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.

Substation Bus - Open Air ≥ 345kV					
Component Classification Categories					
Criticality	I	X			Nuclear Switchyards ≥ 220kV as defined in the respective Nuclear Plant Interface Requirements (NPIRs).
	II		X		345kV & 765kV locations exclusive of Criticality I locations
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		

Condition Monitoring Tasks	**Task Frequencies**		**Failure Codes**	**Comments**
None	**N/A**	**N/A**		
Failure Finding Tasks	**Task Frequencies**		**Failure Codes**	**Comments**
Visual Inspection - Open Air	**5W**	**10W**	**1a-b, 2a-b, 3a-c, 4a-e**	
Thermography	**1Y**	**1Y**	**1a-b**	
Corona Survey	**1Y**	**1Y**	**2b**	Limited to Nuclear Switchyards as defined in the respective Nuclear Plant Interface Requirements (NPIRs) and their Next Terminal Out, 765kV locations, Critical Transmission Interconnections and ≥345 TDC, TSS locations that serve O'Hare & Midway Airports.
Time Directed Tasks	**Task Frequencies**		**Failure Codes**	**Comments**
Detailed Visual Inspection	**8Y**	**8Y**	**1b, 2a-b, 3a-b, 4b**	Bus outage required; bus availability may be limited at nuclear switchyards due to operational concerns. Tasks should be performed where accessible and where access to insulators does not pose unacceptable risk to personnel or to bus below at cross-over sections. On generator output bus at nuclear switchyards, perform tasks on 6 year frequency.
Check Insulators	**8Y**	**8Y**	**2b**	
Condition Directed Tasks	**Task Frequencies**		**Failure Codes**	**Comments**
None	**N/A**	**N/A**		

Substation Bus - Open Air 69kV to 138kV							
Component Classification Categories							
Criticality	I	X					DC, SS, TDC, TSS locations that directly serve O'Hare & Midway Airports
	II		X				Critical Transmission Interconnections
	III			X			Critical Equipment / Locations per ComEd AM-CE-P034-R0001 (Equipment / Locations Exclusive of Criticality I & II)
	IV				X		All Other locations
Duty Cycle	Heavy Load	N/A	N/A	N/A	N/A		
	Normal Load	N/A	N/A	N/A	N/A		
Service Condition	In Service	X	X	X	X		
	Spare	N/A	N/A	N/A	N/A		

Condition Monitoring Tasks	**Task Frequencies**				**Failure Codes**	**Comments**
None	**N/A**	**N/A**	**N/A**	**N/A**		
Failure Finding Tasks	**Task Frequencies**				**Failure Codes**	**Comments**
Visual Inspection - Open Air	**5W**	**10W**	**10W**	**10W**	**1a-b, 2a-b, 3a-c, 4a-e**	
Thermography	**1Y**	**1Y**	**1Y**	**1Y**	**1a-b**	
Corona Survey	**1Y**	**1Y**	**1Y**	**N/A**	**2b**	
Time Directed Tasks	**Task Frequencies**				**Failure Codes**	**Comments**
Detailed Visual Inspection	**8Y**	**8Y**	**8Y**	**AR**	**1b, 2a-b, 3a-b, 4b**	Bus outage required; bus availability may be limited at nuclear switchyards due to operational concerns. Tasks should be performed where accessible and where access to insulators does not pose unacceptable risk to personnel or to bus below at cross-over sections.
Check Insulators	**8Y**	**8Y**	**8Y**	**AR**	**2b**	
Condition Directed Tasks	**Task Frequencies**				**Failure Codes**	**Comments**
None	**N/A**	**N/A**	**N/A**	**N/A**		

Substation Bus - Open Air ≤34 kV								
Component Classification Categories								
Criticality	I	X						DC, SS, TDC, TSS locations that serve O'Hare & Midway Airports
	II		X					Critical Equipment / Locations per ComEd AM-CE-P034-R0001 (Equipment / Locations exclusive of Criticality I)
	III			X				Locations exclusive of Criticality I & II, DC and ≤34kV ESS locations
	IV				X			DC Locations
	V					X		≤34kV ESS locations
Duty Cycle	Heavy Load	N/A	N/A	N/A	N/A	N/A		
	Normal Load	N/A	N/A	N/A	N/A	N/A		
Service Condition	In Service	X	X	X	X	X		
	Spare	N/A	N/A	N/A	N/A	N/A		

Condition Monitoring Tasks	**Task Frequencies**					**Failure Codes**	**Comments**
None	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**		
Failure Finding Tasks	**Task Frequencies**					**Failure Codes**	**Comments**
Visual Inspection	**5W**	**10W**	**10W**	**3M**	**6M**	**1a-b, 2a-b, 3a-c, 4a-e**	
Thermography	**1Y**	**1Y**	**1Y**	**1Y**	**4Y**	**1a-b**	
Time Directed Tasks	**Task Frequencies**					**Failure Codes**	**Comments**
Detailed Visual Inspection	**16Y**	**16Y**	**AR**	**AR**	**AR**	**1b, 2a-b, 3a-b, 4b**	
Check Insulators	**16Y**	**16Y**	**AR**	**AR**	**AR**	**2b**	
Condition Directed Tasks	**Task Frequencies**					**Failure Codes**	**Comments**
None	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**		

Substation Bus - Metal Clad / Duct								
Component Classification Categories								
Criticality	I	X						DC, SS, TDC, TSS locations that serve O'Hare & Midway Airports
	II		X					Critical Equipment / Locations per ComEd AM-CE-P034-R0001 [Equipment / Locations Exclusive of Criticality I]
	III			X				Locations exclusive of Criticality I & II, DC and ≤34kV ESS locations
	IV				X			DC Locations
	V					X		≤34kV ESS locations
Duty Cycle	Heavy Load	N/A	N/A	N/A	N/A	N/A		
	Normal Load	N/A	N/A	N/A	N/A	N/A		
Service Condition	In Service	X	X	X	X	X		
	Spare	N/A	N/A	N/A	N/A	N/A		

Condition Monitoring Tasks	**Task Frequencies**					**Failure Codes**	**Comments**
None	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**		
Failure Finding Tasks	**Task Frequencies**					**Failure Codes**	**Comments**
Visual Inspection	**5W**	**10W**	**10W**	**3M**	**6M**	**1a-b, 2a-b, 3a-c, 4a-e**	
Thermography	**1Y**	**1Y**	**1Y**	**1Y**	**4Y**	**1a-b**	
Time Directed Tasks	**Task Frequencies**					**Failure Codes**	**Comments**
Detailed Visual Inspection - Metal Clad / Duct Outdoor (Includes Unit Sub and Sheltered Isle)	**12Y**	**12Y**	**AR**	**AR**	**AR**	**1b, 2a-c, 3a-b, 4b**	Where the condition of any Bus type configuration is degraded and/or subjected to environmental factors (e.g. heavy debris, salt fog, etc.), maintenance performed at a lesser frequency is acceptable.
Detailed Visual Inspection - Metal Clad / Duct Indoor (Includes Indoor Bldg and Prefabricated)	**16Y**	**16Y**	**AR**	**AR**	**AR**		
Condition Directed Tasks	**Task Frequencies**					**Failure Codes**	**Comments**
None	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**		

SUBSTATION BUS FAILURE MODES

FAILURE MODES	FAILURE CAUSES	MAINTENANCE TASKS
1. Fails to provide conduction path	1a. Bus High Resistance	Visual Inspection - Open Air Bus
1. Fails to provide conduction path	1a. Bus High Resistance	Visual Inspection - Metal Clad Bus
1. Fails to provide conduction path	1a. Bus High Resistance	Thermography
1. Fails to provide conduction path	1b. Bus Welds Failure	Visual Inspection - Open Air Bus
1. Fails to provide conduction path	1b. Bus Welds Failure	Visual Inspection - Metal Clad Bus
1. Fails to provide conduction path	1b. Bus Welds Failure	Thermography
1. Fails to provide conduction path	1b. Bus Welds Failure	Detailed Visual Inspection - Open Air Bus
1. Fails to provide conduction path	1b. Bus Welds Failure	Detailed Visual Inspection - Metal Clad / Duct
2. Fails to Provide Adequate Insulation Level	2a. External Contamination	Visual Inspection - Open Air Bus
2. Fails to Provide Adequate Insulation Level	2a. External Contamination	Visual Inspection - Metal Clad Bus
2. Fails to Provide Adequate Insulation Level	2a. External Contamination	Detailed Visual Inspection - Open Air Bus
2. Fails to Provide Adequate Insulation Level	2a. External Contamination	Detailed Visual Inspection - Metal Clad / Duct
2. Fails to Provide Adequate Insulation Level	2a. External Contamination	Check / Re-apply Insulator Coating
2. Fails to Provide Adequate Insulation Level	2b. Cracked/Broken Insulator	Visual Inspection - Open Air Bus
2. Fails to Provide Adequate Insulation Level	2b. Cracked/Broken Insulator	Visual Inspection - Metal Clad Bus
2. Fails to Provide Adequate Insulation Level	2b. Cracked/Broken Insulator	Detailed Visual Inspection - Open Air Bus
2. Fails to Provide Adequate Insulation Level	2b. Cracked/Broken Insulator	Detailed Visual Inspection - Metal Clad / Duct
2. Fails to Provide Adequate Insulation Level	2b. Cracked/Broken Insulator	Check Insulators
2. Fails to Provide Adequate Insulation Level	2b. Cracked/Broken Insulator	Corona Survey
2. Fails to Provide Adequate Insulation Level	2c. Internal Contamination	Detailed Visual Inspection - Metal Clad / Duct
3. Fails to Provide Adequate Conductor Support	3a. Metal Corrosion	Visual Inspection - Open Air Bus
3. Fails to Provide Adequate Conductor Support	3a. Metal Corrosion	Visual Inspection - Metal Clad Bus
3. Fails to Provide Adequate Conductor Support	3a. Metal Corrosion	Detailed Visual Inspection - Open Air Bus
3. Fails to Provide Adequate Conductor Support	3a. Metal Corrosion	Detailed Visual Inspection - Metal Clad / Duct
3. Fails to Provide Adequate Conductor Support	3b. Mechanical Fastening Failure (weld, bolt, etc.)	Visual Inspection - Open Air Bus
3. Fails to Provide Adequate Conductor Support	3b. Mechanical Fastening Failure (weld, bolt, etc.)	Visual Inspection - Metal Clad Bus
3. Fails to Provide Adequate Conductor Support	3b. Mechanical Fastening Failure (weld, bolt, etc.)	Detailed Visual Inspection - Open Air Bus
3. Fails to Provide Adequate Conductor Support	3b. Mechanical Fastening Failure (weld, bolt, etc.)	Detailed Visual Inspection - Metal Clad / Duct
3. Fails to Provide Adequate Conductor Support	3c. Metal Fatigue	Visual Inspection - Open Air Bus
3. Fails to Provide Adequate Conductor Support	3c. Metal Fatigue	Visual Inspection - Metal Clad Bus
4. Loss of Structural Integrity	4a. Concrete Deterioration	Visual Inspection - Open Air Bus
4. Loss of Structural Integrity	4a. Concrete Deterioration	Visual Inspection - Metal Clad Bus
4. Loss of Structural Integrity	4b. Loose Connections	Visual Inspection - Open Air Bus
4. Loss of Structural Integrity	4b. Loose Connections	Visual Inspection - Metal Clad Bus
4. Loss of Structural Integrity	4b. Loose Connections	Detailed Visual Inspection - Open Air Bus
4. Loss of Structural Integrity	4b. Loose Connections	Detailed Visual Inspection - Metal Clad / Duct
4. Loss of Structural Integrity	4c. Anchor Corrosion	Visual Inspection - Open Air Bus
4. Loss of Structural Integrity	4c. Anchor Corrosion	Visual Inspection - Metal Clad Bus
4. Loss of Structural Integrity	4d. Erosion	Visual Inspection - Open Air Bus
4. Loss of Structural Integrity	4d. Erosion	Visual Inspection - Metal Clad Bus
4. Loss of Structural Integrity	4e. Sink Holes	Visual Inspection - Open Air Bus
4. Loss of Structural Integrity	4e. Sink Holes	Visual Inspection - Metal Clad Bus
4. Loss of Structural Integrity	4c. Anchor Corrosion	Visual Inspection - Open Air Bus
4. Loss of Structural Integrity	4c. Anchor Corrosion	Visual Inspection
4. Loss of Structural Integrity	4d. Erosion	Visual Inspection - Open Air Bus
4. Loss of Structural Integrity	4d. Erosion	Visual Inspection
4. Loss of Structural Integrity	4d. Erosion	Visual Inspection - Duct
4. Loss of Structural Integrity	4d. Erosion	Visual Inspection - Cubical
4. Loss of Structural Integrity	4e. Sink Holes	Visual Inspection - Open Air Bus
4. Loss of Structural Integrity	4e. Sink Holes	Visual Inspection
4. Loss of Structural Integrity	4f. Corrosion	Detailed Visual Inspection - Open Air Bus
4. Loss of Structural Integrity	4f. Corrosion	Detailed Visual Inspection - Metal Clad
4. Loss of Structural Integrity	4f. Corrosion	Detailed Visual Inspection - Duct
4. Loss of Structural Integrity	4f. Corrosion	Detailed Visual Inspection - Cubical

SUBSTATION BUS MAINTENANCE TASK DEFINITION

TASK	DEFINITION
Check / Re-apply Insulator Coating	Locations with history of contamination where coatings have been applied to insulators -- Inspect condition of any applied protective silicone rubber coating or equivalent. -- As necessary, clean insulators and/or re-coat with new silicone rubber coating or equivalent.
Check Insulators	Perform a close-up, visual inspection and perform "ping test" on insulators to identify surface cracks and hidden surface defects. A ping test shall only be performed on de-energized equipment.Tapping lightly on the side of a good insulator with a wooden hammer handle (for example) will give a high-pitched ping sound. A ping test on a defective insulator will give a “thud”, flat sound. Insulators that fail the ping test must be replaced.
Corona Survey	Perform corona survey of energized switchyard bus equipment using a hand held Corona Imaging Camera. Anomalies to be documented and sent to Engineering for further evaluation.
Detailed Visual Inspection - Open Air Bus	The Detailed Visual Inspection and Cleaning consists of the following tasks with the bus denergized and blocked: -- Perform a detailed visual inspection. -- Check for loose missing or damaged hardware. -- Check insulators and bushings for signs of cracking, leaks, and contamination. -- Check condition of grounding connections. -- Check bus expansion joints/vibration damper -- Verify Tightness of Bolted Connections
Detailed Visual Inspection - Metal Clad / Duct Indoor	Inspect Bus, Bus Duct and Cubicals -- Check insulation systems for signs of overheating, cracking, tracking and contamination. -- Inspect bus ports and perform cubical inspections. -- Verify cubical heater operation. -- Check for loose missing or damaged hardware. -- Check condition of grounding connections. -- Check all primary cable shield ground connections for tightness and that there are no signs of overheating. -- Check condition of control wiring and secondary components. -- Check and lubricate the switchgear racking mechanism. -- Clean all insulation, bus surfaces, surrounding duct. -- Check condition of RTV in all air gaps between the bus work and the insulating boards. -- Check for signs of moisture intrusion. -- Check that the air breathers are functional. -- Re-apply waterproofing materials.
Detailed Visual Inspection - Metal Clad / Duct Outdoor	Inspect Bus, Bus Duct and Cubicals -- Check insulation systems for signs of overheating, cracking, tracking and contamination. -- Inspect bus ports and perform cubical inspections. -- Verify cubical heater operation. -- Check for loose missing or damaged hardware. -- Check condition of grounding connections. -- Check all primary cable shield ground connections for tightness and that there are no signs of overheating. -- Check condition of control wiring and secondary components. -- Check and lubricate the switchgear racking mechanism. -- Clean all insulation, bus surfaces, surrounding duct. -- Check condition of RTV in all air gaps between the bus work and the insulating boards. -- Check for signs of moisture intrusion. -- Check that the air breathers are functional. -- Re-apply waterproofing materials.
Thermography	Infrared inspection of electrical equipment and power path components, connections, and insulators.
Visual Inspection - Metal Clad Bus	The visual inspection consists of the following: -- Check signs of moisture intrusion -- Check for unusual noises and smells. -- Verify cabinet heater operation. -- Check for loose missing or damaged hardware/barriers. -- Check condition of exposed grounding connections.
Visual Inspection - Open Air Bus	The visual inspection consists of the following: -- Check for loose missing or damaged hardware. -- Check insulators and bushings for signs of cracking and contamination. -- Check condition of grounding connections.

SUBSTATION BUS MAINTENANCE BASIS

Substation Bus 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

Boundary Definition
The boundary of a bus includes:

- Bushings
- Insulators
- Buswork
- Bus Duct

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

Vendor Recommendations
MidSun recommendations for checking and recoating insulators with silicon coating included.

Disposition of Vendor Recommendations
N/A

Basis For Template Tasks

Check Insulators - Close-up visual inspection and 'ping test" on insulators will identify surface cracks and hidden surface defects. Ping test applies only to porcelain, post type insulators.

Check / Re-apply Insulator Coating - Resulting from insulator flashover events in areas of high contamination, and noting the need to continue to monitor applied insulator coatings, clean, and re-apply as necessary.

Corona Survey - Inspection of the energized bus and insulators using a corona camera can be employeed to identify sharp surfaces, broken hardware and damaged or contaminated insulators.

Detailed Visual Inspection: This task is to provide a detailed inspection for open air bus and detailed inspection of metal-clad and switchgear and bus duct and is intended to address issues of contamination and tracking.

Thermography: A primary tool for detection of connection issues, bushing issues, and insulator degradation.

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.

SUBSTATION BUS TEMPLATE DEVELOPMENT HISTORY

	Revision 0	**Date 12/29/2006**
Writer	George Leinhauser	
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	Chris Stefanski	
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 04/29/2011**
Writer	Chris Stefanski (Material Condition)	
Reviewer(s)	Ken Wendt, Drew Reindel, Jim Crane	
Approver(s)	Bill Fluhler (ComEd)	
Reason Written	Modified criticality definitions and incorporated 10-week, 3-month and 6-month inspection task frequencies	

	Revision 3	**Date 12/18/2012**
Writer	Chris Stefanski (Material Condition)	
Reviewer(s)	Ken Wendt, Jim Crane, Greg Hitzke	
Approver(s)	Bill Fluhler (UFAM ComEd)	
Reason Written	Added insulator check and corona survey (Reference Byron RCI on S-Bus Failure) for ≥ 69kV; added separate tab for ≤34 kV.	

	Revision 4	**Date 01/08/2015**
Writer	Chris Stefanski (Exelon Utilities)	
Reviewer(s)	Ken Wendt, Greg Hitzke, Steve Scalcucci	
Approver(s)	Michael Moy (UFAM ComEd)	
Reason Written	Added Detailed Visual Inspection task. Changed 6 year frequency of maintenance to 8 years on ≥ 69kV bus.	

SUBSTATION BUS TEMPLATE DEVELOPMENT HISTORY

	Revision 5	Date 03/31/2016
Writer	Hugo Castaneda (Material Condition)	
Reviewer(s)	Ken Wendt, Greg Hitzke, Doug Mason, Nitin Patel, Elizabeth Jakosz	
Approver(s)	Michael Moy (UFAM ComEd)	
Reason Written	Added Metal Clad / Duct configurations with associated maintenance tasks, task detail and maintenance basis. Modified Open Air Bus maintenance to align with Switch maintenance program at locations outside of Nuclear.	

	Revision 6	Date 09/22/2017
Writer	Hugo Castaneda (ComEd Material Condition)	
Reviewer(s)	Dale Player (ComEd Material Condition Manager), Nitin Patel (ComEd T&S Equipment Stds Manager), Greg Hitzke (ComEd T&S Equipment Stds), Elizabeth Spolarich (ComEd T&S Equipment Stds), Richard Bellino (ComEd T&S Equipment Stds), Doug Mason (ComEd T&S Equipment Stds), Ismael Rivera Jr (Dresden Nuclear Station Systems Engineer), Travis Greene (Byron Nuclear Station Systems Engineer), Sachin Shukla (Braidwood Nuclear Station Systems Engineer), Aaron Kulow (Quad Cities Nuclear Station Systems Engineer), Kent Nelson (LaSalle Nuclear Station Systems Engineer)	
Approver(s)	Michael Moy (UFAM ComEd)	
Reason Written	Revised Criticalities to reflect AM-CE-P034-R0001 categories.	