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Project Operations
Locks and Dams Maintenance Standards

FOR THE COMMANDER:

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Purpose. This engineer circular establishes policy for maintenance practices for locks and dams. It defines the project maintenance plans, maintenance standards, standard maintenance categorization, and maintenance management control that will be included in a future maintenance regulation.

Applicability. This circular applies to all U.S. Army Corps of Engineers Civil Works elements and all U.S. Army Corps of Engineers commands having locks and dams.

Distribution Statement. Approved for public release; distribution is unlimited.

Proponent and Exception Authority. The proponent of this circular is the Directorate of Civil Works, Operations and Regulatory Division. The proponent has the authority to approve exceptions or waivers to this circular that are consistent with controlling law and regulations. Only the proponent of a publication or form may modify it by officially revising or rescinding it.

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This section contains no entries.

1. Purpose

This engineer circular establishes policy for maintenance practices for locks and dams. It defines the project maintenance plans, maintenance standards, standard maintenance categorization, and maintenance management control that will be included in a future maintenance regulation.

2. Distribution statement

Approved for public release; distribution is unlimited.

3. References

See Appendix A.

4. Records management (recordkeeping) requirements

The records management requirement for all record numbers, associated forms, and reports required by this publication are addressed in the Army Records Retention Schedule. Detailed information for all related record numbers is located on the U.S. Army Corps of Engineers (USACE) Records Management Site <https://usace.dps.mil/sites/INTRA-CIOG6/SitePages/Records-Management.aspx>. If any record numbers, forms, and reports are not current, addressed, and/or published correctly, see DA Pam 25-403 for guidance.

5. Associated publications

This section contains no entries.

6. Policy

This circular requires lock and dam maintenance practices for all USACE Civil Works projects to conform with project-specific maintenance plans, standard maintenance categorization, maintenance management control, and maintenance standards.

7. Project Maintenance Management Plans

a. Project Maintenance Management Plans (PMMPs) will be developed to plan and adapt the tasks necessary to maintain lock and dam facilities. PMMPs will be based on the maintenance standards defined herein. PMMPs will identify roles and requirements of those responsible for ensuring maintenance is performed according to the specific maintenance plans.

b. The PMMPs must be reviewed and approved at the Operations Project Manager (OPM) level and above. OPMs will review PMMPs at least every 5 years and update as needed. Updates will also be made within 1 year of change in equipment or other events that affect details in the plan.

8. Standard maintenance categorization

a. According to the guidance provided by the major subordinate command (MSC), all lock and dam maintenance and inspection activities will be prioritized by the OPM for the affected facility. The OPM will ensure that identified, priority maintenance and inspection activities are scheduled, maintenance history captured, and accountability for performance documented in the Facilities and Equipment Maintenance System (FEM). The work order priority application will be used to manage maintenance activities and defer work according to MSC guidance.

b. The four categories of locks and dams maintenance are defined as:

(1) Preventive Maintenance – the systematic care, servicing, and inspection of assets, facilities, equipment, and components for the purpose of detecting and correcting incipient failures and accomplishing minor maintenance. The frequency of preventive maintenance is generally less than 1 year.

(2) Corrective Maintenance – the repair or renewal of an item that has failed or is about to fail. In a mature maintenance organization, this corrective maintenance work is frequently identified during the performance of inspections or preventive maintenance work and corrected before an unplanned failure occurs.

(3) Recurring Maintenance – the replacement or renewal of items that are required on a recurring basis, with a frequency of greater than 1 year and less than 7 to 10 years. Examples are painting, floor coverings, engine overhauls, etc. These generally fall below the capital thresholds. These are also the items that are frequently deferred. Recurring maintenance is sometimes referred to as cyclic maintenance.

(4) Component Renewal – the renewal or replacement of major asset components (roofs, large heating, ventilation, and air conditioning system; lock and dam gates and mechanisms; etc.) The work almost always exceeds the capital threshold and generally has a frequency of greater than 7 to 10 years but is not a capital improvement.

c. Common maintenance strategies employ the above maintenance categories in a deliberate approach as follows:

(1) Predictive Maintenance – the practice of choosing maintenance actions based on a well-developed program that includes equipment history, monitoring, analysis, scheduling, documentation, and benchmark testing to determine imminent equipment operational degradation. Predictive maintenance is a technique used extensively in a reliability-centered maintenance program that uses a condition-based approach where the equipment is monitored and measured to determine when maintenance is needed. It includes evaluation of equipment history, monitoring, analysis, documentation, and benchmark testing to determine imminent equipment operational degradation and the implementation of appropriate repair or replace evaluation. The goal of predictive maintenance is to avoid excessive maintenance while detecting impending failures and repairing or replacing components or equipment before it fails in service.

(2) Reactive Maintenance – the practice of structuring maintenance and operation activities around performing repairs when equipment has already functionally failed, in order to restore the equipment to its normal operating condition.

9. Responsibilities

a. The Chief of Operations at the MSC is responsible for oversight and coordination within the region to ensure maintenance standards are applied at each lock and dam facility. They, or their designee at the regional level, are also responsible for approval of variances requested to the maintenance standards. Approval for variances to the maintenance standards may be delegated to the District Chief of Operations but not lower.

b. The Chief of Operations at the District is responsible for the implementation of the maintenance standards at the locks and dams. They are also responsible for reviewing the request for a variance to the maintenance standards. When authority is delegated, they are responsible to approve deviations from the maintenance standards.

c. Operations Managers (OMs) and OPMs are responsible for documenting performance of the maintenance standards in FEM. They are responsible for submitting any requests for variance to the MSC Chief of Operations for approval. OMs/OPMs are responsible for incorporating the maintenance standards into preventive maintenance program at their facilities. The OPM is responsible to maintain a record of approval by the MSC Chief of Operations or designee for any deviation from the maintenance standards provided in this policy.

d. The maintenance manager at each lock and dam is responsible to assure maintenance actions are completed and the work was performed according to the standards.

10. Maintenance standards

a. A maintenance standard is defined by the task and the task frequency taken together. Appendixes B through T list the required maintenance tasks and frequencies for essential operating systems and subsystems common across the enterprise. This set of standards is used to establish an initial maintenance plan.

b. Because a maintenance standard is defined by the task and frequency of performance, maintenance task frequencies may be adjusted based on recommendations provided below in Table 1 and only when an approved variance is granted.

Table 1
Maintenance frequency matrix

Equipment Reliability Requirements	Asset Condition		
	Poor	Fair	Good
Low	Standard	Less Frequent	Least Frequent
Medium	More Frequent	Standard	Less Frequent
High	Most Frequent	More Frequent	Standard

c. Appendixes B through T do not specify “how” to perform maintenance tasks. The standard of quality for maintenance work associated with a task is based on the professional standards of the craft trade performing the work and are influenced by applicable equipment standards, specific manufacturer’s maintenance manuals and recommendations, equipment condition and history, criticality, environment, severity of use, and other pertinent parameters.

d. The InterNational Electrical Testing Association (NETA) Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems (ANSI/NETA MTS) is a document used worldwide by individuals seeking to assure that the electrical power equipment and systems in their care operate reliably and safely in conformance with industry and manufacturer standards and tolerances. NETA-referenced tasks must incorporate ANSI/NETA MTS Section 3 (Qualifications), Section 4 (Division of Responsibility), and Section 5 (General) by reference as a part of any subsection. The use of NETA-certified contractor support is encouraged.

e. MSC subject matter experts will provide guidance on how to address equipment and variations located at a facility, but are not identified in appendixes B through T.

f. If the appendixes show tasks that do not apply to any equipment at the facility, the task will not be included in the facility’s PMMP and will not need to be included in the facility’s FEM.

11. Training

Training on how to implement the maintenance standards in FEM will be provided by the FEM National Support Center (NSC) through standard NSC training courses, user guides, and quick cards. All training guides will be available on the FEM SharePoint site.

Appendix A References

Section I

Required Publications

Unless otherwise indicated, USACE publications listed below are available at <https://www.publications.usace.army.mil>. Army publications are available at <https://armypubs.army.mil>.

American National Standards Institute/InterNational Electrical Testing Association Maintenance Testing Specifications (ANSI/NETA MTS)
(Available at <https://www.netaworld.org>.)

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC)
(Available at <https://www.asme.org>.)

ASTM D4714
Standard Test Method for Determination of Effect of Moist Heat on Properties of Paper and Board (Available at <https://www.astm.org/>.)

DA Pam 25-403
Guide to Recordkeeping in the Army

EC 1130-2-218
Hydropower Maintenance Standards

EM 385-1-1
Safety and Health Requirements

EM 1110-2-1424
Lubricants and Hydraulic Fluids

EM 1110-2-3200
Wire Rope for Civil Works Structures

EM 1110-2-6054
Inspection, Evaluation, and Repair of Hydraulic Steel Structures

National Electrical Manufacturers Association Industrial Control and Systems (NEMA ICS)
(Available at <https://www.nema.org>.)

National Fire Protection Association (NFPA)
(Available at <https://www.nfpa.org/>.)

UFC 3-560-01

Operation And Maintenance: Electrical Safety, With Change 3 (Available at [https://www.wbdg.org/.](https://www.wbdg.org/))

Section II

Prescribed Forms

This section contains no entries.

Appendix B Lock Filling and Emptying Systems Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

Table B-1
Lock filling and emptying systems maintenance task list

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Filling and Emptying Operating Machinery								
Visually inspect and record on the work order the condition of linkage connections, grease lines, and hardware which are visible.			X					
Grease all moving or rotating parts prior to operation, and ensure grease is seen seeping when possible, and record on the work order.			X					
While valve is operating, grease components which can be safely greased during operation, i.e., trunnion, and record on the work order.			X					
Operate valve and listen for unusual noise, chatter, or irregularities and record on the work order. Ensure valve stops in the correct position in the open position and in the closed position and record on the work order.			X					
Record on the work order the condition of protective coating for corrosion of members.			X					
Hydraulic Cylinders: See Appendix S.								
Gear Drives: See Appendix T.								
Bellcrank Assembly (Hydraulic or Electric)								
Visually inspect and record on the work order the condition of bell crank and strut arms for general condition, check for any cracking, bending, secureness and tightness.			X					
Record on the work order the operation of the bell crank assembly through its range of motion, look and listen for signs of issues.			X					
Gear Drive Assembly (Electric)								
Lubricate open gearing and record on the work order.			X					
Remove brake assembly cover, record on the work order the condition of pads, springs, and assembly.					X			
Record on the work order the condition of open gearing during operation for signs of misalignment, grinding, or excessively worn teeth.						X		
Gear Drive Assembly (Hydraulic)								
Lubricate open gearing and record on the work order.			X					

Maintenance Tasks	O	W	M	Q	S	A	P	References
Remove brake assembly cover, record on the work order the condition of pads, springs, and assembly.					X			
Record on the work order the condition of open gearing during operation for signs misalignment, grinding, or excessively worn teeth.						X		
Rope Hoist Mechanism (Electric)								
Lubricate wire rope with penetrating lubricant and record on the work order.				X				EM 1110-2-3200
Operate, test, and record on the work order the condition of warning, limit, and slack cable switches for proper operation.				X				EM 1110-2-3200
Visually inspect and record on the work order the condition of wire rope for common failure types.					X			EM 1110-2-3200
Remove brake assembly cover, record on the work order the condition of pads, springs, and assembly.					X			EM 1110-2-3200
Visually inspect and record on the work order the condition of wire rope end spelters for condition.					X			EM 1110-2-3200
Visually inspect and record on the work order the condition of wire rope friction block hardware for tightness, look for signs of slippage.					X			EM 1110-2-3200
Filling and Emptying Valve Anchorages and Supports								
Visually inspect and record on the work order the condition of valve bases and supports for visual signs of fatigue and corrosion.						X		
Record on the work order loose or missing hardware.						X		
Filling and Emptying Valves								
Record on the work order the condition of broken or loose rivets and bolts, cracked welds, damage or abnormal wear.				X				
Record on the work order the operating and limit controls.				X				
Record on the work order the condition of seals, bearings, guides, rollers, pins and operating struct, cable and chains.				X				
Record on the work order the condition of protective coating for corrosion of members.						X		
Record on the work order the condition of side and bottom seals for any valve configuration arrangement.						X		
Record on the work order the condition of valve connection to hoist or actuator for sound connection.						X		
Renew protective coating where applicable (as required) and record on the work order.							X	
Repair worn or defective bearings, pins, rollers, cables, chains, spiders, shafts, etc. (as required) and record on the work order.							X	
Make repairs to prevent excessive leakage and to correct excessive vibration, looseness or other conditions that affect dependable operation, and record on the work order.							2	

Appendix C

Lock Gates and Operating Machinery Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

Table C-1
Lock gates and operating machinery maintenance task list

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Lock Gate Anchorages and Support Features								
Record on the work order the condition, soundness, and signs of cracking or corrosion.		X						
Record on the work order the condition of anchor pins and keepers for proper assembly.			X					
Grease all pins and equipment where grease zerks are provided, including anchor bar nuts, and record on the work order.			X					
Anchor Eye Bars – Record on the work order the condition of sleeve nut for indications of turning.				X				
Anchor Eye Bars – Closely visually inspect under operating conditions and record on the work order the condition of all parts of anchorage assembly for signs of excessive looseness in assembly, binding and deflection of the eye bars or other abnormal conditions.				X				
Miter Gate Anchorage								
Record on the work order the soundness and signs of cracking or corrosion.		X						
Record on the work order signs of cracking or deteriorating concrete around the embedded portions.		X						
Record on the work order the condition of the entire assembly for wear, looseness, or abnormal conditions. Record on the work order the condition of pin retainer for looseness, broken bolts, or movement. Record on the work order the condition of gate casting for indications of movement and conditions of bolts.				X				
Visually inspection and record on the work order malfunctioning, looseness, condition of protective thread covering, or other abnormal condition.				X				
In case of split type sleeve nuts, record on the work order the condition of clamping bolts for looseness by tapping.				X				
Record on the work order the condition of anchor pins and keepers for proper assembly.				X				

Maintenance Tasks	O	W	M	Q	S	A	P	References
Record on the work order significant concrete cracks in embedded portion of anchorages, note any drastic changes in pre-existing concrete cracks.				X				
Record on the work order the condition of exposed threads on eye bar by magnaflux method or nondestructive method.						X		
Lock Gate Operating Equipment								
Lubricate open gears and record on the work order.		X						
Visually inspect and record on the work order the condition of gears, bearings, and shear bolts for misalignment, wear, and cracked or broken parts.			X					
Visually inspect and record on the work order the condition of linkage connections, grease lines, and hardware which are visible.			X					
Grease all components on moving or rotating parts prior to operation, and ensure grease is seen seeping when possible, and record on the work order.			X					
While gate is operating, grease components which can be safely greased during operation, i.e. trunnion, and record on the work order.			X					
Operate gate and listen for unusual noise, chatter, or irregularities, and record on the work order. Ensure gate stops in the correct position in the open position and in the closed position and record on the work order.			X					
Record on the work order the condition of protective coating for corrosion of members.			X					
Record on the work order the condition of loose or worn bearings, misalignment and wear of shafts and gears; shear bolts for wear; loose foundation bolts, pins, bushings, keys, etc. Record on the work order the automatic brake coupling adjustment.					X			
Hydraulic Cylinders: See Appendix S.								
Gear Drives: See Appendix T.								
Chain Hoist Mechanism (Electric)								
Lubricate roller chain and record on the work order.		X						
Lubricate sprocket hoist wheel and record on the work order.				X				
Visually inspect and record on the work orders the condition of chain links for cracks or broken components.						X		
Record on the work order the condition of chain couplings have mousing wire or are otherwise locked from unthreading.						X		
Wire Rope Cable (Horizontal Pull)								
Lubricate wire rope and record on the work order.			X					EM 1110-2-3200
Visually inspect and record on the work order the condition of wire rope for common failure types.				X				EM 1110-2-3200
Visually inspect and record on the work order the condition of wire rope end spelters.				X				EM 1110-2-3200
Visually inspect and record on the work order the condition of wire rope friction block hardware for tightness, look for signs of slippage.				X				EM 1110-2-3200

Maintenance Tasks	O	W	M	Q	S	A	P	References
Lubricate wire rope with penetrating lubricant and record on the work order.					X			EM 1110-2-3200
Operate, test, and record on the work order the condition of warning, limit, and slack cable switches for proper operation.					X			EM 1110-2-3200
Automatic Lubrication System (ALS)								
Record on the work order the lubricant level is sufficient.			X					
Verify and record on the work order the efficacy of system by checking components for sufficient lubrication.			X					
Record on the work order the components are in good working order and system is supplying appropriate lubrication.			X					
Record on the work order the timer is appropriately starting and stopping the lubrication system.			X					
Record on the work order the lubrication metering device is applying appropriate amount of lubrication.			X					
Record on the work order the injectors and nozzles are adequately and evenly applying lubricant.			X					
Lock Gate Structures								
Record on the work order by operator at time of each operation to assure that gates and controls are operating properly and that recesses are clear.	X							
Record on the work order the condition of mitering devices. Record on the work order the condition of protective coating.			X					
Record on the work order the condition of gate for obstructions.				X				
Record on the work order the condition of gate for plum and level.				X				
Record on the work order the condition of lock gate structures for signs of fatigue or deformation.					X			
Record on the work order the condition of wear, looseness, damage, deterioration, or misalignment.					X			
Record on the work order the condition of quoin and miter posts and seals for proper adjustment and alignment.					X			
Record on the work order the condition by unwatering the lock gates, or removing them by gate lifter, and at the same time repair or replace submerged parts and otherwise completely recondition the gates. Salt water or other types of corrosive water conditions may require more frequent inspections.						X		
Record on the work order by diver the condition of underwater portion of gate.						X		
Record on the work order by diver the condition of pintle assemblies, seals, sill, etc.							2	
Record on the work order the latch mechanism and latch surface on the gate are clear of debris or obstructions.			X					

Maintenance Tasks	O	W	M	Q	S	A	P	References
Verify and record on the work order proper latching when the gate enters recess.			X					
Lubricate latch mechanism if equipped with zerk fittings and record on the work order.			X					
Pintles								
Lubricate pintle while miter gate is in motion and record on the work order.		X						
Record on the work order the excessive wear, improper sealing, misalignment of gate and for any abnormal condition. Use diver for examination when necessary. Make test operation of gate, observing closely for indication of movement of the pintle assembly on its base casting and record on the work order. Take elevations of quoin and miter ends of gate in both open and closed positions and compare with previous readings and record on the work order. Keep sliding surfaces well lubricated and record on the work order.							2	
Take elevations of quoin and miter ends of miter gate, compare with previous readings and record on the work order.							2	
Record on the work the order quoin blocks and miter blocks are adjusted and making contact properly, they should not make contact too soon.							2	
Gate Seals								
Record on the work order the condition of sealing members and wall liner plates for wear, deterioration, soundness, and misalignment.		X						
Record on the work order the visible portions of rubber seals appear to be in acceptable condition.			X					
Lock Gate Fenders								
Record on the work order the condition of fenders, replace if necessary.							2	
Miter Guide								
Lubricate roller and record on the work order.					X			
Visually inspect and record on the work order the condition of malfunctioning or damage. Record on the work order the condition of misalignment, excessive wear, and loose or broken fastenings.					X			
Quoin Blocks and Other Load Blocks								
Visually inspect and record on the work order the condition of proper alignment of quoins and miters, for proper clearance and bearing. Record on the work order the condition of structural backing for signs of cracking or failure. Record on the work order the condition of adjusting blocks, wedges, and screws.						X		
Take elevations of quoin and miter ends of miter gate, compare with previous readings and record on the work order.							2	
Visually inspect and record on the work order by lock operator during each lockage for abnormal operation, such as binding in the quoin and failure to miter properly miter.							2	
Lock Gate Cathodic Protection								

Maintenance Tasks	O	W	M	Q	S	A	P	References
Record on the work order the condition of gates, valves, or other equipment which has cathodic protection for corrosion.						X		
Visually inspect and record on the work order the condition of anodes. Replace when 50% of anode is expended.						X		
Gate Fire Suppression System								
Test and record on the work order the condition of visual and audible alarms.			X					
Test and record on the work order the condition of control devices.			X					
Test run and record on the work order the fire pumps are allowing water to discharge safely.					X			

Appendix D Lock Structure Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

**Table D-1
Lock structure maintenance task list**

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Lock Walls and Other Lock Structures								
Record on the work order by operating employees the detection of cracks, movement, misalignment, or other irregularities. Deficiencies should be reported to the district office promptly.	X							
Visually inspect and record on the work order the condition of walls, galleries, expansion joints, shafts, wall faces, armor pipe trenches, pipe shafts to determine movement, misalignment, spalling, leaks, etc.						X		
Miscellaneous Lock Features								
Machinery Houses								
Record on the work order that machinery houses are preventing water and debris from getting onto gears or equipment to the greatest extent possible.			X					
Record on the work order that safety interlocks are operating correctly.				X				
Lubricate rotating machinery where zerks are provided and record on the work order.				X				
Jib Cranes/Davits/Light Hoists								
Record on the work order the lubricant oil level.			X					
Operate and record on the work order the equipment using controls to ensure motor stops and starts.			X					
Operate and record on the work order the equipment through full range of motion, ensure high limit stop seizes equipment operation.			X					
Record on the work order the condition of wire rope or chains for indication of wear or fatigue.						X		
Record on the work order the condition of anchors for loose or missing hardware or corrosion.						X		

Appendix E Navigation Aids and Auxiliary Facilities Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

**Table E-1
Navigation aids and auxiliary facilities maintenance task list**

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Navigation Aids Primary								
Operating employees should keep under surveillance all navigation aids including safety signs, signals, and lighting which are the responsibility of the Corps of Engineers to detect damage, obstructions, and all malfunctioning of automatic signaling devices, and record on the work order.	X							
Tow Haulage System								
Record on the work order the condition of wire rope pull cable for flaws and wear. Record on the work order the condition of brake and clutch for wear and proper adjustment. Record on the work order the wear of all gears, bearings, shaft brake and clutch lining. Record on the work order the condition of cable for broken strands and need for greasing.		X						
Verify and record on the work order the safety shutoff devices properly stop equipment when tripped.			X					
Record on the work order the traveling mooring bitt(s) are rolling smoothly without binding, verify and record on the work order the condition of rail alignment and rails support anchors.				X				
Lubricate wire rope and record on the work order.						X		

Appendix F Dam Gates and Operating Machinery Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

**Table F-1
Dam gates and operating machinery maintenance task list**

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Dam Gate Anchorages and Support Features								
Grease all moving parts where zerks are provided and record on the work order.			X					
Visually inspect and record on the work order the condition of linkage connections, grease lines, and hardware which are visible.			X					
Record on the work order the condition, soundness, and signs of cracking or corrosion.				X				
Record on the work order the condition of cracking or deteriorating concrete around the embedded portions.				X				
Dam Gate Operating Machinery								
While dam gate is operating, grease zerks which can be safely greased during operation, i.e. trunnion, and record on the work order.				X				
Operate dam gate and listen for unusual noise, chatter, or irregularities and record on the work order. Ensure gate stops in the correct position in the open position and in the closed position and record on the work order.				X				
Lubricate open gears and record on the work order.				X				
Visually inspect and record on the work order the condition of chain links.				X				
Lubricate lifting chain and record on the work order.				X				
Lubricate sprocket hoist wheel or drum and record on the work order.				X				
Visually inspect and record on the work order the condition of brake mechanisms and brake pads.				X				
Grease all zerks on moving or rotating parts, record on the work order the grease is seen seeping when possible, i.e. couplings, pillow block bearings.				X				
Lubricate wire rope and record on the work order.				X				
Record on the work order the condition of protective coating for corrosion of members.					X			
Visually inspect and record on the work order the condition of wire rope and end spelters and note broken strands or bird caging.						X		

Maintenance Tasks	O	W	M	Q	S	A	P	References
Visually inspect and record on the work order the condition of wire rope friction block hardware for tightness and signs of slippage.						X		
Record on the work order the condition of all safety devices, limit switches, and control devices.						X		
See Appendix S for Hydraulic System Tasks covers piping, inspection, fluid testing, and other hydraulic tasks.								
See Appendix T for Closed Gear Reducer Tasks covers fluid testing, inspection, and other gear reducer tasks.								
Dam Gate Structures								
Operate gates to determine smoothness of operation, record on the work order the condition of racks, gears, trunnion pins, skin plates, sills, lift chains or ropes, and structural members.				X				
Visually inspect and record on the work order the condition of structural members of gates and supports for signs of bending, cracking, or significant corrosion.					X			
Record on the work order the emergency bulkhead operation and lubricate rollers.					X			
Visually inspect and record on the work order the skin plate for damage.					X			
Visually inspect and record on the work order the condition of grease lines which run for long distances and ensure connection.					X			
Visually inspect and record on the work order the condition of side seals for effectiveness.					X			
Visually inspect and record on the work order the condition of roller gate and roller gate rack.					X			

Appendix G Dam Structures Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

**Table G-1
Dam structures maintenance task list**

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Dam Piers								
Record on the work order the condition of cracks, leaks, collection of ice or heaving slabs, movement or misalignment of walls, debris formation, displacements, offset at joints, or other irregularities.	X							
Visually inspect and record on the work order the condition of expansion joints for signs of leaks, defective joint material, or faulty water stops.					X			
Record on the work order close and more complete inspection to detect cracks, leaks, spalling, and deterioration of concrete.						X		
Dam Spillway Sections								
Record on the work order the condition of baffles, piers, baffle deck apron, and end of sills for deterioration.							5	
Misc. Dam Structures								
Record on the work order the condition of abutments for cracks, leaks, movement or misalignment, debris formation, displacements, offset at joints, or other irregularities.	X							
Record on the work order close and more complete inspection to detect cracks, leaks, spalling, and deterioration of concrete.						X		

Appendix H Emergency Maintenance and Closure System Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

**Table H-1
Emergency maintenance and closure system maintenance task list**

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Dam Closure Hoisting Machinery/Crane and Lifting Beam								
GENERAL								
Record on the work order the condition of all functioning operating mechanisms and their components for excessive wear or damage.			X ²					EC 1130-2-218
Verify and record on the work order the crane and hoist motions are smooth and regular for all speed steps, with no hesitations, vibration, binding, weaving, unusual noise, or other irregularity.			X ²					EC 1130-2-218
Clean the crane cab, record on the work order the condition of seat, windows, doors, hand, and foot controls, etc.			X ²					EC 1130-2-218
Record on the work order the condition of fire extinguisher in the crane cab.			X ²					EC 1130-2-218
Verify and record on the work order the crane operation and maintenance log book is being used properly.			X ²					EC 1130-2-218
With crane in motion, record on the work order the condition of abnormal vibration or skewing in the crane support structure, bracing and crane rails.			X ²					EC 1130-2-218
Record on the work order the condition of handrails and ladders.			X ²					EC 1130-2-218
Record on the work order the condition of ladder rungs and stairs for significant wear of anti-slip surfaces.			X ²					EC 1130-2-218
Record on the work order the footwalks and toeboards are secure and in good condition.			X ²					EC 1130-2-218
Verify and record on the work order that all guards are in place and securely fastened.			X ²					EC 1130-2-218
Record on the work order the condition of all framework for deformation, cracks, and corrosion, paying close attention to load bearing members and welded joints.						X		EC 1130-2-218
On fixed cranes, record on the work order the condition of column anchorage and supports for deformed bolts or concrete cracks in the baseplate and foundation.						X		EC 1130-2-218
Record on the work order the condition of stops and bumpers for wear, cracks, corrosion, or distortion.						X		EC 1130-2-218

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Record on the work order the leaking of hydraulic bumpers and fill to proper level.						X		EC 1130-2-218
Record on the work order the condition of rubber or plastic bumpers for cracks or other damage.						X		EC 1130-2-218
Perform crane load test and record on the work order.							5	EC 1130-2-218
CRANE RAILS								
Clean crane rail as needed and record on the work order.				X				EC 1130-2-218
Record on the work order the condition of rails for alignment and level, look for dips, cleanness, grease, oil.						X		EC 1130-2-218
Record on the work order the condition of crane rail clips or welds for damage.						X		EC 1130-2-218
Record on the work order the condition of crane rail expansion gaps for uniformity and conformance with spacing tolerances.						X		EC 1130-2-218
Record on the work order the condition of wear on the crane rails, both on the top and side of the rail head.						X		EC 1130-2-218
Record on the work order the condition of concrete crane rail support for corrosion or spalling.						X		EC 1130-2-218
Record on the work order the condition of steel crane rail supports for corrosion and loose bolts or rivets.						X		EC 1130-2-218
Record on the work order the condition of crane rail stops.						X		EC 1130-2-218
Adjust rail sweeps as required and record on the work order.						X		EC 1130-2-218
CONTROL SYSTEM								
Verify and record on the work order the function of the general crane control systems and components thereof.			X ²					EC 1130-2-218
Verify and record on the work order the function and adjustment of the lower-limit switch (as applicable) and verify on the work order that at least two full wraps of wire rope remain on the drum at the lower limit.			X ²					EC 1130-2-218
Verify and record on the work order the function and adjustment of the upper-limit switch and verify and record on the work order proper wire rope spooling on drum.			X ²					EC 1130-2-218
Record on the work order the function of brake control circuits for bridge, trolley, main and auxiliary hoist.			X ²					EC 1130-2-218
Record on the work order the proper operation of all electrical safety devices including emergency stop switches.			X ²					EC 1130-2-218
Record on the work order the condition of lights for proper operation.			X ²					EC 1130-2-218
Record on the work order that all wiring and connections are in good condition.						X		EC 1130-2-218
Record on the work order the required control labels are present and are legible.						X		EC 1130-2-218
Record on the work order the condition of contacts for signs of deterioration and overheating.						X		EC 1130-2-218
Record on the work order the condition of levers and cams, ensure adequate lubrication.						X		EC 1130-2-218

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Visually inspect and record on the work order the condition of resistor tubes for crack loose bands and connections, and broken resistance wire.						X		EC 1130-2-218
Clean resistor banks if dirty and record on the work order.						X		EC 1130-2-218
ROPE, DRUMS, SHEAVES, HOOKS, LOAD CHAIN								
Visually inspect and record on the work order the condition of hoisting rope or chain for damage, wear, and proper lubrication.			X ²					EC 1130-2-218
Visually inspect and record on the work order the condition of hoist rope for proper reeving and spooling.			X ²					EC 1130-2-218
Record on the work order the condition of wire ropes.			X ²					EC 1130-2-218
Verify and record on the work order the hoist chain feeds smoothly into and away from sprockets.			X ²					EC 1130-2-218
Verify and record on the work order the condition of hooks for wear, cracking, corrosion, and deformation.			X ²					EC 1130-2-218
Verify and record on the work order the function of hook latches.			X ²					EC 1130-2-218
Verify and record on the work order the swivel hooks are free to rotate.			X ²					EC 1130-2-218
With a sheave gage, record on the work order the condition of grooves of drums and sheaves for wear.						X		EC 1130-2-218
Record on the work order the condition of load block guards for contact with sheaves or wire rope.						X		EC 1130-2-218
Record on the work order the condition of wire rope dead-ends.						X		EC 1130-2-218
Record on the work order the condition of end connections.						X		EC 1130-2-218
Run out the rope or chain to visually inspect and record on the work order portions that flex over sheaves, sprockets, and other areas subject to wear or abrasion.						X		EC 1130-2-218
Clean and lubricate wire rope, sheaves, and drums and record on the work order.						X		EC 1130-2-218
Lubricate swivel and sheave bearing as required and record on the work order.						X		EC 1130-2-218
BRAKES								
Record on the work order the brakes are functioning normally and that there is no slippage, excessive play, or binding.			X ²					EC 1130-2-218
Record on the work order the operation of drive system, bridge and trolley brakes, and look for leaks in hydraulic lines.			X ²					EC 1130-2-218
Record on the work order the condition of brake lining for excessive wear and oil contamination, inspect for signs of heating.			X ²					EC 1130-2-218
Record on the work order the condition of brake fluid.			X					EC 1130-2-218
Clean dust and dirt from brakes and record on the work order.						X		EC 1130-2-218
Measure and record brake shoe clearance and thickness on the work order.						X		EC 1130-2-218

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Adjust brake shoe clearance and record on the work order.						X		EC 1130-2-218
Check brake drums for scoring and wear and record on the work order.						X		EC 1130-2-218
Lightly lubricate brake pivot points and record on the work order.						X		EC 1130-2-218
GEAR BOXES, DRIVE SYSTEMS								
Listen for abnormal noise in gear boxes and motors and record on the work order.			X ²					EC 1130-2-218
Record on the work order the drive chain feeds into and away from sprockets smoothly.			X ²					EC 1130-2-218
Record on the work order the condition of drive chain for stretch, wear, corrosion, and other damage.			X ²					EC 1130-2-218
Record on the work order the condition of roller type drive chain for damage, corrosion, etc.			X ²					EC 1130-2-218
Record on the work order the condition of mounted bearings for tightness, wear, and proper lubrication.						X		EC 1130-2-218
Record on the work order the condition of oil and gear boxes for metal and nonmetallic particles.						X		EC 1130-2-218
Record on the work order the condition of oil seals for leaks.						X		EC 1130-2-218
Record on the work order the condition of gears for missing or worn teeth, abnormal wear patterns, and excessive heat.						X		EC 1130-2-218
Record on the work order the proper lubrication of gear boxes, bearings, etc.						X		EC 1130-2-218
Record on the work order the condition of shafts and couplings.						X		EC 1130-2-218
Record on the work order the condition of protective guards.						X		EC 1130-2-218
Record on the work order the condition of roller type drive chain under load in lifting and lowering directions, observing for smooth feed of chain into and away from the sprockets.						X		EC 1130-2-218
Clean and lubricate roller type drive chain and record on the work order.						X		EC 1130-2-218
MOTOR								
See Appendix M for electrical maintenance of motor-driven machinery.						X		
POWER SUPPLY								
See Appendix M for electrical maintenance of motor-driven machinery.						X		
X ² = Before each use, otherwise monthly								
Bulkhead Hoist – Power System								
Conductor/Collector Rail System: Record on the work order the condition of contact surfaces of open conductors and collectors for signs of arcing damage, pitting, and corrosion.						X		EC 1130-2-218

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Conductor/Collector Rail System: Clean insulators and record on the work order.						X		EC 1130-2-218
Conductor/Collector Rail System: Verify and record on the work order the festoon-type conductor cable moves freely.						X		EC 1130-2-218
Plug and Receptacle System: Record on the work order the condition of plug and receptacle for cracks, missing parts, distortion, or discoloration.						X		NFPA 70B §24
Plug and Receptacle System: Verify and record on the work order the receptacle contacts retain the inserted plug firmly.						X		NFPA 70B §24
Plug and Receptacle System: Verify and record on the work order the integrity of equipment grounding conductor.						X		NFPA 70B §24
Plug and Receptacle System: Clean faces of plug and receptacle and record on the work order.						X		NFPA 70B §24
Plug and Receptacle System: Record on the work order the condition of cord clamps and strain relief fittings.						X		NFPA 70B §24
Lifting Beam								
Before using, record on the work order the condition of alignment, corrosion, tightness of rivets and bolts; observe carefully for any indication of over stressed members.	X							
Record on the work order the condition of all framework for deformation, cracks, and corrosion, paying close attention to load bearing members and welded joints.						X		EC 1130-2-218
Dam Closure System								
Emergency Bulkhead								
Lubricate roller bushings after each use and record on the work order.	X							
Record on the work order the condition of excessive rust, corrosion, and other forms of deterioration, clean and repair as needed.							2	
Record on the work order the condition of seals for excessive wear and deterioration, repair or renew seals as needed.							2	
Paint as necessary and record on the work order.							2	
Record on the work order rollers are free to move.							2	
Record on the work order the condition of excessive wear, corrosion, or other forms of deterioration.							2	
Repair or replace broken or damaged items as necessary to place equipment in a satisfactory operating condition and record on the work order.							2	
Record on the work order the latches and dogging devices are operating freely, lubricate as required.							2	
Dam Service Cranes								
See Dam Closure Hoisting Machinery/Crane.								
Lock Closure Hoisting Machinery/Cranes/Lifting Beams								
Lock Closure Systems								

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Record on the work order the wear, damage, and degradation prior to and after each use.	X							
Document structural critical weld testing before use and record on the work order.	X							
Record on the work order the leakage during each use.	X							
Record on the work order adequacy and condition of all unwatering facilities.						X		
Record on the work order the condition of rewatering valve for function, manually open and close valve and lubricate.						X		
Inspect per EM 1110-2-6054 and record on the work order.							5	EM 1110-2-6054
Boule Dam								
A-frames, prop chains, and connecting chains by divers. Clean mud, silt, and debris from all slots.	X							
Center Beam Support System								
Record on the work order the condition of center piers by divers for damage, and clean mud, silt, and debris before use.	X							
Dewatering Gates								
See Appendix M for electrical maintenance of motor-driven machinery.								
Emergency Gate System								
During dewaterings, record on the work order the condition of protective coating for any damages (as dewatered).								
Floating Caisson Primary								
Record on the work order broken piping, inoperable valves and manifold prior to each use.	X							
Record on the work order the condition of protective coating after each use.	X							
Guard Gates								
See Appendix M for electrical maintenance of motor-driven machinery.								
Maintenance Bulkhead								
Record on the work order the condition of protective coating after each use.	X							
Needle Dam								
Record on the work order the condition of panel protective coating after each use.	X							
Poiree Dam								
Record on the work order the condition of embedded base for poiree trusses before each use by diver.	X							
Remove mud, silt, debris from slots before inserting trusses.	X							
Reverse Head (Storm Protection) Gates								
See Appendix M for electrical maintenance of motor-driven machinery.								

Maintenance Tasks	O	W	M	Q	S	A	P	Reference

Appendix I

Controls/Indicators/Interlocks/Programmable Logic Controller Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

Table I-1

Controls/indicators/interlocks/programmable logic controller maintenance task list

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Dam Gate Controls and Control Systems								
Centralized Dam Gate Programmatic Logic Control (PLC) System								
Centralized PLC Hardware: Record on the work order the physical condition. Verify and record on the work order the equipment has been operating with the enclosure closed. Clean heat sinks and vents as record on the work order. Record on the work order the condition of power cord for damage.				X				
Centralized PLC Power Backup: Record on the work order the physical condition. Verify and record on the work order that no alarm conditions are active. Record on the work order the condition of cords for damage.				X				
Centralized PLC Alarm System: Verify and record on the work order the correct operation of alarms and indicating devices. Verify and record on the work order that no alarm conditions are active.				X				ANSI/NETA MTS §8
Centralized PLC Indicator Displays: Record on the work order the physical condition. Clean heat sinks and vents and record on the work order.						X		
Communication and Control Cables (Fiber Optic): Record on the work order the physical condition of cable and connectors.						X		ANSI/NETA MTS §7.25
Communication and Control Cables (Fiber Optic): For critical backbone systems, perform transmit and receive power readings from local device and remote device using spare fiber and record on the work order.						X		ANSI/NETA MTS §7.25
Communication and Control Cables (Twisted Pair): Record on the work order the physical condition of cable and connectors.						X		
Communication Lines: Verify and record on the work order lines are operational.						X		ANSI/NETA MTS §8
Relays: See Appendix M for electrical maintenance of control panels.								
Centralized PLC Control Panel: See Appendix M for electrical maintenance of control panels.								

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Dam Gate Position Indicators								
Control Cable (Fiber Optic): Record on the work order the physical condition of cable and connectors.						X		ANSI/NETA MTS §7.25
Control Cable (Twisted Pair): Record on the work order the physical condition of cable and connectors.						X		
Gate Position Indicator Panel: Record on the work order physical condition. Verify and record on the work order the operation and calibration of displayed values.						X		
Limit Switches: Record on the work order the physical condition. Verify and record on the work order the operation and alignment.						X		
Relays: See Appendix M for electrical maintenance of control panels.								
SCADA System: See Appendix M for electrical maintenance of SCADA.								
Dam Hydraulic Power Controls								
Automated Local Controls								
Control Cable (Fiber Optic): Record on the work order the physical condition of cable and connectors.						X		ANSI/NETA MTS §7.25
Control Cable (Twisted Pair): Record on the work order the physical condition of cable and connectors.						X		
Mechanical Switch (Pushbutton): Verify and record on the work order the proper operation. Record on the work order physical condition.						X		
Control Panel: See Appendix M for electrical maintenance of control panels.								
PLC System: See Appendix M for electrical maintenance of PLCs.								
Automated Remote Control Signal								
Control Cable (Fiber Optic): Record on the work order the physical condition of cable and connectors.						X		ANSI/NETA MTS §7.25
Control Cables (Fiber Optic): For critical backbone systems, perform transmit and receive power readings from local device and remote device using spare fiber and record on the work order.						X		
Control Cable (Twisted Pair): Record on the work order the physical condition of cable and connectors.						X		
SCADA System: See Appendix M for electrical maintenance of SCADA.								
Manual Motor Controls								
Control Cable (Twisted Pair): Record on the work order the physical condition of cable and connectors.						X		
Mechanical Switch (Pushbutton): Verify and record on the work order the proper operation. Record on the work order the physical condition.						X		
Control Panel: See Appendix M for electrical maintenance of control panels.								

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Filling and Emptying System Controls and Control Systems								
Local Position – Automated Electric Controls								
Local Position – Electric Controls (Manual or Automated).								
Local control panel: See Appendix M for electrical maintenance of control panels.								
Operator (pushbutton): Verify and record on the work order the proper operation. Record on the work order the physical condition.						X		
Operator (other type): Verify and record on the work order the proper operation. Record on the work order the physical condition.						X		
Control cable (twisted pair): Record on the work order the physical condition of cable and connectors.						X		
Control cable (fiber optic): Record on the work order the physical condition of cable and connectors.						X		ANSI/NETA MTS §7.25
Relays: See Appendix M for electrical maintenance of control panels.								
Filling and Emptying System Interlocks								
Valve Interlock Controls (Primary or Auxiliary)								
PLC System: See Appendix M for electrical maintenance of PLCs.								
Gate control interlock devices (electrical): Verify no alarms are active and record on the work order.			X					ANSI/NETA MTS §8
Valve position indicator panel and panel lights: Verify and record on the work order the operation of lamps and indicators. Verify and record on the work order the calibration of displayed values.			X					NFPA 70B Table L.1
Gate control interlock devices (mechanical): Verify and record on the work order the alignment and operation. Record on the work order the physical condition.						X		ANSI/NETA MTS §8
Gate control interlock devices (electrical): Verify and record on the work order the operation. Record on the work order the physical condition.						X		ANSI/NETA MTS §8
Control cable (fiber optic): Record on the work order the physical condition of cable and connectors.						X		ANSI/NETA MTS §7.25
Control cable (fiber optic): For safety-related systems, perform transmit and receive power readings from local device and remote device using spare fiber and record on the work order.						X		ANSI/NETA MTS §7.25
Control cable (twisted pair): Record on the work order the physical condition of cable and connectors.						X		
Relays: See Appendix M for electrical maintenance of control panels.								
Interlock – Fill Valve to Empty Valve								
Limit switches: Record on the work order the physical condition. Verify and record on the work order the operation and alignment.						X		

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Lock Gate Controls and Control Systems								
Centralized Lock PLC System								
Centralized PLC Indicator Displays: Verify and record on the work order the operation of lamps and indicators. Verify and record on the work order the calibration of displayed values.			X					NFPA 70B Table L.1
Centralized PLC Hardware/Human Machine Interface (PLC/HMI): Record on the work order the physical condition. Verify and record on the work order the equipment has been operating with the enclosure closed. Clean heat sinks and vents and record in the work order. Record on the work order the condition of power cord for damage.				X				
Centralized PLC Power Backup: Record on the work order the physical condition. Verify and record on the work order that no alarm conditions are active. Record on the work order the condition of cords for damage.				X				
Centralized PLC Alarm System: Verify and record on the work order the correct operation of alarms and indicating devices. Verify and record on the work order that no alarm conditions are active.				X				ANSI/NETA MTS §8
Communication and Control Cable (Fiber Optic): Record on the work order the physical condition of cable and connectors.						X		ANSI/NETA MTS §7.25
Communication and Control Cable (Fiber Optic): For critical backbone systems, perform transmit and receive power readings from local device and remote device using spare fiber and record on the work order.						X		ANSI/NETA MTS §7.25
Communication and Control Cable (Twisted Pair): Record on the work order the physical condition of cable and connectors.						X		
Communication Lines: Verify and record on the work order the lines are operational.						X		ANSI/NETA MTS §8
Centralized PLC Control Panel: See Appendix M for electrical maintenance of control panels.								
Relays: See Appendix M for electrical maintenance of control panels.								
Local Position – Manual Electric Controls								
Operator (pushbutton): Verify and record on the work order the proper operation. Record on the work order the physical condition.						X		
Operator (other type): Verify and record on the work order the proper operation. Record on the work order the physical condition.						X		
Control cable (fiber optic): Record on the work order the physical condition of cable and connectors.						X		ANSI/NETA MTS §7.25
Control cable (twisted pair): Record on the work order the physical condition of cable and connectors.						X		
Local control panel: See Appendix M for electrical maintenance of control panels.								
Relays: See Appendix M for electrical maintenance of control panels.								
Local/Remote Selection Switch – Lock Controls								

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Verify and record on the work order the proper operation. Record on the work order the physical condition.						X		
PLC Bypass Switch								
Verify and record on the work order the proper operation. Record on the work order the physical condition.						X		
Remote Position – Lock Controls								
Control panel: See Appendix M for electrical maintenance of control panels.								
PC Hardware: Record on the work order the physical condition. Verify and record on the work order the equipment has been operating with the enclosure closed. Clean heat sinks and vents and record on the work order. Record on the work order the condition of power cord for damage.				X				
PC power backup: Record on the work order the physical condition. Verify and record on the work order that no alarm conditions are active. Record on the work order the condition of cords for damage.				X				
PC Software:								
Relays: See Appendix M for electrical maintenance of control panels.								
Input/Output (I/O) converters:								
Automated operator (pushbutton): Record on the work order the proper operation. Record on the work order the physical condition.						X		
Automated operator (other type): Verify and record on the work order the proper operation. Record on the work order the physical condition.						X		
Communication and Control Cable (Fiber Optic): Record on the work order the physical condition of cable and connectors.						X		ANSI/NETA MTS §7.25
Communication and Control Cable (Fiber Optic): For critical backbone systems, perform transmit and receive power readings from local device and remote device using spare fiber and record on the work order.						X		ANSI/NETA MTS §7.25
Communication and Control Cable (Twisted Pair): Record on the work order the physical condition of cable and connectors.						X		
Lock Gate Interlocks								
Gate Control Interlock Devices (Mechanical): Verify and record on the work order the alignment and operation. Record on the work order the physical condition.						X		ANSI/NETA MTS §8
Lock Gate Position Indicator Panel and Panel Lights: Verify and record on the work order the operation of lamps and indicators. Verify and record on the work order the calibration of displayed values.			X					NFPA 70B Table L.1
Gate Position Indicator Panel: Verify and record on the work order the calibration of displayed values.			X					NFPA 70B Table L.1
Gate Control Interlock Devices (Electrical): Verify and record on the work order the operation. Record on the work order the physical condition.			X					ANSI/NETA MTS §8

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Gate Control Interlock Devices (Electrical): Verify and record on the work order that no alarms are active.			X					ANSI/NETA MTS §8
Control Cable (Fiber Optic): Record on the work order the physical condition of cable and connectors.						X		ANSI/NETA MTS §7.25
Control Cable (Twisted Pair): Record on the work order the physical condition of cable and connectors.						X		
PLC System: See Appendix M for electrical maintenance of PLCs.								
Relays: See Appendix M for electrical maintenance of control panels.								
Interlock – Lock Gate to Valve (Downstream, Intermediate, or Upstream) (Primary or Auxiliary) (Fill or Empty)								
Limit Switches – Valve: Record on the work order the physical condition. Verify and record on the work order the operation and alignment.						X		
Limit Switches – Lock Gate: Record on the work order the physical condition. Verify and record on the work order the operation and alignment.						X		
Water Level Sensors: Record on the work order the physical condition. Verify and record on the work order the operation and calibration of displayed values.						X		
Automated Local Controls								
Control Cable (Fiber Optic): Record on the work order the physical condition of cable and connectors.						X		NETA MTS §7.25
Control Cable (Twisted Pair): Record on the work order the physical condition of cable and connectors.						X		
Mechanical Switch (Pushbutton): Verify and record on the work order the proper operation. Record on the work order the physical condition.						X		
PLC System: See Appendix M for electrical maintenance of PLCs.								
Control Panel: See Appendix M for electrical maintenance of control panels.								

Appendix J Primary Utilities Distribution and Controls Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

**Table J-1
Primary utilities distribution and controls maintenance task list**

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Primary Electrical Service and Distribution								
Conduits/Cable Trays/Cable Supports								
Conduits: Verify and record on the work order the proper bonding to fittings.							3	NFPA 70B §20
Cable trays: Record on the work order the sharp corners, intrusions, and other conditions that might damage cable insulation.							3	NFPA 70B §20
Cable trays: Verify and record on the work order the proper fill and separation of cables.							3	NFPA 70B §20
Cable trays: Verify and record on the work order the proper ventilation. Remove debris and record on the work order.							3	NFPA 70B §20
Cable trays: Verify and record on the work order the mounting hardware is intact.							3	NFPA 70B §20
Cable supports: Record on the work order the damage caused by vibration.							3	NFPA 70B §35.10
Dam Lighting								
Lighting: Verify and record on the work order the operation and inspect for physical damage.		X						
Emergency/Backup Power System								
Emergency generator: Record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage, alignment, and grounding.			X					ANSI/NETA MTS §7.22.1
Emergency generator: Conduct performance test monthly for at least 30 minutes with load not less than 30% of standby nameplate kW rating and record on the work order. Initiate the test by simulating loss of normal power at the transfer switch and record on the work order. Standby operation may substitute for a test.			X					ANSI/NETA MTS §7.22.1; NFPA 110 §8
Emergency generator: Clean the unit and record on the work order.				X				ANSI/NETA MTS §7.22.1
Emergency generator: Measure insulation resistance on generator winding-to-ground in accordance with IEEE 43 and record on the work order. Calculate polarization index and record on the work order.						X		ANSI/NETA MTS §7.22.1

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Emergency generator: (See Appendix N for electrical maintenance of protective relays).						X		ANSI/NETA MTS §7.22.1
Emergency generator: Functionally test engine shutdown for low oil pressure, overtemperature, and overspeed, and record on the work order. Verify and record on the work order correction functioning of governor and regulator.						X		ANSI/NETA MTS §7.22.1
Record on the work order the condition of day tank and filters.						X		
Record on the work order the condition of primary fuel tank and filters.						X		
Record on the work order the condition of secondary fuel tank and filters.						X		
Power cable conduit: Verify and record on the work order the proper bonding to fittings.							3	NFPA 70B §20
Clean day tank and record on the work order.							10	
Clean primary fuel tank and record on the work order.							10	
Clean secondary fuel tank and record on the work order.							10	
Circuit breaker: See Appendix N for electrical maintenance of circuit breakers.								
Power cable: See Appendix O for electrical maintenance of power cables.								
Feeder System								
Low voltage (less than 600V): See Appendix O for electrical maintenance of power cables.								
Medium voltage (greater than 600V): See Appendix O for electrical maintenance of power cables.								
Feeder selection switch – Motor Control Center (MCC) or Power Perfect Box (PPB): See Appendix Q for electrical maintenance of switches.								
Grounding System								
Ground bus system: Verify and record on the work order the ground system complies with NFPA 70 (NEC) Article 250. Record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage.				X				ANSI/NETA MTS §7.13
Lightning strike frequency: Visually verify and record on the work order the lightning protection system is in good repair; has no loose connections; has not been weakened by corrosion or vibration; has intact down conductors and electrodes; is securely fastened and protected; protects any structural additions or alterations; and has intact surge suppressors.						X		NFPA 780 §D.1.2
Ground bus system: Measure resistance through bolted connections with a low-resistance ohmmeter and record on the work order. Perform fall-of-potential or alternative test in accordance with IEEE 81 on the main grounding electrode or system and record on the work order. Perform point-to-point tests to determine the resistance between main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points, and record on the work order.							2	ANSI/NETA MTS §7.13

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Lightning strike frequency: For the lightning protection system, test to verify continuity of concealed parts that are not available for visual inspection and record on the work order. Test and record on the work order the ground resistance of the grounding electrode termination system if disconnecting means have been provided. Test and record on the work order the continuity to determine if equipotential bonding has been established for any new services or constructions.							3	NFPA 780 §D.1.3
Lighting								
Verify and record on the work order the operation and record on the work order the damage.			X					
Miscellaneous Power Features								
Substation buildings and enclosures:								
Record on the work order the condition of exterior and interior walls and siding, repair as necessary.						X		
Record on the work order the condition of windows and window casings, repair as necessary.						X		
Record on the work order the condition of doors and door jams, repair as necessary.						X		
Record on the work order the condition of roofing, fascia, and flashing; repair as necessary.						X		
Record on the work order the condition of stairs, ladders, and handrails; repair as necessary.						X		
Substation security fencing								
Record on the work order the condition of posts and corner posts, support guys, and horizontal bars between each support post.						X		
Record on the work order the condition of wire and anchor point; re-stretch and re-anchor if necessary.						X		
Record on the work order the condition of fence anchors along the bottom of the fence and at the point where the fence is connected to the post.						X		
Treat with galvanized protectant where rust has developed and record on the work order.						X		
Visually inspect and record on the work order the condition of fence grounding electrodes, conductors, and connections.						X		
Record on the work order the condition of bolted grounding connections for high-resistance using a low-resistance ohmmeter.							2	ANSI/NETA §MTS 7.13
Substation security gate								
Record on the work order the condition of pivot points, hinges, latches, etc. Lubricant where needed.						X		
Record on the work order the condition of locking devices. Lubricate as required.						X		
Record on the work order the condition of center gate support rollers and lubricate as required.						X		

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Clean roller track of any debris and record on the work order.						X		
Record on the work order the condition of bolts, fasteners, and mounting hardware. Tighten or adjust as necessary.						X		
Record on the work order the obstructions that retard full swing or movement of the gate.						X		
Record on the work order the condition of open devices for proper operation. Lubricate as required.								
Substation transformer pads and slabs								
Record on the work order the condition of concrete cracking, repair as necessary.						X		
Record on the work order the condition of surface distress (spalling, disintegration of the surface, surface honeycomb, scaling), repair as necessary.						X		
record on the work order the condition of water leakage (surface dampness, seepage or leakage through joints or cracks), repair as necessary.						X		
Record on the work order the condition of movement (deflections, heaving, settlement), repair as necessary.						X		
Record on the work order the condition of metal corrosion (rust staining, exposed reinforcing bars), repair as necessary.						X		
Power								
Power interruption: See Appendix N for electrical maintenance of circuit breakers.								
Power service line (overhead): See Appendix O for electrical maintenance of power cables.								
Power service line (submerged/buried): See Appendix O for electrical maintenance of power cables.								
Power service line (utility tunnel/raceways): See Appendix O for electrical maintenance of power cables.								
Power distribution system								
Dam gate control panel (operating equipment): See Appendix M for electrical maintenance of control panels.								
Motor control center: See Appendix R for electrical maintenance of bus assemblies.								
Motor control center: See Appendix N for electrical maintenance of circuit breakers.								
Motor control center: See Appendix Q for electrical maintenance of switches.								
Motor control center: See Appendix M for electrical maintenance of motor starter.								
Power distribution panelboard: See Appendix N for electrical maintenance of circuit breakers.								
Power distribution panelboard: See Appendix R for electrical maintenance of bus assemblies.								

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Stepdown transformer (low voltage – less than 600V): See Appendix P for electrical maintenance of transformers.								
Switchboard: See Appendix N for electrical maintenance of circuit breakers.								
Switchboard: See Appendix R for electrical maintenance of bus assemblies.								
Power Transformation and Regulation								
Circuit breaker: See Appendix N for electrical maintenance of circuit breakers.								
Fused disconnect switch: See Appendix Q for electrical maintenance of switches.								
Non-fused disconnect switch: See Appendix Q for electrical maintenance of switches.								
Power factor correction capacitor: Record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage, alignment, grounding, and required clearances.			X					ANSI/NETA MTS §7.20.1
Power factor correction capacitor: Clean the unit and record on the work order. Verify and record on the work order the capacitors are electrically connected in their specified configuration.						X		ANSI/NETA MTS §7.20.1
Power factor correction capacitor: Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter.							2	ANSI/NETA MTS §7.20.1
Power factor correction capacitor: Measure insulation resistance tests from phase terminal(s) to case for one minute and record on the work order. Measure the capacitance of all terminal combinations and record on the work order. Measure resistance of internal discharge resistors and record on the work order.							2	ANSI/NETA MTS §7.20.1
Safety disconnect switch: See Appendix Q for electrical maintenance of switches.								
Stepdown transformer (medium-low voltage): See Appendix P for electrical maintenance of transformers.								
Switchgears medium-low voltage: See Appendix R for electrical maintenance of bus assemblies.								
Voltage regulator: For load tap changer, record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage, alignment, and grounding. Record position indicator as-found, maximum, and minimum values, and record on the work order.			X					ANSI/NETA MTS §7.12.3

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Voltage regulator: For load tap changer, clean the unit and record on the work order. Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter. Verify and record on the work order the correct auxiliary device operation. Verify and record on the work order the motor and drive train for correct operation and automatic motor cutoff at maximum and minimum raise. Verify and record on the work order the correct liquid level in all tanks. Visually inspect and record on the work order the condition of wear and erosion indicators on vacuum bottles. Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces. Record on the work order as-found and as-left operation counter readings.						X		ANSI/NETA MTS §7.12.3
Voltage regulator: For load tap changer, measure insulation resistance in any off-neutral position and record on the work order. Measure insulation power factor or dissipation factor in off-neutral position and record on the work order. Measure turns ration at all tap positions and record on the work order. Perform vacuum bottle integrity tests (dielectric withstand voltage) across each vacuum bottle with the contacts in the open position in strict accordance with manufacturer's published data and record on the work order. Verify and record on the work operation of heaters.							2	ANSI/NETA MTS §7.12.3
Voltage regulator: For load tap changer, remove a sample of insulating liquid in accordance with ASTM D923 and test dielectric breakdown voltage (ASTM D877 or ASTM D1816); color (ASTM D1500); and visual condition (ASTM D1524) and record on the work order. Remove a sample of insulating liquid in accordance with ASTM D3613 and perform dissolved gas analysis (DGA) (IEEE C57.104 or ASTM D3612) and record on the work order.							2	ANSI/NETA MTS §7.12.3
Transfer Switching (Local backup source)								
Automatic transfer switch: See Appendix Q for electrical maintenance of switches.								
Manual transfer switch: See Appendix Q for electrical maintenance of switches.								

Appendix K Secondary Utilities and Distribution Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

**Table K-1
Secondary utilities and distribution maintenance task list**

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Secondary Utilities and Distribution								
Compressed Air System								
GENERAL								
Record on the work order the operation of gages.		X						EC 1130-2-218
Drain condensation from bottom of reservoirs/accumulator tanks and record on the work order.			X					EC 1130-2-218
Verify and record on the work order the compressor starts unloaded.			X					EC 1130-2-218
Record on the work order the oil pressure and level.			X					EC 1130-2-218
Record on the work order the flow of water or coolant through compressor and aftercooler. Flush as required and record on the work order.			X					EC 1130-2-218
Record on the work order the operation of dryers.			X					EC 1130-2-218
Clean or replace air intake filter element and record on the work order.				X				EC 1130-2-218
Record on the work order the condition of belts/chains for tension, wear, and aging.				X				EC 1130-2-218
Record on the work order the condition of pulley clamp bolts and screws for tightness.				X				EC 1130-2-218
Record on the work order the hour meter reading.				X				EC 1130-2-218
Replace oil filter as required and record on the work order.				X				EC 1130-2-218
Record on the work order the operation/calibration of pressure/temperature switches.						X		EC 1130-2-218
Record on the work order the condition of compressor components for corrosion and fatigue.						X		EC 1130-2-218
Record on the work order the condition of shaft couplings for excessive runout or vibration.						X		EC 1130-2-218
Thoroughly clean cooling fins of air-cooled compressors and radiators of water-cooled compressors and record on the work order.						X		EC 1130-2-218
Record on the work order the condition of the piping for corrosion.						X		EC 1130-2-218

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Record on the work order the condition of reed valves for corrosion and correct operation.						X		EC 1130-2-218
Clean control cabinets and devices and record on the work order.						X		EC 1130-2-218
Record on the work order the condition of wiring and connections.						X		EC 1130-2-218
Record on the work order the condition of controls for correct operation.						X		EC 1130-2-218
Lubricate motor bearings and record on the work order.								EC 1130-2-218
Record on the work order the condition of crankcase heaters for correct operation.								EC 1130-2-218
Record on the work order the motor insulation resistance.								EC 1130-2-218
Record on the work order the condition of motor cooling fins.						X		EC 1130-2-218
Visually inspect and record on the work order the condition of starters/contactors.						X		EC 1130-2-218
Measure motor full load amps and record on the work order.						X		EC 1130-2-218
Infrared scan motor and record on the work order.						X		EC 1130-2-218
Record on the work order the calibration of transducers.						X		EC 1130-2-218
Record on the work order the operation of pressure relief valves.						X		EC 1130-2-218
Record on the work order the calibration of pressure relief valves.						X		EC 1130-2-218
PRESSURE VESSELS								
Drain condensate from air receivers and record on the work order.		X						EC 1130-2-218
Record on the work order the operation of pressure relief valves.						X		EC 1130-2-218
Record on the work order the condition of receiver tanks.							5	EC 1130-2-218
Record on the work order the calibration of pressure relief valves.							5	EC 1130-2-218
PIPING								EC 1130-2-218
Record on the work order the operation of gages.		X						EC 1130-2-218
Clean strainer and check for corrosion or scale buildup and record on the work order.			X					EC 1130-2-218
Drain condensation from traps and record on the work order.			X					EC 1130-2-218
Record on the work order the condition of air distribution system for air leaks.				X				EC 1130-2-218
Record on the work order the condition of regulating valves for correct pressure.						X		EC 1130-2-218
Exercise isolation valves and record on the work order.						X		EC 1130-2-218
Record on the work order the condition of automatic traps for leaks and proper operation.						X		EC 1130-2-218
record on the work order the condition of pipe hangers and brackets.						X		EC 1130-2-218
Calibrate gages and transducers and record on the work order.						X		EC 1130-2-218

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Steam System								
Perform daily water chemical testing for conductivity, P-alkalinity, M-alkalinity, and OH, dissolved oxygen, and any protective chemicals used, and record on the work order. Treat as needed and record on the work order. Adjust continuous blowdown as needed and record on the work order. Monitor control system for warning and alarms and record on the work order. Make rounds of the boiler checking for leaks, exhaust, noises, or alarms at least daily and record on the work order.								
Blow down mud drum and record on the work order.		X						
Perform monthly safety checks to include, low water shutdown, low low water shutdown (if equipped), high water shutdown, low pressure gas/oil shutdown on boilers and tanks, and record on the work order.			X					ASME BPVC.VII-2019
Record on the work order the condition of the connection of chemical feeds and blowdown lines for plugging, security, and leaks on boilers and tanks.			X					ASME BPVC.VII-2019
Record on the work order the condition of feedwater system for proper operation and leaks.			X					ASME BPVC.VII-2019
Record on the work order the operation of gauges.			X					ASME BPVC.VII-2019
Clean sight glasses and record on the work order.			X					ASME BPVC.VII-2019
Test and record on the work order the condition of high pressure shutdown switches.					X			ASME BPVC.VII-2019
Test and record on the work order the condition of safety valves allowing overpressure to open the valves. Ensure valve reseats and record on the work order.					X			ASME BPVC.VII-2019
Have high pressure boilers (15 psi or more) inspected by state or local officials and record on the work order.						X		ASME BPVC.VII-2019
Record on the work order the condition of water side of drums, headers, and tubes for corrosion, scale, or pitting with boiler off and drained.						X		ASME BPVC.VII-2019
Record on the work order the condition of fire side of drums, headers, and tubes for corrosion, scale, or pitting with boiler off and drained.						X		ASME BPVC.VII-2019
Record on the work order the condition of exterior of all tubes and pipes for corrosion, buildup, erosion, blisters, and sagging.						X		ASME BPVC.VII-2019
Fully cycle all valves open and closed with boiler off and record on the work order.						X		ASME BPVC.VII-2019
Record on the work order the condition of furnace tile, brick, and castable refractory for loose, spalled, or missing pieces.						X		ASME BPVC.VII-2019
Tune boiler burner and burner management system to ensure maximum efficiency and record on the work order.						X		ASME BPVC.VII-2019
Record on the work order the condition and operation of all feedwater, blowdown, drain, and other miscellaneous valves. Replace parts as necessary and repack and record on the work order.						X		ASME BPVC.VII-2019

Maintenance Tasks	O	W	M	Q	S	A	P	Reference
Record on the work order the condition of air dampers and vanes in windbox for corrosion and erosion, damper, and vane operating mechanism.						X		ASME BPVC.VII-2019
Record on the work order the condition of all insulation for steam system.						X		
Record on the work order the condition of gas nozzles for erosion, burning, or plugging.						X		ASME BPVC.VII-2019
Record on the work order the condition of fuel oil motor and turbine drive gear-type pumps for excessive clearances, excessive backlash, worn bearings, or leakage.						X		ASME BPVC.VII-2019
Descale boiler drum and piping (if needed) and record on the work order.							2	ASME BPVC.VII-2019

Appendix L

Motor-Driven Machinery (≤ 600 Volt; 1 to 200 Horsepower) Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

Table L-1
Motor-driven machinery (≤ 600 Volt; 1 to 200 Horsepower) maintenance task list

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Motor								
Verify and record on the work order the absence of unusual mechanical or electrical noise.						X		EC 1130-2-218
Record on the work order the physical condition, anchorage, alignment, grounding, air baffles, filter media, cooling fans, and bearings.						X		ANSI/NETA MTS §7.15.1
Clean air intake and record on the work order.						X		EC 1130-2-218
Record on the work order the motor bearings are properly lubricated.						X		ANSI/NETA MTS §7.15.1
Measure motor full load amps and record on the work order.						X		EC 1130-2-218
Record on the work order the condition of bolted electrical connections for high resistance using ohm-meter.							2	ANSI/NETA MTS §7.15.1
Measure insulation resistance at 30 seconds and 1 minute and record on the work order. Calculate the dielectric-absorption ratio and record on the work order. Record the ambient temperature on the work order.							2	ANSI/NETA MTS §7.15.1
Controls (local)								
Verify and record on the work order the correct operation of alarms and indicating devices.				X				ANSI/NETA MTS §8
Verify and record on the work order that no alarm conditions are active.				X				ANSI/NETA MTS §8
Verify and record on the work order the operation of interlock safety devices for fail-safe functions.						X		ANSI/NETA MTS §8
Contactor: Verify and record on the work order the mechanical operation.						X		ANSI/NETA MTS §7.16.1.1
Contactor: Record on the work order the condition of bolted electrical connections for high resistance using ohm-meter.						X		ANSI/NETA MTS §7.16.1.1
Contactor: Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA MTS §7.16.1.1
Verify and record on the work order the correct overload settings.						X		ANSI/NETA MTS §7.16.1.1
Verify and record on the work order the correct protective device setting or rating.						X		NEMA ICS 1.3 §5.7

Maintenance Tasks	O	W	M	Q	S	A	P	References
Contactors: Measure insulation resistance phase-to-phase with closed contacts; phase-to-ground with open contacts; and across open contacts, and record on the work order.							2	ANSI/NETA MTS §7.16.1.1
Verify and record on the work order the condition of operation of local initiating and stopping control devices.							2	ANSI/NETA MTS §7.16.1.1
VFD: Measure output currents and voltages and record on the work order. Verify and record on the work order the correct levels and phase balance. For drives de-energized more than 1 year, bring output voltage and frequency up very slowly over 2 hours to avoid capacitor failure.							2	NFPA 70B §11.22
VFD: Verify and record on the work order the proper waveform of firing signals.							2	NFPA 70B §11.22
VFD: Test and record on the work order the feedback signals.							2	NFPA 70B §11.22
VFD: Push electronic cards to ensure they are fully seated and record on the work order. Do not remove.						X		NEMA ICS 1.3 §5.6, NFPA 70B §22.4.2
Cables (branch)								
See Appendix O for electrical maintenance of power cables.								
Conduits and cable trays								
Cable tray: Record on the work order the condition of sharp corners, intrusions, and other conditions that might damage cable insulation.							3	NFPA 70B §20
Cable tray: Verify and record on the work order the proper fill and separation of cables.							3	NFPA 70B §20
Cable tray: Verify and record on the work order the condition of proper ventilation. Remove debris and record on the work order.							3	NFPA 70B §20
Cable tray: Verify and record on the work order the mounting hardware is intact.							3	NFPA 70B §20
Conduit: Verify and record on the work order the condition of proper bonding to fittings.							3	NFPA 70B §20
Control panel (local)								
See Appendix M for electrical maintenance of control panels.								

Appendix M

Control Panels and Supervisory Control and Data Acquisition Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

Table M-1
Control panels and supervisory control and data acquisition maintenance task list

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Control panel								
Verify and record on the work order that equipment has been operating with the enclosure closed.			X					NEMA ICS 1.3 §4.1.3
Remove foreign material, dirt, hardware, or debris from the outside top surface of the enclosure before opening it.			X					NEMA ICS 1.3 §4.1.1
Eliminate the source of any dust, dirt, moisture, or other contaminants found inside the enclosure. Clean inside the enclosure and record on the work order.			X					NEMA ICS 1.3 §4.1.2; NFPA 70B Table L.1
Clean or replace dirty, wet, or contaminated control equipment and record on the work order.			X					NEMA ICS 1.3 §4.1.4
Verify and record on the work order that all labels and nameplates are intact.			X					NEMA ICS 1.3 §5.9
Verify and record on the work order the operation of lamps and indicators.			X					NFPA 70B Table L.1
Test and record on the work order the condition of the batteries.					X			NFPA 70B Table L.1
Actuate switches and record on the work order.					X			NFPA 70B Table L.1
Correct noisy solenoids in relays and contactors and record on the work order.						X		NEMA ICS 1.3 §5.5
Verify and record on the work order the operation of ventilation, heating, and cooling systems.						X		NEMA ICS 1.3 §4.3.1
Record on the work order the condition of insulation on conductors for overheating or chafing.						X		NEMA ICS 1.3 §5.3
Calibrate sensors, transmitters, and meters, and record on the work order.						X		NFPA 70B Table L.1
Test and record on the work order the automatic control sequences.						X		NFPA 70B Table L.1
Verify and record on the work order the condition of alarms.						X		NFPA 70B Table L.1
SCADA or PLC								
Verify and record on the work order that no components are overheating.			X					NFPA 70B Table L.1

Maintenance Tasks	O	W	M	Q	S	A	P	References
Verify and record on the work order the correct operation of alarms and indicating devices.			X					ANSI/NETA MTS §8
Verify and record on the work order that no alarms are active.			X					ANSI/NETA MTS §8
Run SCADA or PLC diagnostics and record on the work order.					X			NFPA 70B Table L.1
Push electronic cards to ensure they are fully seated and record on the work order. Do not remove.						X		NEMA ICS 1.3 §5.6, NFPA 70B §22.4.2
Test and record on the work order the automatic control sequences.						X		NFPA 70B Table L.1
Verify and record on the work order the operation of interlock safety devices for fail-safe functions.						X		ANSI/NETA MTS §8
Verify and record on the work order the operation of remote initiating and stopping control functions.						X		

Appendix N Circuit Breakers Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

**Table N-1
Circuit breakers maintenance task list**

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Low-voltage molded-case circuit breakers								
Record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage and alignment.			X					ANSI/NETA MTS §7.6.1.1
Clean the unit and record on the work order. Operate to ensure smooth operation and record on the work order.						X		ANSI/NETA MTS §7.6.1.1
Low-voltage molded-case circuit breakers – main breakers and breakers rated 225 amps or greater								
Record on the work order the condition of bolted electrical connections for high resistance using ohm-meter.						X		ANSI/NETA MTS §7.6.1.1
Record on the work order the condition of operating mechanism, contacts, and arc chutes in unsealed units.						X		ANSI/NETA MTS §7.6.1.1
Verify and record on the work order the protective device settings match coordination study.						X		ANSI/NETA MTS §7.6.1.1
Measure resistance through bolted connections using low-resistance ohmmeter and record on the work order.							3	ANSI/NETA MTS §7.6.1.1
Measure insulation resistance for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole, and record on the work order.							3	ANSI/NETA MTS §7.6.1.1
Perform a static contact or pole resistance test and record on the work order.							3	ANSI/NETA MTS §7.6.1.1
Determine long-time pickup and delay by primary current injection and record on the work order.							3	ANSI/NETA MTS §7.6.1.1
Determine short-time pickup and delay by primary current injection and record on the work order.							3	ANSI/NETA MTS §7.6.1.1
Determine instantaneous pickup current by primary injection and record on the work order.							3	ANSI/NETA MTS §7.6.1.1
Perform minimum pickup voltage test on shunt trip and close coils and record on the work order.							3	ANSI/NETA MTS §7.6.1.1

Maintenance Tasks	O	W	M	Q	S	A	P	References
Verify and record on the work order the correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, and trip unit battery condition.							3	ANSI/NETA MTS §7.6.1.1
Low-voltage power circuit breakers								
Record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage, alignment, and grounding.			X					ANSI/NETA MTS §7.6.1.2
Verify and record on the work order that all maintenance items are available for service and operating the breaker.						X		ANSI/NETA MTS §7.6.1.2
Clean the unit and record on the work order. Record on the work order the condition of arc chutes. Record on the work order the moving and stationary contacts for condition, wear, and alignment.						X		ANSI/NETA MTS §7.6.1.2
Verify and record on the work order that essential primary and secondary contact wipe and other dimensions are in accordance with manufacturer's published data.						X		ANSI/NETA MTS §7.6.1.2
Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism in accordance with manufacturer's published data and record on the work order.						X		ANSI/NETA MTS §7.6.1.2
Measure resistance through bolted connections using low-resistance ohmmeter and record on the work order.						X		ANSI/NETA MTS §7.6.1.2
Verify and record on the work order the cell fit and element alignment.						X		ANSI/NETA MTS §7.6.1.2
Verify and record on the work order the racking mechanism operation.						X		ANSI/NETA MTS §7.6.1.2
Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA MTS §7.6.1.2
Verify and record on the work order that protective device settings match coordination study.						X		ANSI/NETA MTS §7.6.1.2
Measure insulation resistance for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole, and record on the work order.							3	ANSI/NETA MTS §7.6.1.2
Perform a static contact or pole resistance test and record on the work order.							3	ANSI/NETA MTS §7.6.1.2
Determine long-time pickup and delay by primary current injection and record on the work order.							3	ANSI/NETA MTS §7.6.1.2
Determine short-time pickup and delay by primary current injection and record on the work order.							3	ANSI/NETA MTS §7.6.1.2
Determine ground-fault pickup and delay by primary current injection and record on the work order.							3	ANSI/NETA MTS §7.6.1.2
Determine instantaneous pickup current by primary injection and record on the work order.							3	ANSI/NETA MTS §7.6.1.2
Perform minimum pickup voltage test on shunt trip and close coils and record on the work order.							3	ANSI/NETA MTS §7.6.1.2

Maintenance Tasks	O	W	M	Q	S	A	P	References
Verify and record on the work order the correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, and trip unit battery condition.							3	ANSI/NETA MTS §7.6.1.2
Verify and record on the work order the operation of charging mechanism.							3	ANSI/NETA MTS §7.6.1.2
Medium-voltage vacuum circuit breakers								
Record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage, alignment, and grounding.			X					ANSI/NETA MTS §7.6.3
Verify and record on the work order that all maintenance items are available for service and operating the breaker.						X		ANSI/NETA MTS §7.6.3
Clean the unit and record on the work order. Record on the work order the condition of vacuum bottle assemblies. Measure critical distances such as contact gap as recommended by the manufacturer and record on the work order.						X		ANSI/NETA MTS §7.6.3
If recommended by the manufacturer, slow close and open the breaker and check for binding, friction, contact alignment, contact sequence, and penetration, and record on the work order.						X		ANSI/NETA MTS §7.6.3
Perform all mechanical tests on the operating mechanism in accordance with manufacturer's published data and record on the work order.						X		ANSI/NETA MTS §7.6.3
Measure resistance through bolted connections using low-resistance ohmmeter and record on the work order.						X		ANSI/NETA MTS §7.6.3
Verify and record on the work order the cell fit and element alignment.						X		ANSI/NETA MTS §7.6.3
Verify and record on the work order the racking mechanism operation.						X		ANSI/NETA MTS §7.6.3
Record on the work order the vacuum bellows operation.						X		ANSI/NETA MTS §7.6.3
Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA MTS §7.6.3
Perform contact timing test and record on the work order.						X		ANSI/NETA MTS §7.6.3
Measure insulation resistance for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole, and record on the work order.							2	ANSI/NETA MTS §7.6.3
Perform a static contact or pole resistance test and record on the work order.							2	ANSI/NETA MTS §7.6.3
In the test position, trip and close the breaker with the control switch; trip breaker by operating each of its protective relays; and verify mechanism charge, trip-free, and antipump functions, and record on the work order.							2	ANSI/NETA MTS §7.6.3
Test and record on the work order the vacuum bottle integrity with dielectric withstand voltage across each bottle with breaker in the open position. Follow manufacturer's published data.							2	ANSI/NETA MTS §7.6.3
Verify and record on the work order the operation of heaters.							2	ANSI/NETA MTS §7.6.3

Maintenance Tasks	O	W	M	Q	S	A	P	References
Medium-voltage air circuit breakers								
Record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage, alignment, and grounding.			X					ANSI/NETA MTS §7.6.1.3
Verify and record on the work order that all maintenance items are available for service and operating the breaker.						X		ANSI/NETA MTS §7.6.1.3
Clean the unit and record on the work order. Record on the work order the condition of arc chutes. Record on the work order the moving and stationary contacts for condition, wear, and alignment.						X		ANSI/NETA MTS §7.6.1.3
If recommended by the manufacturer, slow close and open the breaker and check for binding, friction, contact alignment, contact sequence, and penetration, and record on the work order.						X		ANSI/NETA MTS §7.6.1.3
Perform all mechanical tests on the operating mechanism in accordance with manufacturer's published data and record on the work order.						X		ANSI/NETA MTS §7.6.1.3
Measure resistance through bolted connections using low-resistance ohmmeter and record on the work order.						X		ANSI/NETA MTS §7.6.1.3
Verify and record on the work order the cell fit and element alignment.						X		ANSI/NETA MTS §7.6.1.3
Verify and record on the work order the racking mechanism operation.						X		ANSI/NETA MTS §7.6.1.3
Record on the work order the puffer operation.						X		ANSI/NETA MTS §7.6.1.3
Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA MTS §7.6.1.3
Perform contact timing test and record on the work order.						X		ANSI/NETA MTS §7.6.1.3
Measure insulation resistance for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole, and record on the work order.							3	ANSI/NETA MTS §7.6.1.3
Perform a static contact or pole resistance test and record on the work order.							3	ANSI/NETA MTS §7.6.1.3
In the test position, trip and close the breaker with the control switch; trip breaker by operating each of its protective relays; and verify mechanism charge, trip-free, and antipump functions, and record on the work order.							3	ANSI/NETA MTS §7.6.1.3
Verify and record on the work order the blowout coil circuit continuity.							3	ANSI/NETA MTS §7.6.1.3
Verify and record on the work order the operation of heaters.							3	ANSI/NETA MTS §7.6.1.3
Protective relays, microprocessor-based								
Record model number, style number, serial number, firmware revision, software revision, and rated control voltage, and record on the work order.			X					ANSI/NETA MTS §7.9.2
Download the sequence of events, maintenance data, and statistical data prior to testing the relay.			X					ANSI/NETA MTS §7.9.2
Verify and record on the work order the operation of light-emitting diodes, display, and targets.			X					ANSI/NETA MTS §7.9.2

Maintenance Tasks	O	W	M	Q	S	A	P	References
Clean the front panel and remove foreign material from the case, and record on the work order.						X		ANSI/NETA MTS §7.9.2
Record on the work order the condition of tightness of connections.						X		ANSI/NETA MTS §7.9.2
Verify and record on the work order the frame is grounded per manufacturer's instructions.						X		ANSI/NETA MTS §7.9.2
Download settings and logic from the relay and record on the work order. Compare settings to those specified in the coordination study and record on the work order.						X		ANSI/NETA MTS §7.9.2
Verify and record on the work order the relay displays the correct date and time. Compare relay time to actual time and record the difference on the work order.						X		ANSI/NETA MTS §7.9.2
Record on the work order the applicable firmware updates and product recalls.						X		ANSI/NETA MTS §7.9.2
Inspect, clean, and verify operation of shorting devices and record on the work order.						X		ANSI/NETA MTS §7.9.2
Apply voltage or current to all analog inputs and verify correct registration of the relay meter functions and record on the work order.						X		ANSI/NETA MTS §7.9.2
For controls, check operation of all active digital inputs; check all output contacts or silicon controlled rectifier (SCR) (preferably by operating the controlled device such as circuit breaker, auxiliary relay, or alarm); perform protection system communication tests for pilot schemes; after testing, reset all min/max records and fault counters; after testing, delete sequence-of-events records and all event records; and verify trip and close coil monitoring functions, and record on the work order.						X		ANSI/NETA MTS §7.9.2
Protective relays, electromechanical and solid-state								
Record on the work order the condition of relays and cases for physical damage.			X					ANSI/NETA MTS §7.9.1
Clean and inspect the unit and record on the work order. For the relay case, tighten case connections; inspect cover for correct gasket seal; clean cover glass; inspect shorting hardware, connection paddles, and/or knife switches; remove any foreign material from the case; and verify target reset. For the relay, inspect for foreign material, particularly in disk slots of the damping and electromagnets; verify disk clearance; verify contact clearance and spring bias; inspect spiral spring convolutions; inspect disk and contacts for freedom of movement and correct travel; verify tightness of mounting hardware and connections; burnish contacts; inspect bearings and pivots.						X		ANSI/NETA MTS §7.9.1
Verify and record on the work order the protective device settings match coordination study.						X		ANSI/NETA MTS §7.9.1
Measure insulation resistance for one minute on each circuit-to-frame and record on the work order.						X		ANSI/NETA MTS §7.9.1
For test targets and indicators, determine pickup and dropout of electromechanical targets; verify and record on the work order the operation of all light-emitting diode indicators; and set contrast for liquid-crystal display readouts.						X		ANSI/NETA MTS §7.9.1

Maintenance Tasks	O	W	M	Q	S	A	P	References
For ANSI device 50 (instantaneous overcurrent), determine pickup; and determine dropout, and record on the work order.						X		ANSI/NETA MTS §7.9.1
For ANSI device 51 (time overcurrent), determine minimum pickup; and determine time delay at two points on the time current curve, and record on the work order.						X		ANSI/NETA MTS §7.9.1
For ANSI device 67 (directional overcurrent), determine directional unit minimum pickup at maximum torque angle; determine contact closing zone; determine overcurrent unit pickup; and determine overcurrent unit time delay at two points on the time current curve, and record on the work order.						X		ANSI/NETA MTS §7.9.1
For ANSI device 87 (differential), determine operating unit pickup; determine the operation of each restraint unit; determine slope; determine harmonic restraint; and determine instantaneous pickup, and record on the work order.						X		ANSI/NETA MTS §7.9.1
For controls, verify and record on the work order that each of the relay contacts performs its intended function in the control scheme including breaker trip tests, close inhibit tests, 86 lockout tests, and alarm functions.						X		ANSI/NETA MTS §7.9.1
Ground-fault protection systems, low-voltage								
Record on the work order the condition of components for damage and errors in polarity or conductor routing. Verify and record on the work order the ground connection is made on the source side of the neutral disconnect link and also on the source side of any ground fault sensor. Verify and record on the work order the neutral sensors are connected with correct polarity on both primary and secondary. Verify and record on the work order that all phase conductors and the neutral pass through the sensor in the same direction for zero-sequence systems. Verify and record on the work order that grounding conductors do not pass through zero-sequence sensors. Verify and record on the work order that grounded conductor is solidly grounded.				X				ANSI/NETA §7.14
Clean the unit and record on the work order.						X		ANSI/NETA §7.14
Record on the work order the condition of bolted electrical connections for high resistance using ohm-meter.						X		ANSI/NETA §7.14
Verify and record on the work order the correct operation of all functions of the self-test panel.						X		ANSI/NETA §7.14
Verify and record on the work order the pickup and time-delay settings in accordance with the coordination study. Record appropriate operation and test sequences per NFPA 70 Article 230.95 and record on the work order.						X		ANSI/NETA §7.14
Measure the system neutral-to-ground insulation resistance with the neutral disconnect link temporarily removed and record on the work order. Replace neutral disconnect link after testing.						X		ANSI/NETA §7.14
Perform ground fault protective device pickup tests using primary current injection and record on the work order.						X		ANSI/NETA §7.14

Maintenance Tasks	O	W	M	Q	S	A	P	References
For summation type systems utilizing phase and neutral current transformers, verify and record on the work order the correct polarities by applying current to each phase-neutral current transformer pair. This test also applies to molded-case breakers utilizing an external neutral current transformer.						X		ANSI/NETA §7.14
Measure time delay of ground fault protective device at a value equal to or greater than 150 percent of the pickup value and record on the work order.						X		ANSI/NETA §7.14
Verify and record on the work order the reduced control voltage tripping capability is 55 percent of ac systems and 80 percent for dc systems.						X		ANSI/NETA §7.14
Verify and record on the work order the blocking capability of zone interlock systems.						X		ANSI/NETA §7.14

Appendix O Power Cables Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

**Table O-1
Power cables maintenance task list**

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Low-voltage power cables (less than 600V)								
Record on the work order the condition of exposed sections of cables for overheating and physical damage.				X				ANSI/NETA MTS §7.3.2
Record on the work order the condition of bolted electrical connections for high resistance using ohm-meter.							3	ANSI/NETA MTS §7.3.2
Measure insulation resistance to ground and adjacent conductors for 1 minute and record on the work order. Record the ambient temperature on the work order.							3	ANSI/NETA MTS §7.3.2
Medium-voltage power cables (greater than 600V)								
Record on the work order the conditions of exposed sections of cable, terminations, and splices for physical damage, evidence of overheating, and corona.				X				ANSI/NETA MTS §7.3.3
Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter. Record on the work order the condition of shield grounding and cable support. If cables are terminated through window-type current transformers, verify neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.						X		ANSI/NETA MTS §7.3.3
Measure insulation resistance on each conductor with all other conductors and shields grounded and record on the work order. Perform dielectric withstand and/or other diagnostic tests per available test methods, manufacturer's published data, and a review of the installed cable system and record on the work order.							3	ANSI/NETA MTS §7.3.3
Test and record on the work order the shield continuity on each power cable using an ohmmeter.							3	ANSI/NETA MTS §7.3.3

Appendix P Transformers Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

**Table P-1
Transformers maintenance task list**

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Dry, air-cooled, low-voltage, at most 600 V, three-phase, at most 500 kVA								
Record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage, alignment, and grounding.				X				ANSI/NETA §7.2.1.1
Clean the unit and record on the work order. Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter. Verify and record on the work order tap connections are as specified.						X		ANSI/NETA §7.2.1.1
Measure insulation resistance winding-to-winding and each winding-to-ground and record on the work order. Apply voltage in accordance with manufacturer's published data and record on the work order. Calculate dielectric absorption ratio or polarization index and record on the work order.							3	ANSI/NETA §7.2.1.1
Test and record on the work order the transformer neutral grounding impedance devices.							2	ANSI/NETA §7.2.2
Dry, air-cooled, over 600 V; or dry, air-cooled, at most 600 V, over 500 kVA								
Record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage, alignment, and grounding. Verify and record on the work order cooling fans operate correctly.				X				ANSI/NETA §7.2.1.2
Clean the unit and record on the work order. Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter. Verify and record on the work order tap connections are as specified. Verify and record on the work order the presence of surge arresters.						X		ANSI/NETA §7.2.1.2

Maintenance Tasks	O	W	M	Q	S	A	P	References
Measure insulation resistance winding-to-winding and each winding-to-ground and record on the work order. Apply voltage in accordance with manufacturer's published data and record on the work order. Calculate dielectric absorption ratio or polarization index and record on the work order. Perform insulation power-factor or dissipation-factor tests on all windings in accordance with the test equipment manufacturer's published data and record on the work order. Perform turns-ratio test at the designated tap position and record on the work order. Perform an excitation-current test on each phase and record on the work order. Measure core insulation resistance at 500 volts dc if the core is insulated and if the core ground strap is removable and record on the work order. Verify and record on the work order the correct secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.							2	ANSI/NETA §7.2.1.2
For medium- and high-voltage surge arresters, record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage, alignment, and grounding.				X				ANSI/NETA §7.19
For medium- and high-voltage surge arresters, clean the unit and record on the work order. Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter. Verify and record on the work order the ground lead on each device is individually attached to a ground bus or ground electrode. Verify and record on the work order the stroke counter, if present, is correctly mounted and electrically connected.						X		ANSI/NETA §7.19
For medium- and high-voltage surge arresters, measure insulation resistance from phase terminal(s) to case for one minute and record on the work order. Test and record on the work order the voltage and minimum resistance shall be in accordance with manufacturer's published data. Test and record on the work order the condition of grounding connection.							2	ANSI/NETA §7.19
Test and record on the work order the condition of transformer neutral grounding impedance devices.							2	ANSI/NETA §7.2.2
Liquid-filled								
Record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage, alignment, and grounding. Verify and record on the work order the presence of printed circuit board (PCB) labeling. Verify and record on the work order that cooling fans and/or pumps operate correctly.			X					ANSI/NETA §7.2.2
Clean bushings and control cabinets and record on the work order. Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter. Verify and record on the work order that tap connections are as specified. Verify and record on the work order the presence of transformer surge arresters. Test and record on the work order the load tap-changer. Verify and record on the work order that positive pressure is maintained on gas-blanketed transformers. Verify and record on the work order the correct liquid level in tanks and bushings. Verify and record on the work order the operation of alarm, control, and trip circuits from temperature and level indicators; pressure-relief device; gas accumulator; and fault-pressure relay.						X		ANSI/NETA §7.2.2

Maintenance Tasks	O	W	M	Q	S	A	P	References
Measure insulation resistance winding-to-winding and each winding-to-ground and record on the work order. Apply voltage in accordance with manufacturer's published data. Calculate polarization index and record on the work order. Perform turns-ratio test at the designated tap position and record on the work order. Perform insulation power-factor or dissipation-factor tests on all windings and record on the work order. Perform power-factor or dissipation-factor tests on each bushing equipped with a power-factor or capacitance tap; otherwise perform hot-collar tests and record on the work order. Perform excitation-current tests and record on the work order. Measure the resistance of each winding at the designated tap position and record on the work order.							2	ANSI/NETA §7.2.2
Remove a sample of insulating liquid in accordance with ASTM D923. Test dielectric-breakdown voltage (ASTM D1816); acid neutralization number (ASTM D974); interfacial tension (ASTM D1298); color (ASTM D1500); visual condition (ASTM D1524); and water in insulating liquids (ASTM D1533), and record on the work order.							2	ANSI/NETA §7.2.2
Remove a sample of insulating liquid in accordance with ASTM D3613 and perform dissolved-gas analysis (DGA) in accordance with IEEE C57.104 or ASTM D3612 and record on the work order.							2	ANSI/NETA §7.2.2
For medium- and high-voltage surge arresters, record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage, alignment, and grounding.				X				ANSI/NETA §7.19
For medium- and high-voltage surge arresters, clean the unit and record on the work order. Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter. Verify and record on the work order the ground lead on each device is individually attached to a ground bus or ground electrode. Verify and record on the work order the stroke counter, if present, is correctly mounted and electrically connected.						X		ANSI/NETA §7.19
For medium- and high-voltage surge arresters, measure insulation resistance from phase terminal(s) to case for one minute and record on the work order. Test voltage and minimum resistance shall be in accordance with manufacturer's published data. Test the grounding connection and record on the work order.							2	ANSI/NETA §7.19
Test the transformer neutral grounding impedance devices and record on the work order.							2	ANSI/NETA §7.2.2
Instrument transformers, current: Record on the work order the physical and mechanical condition. Clean the unit and record on the work order. Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter. Verify and record on the work order that all grounding and shorting connections provide contact. Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA §7.10.1

Maintenance Tasks	O	W	M	Q	S	A	P	References
Instrument transformers, voltage: Record on the work order the physical and mechanical condition. Clean the unit and record on the work order. Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter. Verify and record on the work order that all required grounding and connections provide contact. Verify and record on the work order the correct operation of transformer withdrawal mechanism and grounding operation. Verify and record on the work order the correct primary and secondary fuse sizes for voltage transformers. Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA §7.10.2
Instrument transformers, current: Measure insulation resistance of each current transformer and wiring-to-ground at 1000 volts dc for one minute and record on the work order. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's recommendations. Measure insulation resistance of the primary winding with the secondary grounded and record on the work order. Perform dielectric withstand voltage tests on the primary winding with the secondary grounded and record on the work order. Verify and record on the work order that current circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.							3	ANSI/NETA §7.10.1
Instrument transformers, voltage: Measure insulation resistance for one minute winding-to-winding and winding-to-ground and record on the work order. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's recommendations and record on the work order. Verify and record on the work order that current circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.							3	ANSI/NETA §7.10.2

Appendix Q Switches Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

**Table Q-1
Switches maintenance task list**

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Switch, air, low-voltage								
Record on the work order the physical and mechanical condition.				X				ANSI/NETA §7.5.1.1
Record on the work order the condition of anchorage, alignment, and grounding.				X				ANSI/NETA §7.5.1.1
Verify and record on the work order the fuse sizes and types are in accordance with drawings, short-circuit study, and coordination study.				X				ANSI/NETA §7.5.1.1
Clean the unit and record on the work order.						X		ANSI/NETA §7.5.1.1
Verify and record on the work order the correct blade alignment, blade penetration, travel stops, and mechanical operation.						X		ANSI/NETA §7.5.1.1
Verify and record on the work order that each fuse has adequate mechanical support and contact integrity.						X		ANSI/NETA §7.5.1.1
Record on the work order the condition of bolted electrical connections for high resistance using low-resistance ohmmeter.						X		ANSI/NETA §7.5.1.1
Verify and record on the work order the operation and sequencing of interlocking systems.						X		ANSI/NETA §7.5.1.1
Verify and record on the work order the phase-barrier mounting is intact.						X		ANSI/NETA §7.5.1.1
Verify and record on the work order the correct operation of indicating and control devices.						X		ANSI/NETA §7.5.1.1
Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA §7.5.1.1
Measure contact resistance across each switchblade and fuseholder and record on the work order.							3	ANSI/NETA §7.5.1.1
Measure insulation resistance for one minute on each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole and record on the work order. Apply voltage in accordance with manufacturer's published data and record on the work order.							3	ANSI/NETA §7.5.1.1
Measure fuse resistance and record on the work order.							3	ANSI/NETA §7.5.1.1

Maintenance Tasks	O	W	M	Q	S	A	P	References
Verify cubicle space heater operation and record on the work order.							3	ANSI/NETA §7.5.1.1
Switch, air, medium-voltage, metal-enclosed								
Record on the work order the physical and mechanical condition.						X		ANSI/NETA §7.5.1.2
Record on the work order the condition of anchorage, alignment, grounding, and required clearances.						X		ANSI/NETA §7.5.1.2
Clean the unit and record on the work order.						X		ANSI/NETA §7.5.1.2
Verify and record on the work order the correct blade alignment, blade penetration, travel stops, arc interrupter operation, and mechanical operation.						X		ANSI/NETA §7.5.1.2
Verify and record on the work order that fuses sizes and types are in accordance with drawings, short-circuit studies, and coordination study.						X		ANSI/NETA §7.5.1.2
Verify and record on the work order that expulsion-limiting devices are in place on all fuses having expulsion-type elements.						X		ANSI/NETA §7.5.1.2
Verify and record on the work order that each fuseholder has adequate mechanical support and contact integrity.						X		ANSI/NETA §7.5.1.2
Record on the work order the condition of bolted electrical connections for high resistance using low-resistance ohmmeter.						X		ANSI/NETA §7.5.1.2
Record on the work order the operation and sequencing of interlocking systems.						X		ANSI/NETA §7.5.1.2
Verify and record on the work order the phase-barrier mounting is intact.						X		ANSI/NETA §7.5.1.2
Verify and record on the work order the correct operation of indicating and control devices.						X		ANSI/NETA §7.5.1.2
Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA §7.5.1.2
Measure contact resistance across each switchblade and fuseholder and record on the work order.							2	ANSI/NETA §7.5.1.2
Measure insulation resistance for one minute on each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole and record on the work order. Apply voltage in accordance with manufacturer's published data and record on the work order.							2	ANSI/NETA §7.5.1.2
Perform a dielectric withstand voltage test on each pole with switch closed and record on the work order. Test and record on the work order that each pole-to-ground with all other poles grounded. Test voltage shall be in accordance with manufacturer's published data.							2	ANSI/NETA §7.5.1.2
Measure fuse resistance and record on the work order.							2	ANSI/NETA §7.5.1.2
Verify cubicle space heater operation and record on the work order.							2	ANSI/NETA §7.5.1.2
Switch, oil, medium-voltage								
Record on the work order the physical and mechanical condition.			X					ANSI/NETA §7.5.2

Maintenance Tasks	O	W	M	Q	S	A	P	References
Record on the work order the condition of anchorage, alignment, grounding, and required clearances.			X					ANSI/NETA §7.5.2
Clean the unit and record on the work order.						X		ANSI/NETA §7.5.2
Perform mechanical operator tests in accordance with manufacturer's published data and record on the work order.						X		ANSI/NETA §7.5.2
Verify and record on the work order the correct operation and adjustment of motor operator limit switches and mechanical interlocks.						X		ANSI/NETA §7.5.2
Verify and record on the work order that each fuseholder has adequate mechanical support and contact integrity.						X		ANSI/NETA §7.5.2
Verify and record on the work order the fuse sizes and types are in accordance with drawings, short-circuit study, and coordination study.						X		ANSI/NETA §7.5.2
Test and record on the work order that all electrical and mechanical interlock systems for correct operation and sequencing.						X		ANSI/NETA §7.5.2
Record on the work order the condition of bolted electrical connections for high resistance using low-resistance ohmmeter.						X		ANSI/NETA §7.5.2
Verify and record on the work order the insulating oil level is correct.						X		ANSI/NETA §7.5.2
Record on the work order the condition of and/or replace gaskets as recommended by the manufacturer.						X		ANSI/NETA §7.5.2
Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA §7.5.2
Record on the work order the as-found and as-left operation counter readings.						X		ANSI/NETA §7.5.2
Perform contact or pole-resistance test and record on the work order.							2	ANSI/NETA §7.5.2
Measure insulation resistance for one minute on each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole and record on the work order. Apply voltage in accordance with manufacturer's published data and record on the work order.							2	ANSI/NETA §7.5.2
Measure fuse resistance and record on the work order.							2	ANSI/NETA §7.5.2
Switch, vacuum, medium-voltage								
Record on the work order the physical and mechanical condition.			X					ANSI/NETA §7.5.3
Record on the work order the condition of anchorage, alignment, grounding, and required clearances.			X					ANSI/NETA §7.5.3
Clean the unit and record on the work order.						X		ANSI/NETA §7.5.3
Perform mechanical operator tests in accordance with manufacturer's published data and record on the work order.						X		ANSI/NETA §7.5.3
Verify and record on the work order the correct operation and adjustment of motor operator limit switches and mechanical interlocks.						X		ANSI/NETA §7.5.3

Maintenance Tasks	O	W	M	Q	S	A	P	References
Measure critical distances on operating mechanism as recommended by manufacturer and record on the work order.						X		ANSI/NETA §7.5.3
Record on the work order the condition of bolted electrical connections for high resistance using low-resistance ohmmeter.						X		ANSI/NETA §7.5.3
Record on the work order the condition of insulating assemblies for evidence of physical damage or contaminated surfaces.						X		ANSI/NETA §7.5.3
Verify and record on the work order the fuseholder has adequate support and contact integrity.						X		ANSI/NETA §7.5.3
Verify and record on the work order the fuse sizes and types are in accordance with drawings, short-circuit study, and coordination study.						X		ANSI/NETA §7.5.3
Test and record on the work order that all electrical and mechanical interlock systems for correct operation and sequencing.						X		ANSI/NETA §7.5.3
Verify and record on the work order that insulating oil level is correct.						X		ANSI/NETA §7.5.3
Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA §7.5.3
Record on the work order the as-found and as-left operation counter readings.						X		ANSI/NETA §7.5.3
Perform contact or pole-resistance test and record on the work order.								ANSI/NETA §7.5.3
Measure insulation resistance for one minute on each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole, and record on the work order. Apply voltage in accordance with manufacturer's published data and record on the work order.							2	ANSI/NETA §7.5.3
Perform vacuum bottle integrity (dielectric withstand voltage) test across each vacuum bottle with the switch in the open position in strict accordance with the manufacturer's published data and record on the work order.							2	ANSI/NETA §7.5.3
Remove a sample of insulating liquid in accordance with ASTM D923. Test dielectric breakdown voltage (ASTM D877); color (ASTM D1500); and visual condition (ASTM D1524), and record on the work order.							2	ANSI/NETA §7.5.3
Verify and record on the work order the open and close operation from control devices.							2	ANSI/NETA §7.5.3
Measure fuse resistance and record on the work order.							2	ANSI/NETA §7.5.3
Switch, SF6, medium-voltage								
Record on the work order the physical and mechanical condition.			X					ANSI/NETA §7.5.4
Record on the work order the condition of anchorage, alignment, grounding, and required clearances.			X					ANSI/NETA §7.5.4
Clean the unit and record on the work order.						X		ANSI/NETA §7.5.4
Service and record on the work order the condition of mechanical operator and SF6 gas insulated system in accordance with manufacturer's published data.						X		ANSI/NETA §7.5.4

Maintenance Tasks	O	W	M	Q	S	A	P	References
Verify and record on the work order the correct operation of SF6 gas pressure alarms and limit switches as recommended by the manufacturer.						X		ANSI/NETA §7.5.4
Measure critical distances on operating mechanism as recommended by manufacturer and record on the work order.						X		ANSI/NETA §7.5.4
Record on the work order the condition of bolted electrical connections for high resistance using low-resistance ohmmeter.						X		ANSI/NETA §7.5.4
Verify and record on the work order the fuse sizes and types are in accordance with drawings, short-circuit study, and coordination study.						X		ANSI/NETA §7.5.4
Verify and record on the work order the fuseholder has adequate support and contact integrity.						X		ANSI/NETA §7.5.4
Verify and record on the work order the operation and sequencing of interlocking systems.						X		ANSI/NETA §7.5.4
Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA §7.5.4
Test and record on the work order any SF6 gas leaks in accordance with manufacturer's published data.						X		ANSI/NETA §7.5.4
Record on the work order the as-found and as-left operation counter readings.						X		ANSI/NETA §7.5.4
Perform contact resistance test and record on the work order.							2	ANSI/NETA §7.5.4
Measure insulation resistance for one minute on each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole and record on the work order. Apply voltage in accordance with manufacturer's published data.							2	ANSI/NETA §7.5.4
Perform a dielectric withstand voltage test across each gas bottle with switch in the open position in accordance with manufacturer's published data and record on the work order.							2	ANSI/NETA §7.5.4
Verify open and close operation from control devices and record on the work order.							2	ANSI/NETA §7.5.4
Measure fuse resistance and record on the work order.							2	ANSI/NETA §7.5.4
Automatic transfer switch								
Record on the work order the physical and mechanical condition.			X					ANSI/NETA §7.22.3
Record on the work order the condition of anchorage, alignment, grounding, and required clearances.			X					ANSI/NETA §7.22.3
Record on the work order the manual transfer warnings are attached and visible.			X					ANSI/NETA §7.22.3
Perform automatic transfer tests and record on the work order. Simulate loss of normal power; return to normal power; simulate loss of emergency power; and simulate all forms of single-phase conditions.			X					ANSI/NETA §7.22.3; NFPA 110 §8
Clean the unit and record on the work order.						X		ANSI/NETA §7.22.3
Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA §7.22.3

Maintenance Tasks	O	W	M	Q	S	A	P	References
Verify and record on the work order the tightness of all control connections.						X		ANSI/NETA §7.22.3
Record on the work order the condition of bolted electrical connections for high resistance using low-resistance ohmmeter.						X		ANSI/NETA §7.22.3
Perform manual transfer operation and record on the work order.						X		ANSI/NETA §7.22.3
Verify and record on the work order the positive mechanical interlocking between normal and alternate sources.						X		ANSI/NETA §7.22.3
Perform contact or pole-resistance test and record on the work order.						X		ANSI/NETA §7.22.3
Verify and record on the work order the settings and operation of control devices.						X		ANSI/NETA §7.22.3
Verify correct operation and timing of normal source voltage-sensing and frequency-sensing relays; engine start sequence; time delay upon transfer; alternate source voltage-sensing and frequency-sensing relays; automatic transfer operation; interlocks and limit switch function; time delay and retransfer upon normal power restoration; and engine cool down and shutdown feature, and record on the work order.						X		ANSI/NETA §7.22.3

Appendix R Bus Assemblies Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

**Table R-1
Bus assemblies maintenance task list**

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Instrument transformers, current								
Record on the work order the physical and mechanical condition.						X		ANSI/NETA §7.10.1
Clean the unit and record on the work order. Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter.						X		ANSI/NETA §7.10.1
Verify and record on the work order that all grounding and shorting connections provide contact.						X		ANSI/NETA §7.10.1
Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA §7.10.1
Measure insulation resistance of each current transformer and wiring-to-ground at 1000 volts dc for one minute and record on the work order. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's recommendations.							3	ANSI/NETA §7.10.1
Measure insulation resistance of the primary winding with the secondary grounded and record on the work order.							3	ANSI/NETA §7.10.1
Perform dielectric withstand voltage tests on the primary winding with the secondary grounded and record on the work order.							3	ANSI/NETA §7.10.1
Verify and record on the work order that current circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3.							3	ANSI/NETA §7.10.1
Instrument transformers, voltage								
Record on the work order the physical and mechanical condition.						X		ANSI/NETA §7.10.2
Clean the unit and record on the work order. Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter.						X		ANSI/NETA §7.10.2
Record on the work order that all required grounding and connections provide contact.						X		ANSI/NETA §7.10.2
Verify and record on the work order the correct operation of transformer withdrawal mechanism and grounding operation.						X		ANSI/NETA §7.10.2

Maintenance Tasks	O	W	M	Q	S	A	P	References
Verify and record on the work order the correct primary and secondary fuse sizes for voltage transformers.						X		ANSI/NETA §7.10.2
Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA §7.10.2
Measure insulation resistance for one minute winding-to-winding and winding-to-ground. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's recommendations, and record on the work order.							3	ANSI/NETA §7.10.2
Verify that current circuits are grounded and have only one grounding point in accordance with IEEE C57.13.3 and record on the work order.							3	ANSI/NETA §7.10.2
Switchgear, switchboard, and panelboard assemblies								
Record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage, alignment, grounding, and required clearances.						X		ANSI/NETA §7.1
Clean the unit and record on the work order. Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter. Verify and record on the work order the fuses and/or circuit breaker sizes and types correspond to drawings, coordination study, and any network addresses. Verify and record on the work order the instrument transformer ratios correspond to drawings. Verify and record on the work order the wiring connections are tight and wiring secure to prevent damage during routine operation of moving parts.						X		ANSI/NETA §7.1
Confirm correct operation and sequencing of electrical and mechanical interlock devices and record on the work order. Attempt closure on locked-open devices. Attempt to open locked-closed devices. Make key exchange with all devices included in the interlock scheme as applicable.						X		ANSI/NETA §7.1
Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.						X		ANSI/NETA §7.1
Record on the work order the condition of insulators for evidence of physical damage or contaminated surfaces.						X		ANSI/NETA §7.1
Verify and record on the work order the correct barrier and shutter installation and operation.						X		ANSI/NETA §7.1
Exercise all active components and record on the work order.						X		ANSI/NETA §7.1
Record on the work order the condition of mechanical indicating devices for correct operation.						X		ANSI/NETA §7.1
Verify and record on the work order filters are in place and/or vents are clear.						X		ANSI/NETA §7.1
Inspect control power transformers for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition and record on the work order. Verify and record on the work order the primary and secondary fuse ratings or circuit breaker ratings match drawings. Verify and record on the work order the correct functioning of drawout disconnecting and grounding contacts and interlocks.						X		ANSI/NETA §7.1

Maintenance Tasks	O	W	M	Q	S	A	P	References
Measure insulation resistance for one minute on each bus section, phase-to-phase and phase-to-ground and record on the work order. Apply voltage in accordance with manufacturer's published data.							2	ANSI/NETA §7.1
For control power transformers, measure insulation resistance winding-to-winding and winding-to-ground and record on the work order. Verify and record on the work order the correct function of control transfer relays located in switchgear with multiple power sources.							2	ANSI/NETA §7.1
Verify and record on the work order the operation of heaters and their controller.							2	ANSI/NETA §7.1
Metering devices, electromechanical and solid-state								
Record on the work order the physical and mechanical condition. Measure insulation resistance using low-resistance ohmmeter and record on the work order.						X		ANSI/NETA §7.11.1
Record on the work order the condition of cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case-shorting contacts, as applicable.						X		ANSI/NETA §7.11.1
Clean the unit and record on the work order. Verify and record on the work order the freedom of movement, end play, and alignment of rotating disk(s).						X		ANSI/NETA §7.11.1
Verify and record on the work order the accuracy of meters at all cardinal points. Calibrate meters in accordance with manufacturer's published data.							3	ANSI/NETA §7.11.1
Metering devices, microprocessor-based								
Record on the work order the condition of meters and cases for physical damage. Clean front panel and record on the work order. Verify and record on the work order tightness of electrical connections. Record on the work order the model number, serial number, firmware revision, software revision, and rated control voltage. Verify and record on the work order the operation of display and indicating devices. Record passwords on the work order. Verify and record on the work order the unit is grounded in accordance with manufacturer's instructions. Verify and record on the work order the unit is connected in accordance with manufacturer's instructions and project drawings. Download settings from the meter, print a copy, and compare to specified settings and record on the work order.						X		ANSI/NETA §7.11.2
Apply voltage or current as appropriate to each analog input and verify correct measurement and indication and record on the work order. Confirm correct operation and setting of each auxiliary input and output feature in use, including mechanical relay, digital, and analog and record on the work order. Confirm measurements and indications are consistent with loads present and record on the work order.							3	ANSI/NETA §7.11.2
Surge arresters								
Record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage, alignment, and grounding.				X				ANSI/NETA §7.19

Maintenance Tasks	O	W	M	Q	S	A	P	References
Clean the unit and record on the work order. Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter. Verify and record on the work order the ground lead on each device is individually attached to a ground bus or ground electrode. Verify and record on the work order the stroke counter, if present, is correctly mounted and electrically connected.						X		ANSI/NETA §7.19
Measure insulation resistance from phase terminal(s) to case for one minute and record on the work order. Test voltage and minimum resistance shall be in accordance with manufacturer's published data and record on the work order. Test and record on the work order the grounding connection.							2	ANSI/NETA §7.19
Metal-enclosed busway								
Record on the work order the physical and mechanical condition. Record on the work order the condition of anchorage, alignment, and grounding. Record on the work order the condition of bolted electrical connections for high resistance using a low-resistance ohmmeter. Confirm physical orientation in accordance with manufacturer's labels to ensure adequate cooling and record on the work order. Examine outdoor busway for removal of "weep-hole" plugs and for the correct installation of joint shield and record on the work order.				X				ANSI/NETA §7.4
Record on the work order the condition of ventilating openings and clean ventilating openings.						X		ANSI/NETA §7.4
Measure insulation resistance of each busway for one minute, phase-to-phase and phase-to-ground and record on the work order. Apply voltage in accordance with manufacturer's published data. Verify and record on the work order the operation of space heaters.							2	ANSI/NETA §7.4
For medium-voltage busway, perform a dielectric withstand test on each busway, phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data, and record on the work order.							2	ANSI/NETA §7.4

Appendix S Hydraulic Systems Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

Table S-1
Hydraulic systems maintenance task list

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Record on the work order the condition of loose fittings and hardware.		X						
Observe reservoir fill level at sight glass and record on the work order.		X						
Change hydraulic fluid and record on the work order.							X - Per oil test results	
Replace filter and record on the work order.							X - Hourly or upon indicator notification	EM 1110-2-1424
Grease movable strut connection and record on the work order.			X					
Grease cardanic ring and record on the work order.			X					
Visually inspect and record on the work order leaks near cylinder.			X					
Visually inspect and record on the work order worn or cracked hoses.			X					
Visually inspect and record on the work order the condition of hydraulic power unit.			X					
Observe operation of hydraulic power unit and record on the work order.			X					
Visually observe and record on the work order the cylinder rod surface condition.			X					
Visually observe and record on the work order the condition of cylinder rod seal.			X					
Observe hydraulic cylinder for load drift (ensure load holding) and record on the work order.			X					
Verify HVAC is working properly in machinery spaces.			X					
Toggle HPU pump and record on the work order.				X				
Test hydraulic fluid and record on the work order.					X			EM 1110-2-1424

Maintenance Tasks	O	W	M	Q	S	A	P	References
Filter and dehumidify hydraulic fluid using bypass filtering and record on the work order.						X		ASTM D4714
Record on the work order the temperature of HPU fluid pump.						X		

Appendix T Closed Gear Reducer Maintenance Tasks

O=Operational, W=Weekly, M=Monthly, Q=Quarterly, S=Semi-Annual, A=Annual, and P=Periodic (Years).

**Table T-1
Closed gear reducer maintenance task list**

Maintenance Tasks	O	W	M	Q	S	A	P	References
Review AHA and follow applicable safety and occupational health requirements per EM 385-1-1 (as required) and record on the work order.								EM 385-1-1
Perform inspection and maintenance unique to the manufacturer (as required) and record on the work order.								Manufacturer O&M Manual
Clean up and disposal of waste material properly and record on the work order.								
Verify and record on the work order the oil level.			X					
Grease bearings where zerk fittings are equipped and record on the work order.			X					
Observe operation for unusual noise or vibration and record on the work order.			X					
Record on the work order the condition of loose or missing hardware.			X					
Visually inspect and record on the work order the condition of gear case alignment and mounting platform.			X					
Take lube oil sample for testing and record on the work order.					X			
Visually inspect and record on the work order the condition of gears/mesh by removing inspection covers.						X		
Where installed and required, check heaters for proper operation and record on the work order.						X		
Operate gear drive, listen for indications for broken or excessively worn teeth, misalignment or improper meshing, and record on the work order.						X		
Deaerate desiccant breathers or replace desiccant materials (once saturated) and record on the work order.							X	
Treat and dehumidify lube oil based on test results and record on the work order. Perform lube oil change for fluids with poor test results and record on the work order. Change lube oil which is in unsalvageable condition (upon failed lab oil test) and record on the work order.							X	

Glossary of Terms

<u>Term</u>	<u>Definition</u>
AC	Alternating Current
AHA	Activity Hazard Analysis
ALS	Automated Lubrication System
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
DC	Direct Current
DGA	Dissolved Gas Analysis
EC	Engineering Circular
EM	Engineering Manual
FEM	Facilities and Equipment Maintenance
HPU	Hydraulic Power Unit
HVAC	Heating Ventilation and Air Conditioning
I/O	Input/Output
IEEE	Institute of Electrical and Electronics Engineers
KVA	Kilovolt-Amperes
MCC	Motor Control Center
MSC	Major Subordinate Command
MTS	Maintenance Testing Specifications
NEC	National Electric Code
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
O&M	Operations and Maintenance
OH	Oxygen Hydroxide
OM	Operations Manager
OPM	Operations Project Manager
PC	Personal Computer
PCB	Printed Circuit Board
PLC	Programmatic Logic Control
PMMP	Project Maintenance Management Plan
PPB	Power Perfect Box
PSI	Pounds per Square Inch
SCADA	Supervisory Control and Data Acquisition
SCR	Silicon Controlled Rectifier
SF6	Sulfur Hexafluoride
USACE	U.S. Army Corps of Engineers
V	Voltage
VFD	Variable Frequency Drives