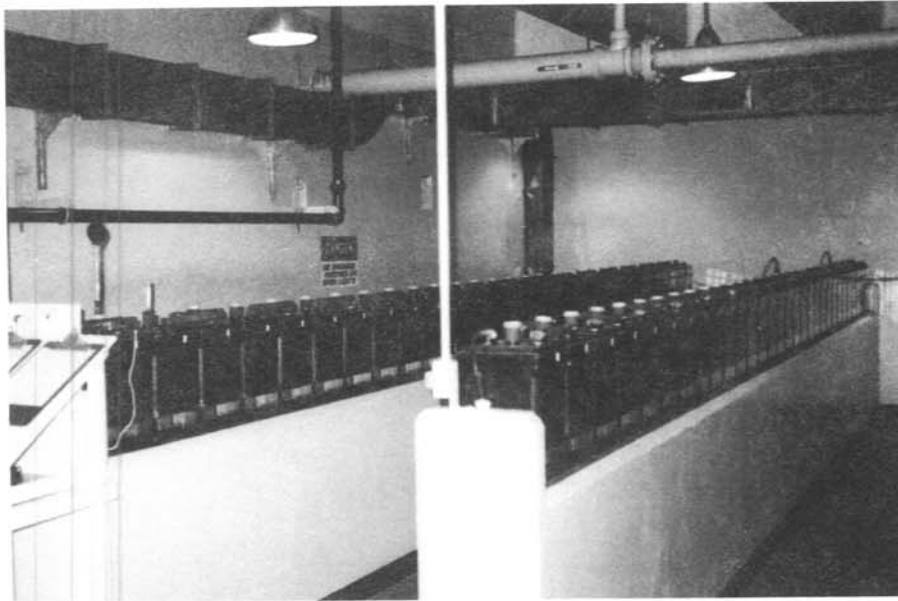


CHAPTER 10 – STORAGE BATTERIES



Battery room.

1. Inspection Checklist

Items of inspection	
<u>Storage batteries</u>	
a. Battery electrolyte	M
b. Connectors	A
c. Hydrometers	A
d. Equipment	A
e. Distilled water	M
f. Battery charger	M

M – Routine monthly inspection when in service.

A – Annual inspection.

a. *Battery electrolyte.*–

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

b. *Connectors.*–

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

c. *Hydrometers.*–

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

d. *Equipment.*–

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

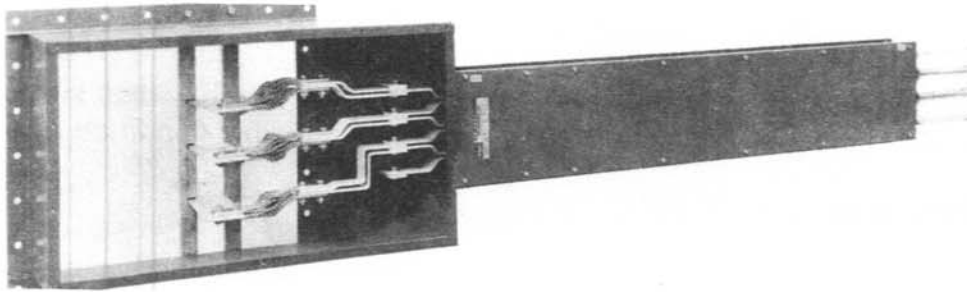
e. *Distilled water.*–

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.

f. *Battery charger.*–

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

CHAPTER 11 – LOW-VOLTAGE SWITCHGEAR, BUSES, AND CABLES



Low-voltage feeder busway.—Front view of transition box and busway (cover removed) for 300-kVa transformer.

1. Inspection Checklist

Items of inspection		
a.	Oil and air circuit breakers	(see Chapter 12)
b.	Disconnecting switches and fuses	(see Chapter 13)
c.	Bus bars, joints, and connections	A
d.	Bus insulators and supports	A
e.	Bus enclosures and barriers	A
f.	Switchgear panels and enclosures	W A
g.	Locks and interlocks	W
h.	Warning and safety signs	W
i.	Current and potential transformers	A
j.	Meters, instruments, and relays	(see Chapter 9)
k.	Control devices	(see Chapter 9)
l.	Panel wiring	(see Chapter 9)
m.	Power cables	A
n.	Potheads	A

W – Routine weekly inspection when in service.

A – Annual inspection.

- a. *Oil and air circuit breakers.*—(See Chapter 12.)
- b. *Disconnecting switches and fuses.*—(See Chapter 13.)
- c. *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.

d. *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 re-varnish if dull.

e. *Bus enclosures and barriers.*—

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

f. *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 nonmetallic hose and nozzle), or with filtered dry compressed air.

g. *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.

h. *Warning and safety signs.*—

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

i. *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.

j. *Meters, instruments, and relays.*—(See Chapter 9.)

k. *Control devices.*—(See Chapter 9.)

l. *Panel wiring.*—(See Chapter 9.)

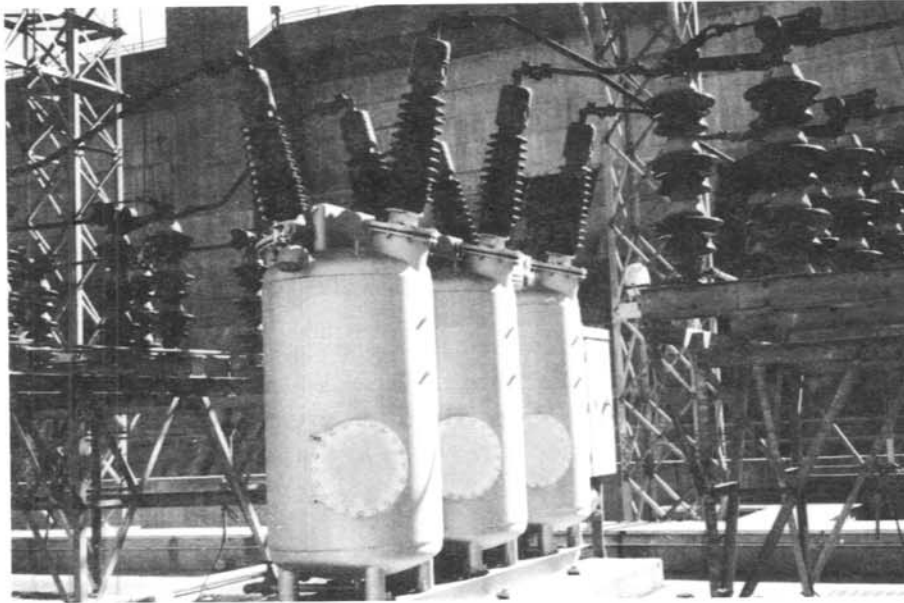
m. *Power cables.*—

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.

n. *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 12 – OIL AND AIR CIRCUIT BREAKERS



Oil circuit breakers.

1. Inspection Checklist

Items of inspection		
a.	Foundation	A
b.	Frame and tanks	W
c.	Oil valves and plugs	A
d.	Oil levels and gauges	W A
e.	Breathers and vents	W A
f.	Panels and cabinets	A
g.	Bushings or insulators	W A
h.	Bushing current transformers and potential devices	A
i.	Main terminals and ground connections	W A
j.	Main contacts	A
k.	Contact pressure springs	A
l.	Flexible shunts	A
m.	Magnetic, air, or oil blowout devices	A
n.	Crosshead	A
o.	Lift rods and guides	A
p.	Operating rods, shafts, and bellcranks	A
q.	Closing solenoid air cylinder, motor, or spring	W A
r.	Manual-operating device	A
s.	Latch and trip mechanism	W A
t.	Tripping solenoid	W A

Items of inspection — Continued

u.	Control and protective relays		(See Chapter 9)
v.	Solenoid valves		A
w.	Auxiliary switches		A
x.	Operation counter	M	A
y.	Position indicator		A
z.	Dashpots or snubbers		A
aa.	Mechanism cabinet		A
bb.	Cabinet lights and heaters	W	A
cc.	Power supplies and wiring	W	A
dd.	Oil dielectric test		A
ee.	Filter oil		NS
ff.	Operation		NS

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

a. *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.

b. *Frame and tanks.*—

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

c. *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.

d. *Oil levels and gauges.*—

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

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

e. *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.

f. *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.

g. *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.

h. *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.

i. *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. Refinish joint contact surfaces if they have been overheating. Inspect ground cable to see that it is not loose or broken.

j. *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.

- (1) All new breakers must have a complete inspection at the end of 1 year.
- (2) Only breakers with good-operating service records should be scheduled for less frequent inspection periods.
- (3) Breakers used on special applications, such as capacitor and reactor switching, should be considered separately.
- (4) If recurring troubles are found on a certain type of breaker, the inspection schedules should be adjusted until the trouble is eliminated.
- (5) Breakers interrupting a large number of faults should be given special attention to determine whether or not early internal inspection is required.
- (6) When oscillographs indicate abnormal breaker operation, an immediate inspection of the breaker should be made.

k. *Contact pressure springs.*—

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

l. *Flexible shunts.*—

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

m. *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.

n. *Crosshead.*—

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

o. *Lift rods and guides.*—

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

p. *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.

q. *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.

r. *Manual-operating device.*—

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

s. *Latch and tip 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 stated in subparagraph p. above (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.

t. *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.

u. *Control and protective relays.*—(See Chapter 9.)

v. *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.

w. *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.

x. *Operation counter.*—

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

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

y. *Position indicator.*—

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

z. *Dashpots or snubbers.*—

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

aa. *Mechanism cabinet.*—

Annual inspection.—Check condition of metal and hardware. Repaint as necessary. See that door gaskets are tight.

bb. *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.

cc. *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.

dd. *Oil dielectric tests.*—

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

ee. *Filter oil.*—

Not scheduled.—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 kV or if there is no noticeable amount of carbon in suspension or in the bottom of the tanks.

ff. *Operation.*—

Not scheduled.—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, 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
RECLOSE 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

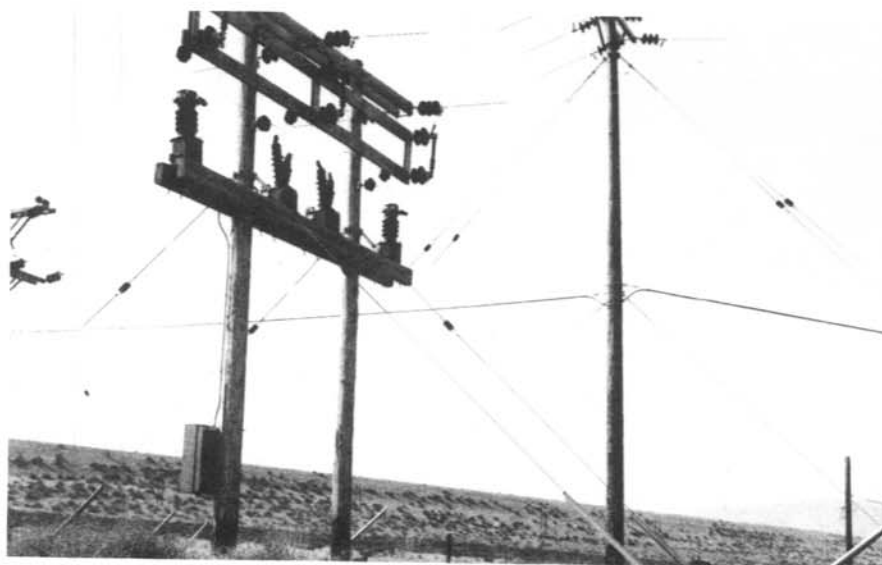
BUSHINGS:
PORCELAIN slightly chipped OIL OR COMPOUND LEAKS None
OIL LEVEL OK OIL CONDITION* OK tested
TERMINALS OK

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
USE SPARE LINES FOR OTHER ITEMS AS NEEDED

Figure 18 (front)

CHAPTER 13 – DISCONNECTING SWITCHES AND FUSES



1. Inspection Checklist

Items of inspection		
a.	Base and mounting	A
b.	Insulators	W A
c.	Line and ground connections	A
d.	Blades and contacts	W A
e.	Contact and hinge springs and shunts	A
f.	Arcing horns	A
g.	Blade latches and stops	W A
h.	Operating rods, levers, and cranks	A
i.	Gearboxes	A
j.	Operating motor	A
k.	Auxiliary and limit switches	A
l.	Locks and interlocks	W A
m.	Switch sticks	W A
n.	Fuse tubes	A
o.	Fuse links	A
p.	Multiple-shot reclosing fuse	W A

W – Routine weekly inspection when in service.

A – Annual inspection.

a. *Base and mounting.*–

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

b. *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 a reliable tester. Tighten base and cap bolts.

c. *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.

d. *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.

e. *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.

f. *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.

g. *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.

h. *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 Chapter 12, subparagraph p.)

i. *Gearboxes.*—

Annual inspection.—Check gears and bearings. Flush out oil or grease and relubricate. (See Chapter 12, subparagraph p.)

j. *Operating motor.*—

Annual inspection.—Check motor. (See Chapter 7—Electric Motors.) Check adjustment of brake.

k. *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.

l. *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.

m. *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.

n. *Fuse tubes.*—

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

o. *Fuse links.*—

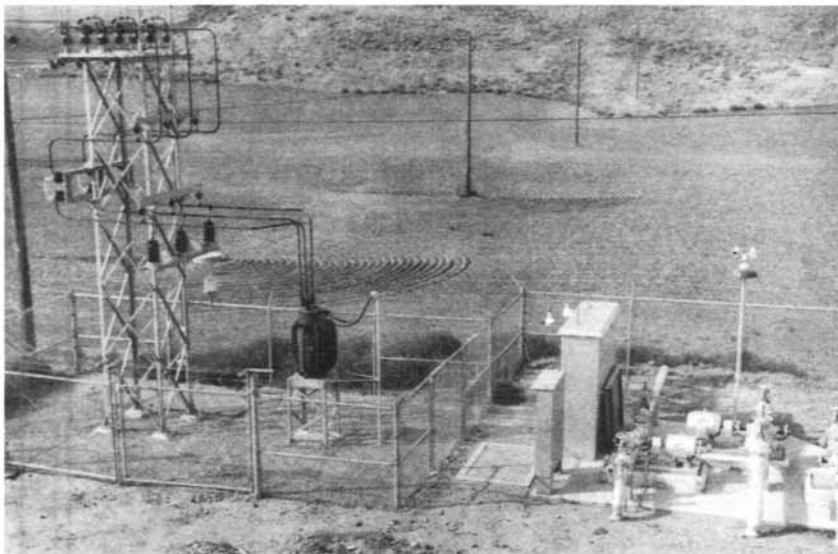
Annual inspection.—See that fuse links are secure at the terminals and are not overheating. See that extra links or new fuses are kept on hand.

p. *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 14 – SWITCHYARDS



Pumping plant switchyard.

1. Inspection Checklist

Items of inspection		
a.	Yard and fences	M A
b.	Wood structures	(see Chapter 17)
c.	Steel structures	(see Chapter 17)
d.	Footings and guy anchors	(see Chapter 17)
e.	Guys	(see Chapter 17)
f.	Warning signs	(see Chapter 17)
g.	Ground connections	M A
h.	Conductors and buses	M A
i.	Hardware	(see Chapter 17)
j.	Insulators	(see Chapter 17)
k.	Transformers and regulators	(see Chapter 15)
l.	Oil and air circuit breakers	(see Chapter 12)
m.	Disconnecting switches and fuses	(see Chapter 13)
n.	Lightning arresters	(see Chapter 16)
o.	Control equipment	(see Chapter 8)
p.	Lighting	M A
q.	Oil storage facilities	M A
r.	Conduits, ducts, trenches, and tunnels	M A
s.	Storage batteries and chargers	(see Chapter 10)
t.	Power supplies and wiring	M A

M – Routine monthly inspection when in service.

A – Annual inspection.

a. *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.

b. *Wood structures.*—(See Chapter 17.)

c. *Steel structures.*—(See Chapter 17.)

d. *Footings and guy anchors.*—(See Chapter 17.)

e. *Guys.*—(See Chapter 17.)

f. *Warning signs.*—(See Chapter 17.)

g. *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.

h. *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.

i. *Hardware.*—(See Chapter 17.)

j. *Insulators.*—(See Chapter 17.)

k. *Transformers and regulators.*—(See Chapter 15.)

l. *Oil and air circuit breakers.*—(See Chapter 12.)

m. *Disconnecting switches and fuses.*—(See Chapter 13.)

n. *Lightning arresters.*—(See Chapter 16.)

o. *Control equipment.*—(See Chapter 8.)

p. *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.

q. *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. Check for corrosion of buried oil piping and apply cathodic protection if necessary.

r. *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.

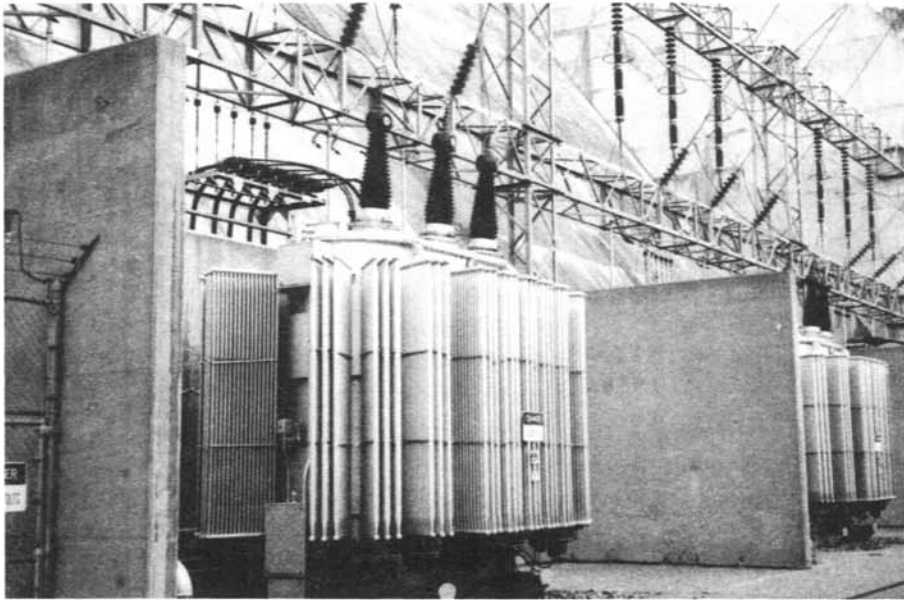
s. *Storage batteries and chargers.*—(See Chapter 10.)

t. *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.

CHAPTER 15 – TRANSFORMERS



1. Inspection Checklist

Items of inspection		
a.	Foundation, rails, and trucks	A
b.	Tanks and radiators	M
c.	Oil and water piping	A
d.	Oil levels, gauges, and relays	M A
e.	Breathers and vents	M
f.	Relief diaphragm	A
g.	Water-cooling coils and piping	A
h.	Flow indicators and relays	D A
i.	Oil pumps	D A
j.	Cooling fans and water sprays	D A
k.	Temperature indicators and relays	M A
l.	Inert gas tanks	A
m.	Gas regulator gauges and relays	W A
n.	Gas piping and valves	A
o.	Gas analysis	A
p.	Bushings	M A
q.	Tap setting	A
r.	Main terminal and ground connections	M A
s.	Core and coils	NS
t.	Internal inspection	NS
u.	Ratio adjuster	M A
v.	Insulation resistance	A

Items of inspection — Continued

w.	Oil dielectric	A
x.	Oil acidity	(every 5 years)
y.	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.

a. *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.

b. *Tanks and radiators.*—

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

c. *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.

d. *Oil levels, gauges, 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 gauge 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.

f. *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.

g. *Water-cooling coils and piping.*—

Annual inspection.—Check external supply and drain piping for leaks. Flush out cooling coils or heat exchanger water passes 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 lbs/in² 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.

h. *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.

i. *Oil pumps.*—

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

Annual inspection.—(See Chapter 5.)

j. *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 7. Check switchboards and control equipment as described in Chapter 9.

k. *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.

l. *Inert gas tanks.*—

Annual inspection.—Check gas pressure in tanks and replace with full tanks when pressure reaches 25 lb/in².

m. *Gas regulator gauges 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 gauges are indicating properly.

n. *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.

o. *Gas analysis.*—

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

p. *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.

q. *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.

r. *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. Refinish joint contact surfaces if they have been overheating. Inspect ground cable to see that it is not loose or broken.

s. **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. Flammable 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.

t. **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 clean up, if necessary. Check connections at terminal board. Tighten all bolted connections, core bolts, etc., within reach.

u. **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.

v. **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.

w. **Oil dielectric.**—

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

γ. *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 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 19 (front)

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				
⊙A OIL TEMP. °C.	44				
⊙A RTD TEMP. °C.					
⊙B OIL TEMP. °C.	45				
⊙B RTD TEMP. °C.					
⊙C OIL TEMP. °C.	48				
⊙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 _____

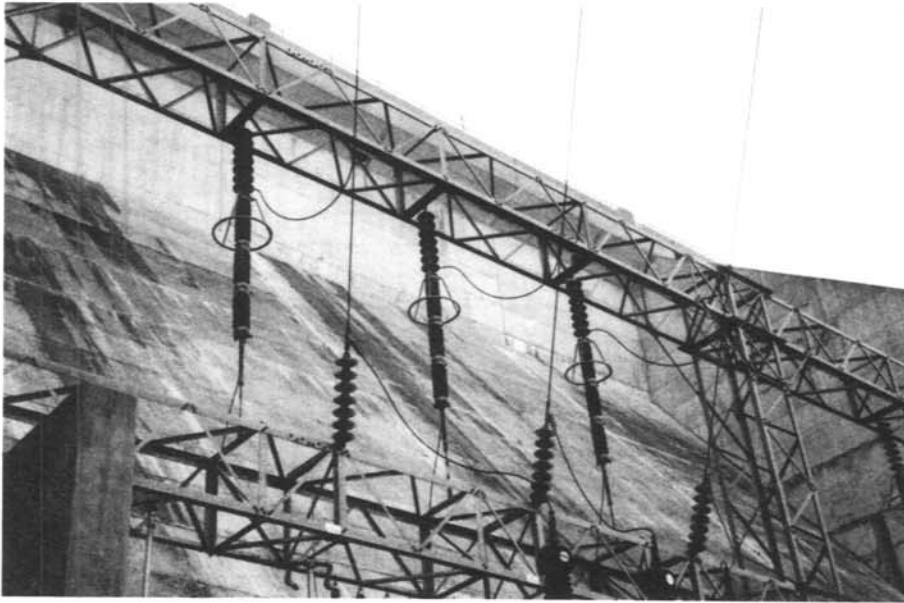
 None

INSPECTION MADE BY: John Smith

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

Figure 19 (back)

CHAPTER 16 - LIGHTNING ARRESTERS



1. Inspection Checklist

Items of inspection			
a.	Base and supports	M	A
b.	Porcelain shells and insulators		A
c.	Grading rings		A
d.	Arrester units	NS	
e.	Gaps		A
f.	Line and ground connections		A
g.	Pressure-relief diaphragms	M	

M - Routine monthly inspection when in service.

A - Annual inspection.

NS - Not scheduled.

a. *Base and supports.*-

Monthly inspection.-Visual inspection to detect cracking, settling, or shifting of base 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.

b. *Porcelain shells and insulators.*—

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

c. *Grading rings.*—

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

d. *Arrester units.*—

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 disks, gaps, resistors, etc. However, if any tests or outside inspection indicates 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.

e. *Gaps.*—

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

f. *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.

g. *Pressure-relief diaphragms.*—

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

CHAPTER 17 – TRANSMISSION LINES



1. 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. Inspection Checklist

Items of inspection	
a. Wood poles	M
b. Crossarms, pins, and braces	A
c. Steel towers	M A
d. Footings and guy anchors	M A
e. Guys	M A
f. Warning signs	A
g. Ground wires and connections	M A
h. Main conductors and overhead ground wires	M A
i. Conductor splices	A
j. Vibration dampers	A
k. Hardware	M A
l. Insulators	M A
m. Right-of-way	M A
n. Line maintenance tools	A

M – Routine monthly inspection when in service.

A – Annual inspection.

a. *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.

b. *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 oily materials such as creosote, and 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.

c. *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.

d. ***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.

e. ***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.

f. ***Warning signs.***—

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

g. ***Ground wires and connections.***—

Monthly inspection.—Make from-the-ground check to detect loose or broken pole downloads, 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.

h. ***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 downloads. Inspect conductors and overhead ground wires at supporting clamps at 5-year intervals for signs of weakening and burns, and reinforce as necessary.

i. *Conductor splices.*—

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

j. *Vibration dampers.*—

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

k. *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.

l. *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.

m. *Right-of-way.*—

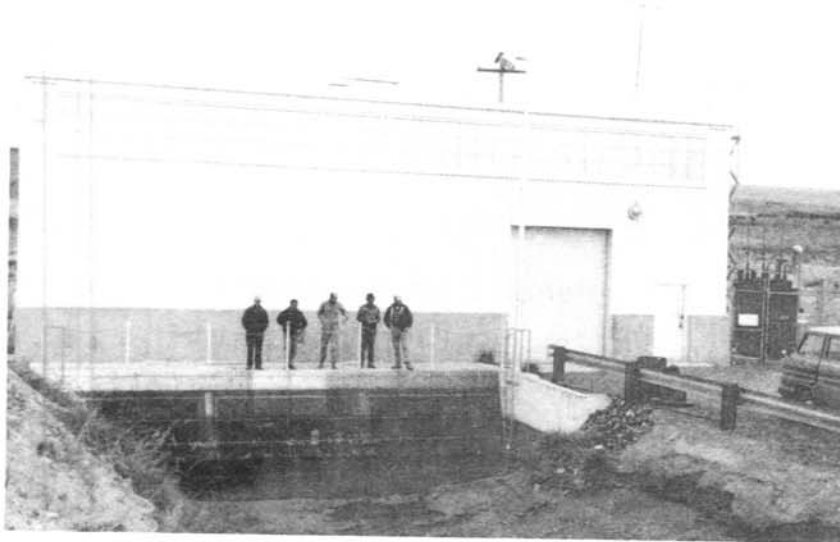
Monthly inspection.—Check for anything unusual, such as accumulation of dry materials around base of poles which might result in fire damage.

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.

n. *Line maintenance tools.*—

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.

CHAPTER 18 – PUMPING PLANT BUILDING



1. Inspection Checklist

Items of inspection		
a.	Doors and windows	M A
b.	Elevators, cranes, and hoists <i>(see Chapter 6)</i>	
c.	Electric space heaters and ventilating fans	W A
d.	Water supply and drain piping	A
e.	Water heaters and coolers	W A
f.	Wash basins, sinks, showers, toilets, etc.	W
g.	Water supply	W A
h.	Lighting	W
i.	Fire protection	M A
j.	Conduit and fittings	A
k.	Wiring and wiring devices	A
l.	Railings and miscellaneous metalwork	A
m.	Stairways and ladders	M A

W – Routine weekly inspection when in service.

M – Routine monthly inspection when in service.

A – Annual inspection.

a. *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.

b. *Elevators, cranes, and hoists.*–(See Chapter 6.)

c. *Electric space heaters and ventilating fans.*—

Weekly inspection.—Visual inspection to insure 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.

d. *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.

e. *Water heaters and coolers.*—

Weekly inspection.—Visual inspection to insure 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.

f. *Wash basins, sinks, showers, toilets, etc.*—

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

g. *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.

h. *Lighting.*—

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

i. *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 CO₂, weigh monthly
- 75- and 100-pound wheel-type portable CO₂, weigh quarterly
- Fixed CO₂ cylinders (usually 50-pound), weigh semiannually
- Soda-acid (all weather-solution types), inspect quarterly

Flush fire hydrants and inspect hose carts, hose, nozzles, etc., quarterly. Review fire-fighting 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.

j. *Conduit and fittings.*—

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

k. *Wiring and wiring devices.*—

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

l. *Railings and miscellaneous metalwork.*—

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

m. *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 19 – 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.

CHAPTER 20 – INFRARED THERMOGRAPHY

All objects radiate infrared energy in an amount that is proportional to their temperature. Infrared thermography is a preventive maintenance technique that converts the infrared energy into a visible picture. Different temperatures are depicted by different shades or colors on the viewing screen. Differences in temperature caused by electrical problems such as loose connections, short circuits, malfunctioning equipment, or mechanical problems such as a hot bearing or clogged cooling water line can readily be seen without taking the equipment out of service. In many instances the only way such problems would be discovered otherwise would be by equipment failure.

Infrared thermography equipment varies greatly in complexity and capability but basically consists of an infrared scanner with some type of viewing screen. The equipment may be a one-piece hand-held unit with an internal viewing screen or it may have a separate scanner and video monitor. The simplest hand-held units have no recording capability, while more complex equipment has the capability to record the infrared images on video tape or floppy disk. The recordings may be kept as part of a history file or in some cases downloaded into a personal computer for further analysis.

The cost of infrared thermography equipment depends on its complexity. A state-of-the-art system may cost over \$40,000, while a simple one-piece nonrecording unit may be under \$10,000. Unless there is a great deal of equipment to be checked, purchasing the infrared equipment is probably not feasible, but there are inspection companies that do provide the service. Inspection companies will usually have state-of-the-art equipment; and since they use the equipment regularly, they also have the experience to analyze the information they gather.

The periodic infrared inspection of switchgear, junction boxes, and other electrical equipment can identify potential problems before they have a chance to fail and cause unscheduled outages. The inspection does not take much time, does not interfere with the normal operation of the equipment, and can be a very helpful part of a preventive maintenance program.