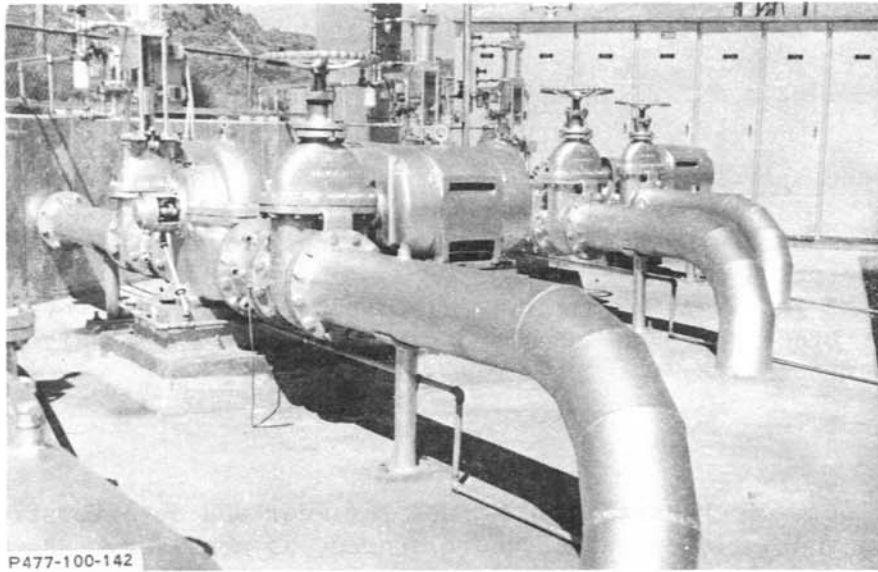


CHAPTER V - GATES AND VALVES



P477-100-142

1. Inspection Checklist

Items of inspection	Inspection interval
<u>Gates and Valves (In General)</u>	A
Seals and guides	NS
Seat, disk, or needle ring and spider	NS
Stems	A
Lubrication	NS A
Spring and cushioning mechanism	NS
Journals, bearings, and bushings	NS
Wheels, pins, and rollers	NS
Operating cylinder or gear mechanism	NS
Control piping	A
Packing glands	W A
Operation check	A
Gate hoist or crane	See Chapter on Cranes, p 49
Electric motors	See Chapter on Motors, p 17
Electrical control equipment	See Chapter on Controls, p 31

W - Routine weekly inspection when in service.

A - Annual inspection.

NS - Not scheduled, frequency as required to maintain equipment and assure its function.

Note: Follow specific maintenance instructions on valves and gates, if available.

Reference

Power O&M Bulletin No. 21, Lubrication of Powerplant Equipment

2. Gates and Valves

Inspect exposed metal parts of valves and gates for corrosion, cracking, deterioration of paint, and other damage. Check rivets, bolts, and welds and repair as necessary. Clean corroded surfaces by sandblasting or other approved means and repaint or apply cathodic protection as necessary.

3. Seals and Guides

Not scheduled. - Check seals and guides for wear and deterioration. Renew seals and build up guides where scored, as necessary. Remove accumulated mineral deposit. Check alinement. Check slot heaters if installed.

4. Seat, Disk, etc.

Not scheduled. - Examine for mineral deposit and remove as necessary. Inspect seat and disk or needle ring for scoring, pitting, and abrasion. Regrind or remachine as necessary.

5. Stems

Annual inspection. - Clean off all grease and dirt, and inspect for wear and breakage of the threads, scoring, and wear of the sliding surface. Renew or repair as necessary by building up scored surfaces and broken threads. Relubricate.

6. Lubrication

Not scheduled. - Lubricate all underwater fittings with suitable underwater grease. Lubricate all fittings exposed to the atmosphere. Flush out fittings on such items as rollers on coaster gates, and wheels on fixed-wheel gates. See that they are free and turn easily.

Annual inspection. - Examine all grease grooves to see that they are not obstructed with hardened grease. Remove any hard deposit. See that all grease supply pipes are clear. Flush all old grease from fittings and refill with fresh lubricant.

7. Springs and Cushioning Mechanism

Not scheduled. - Inspect springs in relief valves for proper tension and for corrosion. Examine oil dashpots where used for tightness of plunger, scoring on cylinder walls and plunger. Examine foot valves if used. Renew oil if sludged or contaminated with water.

8. Journals, Bearings and Bushings

Not scheduled. - Disassemble and check clearance. Examine bearing surfaces and journals for scoring and wear. Replace bronze bushings, re-babbitt and rebore babbitt bearings, build up journals with welding or metalizing and machine to proper dimensions as necessary.

9. Wheels, Pins and Rollers

Not scheduled. - Check to see that all moving parts are free to move. Examine for corrosion and deterioration. Check for alinement of rollers and wheels. Check pins for bending and scoring. Check rollers for wear and corrosion. Check bearing surfaces under linkage. Check linkage for cracks, bending, or weakening.

10. Operating Cylinder or Gear Mechanism

Not scheduled. - Check hydraulic operating cylinders, pistons, rods, guides, bellcrank bearings, etc., for wear. Check motor-driven reduction gears for wear. Flush out and relubricate gear boxes. See that lubricant used is suitable for coldest weather encountered. Check torque limit device if used.

11. Control Piping

Annual inspection. - Check for leaks and repair as necessary. Examine for corrosion and need of paint. Repaint as necessary. Replace gaskets and renew or tighten bolts as necessary.

12. Packing Glands

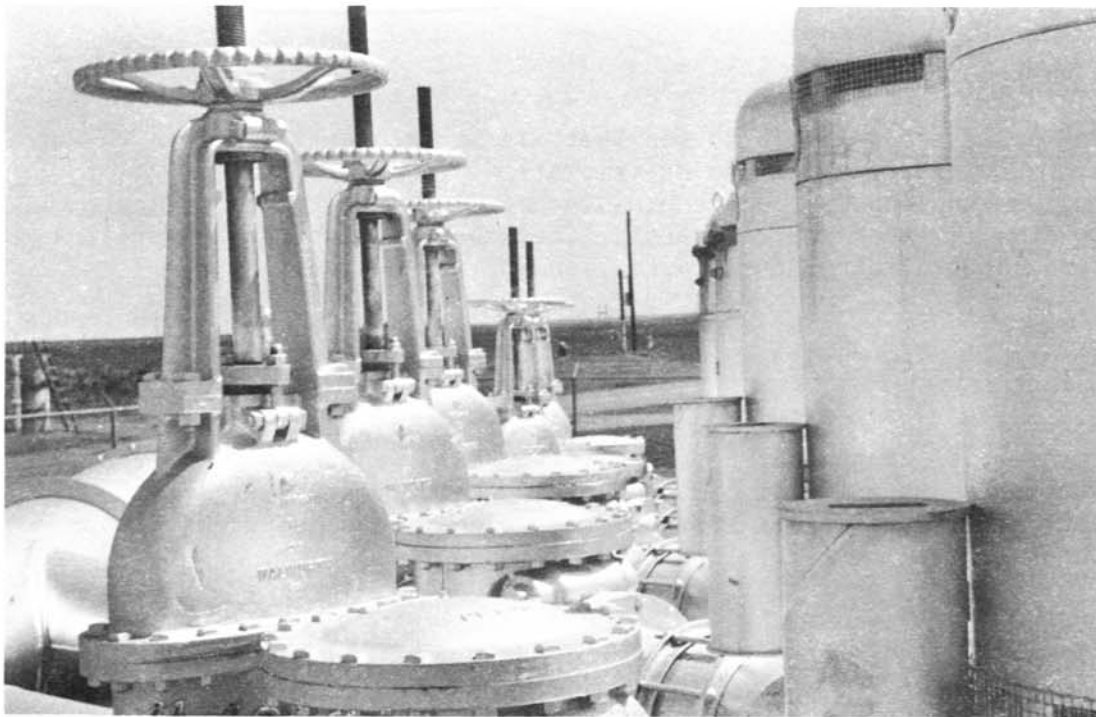
Weekly inspection. - Inspect for leaks and adjust gland as necessary.

Annual inspection. - Clean gland and nuts. Measure clearance between gland and stuffing box. Renew packing when clearance between gland

and stuffing box becomes so small there is doubt as to whether the gland may be adjusted and kept tight until the next outage.

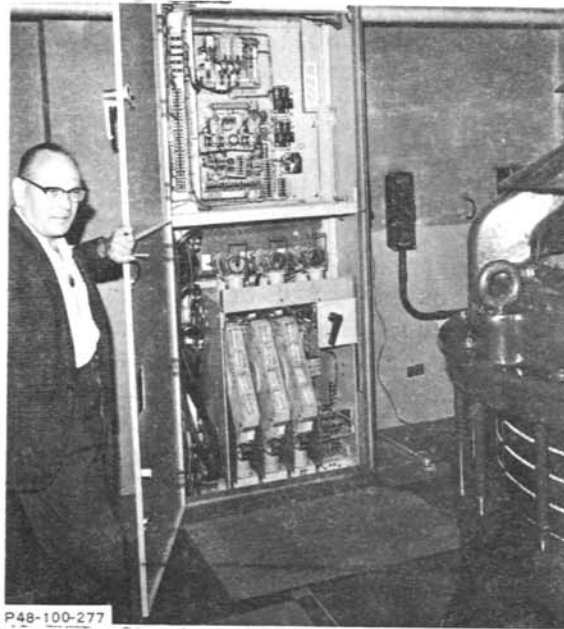
13. Operation Check

Annual inspection. - Make an annual operation check under balanced conditions of gates having emergency closing facilities and which are depended upon for closing in case of a power outage or similar failure, to insure the equipment will operate when called upon. Other gates and valves should be given an annual operation check if conditions will permit.



Southern San Joaquin Municipal Utility District - Central Valley Project, Gate Valves and Check Valves, Pumping Plant S8, Lateral 127.7E. Photo P214-D-58277

CHAPTER VI - SWITCHBOARDS AND CONTROL EQUIPMENT



1. Inspection Checklist

Items of inspection	Inspection interval
<u>Switchboards and Control Panels</u>	
Panels and cabinets	A
Panel wiring and terminal blocks	A
Auxiliary and control relays	W A
Control switches and pushbuttons	W A
Indicating lamps	W A
Meters and instruments	W A
Position indicators	W A
Protective relays	W A
Test switches or blocks	A
Rheostats and resistors	A

W - Routine weekly inspection when in service.
 A - Annual inspection.

References

Power O&M Bulletin No. 16, Field Test Procedure for Protective Relays
 Power O&M Bulletin No. 22, Watthour Meter Maintenance and Testing

2. Panels and Cabinets

Annual inspection. - Repair finish and panel and door hardware and clean up as necessary. Tighten bolts and screws. Check boxes and cabinets in damp locations for corrosion and rust. Clean and re-finish as necessary.

3. Panel Wiring and Terminal Blocks

Annual inspection. - Check for general housekeeping. Blow out wiring and equipment on back of panels with clean, dry, compressed air or use an industrial-type vacuum cleaner with nonmetallic hose fittings if available. Inspect wiring for open circuits, short circuits, and damaged insulation. Check insulation resistance of wiring or equipment on which the insulation appears to be questionable. Re-mark conductor tags or designations before they become obscure. Replace lost conductor tags. Tighten connections at terminal points.

4. Relays

Weekly inspection. - Check condition of contacts wherever possible. Note whether coil temperature is excessive. Check noise and vibration of alternating-current contactor magnet frame and armature.

Annual inspection. - Dress contacts if rough with fine file. Pits in the contact surfaces are not objectionable, but projections should be removed. Replace contacts if repairing is impractical. Blow out dust, check arc chutes, blow out coils, and barriers. Tighten connections. Check contact shunts. Check contact spring pressure and contact wiping action. Check insulation between circuits or phases. Note whether operating coil temperature is excessive. Check alignment and vibration of alternating-current magnet frame and armature and examine shading ring.

5. Control Switches

Weekly inspection. - Try out operation of control switches or push-buttons wherever possible to see if operation is correct.

Annual inspection. - Examine contacts and refinish with fine file if burned or corroded. Check contact operating cams, levers, or drums. Check contact spring pressure. Tighten connections. Examine insulation.

6. Indicating Lamps

Weekly inspection. - Check lamps to see that they are not burned out, and replace as necessary.

Annual inspection. - Inspect indicating lamps, series resistors, and color caps. Check to see that each lamp gives correct intended indication. Tighten connections.

7. Meters and Instruments

Weekly inspection. - Note sticking of moving element of indicating and recording instruments and watt-hour meters, unsatisfactory inking of record on recorders, and incorrect timing of recorder charts. Have these faults corrected at first opportunity.

Annual inspection. - Check calibration of important instruments and recorders or others suspected of being incorrect. Check watt-hour meters against rotating standard and adjust as necessary. Check to see that movement is free and unobstructed. Check pivots and bearings and repair or replace as necessary. See that cover gaskets are tight so as to exclude dust, dirt, moisture, and insects. Clean cover glasses using a damp cloth so as to avoid placing a static charge on the glass which affects the indication of some instruments. Check external resistors, reactors, and potential fuses. Tighten connections. Check wiring connections if any changes have been made in associated circuits or equipment.

8. Position Indicators

Weekly inspection. - Note sticking pointers.

Annual inspection. - Check for correct positioning between transmitter and receiver. Check for friction and vibration of moving element and excessive heating.

9. Protective Relays

Weekly inspection. - Visual inspection for anything unusual about contacts, coils, or moving elements. Check targets and reset them.

Annual inspection. - Dress contacts if rough with fine file. Pits in the contact surfaces are not objectionable, but projections should be removed. Replace contacts if repairing is impractical. Blow out dust, check arc chutes, blow out coils, and barriers. Tighten connections. Check contact shunts. Check contact spring pressure and contact wiping action. Check insulation between circuits or phases. Note whether

operating coil temperature is excessive. Check alinement and vibration of alternating-current magnet frame and armature and examine shading ring.

10. Test Switches

Annual inspection. - Check taps, resistor settings, or other adjustments against relay data sheets. Check setting for correct operation and adjust as necessary. Examine moving parts and see that they are free and unobstructed. Examine relay and test switch contacts and refinish with fine file if burned or corroded. See that cover gaskets are tight so as to exclude dust, dirt, moisture, and insects. Note excessive heating of coils and resistors. Tighten connections. Check wiring connections if any changes have been made in associated circuits or equipment. Try out trip circuit, if possible, to see that relay trips all devices as intended. (See Power O&M Bulletin No. 16.)

11. Rheostats and Resistors

Annual inspection. - Clean contact buttons and brush, check to see if corroded, burned, or cutting. Check brush and hub contact spring pressure. Check resistor elements for burned-out or corroded sections. Test insulation from line to grounded parts.

CHAPTER VII - MOTOR STARTERS AND CONTROLLERS

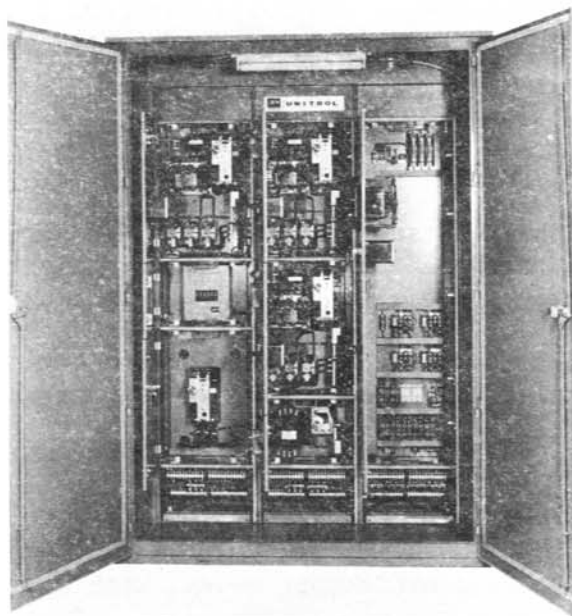


Photo PX-D-68172NA

1. Inspection Checklist

Items of inspection	Inspection interval
Knife switches	A
Fuses and circuit breakers	A
Contacts and shunts	A
Blowout coils and arc chutes	A
Solenoids	A
Operating shaft	A
Mechanical and electrical interlocks	A
Latches and trip devices	A
Auxiliary switches	A
Overload trip	A
Step starter timers	A
Compensator or autotransformer	See Chapter on Transformers, p 76
Miscellaneous control devices	A
Power Supplies and Wiring	W A

W - Routine weekly inspection when in service.

A - Annual inspection.

2. Knife Switches

Annual inspection. - Check hinges and clips for good contact. Tighten connections. Check door interlocks of safety switches if provided. Clean insulating base if dirty.

3. Fuses and Circuit Breakers

Annual inspection. - Check to see that fuse ratings agree with the ratings shown on the drawings. See that fuses are tight in the clips and contact surfaces are clean. See that renewable links are tight in holders. See that spare fuses are on hand. Where small enclosed circuit breakers are used for circuit protection instead of fuses, check mechanical operation of breaker and tighten connections.

4. Contacts and Shunts

Annual inspection. - Dress contacts, if rough, with a fine file. It is necessary to remove only the projecting beads. Pits in a flat, smooth surface are not objectionable. Check for alinement and adjustment. Check rolling or wiping action and spring pressure. Check flexible shunts and replace if frayed. Tighten connections.

5. Blowout Coils and Arc Chutes

Annual inspection. - See that turns of blowout coils are not short circuited and that coil is properly assembled to blow arc outward, not inward. See that arc chutes are in good condition.

6. Solenoids

Annual inspection. - Note if coil is operating too hot, and if so, check resistance for possible short-circuited turns. Check alinement of matching faces of magnet frame. Check shading ring for open circuit. A noisy alternating-current solenoid generally indicates poor alinement or a broken shading ring, either of which will cause heating of the solenoid.

7. Operating Shaft

Annual inspection. - See that shaft is free to move in its bearings or rods are free in the guides.

8. Mechanical and Electrical Interlocks

Annual inspection. - See that interlocks are properly adjusted to prevent closing of both contactors, such as on a reversing starter, at the same time. Check enclosure door interlocks. Tighten operating arm supports.

9. Latches and Trip Devices

Annual inspection. - Check latches on latched-in contactors or manually operated starters for wear and insecure holding. (Check trip solenoid as in Section 6 above on solenoids.)

10. Auxiliary Switches

Annual inspection. - Clean and refinish contacts if corroded or pitted. Check spring pressure. Tighten connections. Check operating levers or linkage. Check closing and opening adjustment with respect to main contacts.

11. Overload Trip

Annual inspection. - Check operating current and time delay of thermal or magnetic overload trip and see that it is correct for the motor or other equipment controlled. See that trip device functions reliably. Check time-delay dashpots for binding; leaking valves; and low, dirty, or incorrect oil.

12. Step Starter Timers

Annual inspection. - Dress contacts if rough with fine file. Pits in contacts surfaces are not objectionable, but projections should be removed. Replace contacts if repairing is impractical. Check time-delay device used for controlling steps on multistep starters to see that proper time delay is obtained and operation is reliable.

13. Miscellaneous Control Devices

Annual inspection. - Check and clean contacts of control devices such as pushbuttons, time switches, pressure, vacuum or float switches, etc., and see that these devices are in proper operating condition.

14. Power Supplies and Wiring

Weekly inspection. - See that all power and control supply circuit switches are closed and fuses in place.

Annual inspection. - Check and tighten wiring connections at terminal points. Inspect wiring for open circuits, short circuits, and damaged insulation. Check insulation resistance of wiring with devices connected.

CHAPTER VIII - STORAGE BATTERIES

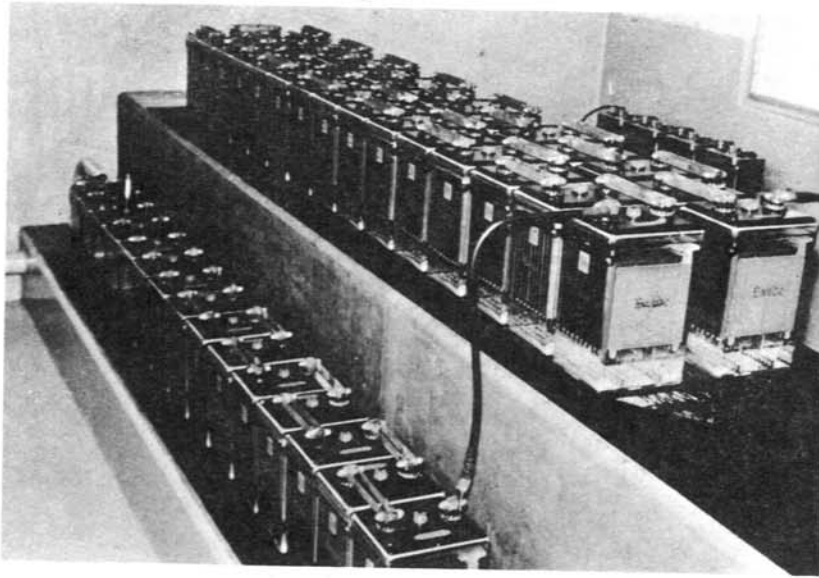


Photo P214-D-68174NA

1. Inspection Checklist

<u>Items of inspection</u>	<u>Inspection interval</u>
<u>Storage Batteries</u>	
Electrolyte	M
Connectors	A
Hydrometers	A
Equipment	A
Distilled water	M
<u>Battery Charger</u>	M

M - Routine monthly inspection when in service.
A - Annual inspection.

References

Power O&M Bulletin No. 12, Storage Battery Maintenance and Principles

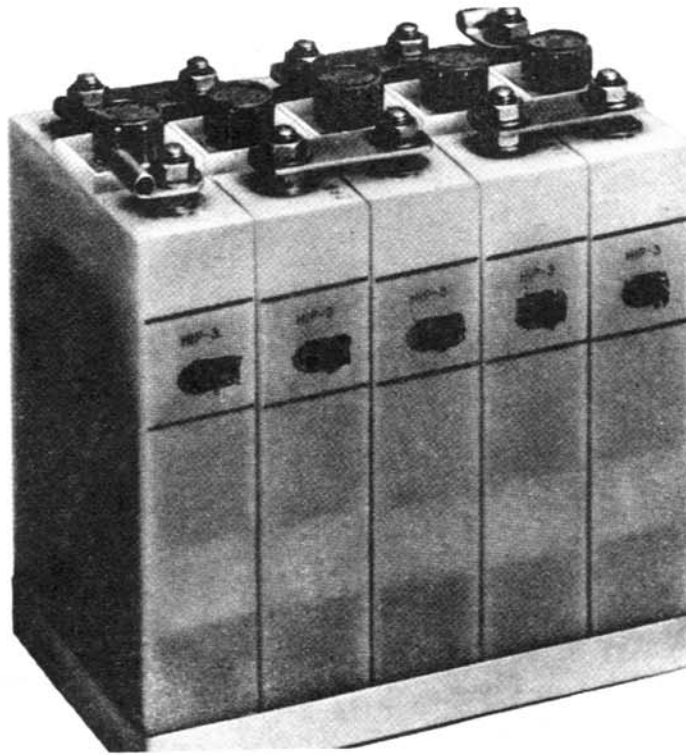


Photo PX-D-67506

2. Battery Electrolyte

Monthly inspection. - Check electrolyte level and add distilled water as necessary.

3. Connectors

Annual inspection. - Clean acid corrosion from connectors and terminals. Tighten terminals.

4. Hydrometers

Annual inspection. - Check condition of hydrometers used for monthly readings.

5. Equipment

Annual inspection. - See that the funnels, fillers, and other distilled water and acid-handling facilities are kept clean and in good usable condition.

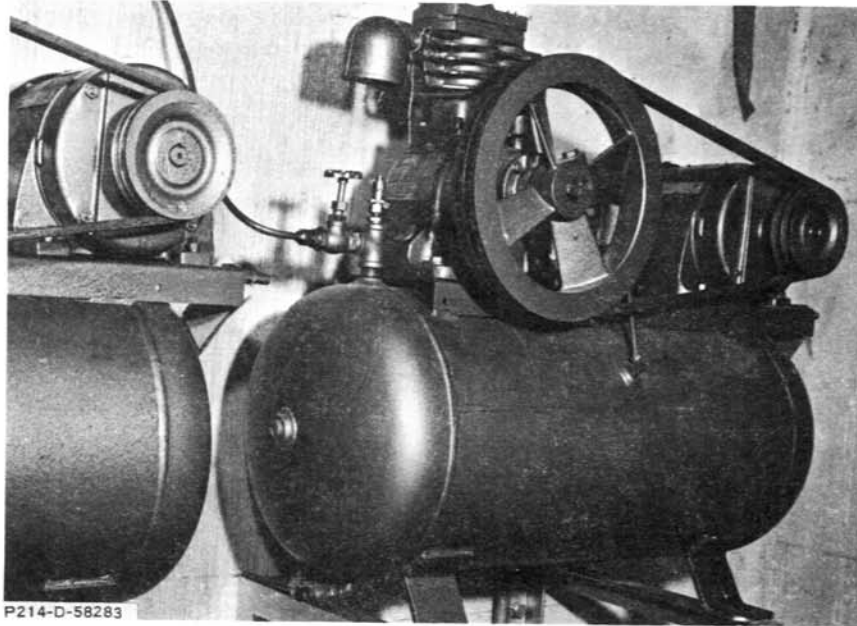
6. Distilled Water

Monthly inspection. - Check adequacy and purity of distilled water. See that enough distilled water and acid are kept in storage to meet current needs. Check containers for cleanliness.

7. Battery Charger

Monthly inspection. - Check operation of battery charger and setting.

CHAPTER IX - COMPRESSORS AND MISCELLANEOUS PUMPS



1. Inspection Checklist

Items of inspection	Inspection interval
<u>Air Compressors, Vacuum and Oil Pumps</u>	
Foundations	A
Frame	A
Belt, chain, or gear drive	W A
Pulleys and idler or coupling	W A
Crankshaft	NS
Connecting rod	NS
Crosshead	W A
Piston	NS
Cylinder	NS
Valves	NS
Bearings	NS
Packing gland	W A
Lubricating system	W A
Cooling system	W A
Receiver tank	W A
Air intake and cleaner	W M
Gages	W A
Pressure switches	M A
Unloader	M A

1. Inspection Checklist - Continued

Items of inspection	Inspection interval
<u>Air Compressors, Vacuum and Oil Pumps</u> - Continued	
Piping and valves	A
Safety valve	M
Guardrails or grills	A
Electric motor	See Chapter on Motors, p 17
Electric control equipment	See Chapter on Controls, p 31
Operation	W
Cleaning	See Section 25 on Cleaning, p 48
Impeller or rotor	NS
Tanks	W A NS
Strainers	W A

W - Routine weekly inspection when in service.

M - Routine monthly inspection when in service.

A - Annual inspection.

NS - Not scheduled, frequency based on equipment operating history.

References

Power O&M Bulletin No. 21, Lubrication of Powerplant Equipment

2. Foundation

Annual inspection. - Check foundation carefully with a level for settling. Examine concrete for cracks and spalling.

3. Frame

Annual inspection. - Tap casting lightly with a hammer. A flat sound indicates a crack. Examine metal for corrosion. Clean and paint as needed.

4. Drive

Weekly inspection. - Note belt for slippage, chain for looseness, and gears for lubrication, excessive noise, vibration, or overheating. Dress and tighten belt as needed. Tighten chain as needed.

Annual inspection. - Check belt splices for weakening. Renew if needed. Check chain for wear or distortion. Replace when distorted or worn excessively. Examine gears for wear or sharp edges, reface, and refit or replace if needed.

5. Pulleys, Idlers, and Couplings

Weekly inspection. - See that bearings are getting sufficient lubrication. Check for looseness, excessive wear, or misalignment.

Annual inspection. - Check wheels for broken rims. Check axles for wear. Build up and machine or replace as needed. Refit bushings as needed. Check weights or springs on idlers for security or proper tension. Check alignment at coupling and wear of flexible coupling.

6. Crankshaft

Not scheduled. - Check crank for alignment. Check journals for scoring, signs of overheating, and wear. Build up and machine as needed.

7. Connecting Rod

Not scheduled. - Inspect for distortion or bending. Examine bearing nuts and bolts for distortion and wear. Replace as needed.

8. Crosshead

Weekly inspection. - If visible, check for looseness, noise, overheating, and sufficient lubrication.

Annual inspection. - Examine shoes for scoring and wear. See that they are tight to the crosshead body if shoes are removable. Check pin for wear and bushings for looseness. Refit if needed. Adjust shoes with additional shims if needed. Note guides for scoring or excessive wear.

9. Piston

Not scheduled. - Check piston for wear. Check clearance with micrometer. Examine rings for tightness and fit. Renew if necessary. Check rod for trueness. See that rod is not bent or distorted. Examine bushings for wear and fit. Renew parts as needed.

10. Cylinder

Not scheduled. - Check cylinder walls for wear and scoring. Measure inside diameters at top, bottom, and sides on two directions 90° apart. If out of round or oversize, rebore cylinder.

11. Valves

Not scheduled. - Inspect valves and seats for scoring and proper seating. Lap valves if needed. See that stems and guides are not bent or cocked. See that springs have proper tension. Check feather valves for proper operation.

12. Bearings

Not scheduled. - Check bearings for fit, scoring, signs of overheating, and proper lubrication. Renew or refit as needed.

13. Packing Gland

Weekly inspection. - Check for leakage or scoring of shaft or rod, and adjust as necessary.

Annual inspection. - Renew packing as needed.

14. Lubricating System

Weekly inspection. - See that oil and grease cups are full or crankcase oil is at the proper level. Replace as needed using approved-type compressor lubricants. See that forced-oil system is working properly. Check for leaks in piping.

Annual inspection. - Clean oil pipes and crankcase or cups. Repair leaks. Examine pump and strainer. Clean strainer and refit or renew pump parts as needed.

15. Cooling System

Weekly inspection. - See that air is not too hot when delivered to the receiver. Check flow of cooling water. Note any leaks in cooling water piping. Note accumulation of dirt and lint on air-cooling fins.

Annual inspection. - Flush and clean out all waterlines. Repair leaks. Clean air-cooling fins. Paint fins with aluminum paint. Clean and paint as needed.

16. Receiver Tank

Weekly inspection. - Open the receiver drain valve and blow down until water is removed. This includes receivers equipped with automatic discharge valves. Check joints and seams for leaks.

Annual inspection. - Open and clean all rust and sludge from interior of all receivers having a volume of more than 1-1/2 cubic feet. Repaint as required using compatible paint. Examine all fittings for tightness. Inspect manhole gasket and seating surfaces. Reface surfaces and renew the gasket if needed. If receiver shell deterioration exists, it should be hydrostatically tested to 1.50 times the maximum allowable working pressure. Air receivers without manholes should be subjected to a similar hydrostatic test every 5 years. Hydrostatic tests are not required on receivers associated with circuit breakers.

17. Air Intake and Cleaner

Weekly inspection. - See that screen and intake are not obstructed.

Monthly inspection. - Remove intake cleaner and clean the screen. If compressor is in a dusty location, it may be necessary to clean the intake screen at more frequent intervals.

18. Gages

Weekly inspection. - Note operation of gages and pressure being held. Check for loose or stuck pointer. Do not operate the compressor without a good pressure gage.

Annual inspection. - Remove all gages and calibrate. Renew defective parts and reinstall.

19. Pressure or Float Switches

Monthly inspection. - See that all pressure or float switches cut in and out at proper pressure or liquid level.

Annual inspection. - Check and clean switch contacts. Check spring tension. Clean and adjust moving parts.

20. Unloader

Monthly inspection. - See that compressor is not being loaded until operating speed is reached in starting and is unloaded when the pressure switch breaks circuit to the motor and unloads at the proper pressure.

Annual inspection. - Inspect valves and air lines for leaks and valves for proper seating. Lap valves if needed. Check weights for security to lever arm and all springs for proper tension. Examine solenoid for deteriorated insulation or loose connections. Examine dashpots for excessive play and refill with oil if needed.

21. Piping and Valves

Annual inspection. - Renew valve packing as needed. Reseat valves as needed. Repair leaks. Clean piping and repaint.

22. Safety Valve

Monthly inspection. - Test safety valves to make sure that they operate on an increase of pressure of 10 to 15 pounds per square inch above maximum normal system pressure or maximum allowable working pressure, whichever is lower.

23. Guardrails or Grills

Annual inspection. - See that guardrails and grills are tightly secured to foundations. See that guards and grills are adequate and give complete protection to both compressor and personnel.

24. Operation

Weekly inspection. - Operate all idle equipment for a few minutes weekly to insure that it is in operating condition and ready for service.

25. Safety Cleaning

Air piping, compressor cylinders, air cleaners, or the receivers shall not be cleaned using kerosene, gasoline, or other inflammable products.

26. Impeller or Rotor

Not scheduled. - Inspect impeller or rotor for erosion of vanes. Rebuild with suitable material and machine if necessary. Measure seal-ring clearances. Refit if necessary. Balance impeller or rotor after test run if needed.

27. Tanks

Weekly inspection. - Note amount of oil or water available in tanks when in continuous use. Check for leaks. Clean up leaking oil which might be a fire hazard. Keep sight-glass cocks turned off to prevent loss of liquid if glass is broken.

Annual inspection. - Check and repair leaks.

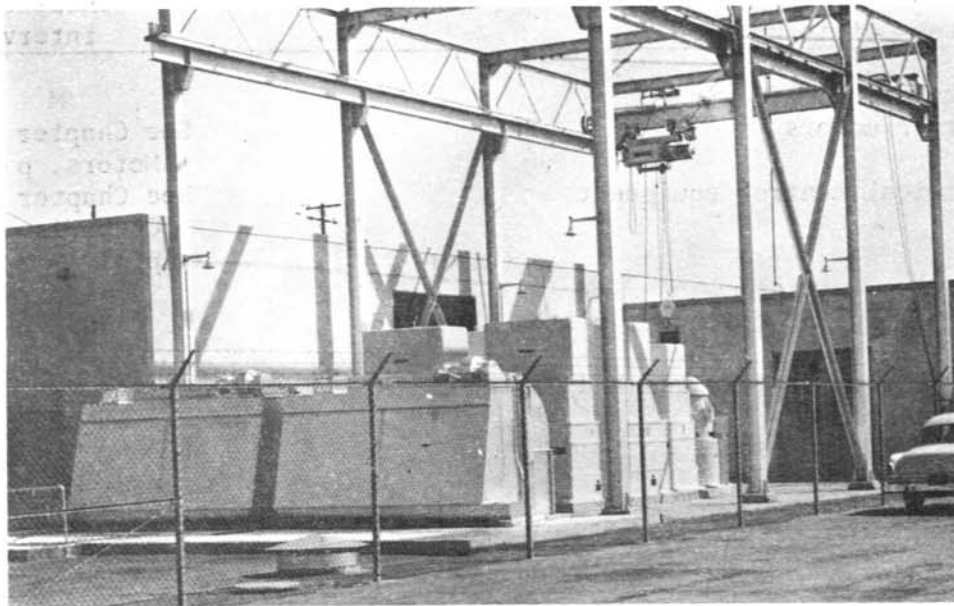
Not scheduled. - Clean inside of tanks used for storage of clean oil or drinking water. Clean and repaint as necessary.

28. Strainers

Weekly inspection. - Flush or remove and clean strainer. Utilize differential gage if so equipped to determine cleaning frequency.

Annual inspection. - Replace strainer when corroded badly or broken.

CHAPTER X - CRANES, HOISTS, AND ELEVATORS



The above photograph shows the Trauger Pumping Plant and Crane of the Lindsay-Strathmore Irrigation District, Friant Division, Central Valley Project, Lindsay, California.
Photo P214-D-58284

1. Inspection Checklist

Items of inspection	Inspection interval
Crane rails, supports, and stops	A
Hoist and bridge framework	A
Bumpers	A
Rails and wires	A
Trolley shoes	M
Catwalks	A
Ladders	A
Cab	A
Driving gears, shafts, bearings, and wheels	W A
Brakes	M A
Cable drums and sheaves	M A
Cables or chains	M A
Lifting beams	A
Counterweights	A

1. Inspection Checklist - Continued

<u>Items of inspection</u>	<u>Inspection interval</u>
Blocks and hooks	M A
Electric motors	See Chapter on Motors, p 17
Electrical control equipment	See Chapter on Controls, p 31
Electrical wiring	A
Hydraulic-hoist cylinder, piston, and rod	NS
Hydraulic pump	M NS
Hydraulic control valves and piping	M NS
Oil Reservoir	M
Guide rails and shoes	M A
Safety devices	M A
Operation	W
Elevator Inspection	A

W - Routine weekly inspection when in service.

M - Routine monthly inspection when in service.

A - Annual inspection.

NS - Not scheduled, frequency as required to maintain the equipment and assure its operating functions.

Note: Always make detailed operation and maintenance checks of cranes and hoists prior to lifting heavy loads.

2. Crane Rails, Supports, and Stops

Annual inspection. - Check rails for alinement and obstructions. Check supports for cracks and spalling of concrete and for corrosion and loose rivets and bolts if steel. Repair concrete as necessary. Tighten or calk loose rivets and bolts. Check stops for security to building or rails.

3. Hoist and Bridge Framework

Annual inspection. - Check framework for looseness and cracks. Check rivets and bolts for tightness. Check girders for alinement. Examine girders for corrosion. Clean and paint as necessary. Check trucks for skew.

4. Bumpers

Annual inspection. - Check for looseness. Examine bumpers to see that they are properly positioned. Tighten or adjust as necessary. Check hydraulic bumpers for leaks and fill to proper level.

5. Rails and Wires

Annual inspection. - Check rails and wires for alinement. Check support for tightness. Adjust as necessary. Check contact surfaces of wire or rails for corrosion and arc burning and clean as necessary. Check and clean insulators.

6. Trolley Shoes

Monthly inspection. - See that contact shoes or wheels are tight and make good contact with rails or wires. Clean as necessary. Check contact spring pressure.

7. Catwalks

Annual inspection. - Check runways and catwalks for obstructions, broken floor material, or other safety hazards.

8. Ladders

Annual inspection. - See that handrails and ladders are firmly secured and rigid. Check ladder rungs for corrosion and weakening. Clean and paint as needed.

9. Cab

Annual inspection. - Check cab for loose articles which would interfere with operation and for general housekeeping. Check for broken windows or doors. Check doors and safety gates. See that lighting is sufficient. Check seats, if fitted, for security. Check for security to bridge girders.

10. Driving Gears, Shafts, Bearings, and Wheels

Weekly inspection. - Check lubrication. Examine for excessive wear.

Annual inspection. - Check bearing clearances. Refit as needed. Examine gears for broken teeth or rough or sharp edges. Misalignment or improper meshing will cause rough edges at the tip of the teeth. Check shafts for alinement and coupling for alinement and lubrication if oil filled. Check wheels for flat sides and wear. Rebuild or machine as needed.

11. Brakes

Monthly inspection. - See that braking surfaces are free from oil and grease. Check spring tension.

Annual inspection. - Check brake lining to see that it has not hardened or worn excessively. Renew as necessary. See that brake drums are not scored. Check spring tension. Adjust brake with adjustment nuts. Adjust spring tension if needed or renew if fatigued.

12. Cable Drums and Sheaves

Monthly inspection. - Check sheaves for broken or chipped wheels. Lubricate. With cable removed, check all cable grooves for wear, chipping, and corrosion. Check bearings for clearance and refit if needed.

13. Cables or Chains

Monthly inspection. - Visual inspection for broken or frayed strands or broken or elongated chain links.

Annual inspection. - Run cable or chain out and inspect carefully for frayed or broken strands, stretched or weakened links. Examine for wear and corrosion, especially down between the cable strands. Lubricate.

14. Lifting Beams

Annual inspection. - Check beams for alinement, corrosion and tightness of rivets. See that members have not been stressed beyond their elastic limits.

15. Counterweights

Annual inspection. - Check counterweights to see that they are secure to the cables or chains and to the guides.

16. Blocks and Hooks

Monthly inspection. - See that the blocks have sufficient lubrication. Examine hook for bending, cracking, stretching, and condition of safety latch.

Annual inspection. - Check block pins for wear and distortion. Renew or machine pins as needed. Check blocks for weakening. Measure hook for distortion. If distorted, replace.

17. Electrical Wiring

Annual inspection. - Check and tighten connections at terminal points. Check for damaged insulation or broken or overheated conductors. Check insulation resistance of wiring and connected devices and equipment.

18. Hydraulic Hoist Cylinder, Etc.

Not scheduled. - Inspect cylinder walls for scoring and piston for wear and fit. Check rod for wear and alinement. Refit or aline if necessary.

19. Hydraulic Pump

Monthly inspection. - Test pump to see that it delivers full pressure.

Not scheduled. - Inspect pump working parts for wear and fit. Renew if needed. Test pump.

20. Hydraulic Control Valves and Piping

Monthly inspection. - Inspect piping for leaks. Test control valves.

Not scheduled. - Check valve seats for wear and refit as needed.

21. Oil Reservoir

Monthly inspection. - See that oil in tank is sufficient for emergency operation. Keep sight-glass cocks turned off to prevent loss of oil if glass is broken when not attended. Check for leaks.

22. Guide Rails and Shoes

Monthly inspection. - Check guide rails and shoes for proper lubrication.

Annual inspection. - Check rails for alinement and scoring. Check and tighten supports. Check shoes for fit and scoring. Refit as needed.

23. Safety Devices

Monthly inspection. - See that all safety devices are in service and functioning properly.

Annual inspection. - Check all mechanical and electrical safety devices for worn or broken parts and proper operation. Renew and refit as needed.

24. Operation

Weekly inspection. - Operate all idle equipment for a few minutes weekly to insure that it is in operating condition and ready for service.

25. Elevator Inspection

Annual inspection. - In states where elevator inspection is available, it should be obtained for all elevators. Where state inspection is not available, the inspections and tests shall be made by a certified inspector of an elevator or insurance company.

CHAPTER XI - LOW-VOLTAGE SWITCHGEAR, BUSES, AND CABLES

1. Inspection Checklist

Items of inspection	Inspection interval
Oil and air circuit breakers	See Chapter on Circuit Breakers, p 58
Disconnecting switches and fuses	See Chapter on Disconnecting Switches, p 68
Bus bars, joints, and connections	A
Bus insulators and supports	A
Bus enclosures and barriers	A
Switchgear panels and enclosures	W A
Locks and interlocks	W
Warning and safety signs	W
Current and potential transformers	A
Meters, instruments, and relays	See Chapter on Controls, p 31
Control devices	See Chapter on Controls, p 31
Panel wiring	See Chapter on Controls, p 31
Power cables	A
Potheads	A

W - Routine weekly inspection when in service.

A - Annual inspection.

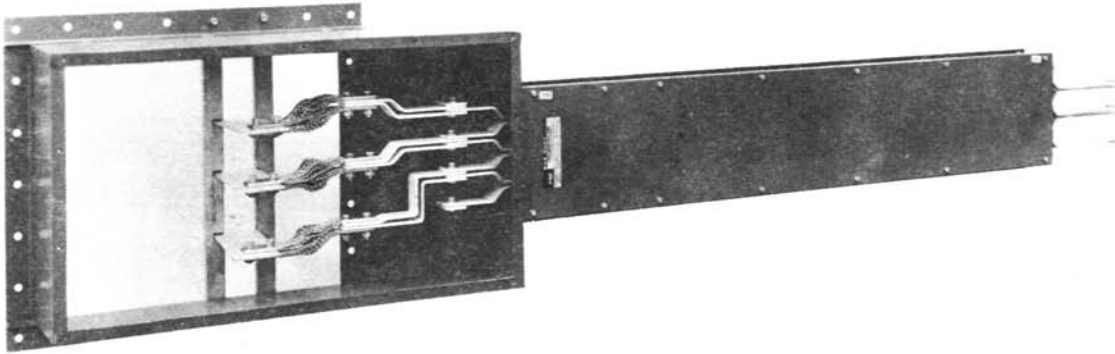
References

Power O&M Bulletin No. 8, Dependable Electrical Contacts

Power O&M Bulletin No. 3, Testing Electrical Equipment Insulation

2. Bus Bars, Joints, and Connections

Annual inspection. - Check bus bars, joints, and connections for overheating. Tighten joint and connection bolts. Refinish joint contact surfaces if annealed from overheating. (See Power O&M Bulletin No. 8.)



Low-Voltage Feeder Busway - Trinity Powerplant, California.
Transition Box and Busway for 300-kva Transformer - Front View
Cover Removed. Photo P389-D-68173NA

3. Bus Insulators and Supports

Annual inspection. - Inspect and clean insulators or insulating block supports. Paint chipped spots on porcelain with red glyptal. Tighten bolts. Check supports for strength and rigidity. Inspect tape insulation on bus bars and revarnish if dull.

4. Bus Enclosures and Barriers

Annual inspection. - Check metal or transite bus enclosures and interphases, barriers, tightness, and adequate ventilation. Clean as needed.

5. Switchgear Panels and Enclosures

Weekly inspection. - See that interior and exterior of enclosures are kept clean and free of oil, insect webs, etc.

Annual inspection. - Clean inside and outside of enclosures. Use solution of mild soap and water to remove dirt and grease from panels. Many cleaning compounds are harmful to the painted surfaces and should not be used. Clean out control wiring and hard-to-reach places with an industrial-type vacuum cleaner (with non-metallic hose and nozzle), or clean, dry compressed air.

6. Locks and Interlocks

Weekly inspection. - See that all keyed locks provided to prevent unauthorized operation of equipment are in place and locked. See that all mechanical interlocks provided for personnel safety are functioning.

7. Warning and Safety Signs

Weekly inspection. - See that adequate warning and safety signs are in place around live parts or other safety hazards.

8. Current and Potential Transformers

Annual inspection. - Check oil level and oil leaks in oil-filled transformers. Check for leaking compound from dry-type transformers. Clean insulators. Check and tighten primary and secondary connections. See that short-circuiting device on current transformer secondary is secured in the open position and that protector tubes or thyrite protectors are not bypassing current at normal loads. Check potential transformer fuses. Check insulation resistance of windings.

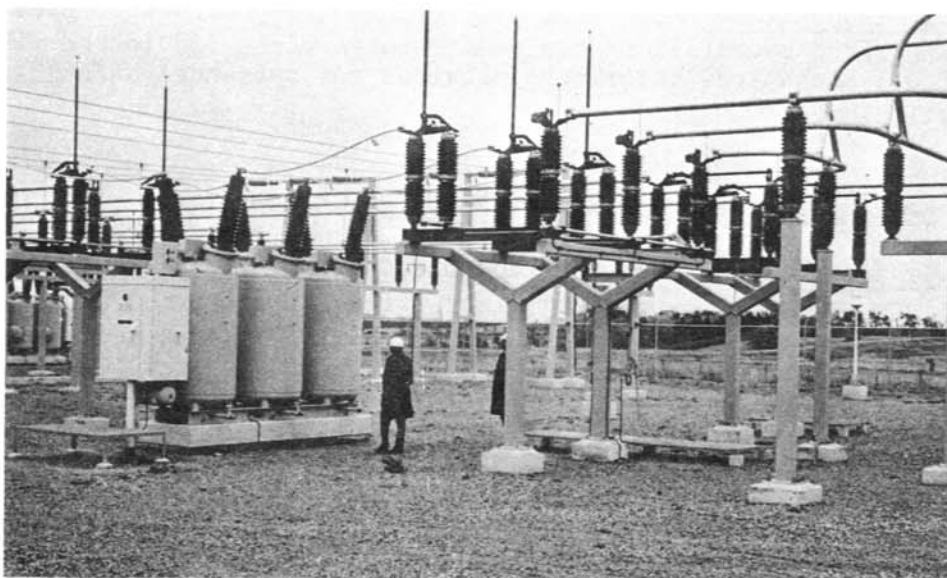
9. Power Cables

Annual inspection. - Check visible portions of cable braid, rubber, or lead sheath for signs of cracking, deterioration, or corrosion. Check for signs of moisture at entrance to conduits or ducts. Check cable terminals and tighten connections. Check for proper support. Check insulation resistance. (See Power O&M Bulletin No. 3.)

10. Potheads

Annual inspection. - Check for oil or compound leaks, and stop as necessary. See that potheads are filled to the proper level with oil or compound. Clean insulators. Repair chipped spots on porcelain with lacquer such as red glyptal. Tighten connections, bolts, and screws.

CHAPTER XII - OIL AND AIR CIRCUIT BREAKERS



115-kv, dead-tank oil-type power circuit breaker shown.
Photo P214-D-68171NA

1. Inspection Checklist

Items of inspection	Inspection interval	
Foundation		A
Frame and tanks	W	
Oil valves and plugs		A
Oil levels and gages	W	A
Breathers and vents	W	A
Panels and cabinets		A
Bushings or insulators	W	A
Bushing current transformers and potential devices		A
Main terminals and ground connections	W	A
Main contacts		A
Contact pressure springs		A
Flexible shunts		A
Magnetic, air, or oil blowout device		A
Crosshead		A
Lift rods and guides		A
Operating rods, shafts, and bellcranks		A
Closing solenoid air cylinder, motor, or spring		A

1. Inspection Checklist - Continued

Items of inspection	Inspection interval
Manual operating device	A
Latch and trip mechanism	W A
Tripping solenoid	W A
Control and protective relays	See Chapter on Controls, p 31
Solenoid valves	A
Auxiliary switches	A
Operation counter	M A
Position indicator	A
Dashpots or snubbers	A
Mechanism cabinet	A
Cabinet lights and heaters	W A
Power supplies and wiring	W A
Oil dielectric test	A
Filter oil	NS
Operation	NS

- W - Routine weekly inspection when in service.
M - Routine monthly inspection when in service.
A - Annual inspection.
NS - Not scheduled.

References

- Power Maintenance Instruction No. 9, Retaining Glaze Burned Insulators in Service, dated September 21, 1967
Power O&M Bulletin No. 11, Maintenance of Liquid Insulation - Mineral Oils and Askarels
Power O&M Bulletin No. 14, Painting of Transformers and Circuit Breakers

2. Foundation

Annual inspection. - Check foundation for cracks and settling. A shift of the breaker tanks may break bushings or cause misalignment of contacts or binding of operating mechanism.

3. Frame and Tanks

Weekly inspection. - Check for oil leaks and note tank temperature by touch.

4. Oil Valves and Plugs

Annual inspection. - Check condition of paint and repaint as necessary. Inspect oil valves and plugs and stop oil leaks. See that oil drain valves which can be operated without wrenches are plugged or locked to prevent unauthorized opening. Tighten bolts. Clean interior of tanks. Inspect underside of cover for moisture and rust, and clean and repaint as necessary. Check tank liners and interphase barriers.

5. Oil Levels and Gages

Weekly inspection. - Check oil level in gages of the tanks and oil-filled bushings. Replenish oil if below normal.

Annual inspection. - Clean dirty gage glasses and connections into tank. Drain out and replace bushing oil if dirty or discolored.

6. Breathers and Vents

Weekly inspection. - Check for external obstructions to breathers and vents.

Annual inspection. - Check to see that screens and baffles in vents or breathers are not obstructed or broken.

7. Panels and Cabinets

Annual inspection. - Check air circuit breaker or other panel insulating material for cracks and cleanliness. Check condition of enclosing cabinets including hinges, latches, locks, door gaskets, and paint.

8. Bushings or Insulators

Weekly inspection. - Check for chipped or broken porcelain, excessive dirt film, oil level, and oil or compound leaks.

Annual inspection. - Clean porcelain with water, chlorothene, or other suitable cleaner. Repair chipped spots by painting with lacquer such as red glyptal. Inspect gaskets for leaks. Tighten bolts. Check insulation resistance with contacts closed and also power factor. Check oil sample from bottom of bushing for dielectric strength and presence of water and dirt which may be entering at top. Replace or replenish oil if necessary. Check and clean interior at least once every 5 years.

9. Bushing Current Transformers and Potential Devices

Annual inspection. - Check tap settings and adjustments at terminal board to see that they agree with diagrams. Check insulation resistance of wiring with devices connected. Check ratio and phase-angle adjustments of potential devices if changes have been made in secondary connections or burden. Tighten connections, including potential device tap into bushing.

10. Main Terminals and Ground Connections

Weekly inspection. - Check for presence of foreign materials, birds' nests, etc., in or near connecting bus work; loose heating connections; and loose or broken frame ground connections.

Annual inspection. - Tighten all bus and ground connections. Re-finish joint contact surfaces if they have been overheating. Inspect ground cable to see that it is not loose or broken.

11. Main Contacts

Annual inspection. - Remove the tanks or drain out oil so that the contacts can be inspected. Dress contacts, if rough, with a fine file. It is necessary to remove only the projecting beads. Pits in a flat, smooth surface are not objectionable. Check contact drop with "ducter" or by direct-current millivolt drop. Frequency of breaker contact maintenance should be based on number and severity of faults interrupted rather than a definite time period. Experience will tell how many faults can be interrupted before contact repairs are necessary. Data should be kept on each breaker to guide future maintenance. Inspection schedules might be extended further as oil-handling methods, methods for determining oil condition, and other improvements are made. The following factors should be established before intervals between inspections can be extended:

- a. All new breakers must have a complete inspection at the end of 1 year.
- b. Only breakers with good operating service records should be scheduled for less frequent inspection periods.
- c. Breakers used on special applications, such as capacitor and reactor switching, should be considered separately.
- d. If recurring troubles are found on a certain type of breaker, the inspection schedules should be adjusted until the trouble is eliminated.

e. Breakers interrupting a large number of faults should be given special attention to determine whether or not early internal inspection is required.

f. When oscillographs indicate abnormal breaker operation, an immediate inspection of the breaker should be made.

12. Contact Pressure Springs

Annual inspection. - Check springs for loss of temper, breaks, or other deterioration.

13. Flexible Shunts

Annual inspection. - Check flexible shunts at contact hinges for overheating and fraying. Tighten connections.

14. Magnetic, Air, or Oil Blowout Devices

Annual inspection. - Check arc-rupturing blowout coils, magnetic circuit, arc chutes, deion grids, oil blast, or other interrupters for proper operation.

15. Crosshead

Annual inspection. - Check contact crosshead for misalignment, breaks, bends, or looseness on lift rod.

16. Lift Rods and Guides

Annual inspection. - Check contact lift rods for breaks, weakening or warping, and pulling out at ends. Check adequacy of guides.

17. Operating Rods, Shafts, and Bellcranks

Annual inspection. - Check for loose locknuts, setscrews, keys, bearings, bent rods or twisted shafts, etc. Clean moving parts of rust, dirt, and accumulated grease and oil. Wash out bearings, pivots, and gears with chlorothene or other suitable cleaner and operate breaker several times to work out dirt and old lubricant. Lubricate with new grease or oil. In cold climates, it is important to use lubricant which will not stiffen too much when cold. Wipe off excess oil. Enclosed dusttight bearings should require less servicing.

18. Closing Solenoid Air Cylinder, Motor, or Spring

Weekly inspection. - Visual inspection to see that equipment is in operating condition. Drain condensation from air cylinder.

Annual inspection. - Observe mechanism during several closing operations to see that everything is in proper working order. Check solenoid plunger for sticking in guides. Check coil resistance and insulation resistance. Dismantle air cylinder and clean and relubricate. Check closing springs for proper tension and closing energy.

19. Manual Operating Device

Annual inspection. - See that manual operating lever or jack is kept on hand and in useable condition. See that breaker is closeable with it.

20. Latch and Trip Mechanism

Weekly inspection. - Visual inspection to see that mechanism is in operating condition.

Annual inspection. - Observe mechanism during several tripping operations to see that everything is in working order. Check pins, bearings, and latches for wear, binding, and misalignment. Clean and relubricate as in Section 17 on Operating Rods, Shafts, and Bellcranks. Check latch carefully to see that it is not becoming worn so as to unlatch from vibration or stick and fail to trip. Tighten bolts and screws.

21. Tripping Solenoid

Weekly inspection. - Visual inspection to see that solenoid trip device is in operating condition.

Annual inspection. - Observe operation during electrical tripping. See that full energy with snappy action of plunger is obtained. Check plunger for sticking in guides. Check coil and insulation resistance.

22. Solenoid Valves

Annual inspection. - Check condition of valve seat, and refit as necessary. See that moving parts are free to operate. Check resistance and insulation resistance of solenoid coil.

23. Auxiliary Switches

Annual inspection. - Check condition of contacts and refinish with fine file if burned or corroded. Check contact springs, operating rods, and levers. Check closing and opening position with respect to main contacts while breaker is being slowly closed and opened manually. Certain auxiliary contacts used for special purposes may require close adjustment in this respect.

24. Operation Counter

Monthly inspection. - Observe and record reading of operation counter.

Annual inspection. - See that operation counter is properly registering the breaker operations.

25. Position Indicator

Annual inspection. - See that position indicator or semaphore is properly indicating the breaker position. Check operating rods or levers for loose parts.

26. Dashpots or Snubbers

Annual inspection. - Check for proper setting and adjust as necessary. Clean out and replenish liquid in liquid dashpots.

27. Mechanism Cabinet

Annual inspection. - Check condition of metal and hardware. Repaint as necessary. See that door gaskets are tight and properly exclude dust and dirt.

28. Cabinet Lights and Heaters

Weekly inspection. - Check cabinet heaters and see that they are in service during cold weather. Replace burned-out lamps.

Annual inspection. - Check heating elements and replace if in poor condition.

29. Power Supplies and Wiring

Weekly inspection. - See that all power and control circuit switches are closed and fuses in place.

Annual inspection. - Inspect fuses or circuit breakers in all power and control supply circuits. Check and tighten wiring connections at terminal points. Inspect wiring for open circuits, short circuits, and damaged insulation. Check insulation resistance of wiring with devices connected.

30. Oil Dielectric Tests

Annual test. - Check dielectric strength of the insulating oil in the main tanks and oil-filled bushings.

31. Filter Oil

The necessity for filtering the insulating oil will depend on the results obtained from the oil dielectric tests and the amount of carbon in the oil. The oil should be filtered if the dielectric strength is below 25 kilovolts or if there is a noticeable amount of carbon in suspension or in the bottom of the tanks. Refer to Power O&M Bulletin No. 11 for detailed test information.

32. Operation

Some breakers, particularly those carrying high values of current, have a tendency to develop contact heating if left closed for long periods. Opening and closing breakers several times at intervals, as system operation will permit, may alleviate the heating by wiping the oxide from the contact surfaces, as well as demonstrate that the breaker is in operating condition.

At each inspection, it may be desirable that a more complete report be made showing briefly what was found and what was done. A form similar to Form O&M-152, Figure 6, pages 66 and 67 may be used for this purpose.

CIRCUIT BREAKER INSPECTION REPORT

LOCATION Indian Hills Substation DATE OF INSPECTION 5-18-67
CIRCUIT DESIGNATION Seminole Line BREAKER No. Ch 364
BREAKER DATA:
MFR. J.C. Electric Co. TYPE P.O. KV. 115 AMPS 600
INTERRUPTING KVA 250,000 INTERRUPTING TIME 8 cycles
RECLOSING TIME No recloser SERIAL No. 6678
CLOSING MECHANISM TYPE Solenoid 125 v DC
TRIPPING MECHANISM TYPE Solenoid 125 v DC

INSPECTION: (CHECK IF SATISFACTORY OR NOTE CONDITION)

OPERATION COUNTER READING - AS FOUND 241 AS LEFT 245
FOUNDATION OK

TANKS OR FRAME:

ALINEMENT OK PAINT yes GROUNDING OK

OPERATING MECHANISM:

CLOSING SOLENOID _____ TRIPPING SOLENOID _____
CLOSING SPRING MECHANISM _____
CLOSING AIR OR OIL CYLINDER _____
AIR COMPRESSOR _____ AIR TANK _____
LATCHES OK RELAYS OK
TRIP-FREE MECHANISM OK
AUXILIARY SWITCHES Contacts pitted POSITION INDICATOR OK
CABINET HEATERS OK CABINET DOOR GASKETS OK
LUBRICATION OK

MAIN CONTACTS:

ALINEMENT OK ADJUSTMENT ø A readjusted
CONDITION - MOVING slightly pitted FIXED slightly pitted
SHUNTS _____
RESISTORS _____
OPERATING RODS AND SHAFTS OK

BUSHINGS:

PORCELAIN slightly chipped OIL OR COMPOUND LEAKS None
OIL LEVEL OK OIL CONDITION* OK tested
TERMINALS OK

INSULATORS:

INSULATING OIL:

LEVEL OK LEAKS slight at 3 ø drain valve
CONDITION* OK 28-30-27 kv See report

Potential Device - Connection loose in C ø terminal box

*REPORT OIL TESTS ON FORM O & M 109 Figure 6
USE SPARE LINES FOR OTHER ITEMS AS NEEDED

OPERATING TESTS:

NORMAL CLOSING SOLENOID VOLTS	125	AMPS	30	TIME*	12 hertz
MINIMUM CLOSING SOLENOID VOLTS	70	AMPS	17	TIME*	20 hertz
NORMAL CLOSING CONTROL RELAY OR VALVE-		VOLTS	125	AMPS	5
MINIMUM CLOSING CONTROL RELAY OR VALVE		VOLTS	60	AMPS	2.5
NORMAL TRIPPING VOLTS	125	AMPS	10	TIME*	8 hertz
MINIMUM TRIPPING VOLTS	70	AMPS	8.7	TIME*	
CLOSING SOLENOID RESISTANCE	4.2	OHMS AT	25		°C
CLOSING RELAY OR VALVE RESISTANCE	25	OHMS AT	25		°C
TRIP COIL RESISTANCE	10	OHMS AT	25		°C
TOTAL TRIP CIRCUIT RESISTANCE	12.5	OHMS AT			°C
CLOSING AIR PRESSURE - NORMAL		PSI - MINIMUM			PSI
AIR LEAKAGE - PRESSURE DROP PER HOUR					PSI
READING OF COMPRESSOR OPERATION COUNTER					
TIME TO PUMP UP AIR PRESSURE		PSI TO		PSI	MINUTES
COMPRESSOR CONTROL SWITCH - CUT IN		PSI - CUT-OUT			PSI
NUMBER OF CLOSURES WITHOUT RECHARGING TANK					
SAFETY VALVE SETTING		PSI			

CLOSING SPRING MOTOR LOAD - VOLTS		AMPS	
TIME TO CHARGE CLOSING SPRING		MINUTES	

REPAIRS OR CHANGES MADE AT TIME OF THIS INSPECTION

Auxiliary switch contacts cleaned
A ø main contacts readjusted
Main contacts dressed slightly
Stopped B ø oil leak
Tightened potential device connection

INSPECTED BY Joe Jones
Al Smith

USE SPARE LINES FOR OTHER ITEMS AS NEEDED
* OVERALL TIME FROM CLOSING OF CONTROL SWITCH CONTACTS