition)	
Approver(s)	Mike Moy (UFAM)	
Reason Written	3 year review, reformat document. No content change	

	Revision 3	Date 02/27/2015
Writer	Robert Munley, Stephen Dasovich, Howard Murray	
Reviewer(s)	George Leinhauser, Ken Wendt, Ken Braerman	
Approver(s)	Mike Moy	
Reason Written	Updated to align across BGE, ComEd, and PECO with incorporation of best practices.	

	Revision 4	Date 02/02/2018
Writer	Howard Murray	
Reviewer(s)	Angelo DeAngelis (Material Condition)	
Approver(s)	Mike Moy (UFAM ComEd)	
Reason Written	3 year review, no content change.	