

Pipe Type Cable System (HPFF) High Pressure Fluid Filled				
Component Classification Categories				
Criticality	I	X		Locations with Remote Monitoring
	II		X	Locations without Remote Monitoring
Duty Cycle	Heavy Load	N/A	N/A	
	Normal load	X	X	
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>
Visual Inspection - Pumping Plant	1M	2W	1a, 2a-b, 3c	
Inspect, Vent Terminations	4Y	4Y	3a, 3d	Done in conjunction with DGA Sampling at Terminations
DGA (Disolved Gas Analysis) Sampling	4Y	4Y	3a	
Fluid Quality	4Y	4Y	3b	
<b>Time Directed Tasks</b>				
	<b>Task Frequencies</b>	<b>Task Frequencies</b>	<b>Failure Codes</b>	<b>Comments</b>
Functional Test Automatic Blocking Valve System	1Y	1Y	1b	Schedule to align with summer / winter readiness activity
Functional Test Forced Cooling Units	6M	6M	1b	Schedule to align with summer / winter readiness activity
Detailed Inspection - Auto Blocking Valve System	1Y	1Y	1b	
Detailed Inspection - Forced Cooling Units	1Y	1Y	1b	
Detailed Inspection - Pumping Plant	1Y	1Y	1b	
Detailed Inspection - Suspended Facilities at Waterways/Roadways	1Y	1Y	1b, 2a, 2b, 2d, 3c	Not applicable, no current suspended HPFF installations.
Detailed Inspection - Buried Facilities at Waterways/Roadways	1Y	1Y	2b, 2c	
<b>Failure Finding</b>				
	<b>Task Frequencies</b>	<b>Task Frequencies</b>	<b>Failure Codes</b>	<b>Comments</b>
Test Alarms	1Y	1Y	1a, 2a-b	Done in conjunction with Pumping Plant Detailed Inspection
Inspect Joint Casings	4Y	4Y	3e	Done in conjunction with Manhole Inspections
Inspect Manholes, Tunnels, (Including Auxiliaries)	4Y	4Y	1a, 2a-b	
<b>Condition Directed Tasks</b>				
	<b>Task Frequencies</b>	<b>Task Frequencies</b>	<b>Failure Codes</b>	<b>Comments</b>
None	N/A	N/A		

### FAILURE MODE

- 1. Fails to Provide Adequate Capacity

- 2. Fails to Maintain Boundary Integrity

- 3. Fails to Provide Adequate Electrical Insulation

### FAILURE CAUSES

- 1a. Low Fluid Pressures
- 1a. Low Fluid Pressures
- 1a. Low Fluid Pressures
- 1b. Low Fluid Pressures
- 1b. Insufficient Cooling
- 1b. Insufficient Cooling
- 1b. Insufficient Cooling
- 1b. Insufficient Cooling

- 2a. Gasket / Joint Failure
- 2b. Corrosion
- 2c. Soil Erosion
- 2d. Mechanical Degradation

- 3a. Tracking / Corona Discharge
- 3a. Tracking / Corona Discharge
- 3b. Moisture Intrusion Poor Fluid Quality
- 3c. Low Pressure Lack of Fluid
- 3c. Low Pressure Lack of Fluid
- 3d. Entrapped Air in Line or Termination
- 3e. Joint corrosion / Improper Bonding

### MAINTENANCE TASKS

- Inspect Manholes (Including Auxiliaries)
- Visual Inspection - Pumping Plant
- Test Alarms
- Visual Inspection - Suspended Facilities at Waterways or Roadways
- Detailed Inspection - Pumping Plant
- Detailed Inspection - Forced Cooling Units
- Detailed Inspection - Auto Blocking Valve System
- Functional Test Forced Cooling Units
- Functional Test Automatic Blocking Valve System

- Inspect Manholes (Including Auxiliaries)
- Visual Inspection - Pumping Plant
- Test Alarms
- Visual Inspection - Suspended Facilities at Waterways or Roadways
- Inspect Manholes (Including Auxiliaries)
- Visual Inspection - Pumping Plant
- Test Alarms
- Visual Inspection - Buried Facilities at Waterways
- Visual Inspection - Suspended Facilities at Waterways or Roadways
- Visual Inspection - Buried Facilities at Waterways
- Visual Inspection - Suspended Facilities at Waterways or Roadways

- Inspect Terminations
- DGA Sampling
- Fluid Quality Sampling
- Visual Inspection - Pumping Plant
- Visual Inspection - Suspended Facilities at Waterways or Roadways
- Vent Terminations
- Inspect Joint Casings

**TASK****DEFINITION**

Detailed Inspection - Auto Blocking Valve System

Perform complete inspection of all electrical and mechanical components of each auto blocking valve system.

Detailed Inspection - Forced Cooling Units

Perform complete inspection of all mechanical and electrical components in the forced cooling units. This includes all OCUs, ACOPs and MROCs.

Detailed Inspection - Pumping Plant

Perform complete mechanical and electrical inspection of each pressurizing unit and all components. Verify operation of all systems. Lubricate all required components.

DGA Sampling

Take syringe samples of insulating fluid from all reservoirs, termination reservoirs and joints.

Functional Test Automatic Blocking Valve System

Check operability of each auto blocking valve system.

Functional Test Forced Cooling Units

Check operability of each forced cooling unit.

Inspect Joint Casings

Inspect protective wrapping integrity. Check exposed casings and piping for corrosion or damage. Inspect bonding connection and casing lead wires for connection integrity. Inspect for leaks from valves and fittings. Check that valves are capped.

Inspect Manholes

Inspect structural integrity of manholes, shaft and tunnel walls, floors and ceilings. Inspect hardware including ladders, cable racking, saddles, verticals, brackets, hangars and duct shields. Inspect frames, covers and necks. Inspect and clean ventilating grates. Inspect sump pumps and electrical equipment.

Inspect Terminations

Inspect for oil leaks, cracks, damaged or broken porcelain and surface tracking. Ensure insulator is clean.

Fluid Quality

Take 1 quart sample of insulating fluid from all reservoirs, termination reservoirs and joints.

Test Alarms

Test pump house / pressurizing unit / insulating fluid tank alarms and record appropriate information. Activate the alarm system as necessary to verify alarms are received at designated authority.

Visual Inspection - Pumping Plant

Inspect and change fluid pressure charts. Alternate operation of the insulating fluid pumps in each pressurizing unit. Replace nitrogen bottles when required. Inspect and record insulating fluid tank levels.

Vent Terminations

Bleed terminations to expel any trapped air or gas and verify they are filled with Insulating fluid.

**TASK**

Visual Inspection - Suspended Facilities at Waterways or Roadways

Visual Inspection - Buried Facilities at Waterways

**DEFINITION**

Inspect Pipe, Pipe Supports, Pipe Coating, Pipe Expansion Joints, suspended from or attached to a third party structure, for oil leaks, mechanical damage or mechanical degradation from corrosion or vibration. Inspect supporting structure for wear or damage. Inspect for accumulation of flammable material/debris located under/near the suspended cable pipes.

Inspect cable route at the waterway crossing for pipe/conduitbank exposure due to soil erosion, bank washout, or changing water levels.

## High Pressure Fluid Filled (HPFF) Cable 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:

EPRI Report TR-101670, Underground Transmission System Reference Book (1992 Edition)  
EEI Underground Systems Reference Book (1957 Edition)  
Transmission Cable Maintenance Guide, Prepared by Detroit Edison Company (9/27/00)

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### Boundary Definition

The boundary of Transmission High Pressure Fluid Filled Cable systems are defined from Termination to Termination, including:

- Alarms and Control Systems
- Auxiliary Equipment
- Bonding Systems
- Joints
- Manholes
- Pressurizing Systems
- Tanks
- Terminations

Excluded from this treatment are: protective, timing, and control relays and Cathodic Protection Systems.

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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

**Detailed Inspection - Auto Blocking Valve System:** The mechanical and electrical inspections required to keep a piece of machinery operating as designed. Replacement of wearable parts and lubrication of moving parts and bearing systems is included as well as leak repairs and seal replacement as indicated by condition.

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**Detailed Inspection - Forced Cooling Units:** The mechanical and electrical inspections required to keep a piece of machinery operating as designed. Replacement of wearable parts and lubrication of moving parts and bearing systems is included as well as leak repairs and seal replacement as indicated by condition.

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**Detailed Inspection - Pumping Plant:** The mechanical and electrical inspections required to keep a piece of machinery operating as designed. Replacement of wearable parts and lubrication of moving parts and bearing systems is included as well as leak repairs and seal replacement as indicated by condition.

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**DGA Sampling:** Analysis of the insulating fluid is used as a tool for detecting electrical degradation of the insulating system.  
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**Functional Test Auto Blocking System:** Verifies auto blocking system is working properly and is available if called upon to do so.

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**Functional Test Forced Cooling Units** Verifies operation prior to summer and winter periods. Also used to ensure equipment is set to operate in the appropriate mode.

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**Inspect Joint Casings:** Inspection approximates real-time condition monitoring that can detect developing problems and degradation, and provides condition data used to initiate corrective action.

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**Inspect Manholes (Including Auxilliaries):** Inspection approximates real-time condition monitoring that can detect developing problems and degradation, and provides condition data used to initiate corrective action.

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**Inspect Terminations:** Inspection approximates real-time condition monitoring that can detect developing problems and degradation, and provides condition data used to initiate corrective action.

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**Fluid Quality:** Analysis of the sample is used as a tool for monitoring aging and condition of the insulating system. The scope of testing includes: Dielectric Strength, Moisture Content, and Power Factor.

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**Test Alarms:** Intent of this task is to verify that any alarm initiated by a device or sensor at the equipment results in a notification at the control building and/or at the control / operations center. Timely and appropriate response to abnormal equipment conditions is contingent on proper operation of the alarm systems.

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**Visual Inspection - Pumping Plant:** Inspection approximates real-time condition monitoring that can detect developing problems and degradation, and provides condition data used to initiate corrective action.

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**Visual Inspection - Suspended Facilities at Waterways or Roadways:** Inspection approximates real-time condition monitoring that can detect developing problems and degradation, and provides condition data used to initiate corrective action.

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**Visual Inspection - Buried Facilities at Waterways:** Inspection approximates real-time condition monitoring that can detect developing problems and degradation, and provides condition data used to initiate corrective action.

<b>Revision 0</b>		<b>Date 11/06/2006</b>
Writer	George Leinhauser (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 06/15/2011</b>
Writer	Chuck Priebe (Mat'l. Condition)	
Reviewer(s)	Ken Wendt (Mgr. Mat'l. Condition), Frank Frentzas (Trans. Eng.), Rob Fournie (Mgr. Trans. Eng.)	
Approver(s)	Bill Fluhler	
Reason Written	Revised Tasks and Frequencies to align with material condition improvement and operating experience.	

<b>Revision 3</b>		<b>Date 06/18/2014</b>
Writer	Angelo DeAngelis	
Reviewer(s)	Ken Wendt (Mgr. Mat'l. Condition), Frank Frentzas (Trans. Eng.),	
Approver(s)	Michael Moy (UFAM ComEd)	
Reason Written	a) Aligned Task Frequencies from 1YR to 3YR for manholes/components previously falling under the Central Business District Criticality Category; includes inspection Tasks for manholes, joint casings. b.) Revised Condition Monitoring Task "DGA Sampling" to "DGA (Dissolved Gas Analysis) Sampling".	

<b>Revision 4</b>		<b>Date 03/04/2015</b>
Writer	Frank Frentzas	
Reviewer(s)	Angelo DeAngelis (Mat'l. Condition), James Flisk (Trans. Eng.),	
Approver(s)	Michael Moy (UFAM ComEd)	
Reason Written	Aligned Task Frequencies to EU North Star Template as part of the PM Alignment initiative.	

<b>Revision 5</b>		<b>Date 12/08/2015</b>
Writer	Angelo DeAngelis (Mat'l Cond. Group)	
Reviewer(s)	Frank Frentzas (Transm. Eng.)	
Approver(s)	Michael Moy (UFAM ComEd)	
Reason Written	Align Tasks to EU North Star Template. Template has been revised addressing the inspection of pipe type cable facilities crossing public waterways or public roadways. Added were two time directed inspection tasks; one task for inspecting suspended facilities such as those attached to a bridge structure and a second task for inspecting buried facilities crossing waterways such as harbors, rivers or streams.	

<b>Revision 6</b>		<b>Date 2/2/2018</b>
Writer	Angelo DeAngelis (Mat'l Cond. Group)	
Reviewer(s)	Frank Frentzas (Transm. Eng.)	
Approver(s)	Michael Moy (UFAM ComEd)	
Reason Written	3 year review, no contet change.	