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

DC In A Box (DCIAB) - Transformer				
Component Classification Categories				
Criticality	I	X		All Locations
	II			
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**
Visual Inspection	**1Y**	**1a, 2a, 3a-b, 4a, 5a-b**	
Check Nitrogen Pressure	**1Y**	**3a-f, 3j**	
Check Oil Level	**1Y**	**1a, 2a, 3a-c, 4a**	
Check Oil Temperature	**1Y**	**1a, 3g**	
Oil DGA	**1Y**	**2a, 4c-d**	
Oil Quality Test	**1Y**	**3a-b, 4a, 4c-d**	
Thermography	**1Y**	**1a,e-f, 4b**	
Time Directed	**Task Frequencies**	**Failure Codes**	**Comments**
None	**N/A**		
Failure Finding Tasks	**Task Frequencies**	**Failure Codes**	**Comments**
Functional Alarm Test	**8Y**	**5b**	Where connected to SCADA
Check / Verify Gauges and Alarms	**8Y**	**1a, 3a-f, 4b, 4d, 5a-b**	Where connected to SCADA
Condition Directed Tasks	**Task Frequencies**	**Failure Codes**	**Comments**
None	**N/A**		

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

DC In A Box (DCIAB) - Recloser				
Component Classification Categories				
Criticality	I	X		All Locations
	II			
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**
Visual Inspection	**1Y**	**4a-b, 5a-b, 6a-d, 7a-d, 8e-f, 9a-b**	
Inspect Control Cabinet	**1Y**	**8c, 8g**	
Time Directed	**Task Frequencies**	**Failure Codes**	**Comments**
Battery Replacement	**4Y**	**1d, 2d, 8b**	
Failure Finding Tasks	**Task Frequencies**	**Failure Codes**	**Comments**
Check Cabinet Heaters	**1Y**	**1b, 1f, 2b, 2f, 3d**	Where installed
Functional Operations Check	**8Y**	**1a-c, 1e-i, 2a-c, 2e-2i ,3a-g, 8a, 8c-g, 9a-d**	Perform task if operation has not occurred within the prescribed frequency
Condition Directed Tasks	**Task Frequencies**	**Failure Codes**	**Comments**
None	**N/A**		

DC In A Box (DCIAB) - Regulator				
Component Classification Categories				
Criticality	I	X		All Locations
	II			
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**
Visual Inspection	**1Y**	**1a-b, 2a, 2c, 4a-c, 5a-e, 6a,c**	
Monitor Output Voltage	**1Y**	**2a-c**	
Oil DGA	**AR**	**4d-e**	DGA can be taken to diagnose a problem if suspected
Oil Quality Test	**AR**	**4d**	Oil Quality can be taken to diagnose a problem if suspected
Thermography	**1Y**	**1a, 3a-c**	
Time Directed	**Task Frequencies**	**Failure Codes**	**Comments**
None	**N/A**		
Failure Finding Tasks	**Task Frequencies**	**Failure Codes**	**Comments**
None	**N/A**		
Condition Directed Tasks	**Task Frequencies**	**Failure Codes**	**Comments**
Calibrate the Voltage Control	**AR**	**2b, 6b**	Triggered by results of Operations or Output Voltage monitoring

FAILURE MODE	FAILURE CAUSES	MAINTENANCE TASKS
	Recloser	
1. Fails to Close	1a. Close coil Failure	Functional Operations Check
1. Fails to Close	1b. Control Circuit Failure	Functional Operations Check
1. Fails to Close	1b. Control Circuit Failure	Check Cabinet Heaters
1. Fails to Close	1c. RTU Failure	Functional Operations Check
1. Fails to Close	1d. Battery Failure	Battery Replacement
1. Fails to Close	1e. Lack of Lubrication	Functional Operations Check
1. Fails to Close	1f. Interrupter Failure	Functional Operations Check
1. Fails to Close	1f. Interrupter Failure	Check Cabinet Heaters
1. Fails to Close	1g. Mechanical/Linkage Failure	Functional Operations Check
1. Fails to Close	1h. Stored Energy Failure	Functional Operations Check
1. Fails to Close	1i. PT/CT/Relay Failure	Functional Operations Check
2. Fails to Open	2a.Open Coil Failure	Functional Operations Check
2. Fails to Open	2b. Control Circuit Failure	Functional Operations Check
2. Fails to Open	2b. Control Circuit Failure	Check Cabinet Heaters
2. Fails to Open	2c. RTU Failure	Functional Operations Check
2. Fails to Open	2d. Battery Failure	Functional Operations Check
2. Fails to Open	2e. Lack of Lubrication	Functional Operations Check
2. Fails to Open	2f. Interrupter Failure	Functional Operations Check
2. Fails to Open	2f. Interrupter Failure	Check Cabinet Heaters
2. Fails to Open	2g. Mechanical/Linkage Failure	Functional Operations Check
2. Fails to Open	2h. Stored Energy Failure	Functional Operations Check
2. Fails to Open	2i. PT/CT/Relay Failure	Functional Operations Check
3. Fails to Interrupt	3a. Open Coil Failure	Functional Operations Check
3. Fails to Interrupt	3b. Control Circuit Failure	Functional Operations Check
3. Fails to Interrupt	3c. Lack of Lubrication	Functional Operations Check
3. Fails to Interrupt	3d. Interrupter Failure	Functional Operations Check
3. Fails to Interrupt	3d. Interrupter Failure	Check Cabinet Heaters
3. Fails to Interrupt	3e. Mechanical/Linkage Failure	Functional Operations Check
3. Fails to Interrupt	3f. Stored Energy Failure	Functional Operations Check
3. Fails to Interrupt	3g. PT/CT/Relay Failure	Functional Operations Check
4. Fails to Provide Conduction Path	4a. Wire Connection Failure	Visual Inspection
4. Fails to Provide Conduction Path	4b. Isolating Switch Failure	Visual Inspection
5. Fails to Provide Bypass Conduction Path	5a. Wire Connection Failure	Visual Inspection
5. Fails to Provide Bypass Conduction Path	5b. Bypass Switch Failure	Visual Inspection

6. Fails to Provide Adequate Insulation Level	6a. Internal/External Contamination	Visual Inspection
6. Fails to Provide Adequate Insulation Level	6b. Loss of Oil	Visual Inspection
6. Fails to Provide Adequate Insulation Level	6b. Loss of Oil	Oil Level Check
6. Fails to Provide Adequate Insulation Level	6c. Bushing Failure	Visual Inspection
6. Fails to Provide Adequate Insulation Level	6d. Surge Arrester Failure	Visual Inspection
6. Fails to Provide Adequate Insulation Level	6d. Surge Arrester Failure	Radio Interference check
7. Fails to Maintain Boundary Integrity	7a. Gasket Failure	Visual Inspection
7. Fails to Maintain Boundary Integrity	7b. Weld Failure	Visual Inspection
7. Fails to Maintain Boundary Integrity	7c. Tank Corrosion	Visual Inspection
7. Fails to Maintain Boundary Integrity	7d. Loose Connections	Visual Inspection
8. Control Fails to Operate Properly	8a. RTU Failure	Functional Operations Check
8. Control Fails to Operate Properly	8b. Battery Failure/UPS	Battery Replacement
8. Control Fails to Operate Properly	8c. Wiring Failure	Inspect Control Cabinet
8. Control Fails to Operate Properly	8c. Wiring Failure	Functional Operations Check
8. Control Fails to Operate Properly	8d. Communication Failure	Functional Operations Check
8. Control Fails to Operate Properly	8e. PT/CT/Relay Failure	Visual Inspection
8. Control Fails to Operate Properly	8e. PT/CT/Relay Failure	Functional Operations Check
8. Control Fails to Operate Properly	8f. Auxiliary Component Failure	Visual Inspection
8. Control Fails to Operate Properly	8f. Auxiliary Component Failure	Functional Operations Check
8. Control Fails to Operate Properly	8g. Blown Fuse	Inspect Control Cabinet
8. Control Fails to Operate Properly	8g. Blown Fuse	Functional Operations Check
9. Fails to Provide Indication	9a. Mechanical Indicator Failure	Visual Inspection
9. Fails to Provide Indication	9a. Mechanical Indicator Failure	Functional Operations Check
9. Fails to Provide Indication	9b. Local Bulb Failure	Visual Inspection
9. Fails to Provide Indication	9b. Local Bulb Failure	Functional Operations Check
9. Fails to Provide Indication	9c. RTU Failure	Functional Operations Check
9. Fails to Provide Indication	9d. Communication Failure	Functional Operations Check
Transformer		
1. Fails to Provide Adequate Capacity	1a. Clogged / Corroded Coolers/ Radiator/ Piping	Visual Inspection
1. Fails to Provide Adequate Capacity	1a. Clogged / Corroded Coolers/ Radiator/ Piping	Monitor Oil Temperature
1. Fails to Provide Adequate Capacity	1a. Clogged / Corroded Coolers/ Radiator/ Piping	Thermography
1. Fails to Provide Adequate Capacity	1a. Clogged / Corroded Coolers/ Radiator/ Piping	Check / Verify Gauges and Alarms
1. Fails to Provide Adequate Capacity	1b. Loss of Oil	Monitor Oil Level
1. Fails to Provide Adequate Capacity	1b. Loss of Oil	Thermography

1. Fails to Provide Adequate Capacity	1b. Loss of Oil	Visual Inspection
1. Fails to Provide Adequate Capacity	1c. High Resistance Connection Failure	Thermography
2. Fails to Transform Voltage/ Current	2a. Winding Failure	Oil DGA
3. Fails to Maintain Boundary Integrity	3a. Gasket Failure	Monitor Nitrogen Pressure
3. Fails to Maintain Boundary Integrity	3a. Gasket Failure	Visual Inspection
3. Fails to Maintain Boundary Integrity	3a. Gasket Failure	Monitor Oil Level
3. Fails to Maintain Boundary Integrity	3a. Gasket Failure	Check / Verify Gauges and Alarms
3. Fails to Maintain Boundary Integrity	3a. Gasket Failure	Oil Quality Test
3. Fails to Maintain Boundary Integrity	3b. Weld Failure	Monitor Nitrogen Pressure
3. Fails to Maintain Boundary Integrity	3b. Weld Failure	Visual Inspection
3. Fails to Maintain Boundary Integrity	3b. Weld Failure	Monitor Oil Level
3. Fails to Maintain Boundary Integrity	3b. Weld Failure	Check / Verify Gauges and Alarms
3. Fails to Maintain Boundary Integrity	3b. Weld Failure	Oil Quality Test
3. Fails to Maintain Boundary Integrity	3c. Main Tank Coolers, Fins, Cooler Corrosion	Monitor Nitrogen Pressure
3. Fails to Maintain Boundary Integrity	3c. Main Tank Coolers, Fins, Cooler Corrosion	Visual Inspection
3. Fails to Maintain Boundary Integrity	3c. Main Tank Coolers, Fins, Cooler Corrosion	Monitor Oil Level
3. Fails to Maintain Boundary Integrity	3c. Main Tank Coolers, Fins, Cooler Corrosion	Check / Verify Gauges and Alarms
3. Fails to Maintain Boundary Integrity	3c. Main Tank Coolers, Fins, Cooler Corrosion	Maintenance Inspection
3. Fails to Maintain Boundary Integrity	3d. Loose Mechanical Connection	Monitor Nitrogen Pressure
3. Fails to Maintain Boundary Integrity	3d. Loose Mechanical Connection	Visual Inspection
3. Fails to Maintain Boundary Integrity	3d. Loose Mechanical Connection	Monitor Oil Level
3. Fails to Maintain Boundary Integrity	3d. Loose Mechanical Connection	Check / Verify Gauges and Alarms
3. Fails to Maintain Boundary Integrity	3d. Loose Mechanical Connection	Maintenance Inspection
3. Fails to Maintain Boundary Integrity	3e. Valve Leakage	Monitor Nitrogen Pressure
3. Fails to Maintain Boundary Integrity	3e. Valve Leakage	Visual Inspection
3. Fails to Maintain Boundary Integrity	3e. Valve Leakage	Monitor Oil Level
3. Fails to Maintain Boundary Integrity	3e. Valve Leakage	Check / Verify Gauges and Alarms
3. Fails to Maintain Boundary Integrity	3e. Valve Leakage	Maintenance Inspection
3. Fails to Maintain Boundary Integrity	3f. Main Tank Over pressurization	Monitor Nitrogen Pressure
3. Fails to Maintain Boundary Integrity	3f. Main Tank Over pressurization	Visual Inspection
3. Fails to Maintain Boundary Integrity	3f. Main Tank Over pressurization	Check / Verify Gauges and Alarms
3. Fails to Maintain Boundary Integrity	3g. Main Tank Internal Compartment	Monitor Oil Temperature
3. Fails to Maintain Boundary Integrity	3g. Main Tank Internal Compartment	Monitor Oil Levels
3. Fails to Maintain Boundary Integrity	3g. Main Tank Internal Compartment	Visual Inspection
3. Fails to Maintain Boundary Integrity	3h. Main Tank External Compartment	Monitor Oil Levels
3. Fails to Maintain Boundary Integrity	3h. Main Tank External Compartment	Visual Inspection
3. Fails to Maintain Boundary Integrity	3i. Pressure Relief Failure	Visual Inspection
3. Fails to Maintain Boundary Integrity	3j. Tank Corrosion	Monitor Nitrogen Pressure

3. Fails to Maintain Boundary Integrity	3j. Tank Corrosion	Visual Inspection
3. Fails to Maintain Boundary Integrity	3j. Tank Corrosion	Monitor Oil Level
4. Fails to Provide Adequate Electrical Insulation	4a. Insulating Oil Breakdown	Oil Quality Test
4. Fails to Provide Adequate Electrical Insulation	4b. Loss of Oil	Monitor Oil Level
4. Fails to Provide Adequate Electrical Insulation	4b. Loss of Oil	Check / Verify Gauges and Alarms
4. Fails to Provide Adequate Electrical Insulation	4b. Loss of Oil	Thermography
4. Fails to Provide Adequate Electrical Insulation	4c. Solid Insulation Failure	Oil DGA
4. Fails to Provide Adequate Electrical Insulation	4c. Solid Insulation Failure	Oil Quality Test
4. Fails to Provide Adequate Electrical Insulation	4d. Winding Insulation Failure	Oil DGA
4. Fails to Provide Adequate Electrical Insulation	4d. Winding Insulation Failure	Oil Quality Test
4. Fails to Provide Adequate Electrical Insulation	4d. Winding Insulation Failure	Check / Verify Gauges and Alarms
4. Fails to Provide Adequate Electrical Insulation	4e. Bushing Failure	Check Bushing Oil Level
4. Fails to Provide Adequate Electrical Insulation	4e. Bushing Failure	Visual Inspection
5. Fails to Alarm	5a. Gauge / Pressure Switch Failure	Check Cabinet Heaters
5. Fails to Alarm	5a. Gauge / Pressure Switch Failure	Check / Verify Gauges and Alarms
5. Fails to Alarm	5a. Gauge / Pressure Switch Failure	Monitor Gas accumulator
5. Fails to Alarm	5b. Control Circuit Failure	Check Cabinet Heaters
5. Fails to Alarm	5b. Control Circuit Failure	Functional Alarm Test (Direct Wired)
5. Fails to Alarm	5b. Control Circuit Failure	Check / Verify Gauges and Alarms
Regulator		
1. Fails to Provide Adequate Cooling	1a. Clogged/Corroded Cooler/Radiator	Visual Inspection
1. Fails to Provide Adequate Cooling	1a. Clogged/Corroded Cooler/Radiator	Thermography
1. Fails to Provide Adequate Cooling	1b. Loss of Oil	Visual Inspection
2. Fails to Regulate Voltage	2a. Control Circuit Failure	Visual Inspection
2. Fails to Regulate Voltage	2a. Control Circuit Failure	Monitor Output Voltage
2. Fails to Regulate Voltage	2b. Control Out of Calibration	Calibrate the Voltage Control
2. Fails to Regulate Voltage	2b. Control Out of Calibration	Monitor Output Voltage
2. Fails to Regulate Voltage	2c. Motor Failure	Visual Inspection
2. Fails to Regulate Voltage	2c. Motor Failure	Monitor Output Voltage
3. Fails to Provide Conduction Path	3a. Contacts High Resistance	Thermography
3. Fails to Provide Conduction Path	3b. Loose Connection	Thermography
3. Fails to Provide Conduction Path	3c. Winding High Resistance	Thermography
4. Fails to Provide Adequate Insulation Level	4a. External Contamination	Visual Inspection
4. Fails to Provide Adequate Insulation Level	4b. Cracked/Broken Bushing	Visual Inspection

4. Fails to Provide Adequate Insulation Level	4c. Loss of Oil	Visual Inspection
4. Fails to Provide Adequate Insulation Level	4d. Poor Oil Quality	Oil Quality Test
4. Fails to Provide Adequate Insulation Level	4d. Winding Dielectric Failure	Oil DGA
4. Fails to Provide Adequate Insulation Level	4e. Solid Dielectric Failure	Oil DGA
5. Fails to Maintain Boundary Integrity	5a. Gasket Failure	Visual Inspection
5. Fails to Maintain Boundary Integrity	5b. Weld Failure	Visual Inspection
5. Fails to Maintain Boundary Integrity	5c. Tank Corrosion	Visual Inspection
5. Fails to Maintain Boundary Integrity	5d. Loose Connections	Visual Inspection
5. Fails to Maintain Boundary Integrity	5e. Control Cabinet Contamination	Visual Inspection
6. Regulator Operates Too Frequently	6a. Control Circuit Failure	Visual Inspection
6. Regulator Operates Too Frequently	6b. Control Out of Calibration	Calibrate the Voltage Control
6. Regulator Operates Too Frequently	6b. Control Out of Calibration	Visual Inspection

TASK	DEFINITION
Transformer	
Check / Verify Gauges and Alarms	Check accuracy of installed gauges and alarms. Verify switch pick up and drop out values against a calibrated instrument or gauge. Verify set points are correct and equipment operates as designed.
Check Nitrogen Pressure	Visual verification of proper Nitrogen pressure by monitoring the Nitrogen Pressure in the main tank and nitrogen bottle (If so equipped.) Add nitrogen as required and record amount added for trending purposes.
Check Oil Temperature	Record present top oil and maximum top oil temperatures.
Check Oil Level	Visual verification of proper oil level in all oil filled compartments. Record oil level. Correct level as required and record amount added/removed for trending.
Functional Alarm Test (Direct Wired)	Verify alarm at transformer is sent to substation control house and System Operations (If applicable). Test should be performed by bringing up an alarm at the equipment and verifying it is received in the substation control house and System Operations.
Oil DGA	Take syringe samples. Data to be trended.
Oil Quality Test	Take 1 quart sample.
Thermography	Infrared inspection of electrical equipment and power path components to identify any hot spots that may exist either in the contacts, bus connections or within control cabinets. Comparisons should be made phase to phase or on tank walls to determine if contact heating can be found or to determine oil levels within all tanks and verify level gauge.
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. These items should be checked: - Check for unusual noises and smells - Check Cabinet Heaters are operational - Verify alarm status and relay flags (if applicable) - Visually inspect for damage, cracked or chipped porcelain insulators - Check for signs of oil leakage from bushings, tank penetrations, gasket and flanges - Check secondary cable bond connections for jacket slippage - Check for loose, missing or damaged hardware - Check condition of grounding connections - Check coolers for debris and general cleanliness - Inspect air filters (where readily accessible) on all air filled compartments
Recloser	
Battery Replacement	Replace the Control & RTU batteries.
Check Cabinet Heaters	Visual/physical verification that cabinet heaters are operational.
Functional Operations Check	Closing and open the device using the local control switch and check the position of the mechanical flag for local operation. Also checking the Hot Line Tag Function to be completed with the replacement of the battery
Inspect Control Cabinet	Check interior of control cabinet for accumulation of dust and dirt; clean as necessary. Check door gasket for effective seal, repair or replace as required. Check for broken or loose wiring terminals and blown fuses. Visually inspect circuit boards for burnt or damaged components. Verify control box heaters are operational (if applicable).
Visual Inspection	Visually inspect external components. Check for broken or cracked bushings, blown arresters, oil leaks, check for paint scratches and other mechanical damage; touch up to inhibit corrosion. Record and trend operations counter. This may include both a mechanical counter and/or a digital counter integral to the controls.

TASK	DEFINITION
Regulator	
Calibrate the Voltage Control	Perform calibration of voltage control to ensure proper band-center, band-width, load-drop compensation, and time-delay settings.
Monitor Output Voltage	Record and verify proper output voltage at the test terminals of the regulator controls.
Oil DGA	Take syringe samples. Data to be trended.
Oil Quality Test	Take 1 jar sample.
Thermography	Infrared inspection of electrical equipment and power path components to identify any hot spots that may exist.
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. These items should be checked: - Check for unusual noises and smells - Check range of operation and present tap position - Visually inspect for damage, cracked or chipped porcelain insulators - Check for signs of oil leakage from bushings, tank penetrations, gaskets and flanges - Check for loose, missing or damaged hardware - Check oil level, where applicable - Check / record operations counter

DC In A Box (DCIAB) 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:

ANSI C37.60, "Requirements for Automatic Circuit Reclosers for Alternating-Current Systems"
ANSI C37.61, "Guide for the Application, Operation and Maintenance of Automatic Circuit Reclosers"
C5370- DC In A Box Transformer
C5371 - DC In A Box Regulator
Cooper Power Systems Service Information S280-15-1, " Type L Recloser Maintenance Instructions"
Cooper Power Systems Service Information S280-15-7, "Type V4L, V4E Single-Phase Maintenance Instructions"
Cooper Power Systems Service Information S280-40-6, "Types VWE, VWVE27,VWVE38X Electronically Controlled Recloser Maintenance Instructions"
Cooper Power Systems Service Information S280-42-1, "Type NOVA Three-Phase, Microprocessor - Controlled Recloser Installation and Operation Instructions"
Cooper Power Systems Service Information S280-45-5, "Type VSA-12, VSA-16 and VSA-20/800 Three-Phase Recloser Maintenance Instructions"
Cooper Power Systems Service Information S280-90-6, " Electronic Control Battery Testing, Charging, and Replacement Instructions"
EPRI 000000000001001779 Guidelines for the Life Extension of Substations
EPRI 1002913 Power Transformer Maintenance and Application Guide
EPRI TR-106857 Preventative Maintenance Basis, V38
IEEE C57.12.00 "IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers"
IEEE C57.15, "IEEE Standard Requirement, Terminology, and Test Code for Step-Voltage Regulators"
IEEE Standard C57.104 IEEE Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers
IEEE Standard C57.106 IEEE Guide for Acceptance and Maintenance of Insulating Oil in Equipment

Boundary Definition

The boundary for the purpose of this document is defined to include the three component areas of the DC In A Box (DCIAB): Self Contained Transformer, a recloser (within the Transformer enclsoure) and three Voltage Regulators. All three component categories are within an enclosure, which is included as part of this document's scope. The boundary will include these three component areas which includes transformer tank, bushings, interrupters, insulating oil, operating mechanism, gages and integral controls.

Excluded from this treatment are: associated secondary equipment that interfaces with the regulator controller such as the scada controls, control relays external to the DCIAB .

Failure Experiences

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

Vendor Recommendations

Vendor documentation was reviewed in the development of this template.

Disposition of Vendor Recommendations

N/A

Basis For Template Tasks

Battery Replacement: Battery life is limited. Replacement of batteries on a time directed basis will ensure that the battery will be operational.

Calibrate the Voltage Control (Regulator): This is a condition directed task triggered by excessive operations (more than 700 operations per month).

Check Cabinet Heaters: Task intended to ensure designed systems are operating properly to prevent moisture intrusion into the transformer control cabinets and/or recloser cabinets. Moisture in these areas have been known to cause corrosion damage to control and alarm circuits.

Check Oil Level: Indicator of possible leaks.

Check Oil Temperature (Transformer): Oil and winding temperature measurement are a result of the load current, ambient temperature and effectiveness of the cooling systems. Temperatures of the oil and winding are directly related to the transformer life. Tracking the actual and maximum temperatures seen can provide insight into the condition of the transformer and correlate to dga oil samples.

Functional Alarm Test: EPRI 106857 identifies functional testing of control circuits to verify proper operation of the auxiliary systems.

Functional Operations Check: ensure that device will operate.

Inspect Control Cabinet: Ensure that the cabinet is free of debrie and the door seal is an effective barrier against moisture intrusion. Also provides for a check for damaged components that need repair

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Monitor Output Voltage: Verify that the equipment is performing as designed.

Oil DGA (Transformer, Regulator): IEEE Standard C57.152 identifies dissolved gas analysis as a primary troubleshooting tool for a range of electrical faults in the transformer, as well as the condition of the insulating oil. EPRI TR-106857-V38 identifies dissolved gas analysis as a tool for detecting electrical degradation of the coils, core, cooling system and insulating system. EPRI 1002913 identifies dissolved gas analysis as an excellent method of assessing transformer condition. The minimum scope for analysis and trending includes: Hydrogen, Carbon Monoxide, Ethylene, Ethane, Methane, Acetylene, Total Dissolved Combustible Gas. Additionally, the following are included in the minimum scope to trend insulation degradation, identify leaks, monitor the integrity of the oil preservation system and verify the quality of the oil sample: Oxygen, Nitrogen, Carbon Dioxide.

Oil Quality Test: IEEE Standard 62 identifies oil quality tests as a tool for monitoring aging and condition of the insulating system. Oil quality tests provide indication of oil condition and long term paper degradation. EPRI 1002913 identifies oil analysis as a primary tool for determining transformer condition. Insulating oil is a significant element in the insulating system. These tests assess the condition of the oil and the cellulose insulation system. EPRI TR-106857-V38 recommends periodic insulating oil quality tests. The scope of testing includes: Dielectric Strength, Power Factor, Interfacial Tension, Color, Sediment, Moisture Content, Acid Number. It is important to obtain the temperature of the equipment at the time of the sample to ensure accurate calculation of H_2O saturation.

Thermography: IEEE Standard C57.152 identifies thermography as a primary tool for detection of connection issues, bushing issues, and issues with the cooling systems. EPRI 1002913 identifies thermography as a tool for detection of connection issues, insulator degradation and cooling system operation. EPRI TR-106857-V38 Identifies thermography as a tool for detection of loose electrical connections, LTC contact problems, local flux current heating, proper cooler operation, bearing wear in pump and fan motors.

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.

	Revision 0	Date 03/31/2016
Writer	Hugo Castaneda (Material Condition)	
Reviewer(s)	Ken Wendt, Doug Mason, Martin Rave, Anil Dhawam, Nitin Patel, Suneetha Parupalli, Elizabeth Jakosz, Peter Yan	
Approver(s)	Mike Moy (UFAM ComEd)	
Reason Written	To document the maintenance program tasks, frequencies, failure modes, and maintenance basis for a DC In A Box.	