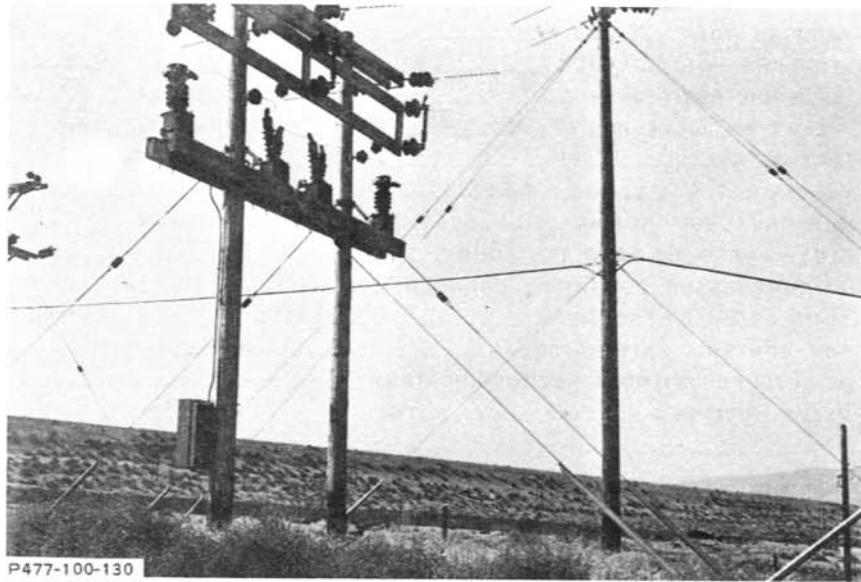


CHAPTER XIII - DISCONNECTING SWITCHES AND FUSES



P477-100-130

1. Inspection Checklist

Items of inspection	Inspection interval
Base and mounting	A
Insulators	W A
Line and ground connections	A
Blades and contacts	W A
Contact and hinge springs and shunts	A
Arcing horns	A
Blade latches and stops	W A
Operating rods, levers, and cranks	A
Gearboxes	A
Operating motor	A
Auxiliary and limit switches	A
Locks and interlocks	W A
Switch sticks	W A
Fuse tubes	A
Fuse links	A
Multiple-shot reclosing fuse	W A

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

## Reference

Power Maintenance Instruction No. 9, Retaining Glaze Burned Insulators in Service, dated September 21, 1967

### 2. Base and Mounting

Annual inspection. - Check for loose bolts and insecure or inadequate supporting structure.

### 3. Insulators

Weekly inspection. - Check for chipped or broken porcelain and excessive dirt film.

Annual inspection. - Clean porcelain with water, chlorothene, or other suitable cleaner if subject to excessive dirt or smoke. Repair chipped spots by painting with lacquer such as red glyptal. Replace broken insulators. Check insulators at 5-year intervals with an insulator tester if a reliable tester is available. Tighten base and cap bolts.

### 4. Line and Ground Connections

Annual inspection. - Check and tighten line terminals and base and operating handle ground connections. See that ground cable is not broken.

### 5. Blades and Contacts

Weekly inspection. - See that blades are properly seated in the contacts.

Annual inspection. - Operate switch several times and see that blades are properly aligned to engage contacts. Clean contact surfaces if corroded. Tighten bolts and screws.

### 6. Contact and Hinge Springs and Shunts

Annual inspection. - Check pressure springs in contact and hinge and replace if not adequate. Replace flexible shunts if frayed.

7. Arcing Horns

Annual inspection. - Check arcing horns of air-break switches to see that they are not bent out of shape. Clean up if burned.

8. Blade Latches and Stops

Weekly inspection. - See that blade latches, where provided, are engaged.

Annual inspection. - Check latches for proper engaging and holding blade against opening force. See that stops are in place and tight.

9. Operating Rods, Levers, and Cranks

Annual inspection. - Check and tighten bolts, screws, and locknuts. See that rods, levers, and cranks are in serviceable condition and repair as necessary. Lubricate pivots and bearings. (See Section 17 on Operating Rods, Shafts, and Bellcranks, page 62.)

10. Gearboxes

Annual inspection. - Check gears and bearings. Flush out oil or grease and relubricate. (See section on Operating Rods, Shafts, and Bellcranks, page 62.)

11. Operating Motor

Annual inspection. - Check motor. See Chapter III - Electric Motors. Check adjustment of brake.

12. Auxiliary and Limit 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 positions with respect to main switch contacts or travel or motor mechanism.

13. Locks and Interlocks

Weekly inspection. - See that switches are properly locked in the open or closed position as required by padlocks or other key-type locks or interlocks.

Annual inspection. - See that locks and keys operate as intended. Check mechanical interlocks, such as between main disconnecting switch and ground switch, for foolproof operation.

#### 14. Switch Sticks

Weekly inspection. - See that wooden switch-operating sticks are in good condition and are kept in a dry place.

Annual inspection. - Inspect wooden operating sticks for cracks, splinters, loose heads, and checked varnish. Broken or badly checked high-voltage sticks should be destroyed, as splicing or repairing may result in low dielectric strength. Good sticks should be revarnished frequently. Care must be exercised in revarnishing to see that stick is thoroughly dry and that varnish does not contain moisture or other foreign conducting material. Check varnish with an oil test set before use. See that means for keeping sticks dry is adequate.

#### 15. Fuse Tubes

Annual inspection. - Check fuse tubes for carbonizing or other deterioration.

#### 16. Fuse Links

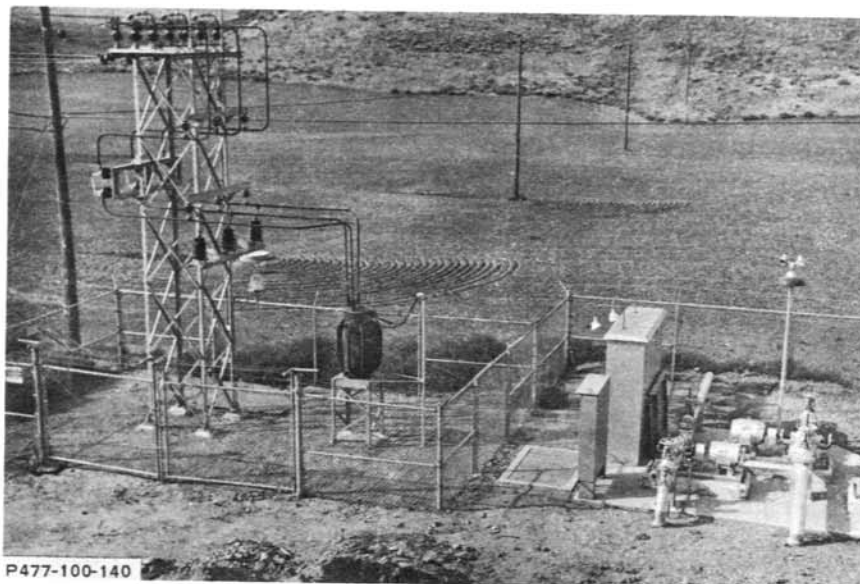
Annual inspection. - See that fuse links are secure at the terminals and are not overheating. See that extra links or new fuses are kept on hand.

#### 17. Multiple-shot Reclosing Fuse

Weekly inspection. - Note whether operation has occurred and replace blown fuse.

Annual inspection. - Check fuse latching and tripping mechanism for proper operation.

## CHAPTER XIV - SWITCHYARDS



### 1. Inspection Checklist

Items of inspection	Inspection interval
Yard and fences	M A
Wood structures	See Chapter on Transmission Lines, p 88
Steel structures	
Footings and guy anchors	
Guy	
Warning signs	
Ground connections	M A
Conductors and buses	M A
Hardware	See Chapter on Transmission Lines, p 88
Insulators	
Transformers and regulators	See Chapter on Transformers, p 76
Oil and air circuit breakers	See Chapter on Circuit Breakers, p 58

1. Inspection Checklist - Continued

Items of inspection	Inspection interval
Disconnecting switches and fuses	See Chapter on Disconnecting Switches, p 68
Lightning arresters	See Chapter on Lightning Arresters, p 85
Control equipment	See Chapter on Control Equipment, p 31
Lighting	M    A
Oil storage facilities	M    A
Conduit, ducts, trenches, and tunnels	M    A
Storage batteries and chargers	See Chapter on Compressors and Miscellaneous Pumps, p 42
Power supplies and wiring	M    A

M - Routine monthly inspection when in service.

A - Annual inspection.

References

- Power O&M Bulletin No. 8, Dependable Electrical Contacts  
 Power Maintenance Instruction No. 9, Retaining Glaze Burned Insulators in Service, dated September 21, 1967
- Power O&M Bulletin No. 25, Use of Cathodic Protection of Buried and Submerged Metals in Corrosion Prevention in Electric Power Installations

2. Yard and Fences

Monthly inspection. - Check for anything unusual on the premises. See that gates, buildings, switches, etc., are locked where necessary to prevent unauthorized persons from entering or tampering with equipment.

Annual inspection. - Check fence and gates for damage or openings through which animals or unauthorized persons might enter. Check fence ground connections. Cut weeds and grass as necessary, and apply weed killers where found to be effective. Repair eroded soil banks, retaining walls, roads, and walks. Clean up and remove rubbish. Check danger signs on fence and gates.

### 3. Ground Connections

Monthly inspection. - Visual inspection to see that structure and apparatus ground leads are not loose or broken.

Annual inspection. - Check and tighten connectors and clamps in ground leads. Check ground leads to a point at least a foot below ground line to see that they are not broken or corroding. Check resistance of ground rods or ground mat.

### 4. Conductors and Buses

Monthly inspection. - Make from-the-ground check of conductors to detect broken or damaged strands or loose connections.

Annual inspection. - Adjust sag in tension buses where necessary. Check tubular buses and flexible expansion joints and adjust if necessary to relieve strain on post-type insulators and bushings. Check joints for looseness and heating. Tighten connectors and clamps.

### 5. Lighting

Monthly inspection. - Note burned-out lamp bulbs in yard and building fixtures and have them replaced.

Annual inspection. - Try out all lights and note whether they are all in proper operating condition. Clean lamp bulbs, lenses, and reflectors. In locations subject to excessive bugs, an additional cleaning may be necessary after the bug season has passed. Tighten fixtures and other lighting devices. Check lighting circuit time switches or other automatic control devices.

### 6. Oil Storage Facilities

Monthly inspection. - Check for oil leaks in storage tanks. Note amount of oil on hand and see that receiving tank is maintained empty when not in actual use for draining oil from transformers or breakers in an emergency.

Annual inspection. - Check and repair oil leaks. Check valves, plugs, and piping. See that valves on active storage tanks, which can be operated without a wrench, are plugged or locked closed. Drain condensate from storage tank sump. Repaint tanks and piping if necessary. Check operation of oil pumps. Check hoses and other accessories used in draining or refilling apparatus tanks. (See Chapter IX, page 42, on Oil Pumps.) Check for corrosion of buried oil piping and apply cathodic protection if necessary. (See Power O&M Bulletin No. 25.)

## 7. Conduits, Ducts, Trenches, and Tunnels

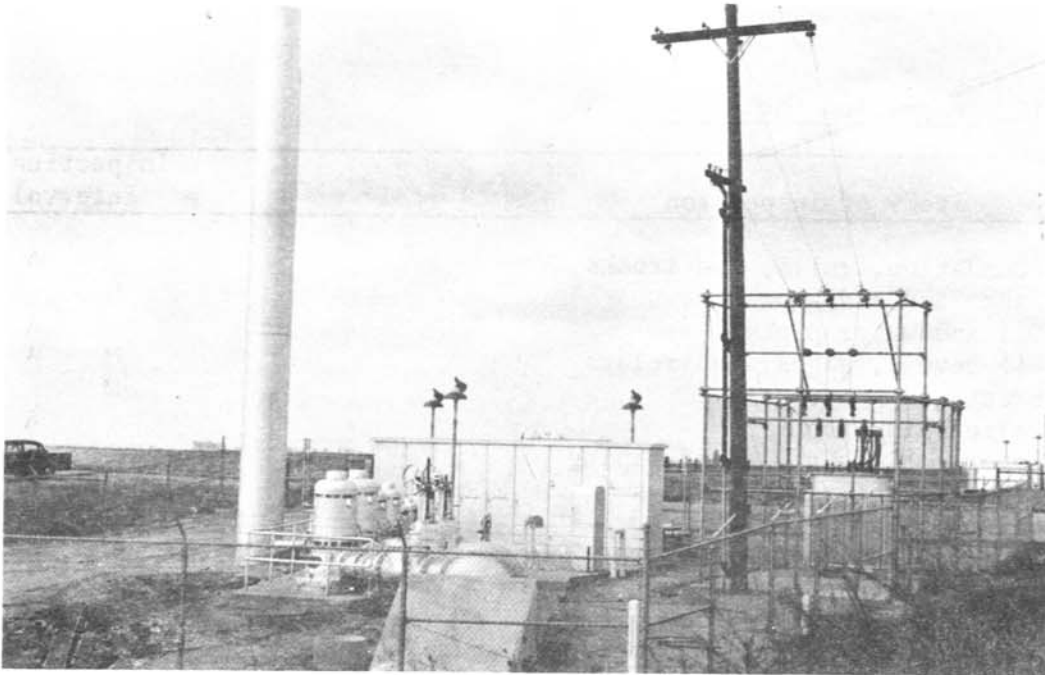
Monthly inspection. - Visual inspection to detect moisture or other unusual conditions in conduit and duct runs, cable trenches, and tunnels.

Annual inspection. - Make close observation of above and provide suitable waterproofing and drains where necessary. Check runs of metal conduit in soil for signs of corrosion. Paint metalwork in tunnels and cable trenches as necessary.

## 8. Power Supplies and Wiring

Monthly inspection. - See that power is available on all essential power, lighting, and control circuits.

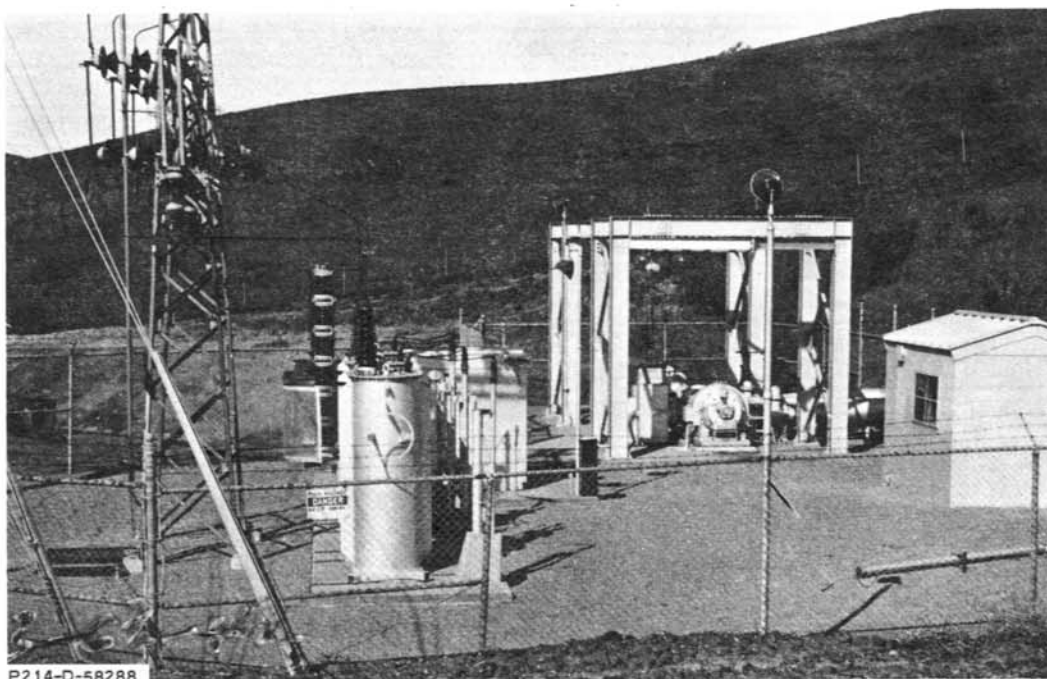
Annual inspection. - Inspect fuses or circuit breakers on power, lighting, and control circuits. Check and tighten wiring connections at terminal points. Inspect wiring for open circuits, short circuits, and damaged insulation. Check insulation resistance of wiring with devices connected.



Delano-Earlimart Irrigation District Lateral 115.8E, Plant D-18 and Switchyard. Friant Division, Central Valley Project, California. Photo P214-D-58287



## CHAPTER XV - TRANSFORMERS



### 1. Inspection Checklist

Items of inspection	Inspection interval	
Foundation, rails, and trucks		A
Tanks and radiators	M	A
Oil and water piping		A
Oil levels, gages, and relays	M	A
Breathers and vents	M	
Relief diaphragm		A
Water-cooling coils and piping		A
Flow indicators and relays	D	A
Oil pumps	D	A
Cooling fans and water sprays	D	A
Temperature indicators and relays	M	A
Inert gas tanks		A
Gas regulator gages, and relays	W	A
Gas piping and valves		A

1. Inspection Checklist - Continued

Items of inspection	Inspection interval
Gas analysis	A
Bushings	M A
Tap setting	A
Main terminal and ground connections	M A
Core and coils	NS
Internal inspection	NS
Ratio adjuster	M A
Insulation resistance	A
Oil dielectric	A
Oil acidity	5 year
Filter and reclaim oil	NS

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

References

- Power O&M Bulletin No. 1, Testing and Maintenance of High Voltage Bushings  
Power O&M Bulletin No. 3, Testing Solid Insulation of Electrical Equipment  
Power O&M Bulletin No. 6, Permissible Overloading of Oil Immersed Transformers and Regulators  
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  
Power O&M Bulletin No. 23, Fire-Fighting, Cause and Prevention (CO<sub>2</sub> Test)

2. Foundation, Rails, and Trucks

Annual inspection. - Check foundation for cracking and settling. A slight shift of the transformers may break bushings or connecting oil or water lines. See that rail stops are firmly in place to hold transformer in position on the rails. Check transfer car and matching of its rails with transformer deck rails at each position. Paint metalwork as needed.

### 3. Tanks and Radiators

Monthly inspection. - Check for unusual noise and oil and water leaks.

### 4. Oil and Water Piping

Annual inspection. - Clean dirt and oil from radiating surfaces. Repaint as necessary. Stop excessive vibration of radiator tubes. Tighten loose or vibrating parts. Check for unusual internal noises. Inspect oil and water piping, valves, and plugs. Manipulate radiator cutoff valves to see that they are in operating condition, and secure in the open position. See that all oil drain valves which can be operated without wrenches are plugged or locked to prevent unauthorized opening.

### 5. Oil Levels, Gages, and Relays

Monthly inspection. - Check oil level in main and auxiliary tanks, oil-filled bushings, etc. Changes in oil levels from time to time should be noted, taking into consideration the change in level caused by change in oil temperature. A rise in level in a water-cooled transformer (for a given temperature) indicates that water is leaking from the cooling coils into the oil.

Annual inspection. - Clean dirty gage glasses and connections into tank. Check oil level indicators and relays for proper operation. Replenish oil if below normal. Drain out and replace bushing oil if dirty or discolored.

### 6. Breathers and Vents

Monthly inspection. - See that relief diaphragm has not opened and breathers and vents appear to be normal.

### 7. Relief Diaphragm

Annual inspection. - See that relief diaphragm is in operating condition and closes tightly. The non-shattering-type diaphragm should be actuated to see that it is not stuck shut from rust or paint. Make sure that the material used in the shattering-type diaphragm is not too thick or tough to be broken by reasonable internal pressure. See that screens and baffles in vents or breathers are not obstructed or broken. If breathers are of the dehydrating type, check chemicals and replace if depleted.

## 8. Water-cooling Coils and Piping

Annual inspection. - Check external supply and drain piping for leaks. Flush out cooling coils or heat exchanger water passages with air and water. Test coils for leaks by applying air pressure to coils and observing for bubbles rising in oil and drop in air pressure with supply valve closed, or use a hydrostatic pressure test. A pressure of about 75 pounds per square inch is recommended. If water scale is present, circulate a solution of 25 percent hydrochloric acid and water through the coils until clean. Then flush out thoroughly. Clean external surfaces of coils.

## 9. Flow Indicators and Relays

Daily inspection. - See that proper supply of cooling water is flowing.

Annual inspection. - Check waterflow indicators and relays for proper operation.

## 10. Oil Pumps

Daily inspection. - See that oil-circulating pumps are in operation when required.

Annual inspection. - See Chapter IX - Compressors and Miscellaneous Pumps, page 42.

## 11. Cooling Fans and Water Sprays

Daily inspection. - See that fans are in operation when necessary and that water spray is adjusted.

Annual inspection. - Check motors as described in Chapter III - Electric Motors, page 17. Check switchboards and control equipment as described in Chapter VI - Switchboards and Control Equipment, page 31.

## 12. Temperature Indicators and Relays

Monthly inspection. - Check and record transformer temperatures.

Annual inspection. - Check calibration of temperature indicators and relays. Check and clean relay contacts and operating mechanism.

13. Inert Gas Tanks

Annual inspection. - Check gas pressure left in tanks and change out at about 25-pound pressure.

14. Gas Regulator Gages and Relays

Weekly inspection. - See that proper gas pressure is being maintained in transformer.

Annual inspection. - Check setting and operation of regulator and relay. See that gages are indicating properly.

15. Gas Piping and Valves

Annual inspection. - Check for gas leaks by applying liquid soap on all joints, valves, connections, etc., with gas pressure raised to the maximum recommended by the transformer manufacturer.

16. Gas Analysis

Annual inspection. - Check analyzer for proper operation. Analyze gas. Purge if oxygen or combustible gas content is over 5 percent.

17. Bushings

Monthly 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 power factor. Check oil sample from bottom of bushing for dielectric strength and presence of water which may be entering at top. Replace or replenish oil if necessary.

18. Tap Setting

Annual inspection. - Check tap setting 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 and burden. Tighten connections, including potential device tap, into bushing.

## 19. Main Terminal and Ground Connections

Monthly inspection. - Check for presence of foreign material, birds' nests, etc., in or near connecting bus work, loose or heating connections, and loose or broken tank 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.

## 20. Core and Coils

Not scheduled. - If the transformer has been properly maintained and not overheated and barring internal failure, it should not require untanking within its normal life. If sludge has been allowed to form due to overheating and oxidation of the oil, the transformer should be untanked and the core, coils, oil passages, tank, and water-cooling coils washed down with clean oil under pressure to remove sludge and other accumulations which prevent proper circulation of the oil. Inflammable liquids should not be used in cleaning the core, coils, or inside of tank. Provide sufficient fresh air for workman while working inside of tank. While untanked, check for loose laminations, core bolts, insulating blocks, etc., and other pertinent features on the check list.

## 21. Internal Inspection

Not scheduled. - Lower the oil level to at least the top of the core. Inspect for sludge on core and windings. Inspect underside of cover for moisture and rust and cleanup. Check connections at terminal board. Tighten all bolted connections, core bolts, etc., within reach.

## 22. Ratio Adjuster

Monthly inspection. - Note position of ratio adjuster and that it is adequately locked to prevent unauthorized operation.

Annual inspection. - Inspect contacts and clean if reachable on internal inspection. If not reachable for visual inspection, check each position with wheatstone bridge across winding to detect poor contact. Work adjuster back and forth over complete range several times.

### 23. Insulation Resistance

Annual test. - Check the insulation resistance between each winding and between each winding and ground. Disconnect all external leads at the bushing terminals, except where the connecting leads can be suitably isolated at adjacent disconnecting switches, for this test. A similar test using a capacitance bridge is recommended where such an instrument is available.

### 24. Oil Dielectric

Annual test. - Check the dielectric strength of the insulating oil in the main and auxiliary tanks and oil-filled bushings. (See Power O&M Bulletin No. 11.)

### 25. Oil Acidity

The acidity of the insulating oil in the main tank should be checked at intervals of not more than 5 years. Transformers operating at high temperatures or showing signs of sludging or dark color of the oil should be checked more frequently. Oil may be checked in the field with a Gerin test kit or samples sent to the Denver Laboratory.

### 26. Filter and Reclaim Oil

Not scheduled. - The necessity for filtering and/or reclaiming the insulating oil will depend on the results obtained from the oil dielectric and oil acidity tests. It may be more economical to replace the oil in small transformers rather than filter or reclaim it.

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 PO&M-151, Figure 7, pages 83 and 84, may be used for this purpose.

**TRANSFORMER INSPECTION REPORT**

LOCATION Mon-View BANK NO. Unit 6 DATE OF INSPECTION 5-18-67  
 MFR. OF TRANSFORMERS General

**RATING:**

HIGH VOLTAGE 19050/33000Y. taps 20955-20478-2002  
 MEDIUM VOLTAGE \_\_\_\_\_  
 LOW VOLTAGE 2300 delta  
 (UNDERLINE TAP OR VOLTAGE USED)

KVA PER TANK 1000  
 PERCENT IMPEDANCE 5.4  
 TYPE A COOLING Oil-self  
 FREQ 60 CYCLES. PHASE 1 TEMP 55 °C  
 SERIAL NUMBERS 79511 - 09-0-10 - 12

BUSHINGS:	TYPE	MFR.	C. T. RATIOS	P. D. RATIOS
H.V.	<u>X</u>	<u>OB</u>	<u>10C/5 delta</u>	
M.V.				
L.V.	<u>Y</u>	<u>OB</u>		

(UNDERLINE RATIO USED)

**TYPE GAS SYSTEM: (CHECK ONE)**

GAS-OIL SEAL \_\_\_\_\_ INERT GAS PRESSURE \_\_\_\_\_ SEALED TANK \_\_\_\_\_ OTHER \_\_\_\_\_

**CONDITIONS OF TRANSFORMERS AND AUXILIARY DEVICES:**

TANK AND RADIATORS OK  
 ANY OIL LEAKS? slight

COOLING FANS \_\_\_\_\_  
 BUSHINGS OK  
 GROUND CONNECTIONS OK  
 GROUND RESISTANCE Station ground 1 ohm  
 ARE TRANSFORMERS NOISY? No  
 THERMOMETERS OK except 0 A sticks  
 TEMPERATURE RELAYS None  
 OIL-LEVEL GAGES OK  
 OIL-LEVEL ALARM RELAYS None  
 COOLING WATER SIGHT FLOW None  
 TAP CHANGERS \_\_\_\_\_  
 AUTO-LOAD RATIO CONTROL \_\_\_\_\_  
 IS PRESENT RANGE ADEQUATE? No  
 CORE Transformer not untanked for this inspection.  
 ARE ALL CLAMPING BOLTS TIGHT? \_\_\_\_\_  
 COIL INSULATION \_\_\_\_\_  
 COOLING COILS \_\_\_\_\_

Figure 7



NITROGEN PURITY: PERCENT OXYGEN \_\_\_\_\_  
 PERCENT COMBUSTIBLE GAS: TEST NO. 1 \_\_\_\_\_ DATE \_\_\_\_\_  
 TEST NO. 2 \_\_\_\_\_ DATE \_\_\_\_\_  
 TEST NO. 3 \_\_\_\_\_ DATE \_\_\_\_\_

NITROGEN PRESSURE IN TRANSFORMER TANK \_\_\_\_\_ SUPPLY TANK \_\_\_\_\_  
 PRESSURE RELIEF \_\_\_\_\_  
 CONSERVATOR \_\_\_\_\_

CONDITION OF INSULATING OIL \_\_\_\_\_  
 WAS OIL TESTED? \_\_\_\_\_  
 WAS INSULATION RESISTANCE TESTED? \_\_\_\_\_  
 WAS INSULATION POWER FACTOR TESTED? \_\_\_\_\_

(RECORD OIL AND INSULATION DATA ON FORM O&M 109)

MAXIMUM LOADING AND TEMPERATURES OF TRANSFORMERS (FROM LOG SHEETS OR TESTS)

DATE	5/18				
HOUR	10 am				
AMPS.	625				
KV.	2280				
KW.					
KVAR. P.F.					
KVA.	2470				
φ A OIL TEMP. °C.	44				
φ A RTD TEMP. °C.					
φ B OIL TEMP. °C.	45				
φ B RTD TEMP. °C.					
φ C OIL TEMP. °C.	48				
φ C RTD TEMP. °C.					
AMBIENT TEMP. °C.	18				
COOLING WATER IN - TEMP. °C.					
COOLING WATER OUT - TEMP. °C.					

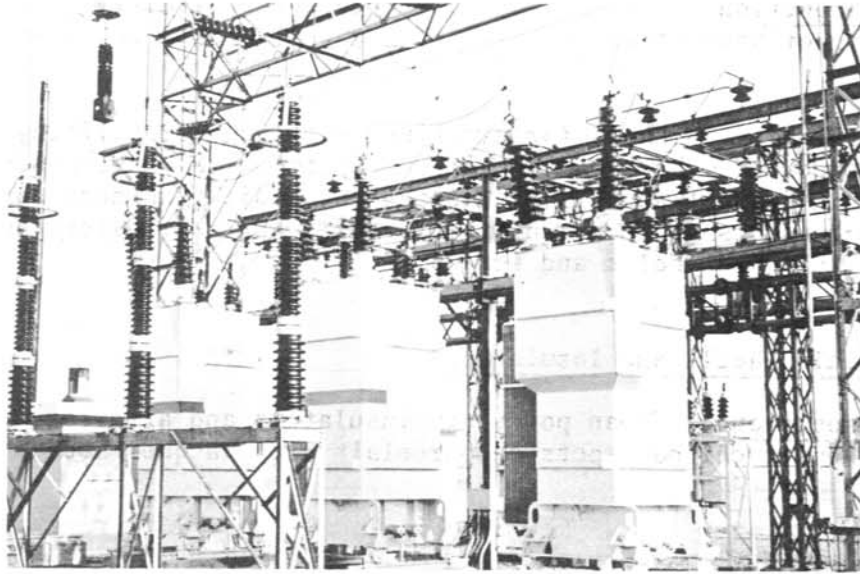
REPAIRS OR CHANGES MADE AT TIME OF THIS INSPECTION \_\_\_\_\_  
 \_\_\_\_\_  
**None**  
 \_\_\_\_\_  
 \_\_\_\_\_

OTHER REPAIRS OR CHANGES RECOMMENDED \_\_\_\_\_  
 \_\_\_\_\_  
**None**  
 \_\_\_\_\_  
 \_\_\_\_\_

INSPECTION MADE BY: **John Smith**

NOTE: CROSS OUT ALL ITEMS WHICH DO NOT APPLY TO THE TRANSFORMERS COVERED BY THIS INSPECTION.

## CHAPTER XVI - LIGHTNING ARRESTERS



115-kv lightning arresters at left. Photo P-214-D-68170NA

### 1. Inspection Checklist

<u>Items of inspection</u>	<u>Inspection interval</u>
Base and supports	M A
Porcelain shells and insulators	A
Grading rings	A
Arrester units	NS
Gaps	A
Line and ground connections	A
Pressure-relief diaphragms	M

M - Routine monthly inspection when in service.

A - Annual inspection.

NS - Not scheduled.

### References

Power O&M Bulletin No. 5A, Proper Installation of Lightning Arresters

## 2. Base and Support

Monthly inspection. - Visual inspection to detect cracking, settling, or shifting of base or supports which might place strain on arrester units.

Annual inspection. - Check for cracking, settling, or shifting of base or supports. Check tension on spring tiedowns on suspended arresters in hottest and coldest weather and adjust as necessary. Clean and revarnish wooden supports for oxide-film arresters as necessary. Tighten bolts and screws.

## 3. Porcelain Shells and Insulators

Annual inspection. - Clean porcelain insulators and arrester unit shells. Repair chipped spots on porcelain with lacquer such as red glyptal.

## 4. Grading Rings

Annual inspection. - Check and tighten grading rings on high-voltage arresters.

## 5. Arrester Units

Monthly inspection. - Inspect monthly for ruptured pressure-relief diaphragms.

Not scheduled. - It would generally not be practical or necessary to dismantle an arrester unit such as a General Electric thyrite unit for inspection of the thyrite discs, gaps, resistors, etc. However, if any tests or outside inspection, indicate possible damage from a heavy discharge, all internal parts should be inspected and replaced as necessary. Check for condensation inside of unit. General Electric does not recommend rebuilding any arrester that has ruptured a pressure-relief diaphragm.

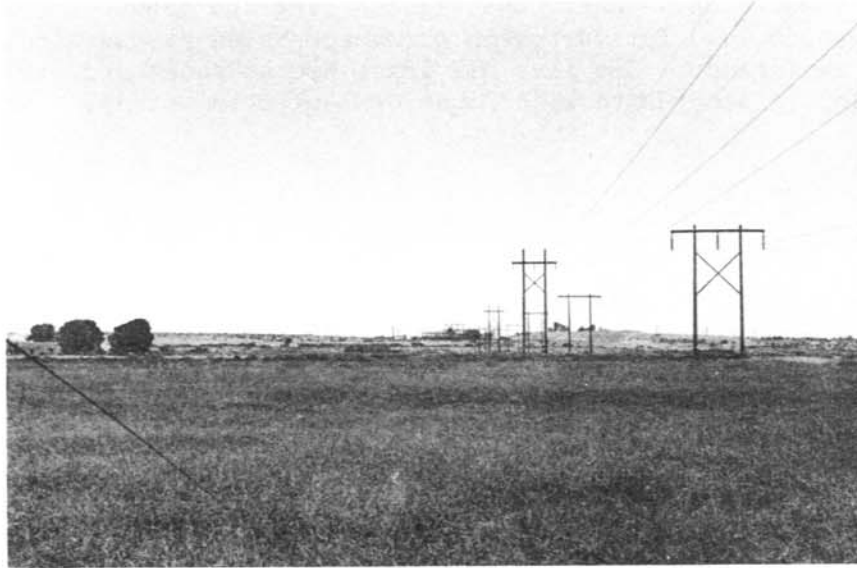
## 6. Gaps

Annual inspection. - Check external gaps, smooth off arc-burned spots, and readjust spacing.

## 7. Line and Ground Connections

Annual inspection. - Check and tighten line and ground connections. Check ground lead for corrosion or damage below ground line. Check ground resistance. See that all leads are as short and direct as possible, in accordance with Power O&M Bulletin No. 5A.

CHAPTER XVII - TRANSMISSION LINES



69-kv transmission line on left. 115-kv transmission line on right. Photo CP50-D-68169NA.

1. Inspection Checklist

Items of inspection	Inspection interval	
Wood poles	M	
Crossarms, pins, and braces		A
Steel towers	M	A
Footings and guy anchors	M	A
Guys	M	A
Warning signs		A
Ground wires and connections	M	A
Main conductors and overhead ground wires	M	A
Conductor splices		A
Vibration dampers		A
Hardware	M	A
Insulators	M	A
Right-of-way	M	A
Line maintenance tools	NS	A

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. 15, Care and Testing of Lineman's Rubber Protective Equipment
- Power O&M Bulletin No. 25, Use of Cathodic Protection of Buried and Submerged Metals in Corrosion Prevention in Electric Power Installations

General. - Make ground or airplane patrol of line at intervals of about 1 month to detect general deterioration that should be repaired by the line crew.

### 2. Wood Poles

Monthly inspection. - Make from-the-ground check of poles for signs of decay, misalignment, and damage from lightning or other causes. Check crossarms for splitting.

### 3. Crossarms, Pins, and Braces

Annual inspection. - Make close inspection of the above. Repair or replace split or weakened poles, crossarms, or braces. See that pins are tight in arms and insulators.

Deterioration of an untreated wood pole in service begins in the ground section due to infection by wood-destroying fungi which are usually present in one form or another in the soil and air. The destructive fungi, once established, will continue to attack the wood unless stopped by the application of some preventive. The section of pole most subject to deterioration is from a few inches above to about 15 inches below the ground line.

Two general classes of preservatives are (a) oily materials such as creosote and (b) water solutions of toxic salts such as zinc chloride and sodium fluoride. Sodium fluoride penetrates well but is not permanent, while creosote or a mixture of creosote and coal tar is more permanent but does not penetrate as well. For this reason, a combination of sodium fluoride, creosote, and coal tar has been used and found very satisfactory and has increased the life of poles by about 6 years. Apply this treatment at 5-year intervals.

The treatment of standing poles, using sodium fluoride, creosote, and coal tar, can be applied as follows:

Remove the dirt from around the pole to a depth of about 15 inches. Remove the fungus rot material. Distribute a pound of sodium fluoride in powdered form against the pole to a point above the ground line and in the bottom of the trench. Backfill the dirt loosely against the pole. Form a narrow trench around the pole and about 10 inches deep. Pour 1-1/2 gallons of the creosote-coal-tar mixture against the pole all around to a height of about 18 inches above the ground line so as to go into all cracks. A container with a flattened spout which will pour a fan-shaped stream is convenient for applying the creosote. After a short period, the creosote-saturated soil should be pressed back against the pole to fill up the trench. If the pole is located where the presence of creosote would not be objectionable on the surface of the ground, an additional one-half gallon of creosote should be applied over the backfilled dirt.

#### 4. Steel Towers

Monthly inspection. - Make from-the-ground check of structure for signs of rusting or loose or damaged members.

Annual inspection. - Make close inspection of the above. Tighten all bolts at 5-year intervals. Brush rusty spots with wire brush and apply a good paint such as gray emulsified asphalt. Apply two coats of black emulsified asphalt paint on the tower legs 18 inches above and below the ground line and over the top of concrete footings where used.

#### 5. Footings and Guy Anchors

Monthly inspection. - Check condition of footings and anchors particularly in locations subject to soil erosion, movement, or settling.

Annual inspection. - Check concrete footings for cracking and spalling. See that footings and anchors are firmly set. Stub poles as necessary. Check anchors and other buried metalwork for corrosion, at intervals of about 3 years, especially in corrosive soil, and apply cathodic protection if necessary. (See Power O&M Bulletin No. 25.)

#### 6. Guys

Monthly inspection. - Check for tightness and general condition.

Annual inspection. - Tighten guy wires and clamps. After the first year of operation of the line, this can be extended to 2- to 5-year intervals. Apply emulsified asphalt paint on rusty spots on cable and guy rods 18 inches above and below ground line.

#### 7. Warning Signs

Annual inspection. - See that an adequate number of warning signs are used on structures, fences, etc., and that they are securely attached.

#### 8. Ground Wires and Connections

Monthly inspection. - Make from-the-ground check to detect loose or broken pole downleads, or broken or corroded ground connections.

Annual inspection. - Tighten clamps on ground connections. Inspect counterpoise conductors at intervals for corrosion and poor connections. This is particularly important in corrosive soil. Check resistance of ground connections and counterpoise. See that ground wire on poles and at tower footings is adequately protected from being broken.

#### 9. Main Conductors and Overhead Ground Wires

Monthly inspection. - Make from-the-ground inspection with field glasses to detect broken strands, incorrect sag and clearances, etc.

Annual inspection. - Adjust sag and clearances where necessary. Tighten connections between overhead ground wires and downleads. Inspect conductors and overhead ground wires at supporting clamps at 5-year intervals for signs of weakening and burns, and reinforce as necessary.

#### 10. Conductor Splices

Annual inspection. - Inspect splices with field glasses to detect failure.

#### 11. Vibration Dampers

Annual inspection. - Tighten damper supports and grading shields at same time that conductor clamps are tightened.



## 12. Hardware

Monthly inspection. - Make from-the-ground inspection of hardware to detect loose bolts, pins, etc.

Annual inspection. - Tighten all clamps, pole bands, and other hardware. After first year of operation of the line, this can be extended to 2- to 5-year intervals. Paint rusty spots with gray emulsified asphalt or similar paint.

## 13. Insulators

Monthly inspection. - Make from-the-ground inspection of condition of insulators to detect broken skirts and excessive dirt.

Annual inspection. - Replace broken insulators. Repair chipped or glaze-burned spots with lacquer such as red glyptal. Clean insulators with water, chlorothene, or other suitable cleaner, if subject to excessive dirt or smoke. Check insulators at 5-year intervals with an insulator tester if a reliable tester is available.

## 14. Right-of-way

Monthly inspection. - Check for anything unusual, such as accumulation of dry materials around base of poles which might result in fire damage.

Annual inspection. - In late summer or fall, clean away dry weeds and grass for a diameter of 10 feet around the base of each structure and guy anchor to prevent possible damage by fire. Structures located in fence corners where tumbleweeds tend to accumulate may require frequent attention during the dry season. Clear away brush and trees at 5-year intervals. Weed-killing chemicals may prove successful for use in stopping growth around structures.

## 15. Line Maintenance Tools

Not scheduled. - See that tools are kept clean, dry, and in safe condition for use at all times.

Annual inspection. - Check over all tools such as hammers, wrenches, pliers, screwdrivers, drills, saws, axes, crowbars, picks, shovels, snatch blocks, ropes, chains, cables, cable grips, sheaves, etc. Have damaged or unsafe tools repaired or replaced. Check hot-line tools according to the manufacturer's instructions. Check rubber gloves, blankets, etc., according to Power O&M Bulletin No. 15.

CHAPTER XVIII - PUMPING PLANT BUILDING



1. Inspection Checklist

Items of inspection	Inspection interval
Doors and windows	M A
Elevators, cranes, and hoists	See Chapter on Cranes, p 49
Electric space heaters	W A
Ventilating fans	A
Water supply and drain piping	A
Water heaters and coolers	W A
Wash basins, sinks, showers, toilets, etc.	W
Water supply	W A
Lighting	W
Fire protection	M A
Conduit and fittings	A
Wiring and wiring devices	A
Railings and miscellaneous metalwork	A
Stairways and ladders	M A

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

## References

Power O&M Bulletin No. 23, Fire--Fighting, Cause, and Prevention  
(CO<sub>2</sub> Test)  
Bureau Paint Manual and Field Painting of Metalwork

### 2. Doors and Windows

Monthly inspection. - Check for general condition of windows, door locks, etc. Keep window glass clean. Replace broken glass.

Annual inspection. - Check windows and window operators, latches, etc. Check doors, hinges, lock operators, etc. Repaint frames, doors, and sash as necessary.

### 3. Electric Space Heaters and Ventilating Fans

Weekly inspection. - Visual inspection to see that heaters and ventilating fans are functioning properly in their respective seasons of use.

Annual inspection. - Check control thermostats, contactors, and fans for proper operation. Check heating elements of heaters for open circuits, short circuits, and damaged insulation. Check air-circulating ducts. Check for adequacy of the heating and ventilating facilities during cold and hot weather, respectively.

### 4. Water Supply and Drain Piping

Annual inspection. - Check for leaks and repair as necessary. Check for obstructions in supply and drain piping and remove as necessary.

### 5. Water Heaters and Coolers

Weekly inspection. - Visual inspection to see that water heaters and coolers are functioning properly.

Annual inspection. - Check electric water heaters for burned out or grounded elements. Flush from bottom of tank and observe for signs of rust. Check thermostat operation and clean contacts. Check water cooler refrigerating element. Lubricate if required.

6. Wash Basins, Sinks, Showers, Toilets, Etc.

Weekly inspection. - Check for dripping faucets and valves and other leaks, and repair as necessary. See that all equipment is maintained in clean and sanitary condition.

7. Water Supply

Weekly inspection. - Check purity and cleanliness of drinking water. Check operation of purifying equipment. Check amount of drinking water in storage and see that supply pumps are in operating condition.

Annual inspection. - Check and clean water storage tanks. Check supply intake for cleanliness and freedom from obstruction. Check purifying equipment. Check and overhaul water-supply pumps, float switches, pressure switches, pressure reducers, etc. Check motors and control equipment.

8. Lighting

Weekly inspection. - Try out normal and emergency lights to see that they are in operating condition, and replace burned out lamps.

9. Fire Protection

Monthly inspection. - Visual inspection of sprinkler system, water-supply control, and fire doors. Flush sprinkler system branch lines. Check fire extinguishers as follows and see that they are kept in specified locations:

15-pound and similar portable CO<sub>2</sub>, weigh monthly  
75- and 100-pound wheel-type portable CO<sub>2</sub>, weigh quarterly  
Fixed CO<sub>2</sub> cylinders (usually 50-pound), weigh semiannually  
Soda-acid (all water-solution types), inspect quarterly

Flush fire hydrants and inspect hose carts, hose, nozzles, etc., quarterly. Review firefighting procedure with all personnel concerned two to four times annually.

Annual inspection. - Test a few sprinkler heads at random for correct operation. Test operation of fire doors.

10. Conduit and Fittings

Annual inspection. - Inspect conduit, condulets, outlet, and switch-boxes, etc., for rust or deterioration from moisture or alkali. Check conduits for proper drainage. Arrange to keep such metalwork as dry as possible.

11. Wiring and Wiring Devices

Annual inspection. - Inspect and tighten connections at terminal points. Check for presence of moisture. Inspect insulation. Test insulation resistance.

12. Railings and Miscellaneous Metalwork

Annual inspection. - See that all stair and guardrailings are securely fastened and rigid. Check metalwork for corrosion, rusting, or other damage, and repaint as necessary.

13. Stairways and Ladders

Monthly inspection. - Visual inspection to detect failures, obstructions, slipperiness, or other safety hazards.

Annual inspection. - Check and tighten bolts and screws. Correct slipperiness, and other safety hazards. Check metalwork for corrosion or rusting and repaint as necessary.

## CHAPTER XIX - SEASONAL MAINTENANCE

### 1. Spring Startup

Before the pumping plants are energized each spring it is important that adequate cleanup and equipment inspection be performed to insure that equipment is not damaged or will not be damaged on initial annual startup. The checklist for spring startup is given below and should be used as a guide in preparing the plants for startup. The items are listed in the preferred order of performance so that each item of equipment will be ready for operation approximately when it is needed.

- (a) Notify the organization or agency responsible for furnishing power that their metering and switchyard equipment should be checked and prepared for spring startup.
- (b) Check that switchyard disconnect switches are open.
- (c) As applicable:
  - (1) Check that switchyard interrupter switch is locked open.
  - (2) Clean transformer bushings and lightning arresters.
  - (3) Check transformer for oil leaks.
  - (4) Perform Meggar test on transformer windings per manufacturer's instructions.
  - (5) Perform dielectric test on transformer oil per manufacturer's instructions.
  - (6) Perform all other required transformer checks per manufacturer's instructions.
  - (7) Clean all switchyard insulators.
- (d) Drain or pump out the remaining water in the pump sump and remove silt and debris. Check the pump suction piece to ascertain that the entrance to the pump is free of foreign material.
- (e) Clean and check access roads to plant and reservoir site.
- (f) Clean and check drainage features around plant and reservoir site.
- (g) Clean and check feeder canal.

- (h) Clean and check reservoir inlet structure.
- (i) Clean and check reservoir overflow structure.
- (j) Clean and check instrument shelter floatwell inlet pipes.
- (k) Clean and check pumping plant trashracks, moss screens, and intake pipes.
- (l) Clean and check fences.
- (m) Clean and check delivery stand, meter, and valve equipment at each delivery point.
- (n) Check for excessive weed growth in and around reservoir.
- (o) Check that all motor control breakers and switches are open.
- (p) Check the recording demand meter to see that adequate supplies of carbon tape and recording tape are available.
- (q) Check and close the switchyard fused disconnect switches.
- (r) Close the switchyard interrupter disconnect switch.
- (s) Close the main power disconnect breaker in the motor control equipment.
- (t) Close station-service transformer switch.
- (u) Close the station-service breakers for the motor control equipment heaters (if applicable) and the lights and receptacles. Close the remaining breakers only as they are needed.
- (v) Energize motor control equipment space heaters 2 weeks prior to plant startup.
- (w) Clean in and around all plant equipment. A vacuum-type cleaner is recommended where practicable.
- (x) Clean all lighting fixtures and replace all burned-out lamps.
- (y) Clean and check each pump and associated motor to see that they rotate smoothly when turned by hand. Check for loose fittings and oil leaks. Change the pump and motor lubricant per manufacturer's instructions.

(z) Clean and check each valve for loose fittings. Lubricate per manufacturer's instructions.

(aa) Clean and check each sump float switch and each instrument shelter float-operated mechanism to see that they operate smoothly. Lubricate per manufacturer's instructions.

(bb) Clean and check the flowmeter and recorder. Check the recorder ink and chart supply and lubricate per manufacturer's instructions.

(cc) Check to see that the manifold drain valve is closed.

(dd) Test the valve operating system by opening and closing each valve.

(ee) Check the oil or grease cups to be certain the mechanical seals are adequately lubricated.

## 2. Fall Shutdown

Following system shutdown at the end of each irrigation season, the pumping plant should be prepared for unattended winter shutdown. The checklist for fall shutdown is given below and should be used as a guide for preparing the plant for shutdown. The procedure should be in approximately the order listed.

(a) Shut down all deliveries at the sectionalizing valves.

(b) Drain the exposed pipeline.

(c) Fill all reservoirs to maximum water level.

(d) Notify the organization or agency responsible for furnishing power that its switchyard and metering equipment should be checked and prepared for winter shutdown.

(e) Open each pumping unit motor isolating switch.

(f) Check each piece of plant equipment for worn or broken parts and order the parts for arrival before spring starting.

(g) Check and clean the flow recorder including removal of the ink supply.

(h) Raise the instrument shelter floats from their floatwells and store the floats on the floor of the instrument shelter. The sump float switch float on the pumping plant deck should be left in the guide-pipe, unless the float can be readily removed and stored in a sheltered location.



- (i) Open all station-service breakers, then open the station-service transformer switch.
- (j) Open the main power disconnect breaker in the motor control equipment and lock it in the open position.
- (k) Open the switchyard gang-operated interrupter switch and lock it in the open position.
- (l) After the switchyard transformer has been deenergized for a few days and has cooled off, the oil should be brought to the proper "full" level.
- (m) Remove all loose equipment from the plant and reservoir site to minimize possible targets for vandals.
- (n) To prevent damage to the structure and pumps due to freezing weather, the sump should be unwatered during the winter shutdown.