Hydroelectric Station Mechanical Maintenance Procedure Schedules

Note: This handbook gives general maintenance inspection frequencies and procedures. The specific technical procedures for each piece of equipment must be followed.

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MECHANICAL MAINTENANCE PROCEDURES

DEFINITIONS AND SCOPE

PREVENTIVE MAINTENANCE:

Preventive maintenance (PM) is an action taken to prolong the life of equipment and prevent premature failures.

MAINTENANCE IDENTIFIER:

PM-1 **Frequency - Normally monthly**

A routinely scheduled inspection of plant and equipment, normally undertaken without shutting down. The opportunity can be used to make minor repairs and adjustments. Results of inspection to be recorded to assist planning for future maintenance work.

PM-2 **Frequency - Every six months**

Scheduled inspection and an opportunity to carry out minor maintenance. Equipment outage, if required, will be short. Written report required.

PM-3 **Frequency - Once per year**

Inspection and minor repairs, requiring that the equipment be taken out of service. Written report required.

PM-4 **Frequency - Minimum of two years**

Planned major inspection of equipment and/or required repairs. Written report required.

Deferrable versus Must Do

Where a task has been classified as deferrable, the deferral period is one year, regardless of the frequency of the task.

Air Systems

Rotary Screw Type Compressors

Procedure: **PM-2** Recommended Frequency: 2500 Hrs Operation or Semi-Annual

Note: Change oil more frequently if required.

1. Shut down and isolate the compressor.

2. Drain the compressor and components of oil and water, then open up the receiver/separator, the main oil filter, the bearing oil filter, line strainers, or other filters and strainers.

3. Clean the interiors of the receiver/separator, oil filters, oil sump and strainers. Clean all sight glasses or level indicators.

4. Check safety valves as per Technical Directive HO 105.

5. Open up the oil cooler (heat exchanger) and clean the oil and water passages. Renew all seals and gaskets.

6. Clean and inspect all oil control valves, check valves and bypass valves for leaks or deficiencies.

7. Clean or replace the air intake filter elements as required.

8. Clean and inspect all water flow control valves and shut-off valves. Service or repack as required.

9. Follow the station start-up procedure for compressors and check for leaks, pump-up time, set pressure, oil and water pressures, oil and water flows, unloader/modulator operation, vibration and noise levels, motor full load amperage, oil and water temperatures, running hour meter operation, and other specified start-up checks.

General

A major overhaul may be initiated by:

1. Excessive pump up time.

2. Excessive noise or vibration.

3. Excessive consumption of oil or evidence of blowby.

4. Low intercooler pressure or high intercooler temperature.

5. The hours of operation or time elapsed since the last overhaul will also be factors to consider.

A rebuild or new air end unit can be obtained from Manufacturer.

Note: Work beyond annual inspection or maintenance be carried out on breakdown or as required basis. The main work beyond annual would be on the air pump unit and it can be rebuilt or replaced as required.

Reciprocating Compressors

Procedure: **PM-3** Recommended Frequency: 5000 Hrs or Annual

Note: Change the oil more frequently if required.

1. Check pump-up time from cut-in to cut-out and record pressures and times. If pump-up time has increased by 20 percent over the original pump-up time, report to supervisor and schedule valve replacement. Recheck and record pump-up time 100 hours after replacing valves or at next monthly inspection.

2. Check Safety Valve operation as per Technical Directive HO 105, HO 186 and this Mechanical Procedures Manual under Safety Relief Valves.

3. Check the piping system for leaks by observing the drop in pressure, when there is no use of air.

4. Check compressor hold down bolts.

5. Drain and clean crankcase sump and strainers.

6. Clean oil cooler inside and outside. Check for leaks.

7. Clean cylinder water jacket.

8. Check belt drive system and equipment.

9. Repack piston rod packing (if soft packing used) if required.

10. Clean radiator fins (if air cooled).

11. Clean intercoolers and aftercoolers (if water cooled).

12. Clean drain traps.

13. Repair unloader valve as required.

14. Check cooling water solenoid valve.

15. Clean lubricators.

16. Check that alarms, such as low air pressure, high air temperature, loss of cooling water, etc, are operative.

Procedure: **PM-4** Recommended Frequency: as required

Requirement for overhaul to be determined by compressor performance.
(See Screw compressor section for performance factors)

Safety Relief Valves

Procedure: **PM-4** Recommended Frequency: Every 3 years

Test valve operation by lifting lever. Valves without levers should be tested either by bench testing.

Procedure: **PM-4** Recommended Frequency: Every 6 years

Valve to be bench tested to verify pressure setting, or replaced

Ref: Technical Directive HO 105 - Examination, Service and Testing of Safety Relief Valves.

Pressure Vessels

Procedure: **PM-4** Recommended Frequency: Every 3 years

1. Perform visual inspection of exterior of vessel and piping for signs of leakage, corrosion etc.

2. Test safety relief valve - see Safety Relief Valve section in this Mechanical Procedures Manual.
3. Confirm the vessel TSSA certificates are current

Procedure: **PM-4** Recommended Frequency: every 15 years (in conjunction with major inspections)

1. Test wall thickness by ultra-sonic measurement.

2. Inspect interior of vessel. (Use video probe equipment if access is limited.)

Filters and Dryers (Below 350 psi)

Procedure: **PM-4** Recommended Frequency: As required

1. Change all replaceable type filter cartridges or elements as required. Attach label to indicate date of replacement.

2. Clean all filter or strainer wire mesh baskets or inserts.

3. Check the diaphragms of air motor activated valves.

4. Service oil separators.

5. Test the safety relief valves as per Technical Directive HO 105 and HO 186.

6. Check the desiccant quantity and condition in the air dryers. Replace screen or top up, as required.

HIGH PRESSURE AIR (600 P.S.I.) AND ABOVE SYSTEM MAINTENANCE

Procedure:

MONTHLY INSPECTIONS

For moisture content refer to Technical Procedure HO 2176-R1

BEFORE STARTING

1. Check and note sequential starting positions
2. Check all oil levels - compressor, oiler, pumps, etc.
3. Check coolant levels
4. Check compressor drive belts - condition - tension
5. Check coolant pump(s) drive belts - condition - tension
6. Check fan belts - condition - tension
7. Check for leaks - Air, Oil, Coolant, etc.
8. Check water traps - Note excessive water
9. Check dewpoint - record
10. Record running hours - Compressor - Dryers

Bleed Down System until Compressor(s) start.

1. Note sequential starting

2. Listen for unusal noises
3. Check that compressors start unloaded
4. Record oil pressure
5. Record air pressure - 1st Stage and 2nd Stage
6. Check dewpoint of each compressor
7. Check all filter differentials
8. Check oiler operation and timing
9. Record all temperature and pressure readings
10. Check for automatic condensation blowdown
11. Check loading and unloading of compressor
12. Record pump-up time to operating pressure
13. Check for leaks - Oil, Coolant, Air
14. Bleed charcoal filters
15. Check radiators - clean - leaks
16. Check coolant sight glasses - flow - clarity
17. Check Dryer - proper operation - proper purge pressure - leaks
18. Check building vents and screens
19. Check yard piping for leaks and security of supports
20. Check breaker cabinets for leaks
21. Check air receivers for leaks and rust
22. Check all bolts, mounts, pipe supports, etc.

250 HOURS

Crankcase Oil

- on most units, it will be necessary to change the Crankcase Oil because of water due to condensation.

EVERY 3 - 4 MONTHS

Change the charcoal in the charcoal filters.

500 HOUR INSPECTION

1. Inspect coolant - test - add or replace as required

2. Remove High Pressure Head:
   a) clean carbon from H.P. Piston
   b) inspect H.P. Piston
   c) clean head
   d) clean and inspect water jackets

3. Remove Low Pressure Inlet and Exhaust Valves:
   a) clean seats
   b) clean piston - inspect for excessive oil

4. Drain Crankcase:
   a) remove crankcase covers
   b) mop out crankcase
   c) check rod ends
   d) clean and check oil catches for crank
   e) reseal and fill with new oil

5. Intercooler:
   a) remove end caps
   b) clean tubes using rifle cleaner
   c) inspect for wear and leakage (N.D.E. if required)

6. Built In Aftercooler:
   a) remove endcaps
   b) clean tubes using rifle brush
   c) inspect tubes for wear and leakage (N.D.E. if required)

7. Intake Air Filter:
   a) clean - refill with oil; if required, replace oil.

8. Oiler:
   a) check operation
   b) clean sight glass

9. Pulleys and Belts:
   a) check tightness and alignment of pulleys
   b) check belts for tension

10. Crank Bearings - check for wear and play

11. Check Hold down Bolts (Anchors)

12. Remove and replace all after filters, dust filters and coalescent filters - clean housings if required.

13. Coolant Pumps:
- check belts
- lubricate if required

14. External Aftercooler
- remove shell and clean

15. Safety Relief Valves:
- check operation as per Technical Direction HO 105, H0 186 and this Mechanical Procedures Manual

16. **If Required**:

a) Change charcoal filter
b) Change desiccant in dryer

AFTER START-UP

1. Check and set Oiler Timing (if equipped)

2. Check belts for correct adjustment

3. Check coolant flows

4. Check coolant levels

5. Check coolant sight glasses for air content

6. Check dump valves for leaks and operation

7. Check pump-up times

8. Check for leaks, air, oil, coolant

9. Check the following dryer functions for proper operation:

a) purge pressure
b) tower purging
c) leaks, etc.

MISCELLANEOUS - YEARLY

1. - check all yard piping and tanks for leaks

2. - Change Pre and After Filters as required

3. - Check all gauges and alarms for operation.

Powerhouse and Gantry Cranes

Procedure: **PM-3** Recommended Frequency: Annual

Inspection, lubrication and or adjustments as per Crane Rigging Handbook and Crane Operator Certification Program. Refer to Technical Procedures HO 621 and HO 622.

Jib Type Swinging Beam Cranes

Procedure: **PM-3** Recommended Frequency: Annual

1. Safety stops or travel limiting devices on the load hook, trolley track, swinging beam, or other.

2. Load chain or wire rope for visible defects or wear.

3. Load hook for spreading or other defects, condition of safety latch, free running of sheave and condition of swivel bearings. Lubricate bearings.

4. Beam tie rods or tie cables, turnbuckles, connecting devices and all beam supporting fittings and bolting to support structures.

5. Trolley gearbox, drive gears, clutch, track wheels, bearings and hoisting drum. Operate hoist and inspect for possible overlap of cable on drum.

6. Inspect pendant control support chain or wire rope for defects.

7. Operate hoist and ensure that load chain enters and leaves the container correctly.

8. Lubricate trolley and hoist mechanisms as per the lubrication schedule.

HOISTS

1. Inspect the wire rope or the load chain for defects or wear. Replace defective wire rope or chain.

2. Inspect the wire rope hoisting drum, or the chain sprocket, for deficiencies. Check the wire rope clamps on the drum for security.

3. Inspect the load hook and swivel for deficiencies (ie, spreading of hook throat, seizure of swivel, defective safety latch).

4. Inspect the load hook sheaves or sprockets for free turning, groove wear, axle wear and defective bearings. Lubricate bearings on completion of work.

5. Carry out non-destructive testing of load hooks as specified in station regulations (every 3 years minimum).

6. Inspect, adjust, or repair the load brake as per the hoist manufacturer's manual of instructions.

7. Ensure that the safe working load (SWL) signs or identification are in position and clearly visible from the operating level.

8. Operate the hoist and ensure that the safety limit switches function correctly.

Emergency Gates
(Headworks, Tailrace and Sluiceway)

Procedure: **PM-4** Recommended Frequency: every 5 years

1. Check that gates and logs are stored properly.

2. Check the condition of any protective coating or preservative. Correct any deficiencies.

3. Check the gate supporting members or structures. Remove any high grass, weeds or other growth which obstructs the free flow of air through the stored logs.

4. Check and repair any visible damage to the seals.

5. Check the springs, rollers, spacers, stops, etc to ensure they are in position and in working order.

6. Inspect and service followers and rigging gear.

Transformer Deluge Systems

There are a variety of different manufacturers of deluge systems used to protect transformers. Each is unique and should be studied on its own. But the spray nozzle rings, water supply piping, intake strainers and other such associated equipment will be similar for maintenance requirements.

Procedure: **PM-2** Recommended Frequency: Semi-annual

Dry Test

This procedure covers heat testing of the Heat Activated Device (HAD) operation; checking the time for the "HAD" to release the deluge valve weight (open solenoid). This procedure should be performed semi-annually, one-half of the "HADS" to be checked at the one time, and the other half six months later. This way all the HADS are checked within a year. Operating times to be recorded and compared to manufacturer's specifications.

There are various types of "HADS" and some require more maintenance of air supply, compressors, strainer, moisture meter, etc., which should be looked at according to specific site type.

Flush fire header were possible up to deluge value.

Procedure: **PM-3** Recommended Frequency: Annual

Wet Test

This test should be conducted during warm weather.

Select a "HAD" which was not used during the previous dry test.

Record the time from application of heat to the time the deluge valve trips.

Observe the flow from the discharge nozzles to ensure full coverage of water spray onto the transformer.

Clean and reset system according to the manufacturer's recommendations.

Generator Water Sprinkler

Procedure: **PM-3** Recommended Frequency: Annual

1. Close valve to unit ring header. Ensure alarm operates.

2. Activate each solenoid individually and flush water to drain.

3. Close main inlet valve and ensure alarm operates.

4. Clean strainer.

5. Restore valves to normal and ensure alarms operate.

6. If system equipped with air solenoid, ensure it operates with water solenoids.

7. Service valves as required.

8. Replace drain cap (should have 1/8" hole to drain any valve leakage) when work complete.

Procedure: **PM-4** Recommended Frequency: 3 to 6 Years
See Technical Procedure HO 349, Major Unit Inspection

Procedures to be performed before unit is shut down are:
Perform PM-3 annual inspection pre-shutdown check.

Permanent Magnet Generator (PMG)

1. Check main bearings.
   Note: Replace main bearings after 10 years operation or as local conditions indicate.

2. Check the speed switches for proper settings and record settings.

Generator

1. Check and record brake pad wear.

2. Check operation of microswitches which indicate brakes are fully released.

3. Inspect brake track for cracking and wear. See Technical Directive HO 72.

4. Check the grout around lower bracket and sole plates.

5. Inspect the rotor arms for cracking

6: Record the bearing temperatures

7. Record the shaft runout at each bearing

8. Inspect for bearing oil leakage

Servomotors

1. Check servomotor security.

2. Replace shaft packing if leaking.

Turbine Wicket Gates and Arms

1. Tighten or change gate stem packing as required. Verify condition of wicket gate stem.

2. Check for signs of wicket gate slamming, pitting, such as twisted wicket gate stems and damage to stop surfaces on head cover.

3. On units with neoprene or plastic seal rings for top and bottom of wicket gates, inspect seal ring and report condition.

4. Record wicket gate clearance - heel, toe and gate to gate. Adjust as required.

Turbine Runner

1. Check and record the runner seal clearances.

2. Check and record any pitting and cracks, showing the area and depth on the sketch.

Note: Areas susceptible to cracks and pitting are the blade area, fillets at hub and band, and the runner band. All relevant indications should be examined by NDE.

3. Check runner hub and cone for irregularities and security.

4. Examine the bottom ring for cracks or pitting and record.

5. On Kaplan units, check for signs of oil leakage at the hub.

6. On units with bolted blades, check security of bolts.

7. On propeller or Kaplan units, check runner blades and throat ring for signs of rubbing or galling.

Scroll Case and Penstock

1. Check concrete for cracks and voids.

2. Check steel liner for erosion and cracking.

3. Check drain valve and cover gratings.

4. Examine penstock and scroll case and report on general condition. The penstocks will be inspected and assessed according to the specific relevant procedures

5. Check condition of air vents and liners.

6. Check for any cracking of stay vanes.

Draft Tube

1. Inspect draft tube drain screen.

2. Inspect water depression control column openings.

3. Inspect draft tube wall for erosion nad cracking

Carbon Seal

Remove and inspect carbon seal or main shaft packing box if operating conditions warrant.

Fire Pumps

Electric Fire Pumps

Procedure: **PM-4** Recommended Frequency: Every 2 years

Monthly inspections done during General Plant Monthly Inspection as per the Ontario Hydro Fire Loss Control Guide B.2.1.2.1.2, page 103.

Every two years, major repairs as required and further inspections and test should be carried out of the pumping capacity, bolts, alignment, lubricate and any minor repairs as per the Ontario Hydro Fire Loss Control Guide B.2.1.2.1.2, page 104.

Engine-Driven Fire Pump (Propane-Gas-Diesel)
Procedure: **PM-3** Recommended Frequency: Annual

Monthly inspections done during General Plant Monthly Inspection.

Annual inspection and maintenance is to be carried out on the engine.

Some main annual items to be done:
- change oil and filter
- inspect engine ignition and replace as required
- inspect coolant level and operating solenoids if equipped
- check fuel levels and replace old fuel as per supplier's recommendations
- clean strainers
- test operate and record readings

Do major repairs/overhauls as required.

Note: For all Fire Protection Equipment, good, concise inspection and maintenance records are to be kept for at least a two-year period with dates, name of person doing work and what was done recorded as per Fire Code.

Headgates and Operating Mechanisms

Procedure: **PM-3** Recommended Frequency: Annual

Note: The following general procedures to be employed where applicable. Dam safety inspection and testing procedures must be followed

1. Conduct a visual inspection of the hoist structures and headgate house for any deficiencies.

2. Inspect all wire ropes, drums, wire rope sheaves, and wire rope clamps. Check block for corrosion and sheaves for rotation.

3. Check lubricant levels. Keep sight glasses clean.

4. Lubricate the bearings of the wire rope sheave block.

5. Check for leaks at flange faces, input and output shaft seals, bearing and covers and drain piping or plugs.

6. Inspect the brake fan and limit switches for any visible deficiencies.

7. Inspect and lubricate drive shaft and thrust bearings. (Bearings exposed to weather should be full of lubricant at all times).

8. Ensure the protective shaft and coupling guards are in position and secure.

9. Drop headgates under load on all units as listed in Technical Procedure, HO 181.

10. For equipment such as headgates, sluicegates, gantry cranes etc., which may stand idle for prolonged periods, it is recommended that where practical, the equipment be operated to restore a coating of lubricant to the gears and components.

Procedure: **PM-4** Recommended Frequency: 3 to 5 Years

1. Inspect headgate seal and bottom plate. Record any leakage.

2. Inspect all wire ropes for deficiencies. Apply wire rope lubricant if specified in station instructions.

3. Inspect wire rope sheaves, drum and clamps. Lubricate wire rope sheave bearings.

4. Inspect gearboxes for gear wear, bearing condition, and seal condition. Replace lubricant and clean air breather (if used).

5. Check the drive shaft bearings and thrust bearings. Relubricate all bearings.

6. Inspect the gears, grids or elements in all flexible shaft couplings. Relubricate as required.

7. Check the shaft alignment at all flexible shaft couplings.

8. Inspect brakes for lining condition, linkage wear, and drum wear. Relubricate as required.

9. Operate brakes and adjust travel, or gap, if required.

10. Check fan for condition of impeller, or blades, shaft bearings, drive assemblies and louvres. Relubricate bearings and linkages.

11. Operate gate under load and check limit controls.

Note: Electrical motor and control maintenance will be carried out in conjunction with the above procedures as per the electrical maintenance procedures.

Headgates - Hydraulic Operated

Procedure: **PM-3** Recommended Frequency: Annual

1. Check and service oil line filters.

2. Obtain a sample of the hydraulic oil and submit the sample to a laboratory for a water content analysis.

3. Headgate Drop Test per Technical Directive HO 181.

4. Raise and lower the gates and carry out the following checks:

   (a) Operation of the pumps.

   (b) Observe and record the cracking pressure.

   (c) Observe and record the raising pressure.

   (d) Observe and record the raising speed.

   (e) Check the accuracy of the gate opening position indicators.

   (f) Observe and record the fast lowering speed.

   (g) Observe and record the slow lowering speed (for the last 12 inches above the sill).

   (h) Check and record the travel of the gates due to by-pass in hydraulic cylinder.

Procedure: **PM-4** Recommended Frequency: With Unit Major Inspection

1. Check condition of protective coating. Schedule sandblasting and painting, if required. Refer to Technical Directive HO 836 for sandblasting and coating.

2. Inspect the headgate seals. Replace as required.

3. Inspect the condition of the wheels and guide rollers. Repair or replace as required.

4. Carry out a visual inspection of hoist structure.

5. Record all details of preventative maintenance and repairs carried out, including parts and materials supplied.

Hydraulic Generating Units
Horizontal

Procedure: **PM-3** Recommended Frequency: Annual

With the Unit In Service

1. Check shaft vibration at turbine and generator bearings at specific loads. This can be checked by hand held instruments and if the vibration is abnormal for the unit at a given load, the source of the problem should be found and the problem corrected. Analyzing equipment may be obtained, if required, through the Production Services Department.

2. Check flange joints around turbine head cover or bottom cover to ensure that all joints are tight.

3. Where non-lubricated bushing materials are installed on head cover for gate operating ring bearing surfaces and wicket gate bushings, check for "stick-slip" during movement of the gate operating ring.

4. Where a standard stuffing box is used for the main shaft seal ensure that there is some leakage past the seal in the normal range of operation - if not the packing is too tight and should be removed and the box repacked on shutdown.

5. Check for unusual noises from the turbine during decrease in load on the unit:
   a) At turbine covers.
   b) At spiral case.
   c) At draft tube.

6. Check all unit compressed air, oil, and water piping systems for leaks - for repairing later with the unit shutdown.

7. On single or twin horizontal units with a spiral casing and exposed gate linkage - check wicket gate stuffing boxes for leakage at maximum gate opening.

8. Check for leakage around flanges, bonnets, and valve stem packing of penstock and draft tube drain valves. Repair as necessary.

During Shutdown of the Unit And Immediately Thereafter

1. Check the unit for excessive vibration.

2. Check servomotor cushion to ensure that servomotor piston moves in an acceptable manner at the closed position, that is, no impact of piston on cylinder head end or stops.

3. Check that servomotor squeeze is adequate to minimize leakage through clearances at contact surfaces of adjacent wicket gates.

4. Where applicable, check position of shut-down solenoid adjustment on the governor or actuator to ensure that sufficient squeeze is applied on gates.

5. Check if unit creeps under the condition with unit stopped, generator brakes released, and headgate up.

With the Unit Shut Down and Penstock And Spiral Case(s) or Flume Dewatered

1. Check leakage at unit headgate or valve, where provided.

2. Verify ability of casing drain to carry away headgate leakage.

3. Check at labyrinth end seals on unit guide bearings for signs of heat buildup or rubbing.

4. Inspect the oil in the guide and thrust bearings. See Technical Directive. Replace or sample as required.

5. Clean the gauge glasses on oil flow indicators.

6. Check and correct as necessary all temperature indicating alarm and shut-down devices on turbine bearings.

7. On pressure-lubricated bearings check:
   a) Oil pressure readings.
   b) Oil flow indicators - operation.
   c) Oil flow switches - operation.
   d) Orifices in oil feed lines are free.

8. Clean the gauge glasses on all water flow indicators.

9. Check the turbine wicket gate linkages and verify that there is no interference of adjacent links or levers, or that eccentric pins have moved.

10. Remove excess grease from the end covers and linkage. Clean the covers, linkage, and surrounding area.

11. Operate the auto greasing system where provided, or grease manually with a hand-operated grease gun and check at all the greasing points for lubricant flow.

12. With hydraulically operated systems, check the servomotors and servomotor piping system for leaks. Repair or adjust as required.

13. Check the servomotor cushioning valves for setting. (Verify cushion timing in conjunction with governor timing checks.)

14. Check compressed air piping for security, water and corrosion (brake lines).

15. Check condition of flywheel braking surface, and adjustment of unit brakes.

16. Inspect, where necessary, the stay vanes, stay ring camber sections, scroll case, and penstock for defects, deficiencies or trash.

17. Inspect the turbine casing relief valve and verify operation of the valve where possible.

18. Clean the turbine unit cooling and service water intake screens which are taken off penstock and/or scroll case. Check interconnecting piping to adjacent units in this respect.

19. Inspect the runner for cavitation and cracks, and record the information. Measure and record runner seal clearances. Verify security of runner and fixed seal rings.

20. Check condition of draft tube and liner or discharge chamber for cavitation. Inspect from manhole or inspection opening in the draft tube, liner or discharge chamber, checking in particular that portion of liner just downstream of the runner outlet.

21. Inspect the wicket gates and check end and horizontal (gates closed, gate servomotor pressure off) clearances. Adjust or correct excessive clearances.

22. Visually inspect turbine and generator shafts for cracks. Suspect areas to be examined by NDE.

23. Check the security of the horizontal stay bolts between head cover and bottom (or discharge) ring. These stay bolts pass through the wicket gate bores.

24. Verify that there is no binding between the link connecting the gate operating ring to the wicket gate and its associated parts. Measure clearance between gate operating ring and bottom ring or head cover on both ends of the unit. Check gate shaft, gate shaft lever, gate shaft links (to gate operating ring) for security and lubrication.

25. Check gate shaft bearing and support (in end cover) for security and lubrication.

26. Check stuffing box(es) where gate shaft passes through end covers for condition of packing and condition of shaft or sleeve.

27. For twin units equipped with a water lubricated bearing on the turbine shaft, check and adjust if required for centre or wear.
    Note: For annual Generation Water Sprinkler maintenance, refer to Page __ in the Mechanical Procedures Manual.

Procedure: **PM-4** Recommended Frequency: 15-20 years

1. Check bearings by removing bearing cover and shell segments as necessary to check condition of bearing material and shaft surface or sleeve, lubricant grooves, lubricating oil rings, oil ring wipers, labyrinth seals, cooling coils.

2. Flush and clean bearing oil reservoirs.

3. Check alignment of shaft and bearings. Check coupling bolts.

4. On bearings adjacent to generator, check for grounds.

5. Dismantle and inspect main shaft packing box or mechanical seal and check condition of sealing elements and shaft surface or sleeve. Clean and buff or polish surface of shaft or sleeve as required.

6. Repair or replace main shaft stuffing box packing gland if defective, gland adjusting bolts, nuts, or lantern ring.

7. Check belts driven from unit shaft or shaft extension for wear, splices, alignment, and tension.

8. Check belt driving pulleys on main shaft for security.

9. Check condition of flywheel bolting to shaft.

10. Check flywheel for signs of flaws by NDE.

11. Open up the spiral casing, flume, or penstock manhole or inspection door and carry out a visual inspection of the casing, runner, wearing rings, and distributor in so far as possible.

12. Clean the unit water passages of debris.

13. Check, where possible, the turbine runner seal clearances.

14. Repack the wicket gate stuffing boxes where required and verify condition of wicket gate stem or sleeve surface.

15. Check radial clearance between gate operating ring and its supporting bearing arrangement whether head cover, lower cover, or spiral case.

16. Check for indications of interference between wicket gate and runner and/or stay ring. Inspect distributor surfaces for "wire drawing".

17. Inspect the runner for cavitation and cracks (by nondestructive testing where possible) and carry out the necessary repairs.

18. Check condition of concrete draft tube, draft tube liner, junction of draft tube liner and discharge ring, transition of draft tube liner to concrete, and bonding of draft tube liner to concrete.

19. Check that distributor facing plates on head cover and bottom ring are securely fastened.

20. Check security of nuts on exposed ends of stay bolts which pass through the end covers.

21. Check calibration of pressure gauges where provided.

On Twin Horizontal or Quadruplex Units with Concrete or Steel (or Cast Iron) Barrel Flume

1. Check gate shaft lever, gate shaft links (to gate operating ring) for pin and bushing wear.

2. Check gate shaft bearing (in end cover) for wear.

Hydraulic Generating Units
Vertical

Procedure: **PM-3** Recommended Frequency: Annual

With the unit in service:

1. Check all piping, servomotors etc. for leakage.

2. Record shaft runout at turbine and generator bearings at gate positions of 100 %, 50 % and equivalent to speed no load(SNL).

3. On units with tailwater depression systems (synchronous condenser operation) check shaft runout with tailwater depressed, and time to depress water level.

4. Inspect wicket gate stems for leaks.

5. Inspect servomotor packing for leaks.

6. Do complete visual inspection around unit and note any conditions that may be corrected during shutdown.

7. Operate headgates under load as per Technical Directive HO 181.

During Shutdown of the Unit and Immediately Thereafter

1. Check that turbo-vent valves open and/or close without excessive leakage.

2. Check the unit rotational speed at which generator brakes are applied.

3. Check time generator brakes remain applied after unit comes to a complete stop before release.

4. Check operation of thrust bearing high pressure lift pump. Verify that there is no reverse rotation of lift pump with pump motor off (faulty check valve).

5. Check servomotor cushion to ensure that servomotor piston moves in an acceptable manner at the closed position, that is, no impact of piston on cylinder head, or stops.

???? 6. Check that servomotor squeeze is adequate to minimize leakage through vertical clearances of wicket gates.

7. Check position of shut-down solenoid adjustment on the governor or actuator to ensure that full squeeze is applied on gates.

8. On units with latch type (single or double) gate lock, check gap between latch and stop at locked position.

9. If the gate lock is oil-cylinder operated (single or double), check cylinder leakage, cylinder or piston travel, operation of control valve and limit switches.

10. Check if unit creeps under the condition with unit stopped, generator brakes released, and head gate up (oil lift off). If unit starts to rotate, either the oil lift must be started immediately or the unit started to avoid low speed rotation that could wipe the thrust bearing.

With the Unit Shutdown and Penstock and Spiral Case Dewatered

1. Check leakage at unit head gate.

2. Verify ability of casing drain to carry away head gate leakage. Ensure drain grate is securely attached as per Technical Directive HO 2358-R1.

3. Note the position of the main leads relative to upstream for alignment analysis based on clearances.

4. For units with water lubricated bearings, check clearance by jacking and adjust or replace if necessary.

5. Inspect and filter the oil in the guide and thrust bearings if required. See Technical Directive HO 439 for oil testing.

6. Check and correct as necessary all temperature indicating alarm and shut-down devices on all bearings.

7. Change HP oil lift filters.

8. Clean all flow meters and sight glasses. Check alarm settings.

9. Remove excess grease from the head cover. Clean the head cover and surrounding area.

10. Operate the auto-greasing system where provided, or grease manually with a hand-operated grease gun and check at all the greasing points for lubricant flow. Adjust timing where necessary.

11. Operate wicket gates through full stroke, and check and record gate closing time over the range of 30 to 80 % gate opening. This result multiplied by two will give the gate timing, and will avoid slamming the gates.

12. Check the servomotor cushioning valves for setting. (Verify cushion timing in conjunction with governor timing checks.)

13. Clean the turbine unit cooling and service water intake screens which are taken off penstock and/or scroll case. Check interconnecting piping to adjacent units in this respect. Clean all cooling water strainers and filters.

14. Visually inspect the wicket gates and check top, bottom, and vertical (gates closed) clearances. Adjust or correct excessive clearances.

15. Inspect distributor surfaces of bottom ring and head cover for galling, "wire drawing," or cavitation.

16. Check that distributor facing plates on head cover and bottom ring, where provided, are tight.

17. Inspect the runner for cavitation and cracks, based on access from turbine distributor (through wicket gates) and/or as viewed from draft tube accesshole opening where tailrace elevation permits. Record the information for future repairs.

18. Measure runner seal clearances and record where practical.

19. Verify security of rotating runner seal rings and adjacent fixed seal rings on head cover and bottom ring.

20. Check rotating runner seal rings and adjacent fixed rings for galling (metal pickup).

21. Check condition of draft tube liner from accesshole opening in draft tube where practical.

22. Clean water depression control elements (if so equipped).

Permanent Magnet Generator (PMG)

1. Inspect rubber bushing and coupling.

2. Check speed switch pinion gears for wear.

3. Check speed switch thrust assembly.

4. Check lower speed rod bore for lubrication.

5. Lubricate speed switches.
6. Check settings of speed switches.

Exciter

1. Check and record air gap clearances.

2. Check exciter hold-down bolts for security.

Rotor

1. Check hub and spider arms for cracking.
2. Check any balance weights for security.
3. Check condition and security of fan blades.
4. Check brake ring for wear, warping, scoring, and security.
5. Check brake operations and brake shoe wear and check operation of position switches.
6. Check security of all piping, both for leakage and vibration (ie, brakes, generator fire lines, oil lines).
7. Check upper and lower bracket, hold-down bolts and dowels.
8. Check air louver operation. Lubricate as required.
9. Check radiators for cleanliness. Remove one elbow and check for pitting, erosion, or algae buildup. Clean radiators if required.
10. Check and record rotor air gap ($\pm$5 percent tolerance).
11. Check rotor security.

On Kaplan (Adjustable Blade Propeller) Turbines

1. Clean out head cover sump.
2. Check oil level in PMG (or SSG) spline drive cup assembly at top of oil head.
3. Check and correct as necessary all temperature indicating, alarm, and shutdown devices on oil head bearings.
4. Check security of oil sampling and air release connections on turbine shaft for lube oil reservoir in runner hub.

Governors and Actuators

Procedure: **PM-3** Recommended Frequency: Annual

1. On belt-driven governors, inspect belts and reclip if necessary.
2. On belt-driven governors, the belt idlers are to be inspected and lubricated and broken belt shutdown checked.
3. Clean strainers at base of pressure regulator and flow control valves in actuator.

4. Check zero position of gate position indicator and adjust the governor restoring mechanism for stretch. Lubricate the sheave and other lubrication points.

5. On governors for Kaplan turbines with cam blade control, verify with blades in full steep and flat position on cam, that there is no steady bypass of oil. This would indicate that pilot valve has not recentered.

6. On governors for Kaplan units, lubricate the sheaves and other lubrication points of the blade restoring mechanism.

7. Dismantle, clean and inspect the dashpot and all its components mechanisms for wear, binding or other defects. Inspect and service any manual or solenoid operated by-pass.

Procedure: **PM-4** Recommended Frequency: 3 Years or as Required

1. Dismantle the flyball head and vibrators. Check the bearings, slide blocks, bushings, springs, pins, discs and other mechanisms for wear or defects. Repair or replace components as required.

2. Inspect all connecting levers, linkages, pins, bushings, return springs, retaining pins, clips, etc, for wear or deficiencies. Repair or replace as required.

3. Visually check any suspension straps for deficiencies.

4. On units with rigid link restoring mechanism, adjust or correct dead band in linkage and lubricate as required.

5. Clean, and replace if necessary, all strainers and filters.

6. Clean and check any emergency hand pump.

7. Lubricate all pivot points, hinge pins, linkages and other lubricated components.

8. Check for any oil leaks and clean up the cabinet and components.

9. Check all auxiliary governor switches with regard to:
   (a) Gate limit.
   (b) Gate position.
   (c) Speed.
   (d) Pressure.
   (e) Control motor limit switches.

10. Service the governor PMG or SSG in accordance with Manufacturer's Instructions (see PM-1, PM-2, and PM-3 for Hydraulic Generating Units - Vertical Units).

Governor Pressure Systems

Procedure: **PM-3** Recommended Frequency: Annual

1. Filter oil in governor system as conditions dictate. Oil may be recirculated if oil storage facilities are not available.

2. On systems containing more than 60 L (15 gal) test a sample every second year, as outlined in the Technical Directive TD 439.

3. Clean governor oil pump suction filters if accessible.

4. Check the accumulator tank safety relief valve as per Technical Directive HO 105.

5. Check any indication of oil or air leakage from accumulator tank, bolted, or threaded pipe connections.

6. Check and record time required for governor pumps to bring system pressure from cut-in pressure to cut-out pressure.

7. Check pressure and level switch settings of pump control, air make-up, level and pressure switches in alarm and shutdown circuits.

Procedure: **PM-4** Recommended Frequency: With major unit inspection, or as determined by condition

1. Remove and filter the oil in the governor pressure system in accordance with approved procedures.

2. Clean sump tank, filter screens, gauge glasses, level switches, and air vents.

3. Clean accumulator tank gauge glasses, level switches and check valves on sight glasses.

4. On units operating with interconnected pressure and sump tank systems, verify the ability of the one system to support the pressure and drain operating requirements.

5. Check clapper valve.

Note: The frequency and scope of the overhaul work will be determined by the annual pump test for pump-up time.

1. Dismantle the pump and inspect for wear, erosion, or other deficiencies on gears, impellers, casing and impeller wear rings, shaft sleeves, bearings, packing glands and shafts. Repair or replace as required.

2. Dismantle unloader and pilot unloader valves and check for wear. Repair or replace parts as required.

3. Dismantle safety relief valve on pump and check for wear and setting.

4. Inspect the drive belts, chain, or flexible coupling.

5. Check the alignment of drive sheaves, sprockets, or flexible shaft couplings.

6. Open up and inspect any drive gearbox for gear wear, excessive backlash, worn bearings, and oil leaks. Repair or replace defective components.

7. Carry out pump-up test and record time, pressure, and volume.

8. See Technical Bulletin HO 2261 for special requirements for Woodward Herringbone Pumps.

MONTHLY PLANT INSPECTION

AIR CONDITIONING SYSTEMS

1. Check operation of supply and return fans and all exhaust fans. Adjust/replace belts as necessary.

2. Check operation of all chiller units and compressors.

3. Check roll filter media and associated filtering equipment for cleanliness and operation.

4. Check all louvres, dampers and fresh air intakes/clean adjust/clean as necessary.

AIR COMPRESSORS

1. Visually inspect all compressors and monitor:
   a) Unusual vibration and noises.

   b) Filter differentials and condition - clean as required.

   c) Oil levels.

2. Check & record the following where applicable:
   a) Discharge pressure and temperature.

   b) Oil pressure and temperature.

   c) Air and oil filter differentials.

   d) Elapsed running hours.

   e) Water flow into compressor and after cooler where applicable.

3. Manually bleed of all condensation from air receivers and traps.

4. Cycle compressor through one load and unload cycle and record:
   a) Pump up time to set pressure.

   b) Start/stop timer (5 minute interval is normal).

   c) Cut in and cut out air pressures.

5. Manually switch lead/lag compressors as applicable.

FILTERS AND DRYERS

1. Check the operation of all filters, separators and dryers and adjust as required.

2. Drain all moisture or oil from filters and separators fitted with drain valves or cocks.

3. Manually switch over dual tower installations from duty to standby as applicable.

4. Inspect all desiccant and dewpoint readings as applicable.

FIRE PROTECTION/SAFETY EQUIPMENT

1. Visually inspect all deluge equipment including piping, air system and alarms and note all defects.

2. Check all portable fire extinguishers for proper charge.

3. Check all fire hose cabinet and ensure that hose and nozzles are in serviceable condition.

4. Check all fire blankets are in their proper locations.

5. Check the system pressure on all CO_2 systems.

6. Inspect all self contained breathing apparatus.

7. Start emergency fire pumps, and test operate as required to ensure correct operation.

8. Check first aid kits, stretcher, self-contained breathing apparatus.

GOVERNORS & ACTUATORS

Reference: Detailed procedures per governor manufacturer's written recommendations.

1. Check flyball head mechanisms, carry out lubrication and check oil reservoir level where provided.

2. Check all governor linkages for freedom of movement and lubricate in accordance with manufacturer's recommendations.

3. Check vibrator mechanism for operation and lubricate as required.

4. Check dashpot assembly oil level.

5. Inspect all gateshaft, external and internal linkages and restoring mechanisms for defects. Lubricate as required.

6. Check servomotors for leaks and other deficiencies.

7. Check all governor pressure system piping for defects and leaks.

8. Pumps - operate governor pumps through one load/unload cycle and monitor the following:
   a) Cut in pressure.

   b) Cut out pressure.

   c) Check for proper unloader sequencing during starting/stopping of pumps.

   d) Check operation of accumulator level pressure control equipment and adjust air cushion as required on non-automatic systems.

   e) Manually switch over governor pumps from lead to lag as required by station procedures.

   f) Switch over governor pilot filters or replace as required.

   g) Check all oil levels and adjust as necessary. Record any additions of oil to system.

HEADWORKS

1. Inspect penstock vents to ensure they are clear of ice and debris.

2. Check trash rack differentials, and record if required.

3. Visually inspect all headgate operating equipment and gate house for defects and oil leaks. Visually check condition of fan brake/solenoid brake and cables.

4. For hydraulically actuated headgates check the following:
   a) Check pumps and oil system for correct operation and leaks.

   b) Check headgate well for oil spills.

5. Check the operation of all hoist house ventilating and heating equipment. Adjust/repair as required.

HEATING & VENTILATING EQUIPMENT

1. Check operation of all louvres including linkages and operators and roof fans to ensure proper functioning.

2. Check all localized exhaust fans to ensure correct operation.

3. Inspect all intake screens for blockage or defects.

4. Hot water heating systems to have the following checks performed:
   a) Check water level in expansion tank.

   b) Check operation of water circulating pumps and associated equipment. Lubricate as required.

   c) Check instrument air system pressure. Drain off accumulated moisture and check filters.

5. Warm Air Heating System.
   a) Check operation of duct heating to ensure correct operation.

6. Heat Pump Heating Systems
   a) Check circulating system pumps.

   b) Check loop temperatures.

   c) Monitor auxiliary heat source for correct operation.

7. For air handling system, see Air Conditioning Section.

HYDRAULIC GENERATING UNITS

Horizontal Units:

1. Inspect oil ring bearings to ensure oil level is correct and that the oil ring is revolving with the shaft and providing adequate oil lubrication. Check oil circulating pumps where provided.

2. Check that operating temperatures on turbine thrust and guide bearings are normal.

3. Check oil leakage at bearing labyrinth seals and ensure labyrinth drains are clear.

4. Check that the water flow and pressure to water cooled oil bearings and water lubricated is adequate.

5. Clean cooling water filter or strainer as required.

6. Check unit for unusual noises, leaks or vibrations.

7. Check and adjust turbine shaft packing.

8. Visually check overspeed switches.

Vertical Units:

- Bearings (oil lubricated)
  1. Check that lubrication, temperature and shaft runout is normal.

- Bearings (water lubricated)
  1. Check volume and pressure of water supply to bearings.

  2. Check differential on water supply filters and stainers. Clean and switch over as required.

- Turbine Pit
  1. Check for leaks at wicket gate packing and all flanged joints. Ensure headcover drains are free.

  2. Check operation of AC & DC headcover sump pumps.

  3. Check leakage past main shaft carbon seal including seal water supply filters and strainers, and adjust cooling water flows as required.

  4. Monitor main shaft packing to ensure there is some leakage past the packing on units equipped with packing. Check water supply filters/strainers to stuffing box. Clean strainers as required, and adjust the water flow, if required.

  5. Ensure check valve in turbovent line seals correctly against water pressure when turbovent is not drawing air.

  6. Check for unusual noises and vibration from the turbine.

  7. Record turbine shaft runout just above bearing cover on units with water lubricated bearings, every three months on units with oil lubricated bearings. See Technical Directive HO 145.

8. Check for broken shear pins or links.

9. Check auto lubrication lines, fittings, switches or grease as required.

- Outside Turbine Pit:
  Check operation of unit dampers and instrument air system where applicable to ensure proper damper operation.

  1. Check lubricant level in auto greasing system.

  2. Check brake air pressure.

  3. On Kaplan Units, verify oil level is within normal operating range for blade position on the unit. Check for noise or vibration.

  4. Check that turbovent intakes and/or draft tube air inlets are clear when drawing air and that they are not passing excessive water leakage when not drawing air. On units with inlet valves, check tightness of air release valves on spiral case or on penstock down stream of the valve body.

  5. Check draft tube manhole and scroll case manhole for leakage and unusual noises.

SLUICE GATES AND BUBBLER SYSTEMS

1. Check leakage past sluice gate and determine operations of seals. Check gate components visually for leaks, water or ice damage.

2. Monitor bubbler system operation and ensure that upstream side of gate is free of ice. Check oil levels and lubricate bubbler equipment as required.

3. Monitor operation of gain heating to ensure heaters are functioning correctly and that any water leakage has not frozen to the back of the gate.

4. Monitor hoisting equipment for any visible defects.

SUMP AND DEWATERING PUMPS

1. Check pumps for any visual defects.

2. Operate pump by toggling float switches as required to start pump. Monitor pump when in operation to ensure satisfactory operation where possible, check pump down rate and record. Check that pump shuts off on low sump level.

3. Check sump visually for debris or pollution deposits.

4. For pumps used as standby dewatering pumps, simulate failure and ensure standby pump starts as required.

VALVES - TURBINE INLET

1. Check all turbine inlet valves for visible defects or leaks.

2. Grease all trunnion bearings and operating linkages including all operating equipment and actuators.

3. For valves with oil lubricated bearings, check level of oil and fill oilers as required.

4. Check trunnion seals and expansion joints for leakage and ensure that the drains from all valve pits are free.

5. Check for drift in the valve operator from the full open position.

6. **Oil Pressure Actuating Systems**
   a) Check oil level in reservoir tank.

   b) Check pump motor sets through one load/unload sequence.

   c) Monitor equipment for leakage, unusual noises and proper operation.

   d) Check for differential on all suction and discharge filters. Repair as required.

   e) For systems with accumulator tanks, check accumulator level and pressure control equipment and adjust air cushion as required on manual systems.

   f) Switch pumps from lead to lag as required by station procedure.

7. **Water Pressure Actuating Systems**
   a) Check all water piping connections to controls and actuators for leaks and defects.

   b) Check all system control pressures and adjust as required.

   c) Blow down all sediment strainers, filters and clean as required.

   d) Check leakage past control valve seals from control system drains.

RAW AND COOLING WATER

1. Inspect and remove weeds or debris from intake grids or screens.

2. Clean suction strainer (if dual type, which permits changeover without shutdown).

3. Where applicable, carry out pump inspection as per the procedure entitled "Pumps" contained in this handbook.

4. Check for oil in the water system.

5. Check the differential pressure across the filters or strainers.

6. Check all pressure gauges for deficiencies.

7. Check the system for leaks.

Pressure and Level Regulation
Pressure Regulating Valves

Procedure: **PM-3** Recommended Frequency: Annual

Pressure regulating valves (compressed air actuated):

1. Check the inlet pressure and the regulated pressure.

2. Inspect the linkage to the valve positioner (if used).

3. Adjust the valve spindle packing gland, replace if required.

4. Check for leakage through the bypass valve (if used).

5. Check the air pressure on the air motor regulator.

6. Inspect the compressed air supply tubing, fittings, and valve air motor for leaks, and clean strainers.

Pumps - Centrifugal

Procedure: **PM-4** Recommended Frequency: 1 - 3 years

1. Open up the pump and carry out a visual inspection of the pump casing, impeller, wearing rings, shaft, shaft sleeves, stuffing boxes, and bearings. Clean out the pump casing and clean the impeller. Frequency will depend on performance of pump.

2. Measure the gap between the flexible shaft coupling flanges and adjust to the manufacturer's recommended gap if necessary. Check alignment and adjust if necessary.

Pumps - Positive Displacement

For information, see Governor Pressure Systems.

Rigging Equipment Maintenance

Procedure: **PM-3** Recommended Frequency: Annual

The Ontario Hydro Craning and Rigging Handbook and RTOS documents cover the recommended procedures for the care and maintenance of equipment used during rigging procedures.

Slings

Procedure: **PM-3** Recommended Frequency: Annual

The two basic types of wire rope slings approved for Ontario Hydro use:

1. Right hand regular lay 6 x 25 wire rope with an independent wire rope gore.

2. Cable laid 3 x 3 x 19 "Hardy Type" wire rope sling.

Note: 1. Wire rope slings must be furnished with eyes incorporating a flemish eye splice.

Reference: Approved and Non-Standard Wire Rope Sling, Technical Bulletin, Elevating and Hoisting, HO 562.

2. All slings must be examined prior to each lift and before storage following the lift or every 12 months.

Reference: Inspection Use and Storage Wire Rope Slings, Technical Directive, Elevating and Hoisting, HO 627.

3. Sling loading - Reference: Craning and Rigging Handbook, Section 7-1 (A) to 7.2.

4. Braided Polypropylene and Webbing Slings - Reference: Craning and Rigging Handbook, Section 7.5.2 to 7.5.4.

Chain and Fittings

Procedure: **PM-3** Recommended Frequency: Annual

Only chains identified with the grade and manufacturer's markings are to be used. Chains not identified by means of a metal tag or markings on the links must be discarded.

1. The chain may be identified by an 8, 80, 800 or T embossed on the links; this identifies it as Grade 80 alloy steel.

2. Working Loads, Inspection, Handling and Storage.
   Reference - Craning and Rigging Handbook, Section 5.0 to 5.3.2.

3. Welding of chain or fittings is not permitted.
   Reference - Craning and Rigging Handbook, Section 5.1.1

4. Only Non-weldable approved fittings or factory installed attachments may be used.
   Reference - Craning and Rigging Handbook, Connecting Link, Section 6.3.6.

Small Hoisting Devices i.e. Chain Hoists, Com-a-Longs, etc.

Procedure: **PM-3** Recommended Frequency: Annual

1. Inspection of these devices shall be carried out by a competent person prior to being used for the first time, and there after as often as necessary but not less frequently than recommended by the manufacturer and at least once a year.

2. A permanent record of inspection must be prepared and maintained on file for each hoist. This record shall include nameplate data, date of inspection, details of maintenance and replacement parts, load test information and next inspection date.

3. All lifting hooks to be examined by NDE every 3 years.
   Reference - Inspection and Maintenance of Hand Lever-Operated Hoists, Technical Procedure, Elevation and Hoisting, HO 179-R1.

   Reference - Craning and Rigging Handbook, Sections 9.1 to 9.3 Inspection and Maintenance.

Non-Destructive Examination (NDE)

Procedure: **PM-4** Recommended Frequency: Every 3 years

For a lifting device undergoing normal usage, the maximum period between NDE inspections shall be 3 years. More frequent tests are to be performed if devices are subject to heavy service, abuse or major lifts.

Lifting Devices include - hooks, eyebolts, rings, shackles, etc.

Reference - Technical Directive, Elevating & Hoisting, HO 430.

Sluice Gates and Operating Mechanisms

(Refer to the dam safety procedures)

Cable Type Gates

Procedure: **PM-3** Recommended Frequency: Annual
(If gates are used frequently, do semi-annually)

Note: Preferred maintenance periods are prior to the spring freshets or the winter freeze-ups.

Safety Note: A reference source for the inspection of wire ropes is the Ontario Hydro Craning and Rigging Handbook.

1. Inspect wire rope for visible defects.

2. Check the wire rope fittings for security.

3. Check the lay of the wire rope on the drum and sheaves for wear.

4. Lubricate carbon steel wire rope using the Ontario Hydro Qualified Lubricant.

5. Lubricate the drum bearings, drive gear bearings, rollers and all lubrication points and fittings.

6. Check the slack rope indicator. Lubricate the cable and pulleys.

7. Check the lubricant level in the gearboxes and add lubricant if required (see "Headgates" in this handbook).

8. Visually check the condition of the superstructure.

9. Visually inspect the exterior and interior of the gates for leaks and water or ice damage.

10. Check for correct sealing of gates.

Procedure: **PM-4** Recommended Frequency: 8 to 15 Years

1. Carry out the sandblasting and application of protective coating as required to the sluice gate as per the Ontario Hydro Technical Directive H0 2358-R1.

2. Inspect the gate seals and replace as required.

3. Inspect the guide rollers and repair or replace as required. Reposition the rollers as per specifications.

4. Flush out gearboxes and refill to the correct operating level with Ontario Hydro Qualified Lubricant.

5. Clean and paint the superstructure as required.

General Note: To minimize the possibility of moisture entry or condensation in bearing housings and gear cases in exterior locations and subject to intermittent use, it is recommended that the lubricant level be kept higher than normal to reduce any unlubricated space.

Screw Type Gates

Procedure: **PM-3** Recommended Frequency:Annually or Semi-Annually If Used Frequently

Note: Preferred maintenance periods are prior to the spring freshets or the winter freeze-ups.

1. Clean and lubricate the screws if required.

2. Inspect the gearboxes and drive mechanisms

3. Check the gearbox lubricant level and top up if required with (Ontario Hydro Qualified Lubricant).

4. Lubricate the drive shaft bearings.

5. Visually inspect the exterior and interior of the gates for leaks and water or ice damage.

6. Check the gates for proper sealing.

7. Inspect the condition of the protective coating on the upstream side of the gates.
8. Check the superstructure for deficiencies.

Procedure: **PM-3** Recommended Frequency: 8 to 15 Years

1. Carry out the sandblasting and protective coating if required to the sluice gates as per the Ontario Hydro Technical Directive HO 2358-R1.

2. Inspect the gate seals and repair or replace as required.

3. Inspect the screws and drive shaft bearings. Replace defective bearings and correct other deficiencies.

4. Inspect the guide rollers and replace or repair as required. Reposition the rollers as per specifications.

5. Flush out gearboxes and refill to the correct operating level with a Ontario Hydro Qualified Lubricant.

6. Carry out a complete lubrication and protective coating (lubricants) of equipment.

7. Clean and paint the superstructure if required.

General Note: To minimize the possibility of moisture entry or condensation in bearing housings or gear cases in exterior locations and subject to intermittent use, it is recommended that the lubricant level be kept higher than normal to reduce any unlubricated space.

Bubbler System

Procedure: **PM-4** Recommended Frequency: Annually

Sump and Dewatering Pumps

Procedure: **PM-4** Recommended Frequency: 3 years or as required

Safety Note: Where an entry into a confined space such as a sump pit is involved, the Occupational Health and Safety Act - Industrial Establishments and any Ontario Hydro directive HO_____ pertaining to entry into confined spaces must be adhered to.

1. Pump out the sump pit and check for safe entry.

2. Inspect the access ladder for condition and security.

3. Check, clean and repair, if necessary, the suction strainer and foot valve or other filtering elements.

4. Inspect the sump for erosion, pitting or other defects. Remove all debris to an approved disposal area. Repair any sump defects.

5. Ensure that all sump guard rails, ladder guard chains, covers or other protective devices are in good condition and secure.

6. Open up and inspect the check valve. Repair as required.

7. Check the suction piping for severe corrosion, pitting or other deficiencies (if used).

8. Dismantle the pump and inspect and repair, if necessary (based on pump performance), set impeller clearances, wear rings, shaft sleeves, bearings and packing gland assembly (if a mechanical shaft seal is used, refer to this handbook under section entitled "Shaft Seals").

9. Measure the electric drive motor amperage.

10. Check the float, guides, guide rods, cables or linkages for deficiencies. Repair as required.

11. Check the reverse rotation device.

12. Flush out and refill the lubricator, clean any sightglasses and lubricate components where applicable.

13. Record pumping time.

Valves - Turbine Inlet

Butterfly Type Valve

Procedure: **PM-3** Recommended Frequency: Annual

1. Check security of lever attachment to valve trunnion.
2. Check position of stroke on position limit switches.
3. Check body split joint for leakage.

Procedure: **PM-4** Recommended Frequency: 5 Years

1. With the turbine shut down, check opening and closing time of valve, check calibration of remote position indicating devices.
2. With the valve closed, drain spiral casing and inlet pipe of turbine and check leakage past the valve disc seal assembly. Adjust, as required, by jacking screws either on wicket or valve body dependent on design and where feasible.
3. With valve closed and pressure on penstock, spiral case drained, check leakage past bypass valve.
4. Check movement and stability of valve housing and operator base:
   (a) During normal closing and opening of the valve.
   (b) With valve closed and spiral casing depressurized until depressurization of penstock is complete.
5. Where the expansion joint is located downstream of the valve body, check the foundation body and sliding pads for wear, protection against corrosion, pitting, bolting security and clearance for movement.
6. Inspect the expansion joint in the pipeline (eg, Dresser coupling):
   (a) Check security of bolting arrangement.
   (b) Check for deterioration of composition or rubber sealing members.
   (c) Clean sliding portion of pipeline and lubricate as necessary.
7. Check security of valve body bolting arrangement to pipeline spiral casing inlet, or transition pieces. Where a rubber liner is provided, check condition of sealing faces.

8. With the turbine shut down, spiral case empty at the start, and wicket gates closed, check operation of bypass valve in the opening sequence:

   (a) Check and record operating time.

   (b) Open and close limits, if operated on other than manual.

   (c) Vibration.

   (d) Security of piping, valve, and operator supports (assuming other than manual operation).

   (e) Operation of air release valve - closes when required without excessive water leakage.

   (f) Operation and security of linkage.

   (g) Seal condition.

   (h) Lubrication.

   (i) Stop arrangement.

   (j) Operation of bypass valve - leakage, past valve disk, stem packing leakage, security of operator, lubrication of gear reduction unit, wear or breakage of gears.

9.?? With penstock or position of intake pipe upstream of valve dewatered, and using auxiliary water and pressure supply if water operated cylinder:

   (a) Open valve disc and check condition of seal and seat ring sealing faces. If rubber-lined, check condition of liner for tears or signs of deterioration.

   (b) Close disc and check seal clearances with feeler gauges.

   (c) Repair sealing surfaces, where the seal surface members are fixed to the main members, by welding, brazing, and dressing where feasible.

   (d) Check the centering of disc in valve body in the direction of the axis of the valve trunnions and verify clearance to establish wear on side thrust bearings.

   (e) Check security of dowelling of disc to through shaft (or stub shaft).

   (f) Inspect valve body split joint for security of bolting material, dowels. Correct locking devices where broken and bolt preloading where loosening has taken place.

10. Check security and wear of valve locking device.

11. Clean valve body drain of accumulated dirt or debris.

12. Check security of operator to its mounting:

(a) Foundation including bolting and dowels.

(b) Connections to valve body, if a body-mounted arrangement.

Butterfly Valve Operator
Hydraulic Cylinder Type - Oil - Water

The following frequencies are suggested and will vary based on judgment of the maintenance staff in view of the frequency of operation of the valves.

Procedure: **PM-3** Recommended Frequency: Annual

During opening and closing sequence:

1. Check for leakage at cylinder-operating rod seal.

2. Check for leakage at swivel pipe joints (where used) on hydraulic cylinder, trunnion, and/or piping.

3. Check all hydraulic piping for leaks.

4. Check condition of flexible tubing and joints for leaks, wear, abrasion, or other signs of deterioration.

5. Check condition of accordion type guard, if provided, protecting the cylinder operating rod.

Procedure: **PM-4** Recommended Frequency: 5 to 10 Years

1. Check wear on trunnion end pin and bushings.

2. Dismantle and overhaul operating cylinder(s) if required based on operation and condition.

3. On units with manual override system, verify operation of the manual override.

Butterfly Valve Operator
Hydraulic Cylinder Oil Pressure System

For air accumulator tank, see section on "Governors - Pressure System."

Procedure: **PM-3** Recommended Frequency: Annual

1. Check oil pump, motor couplings, and lubricate.

2. Clean oil pump suction strainers.

3. Clean filters in lines to control valves and switch over the standby filter (if design incorporates standby) as required.

4. Check the operation of system oil pump(s), unloader, and relief valves. Check settings for operation of the valves.

   Procedure: **PM-4** Recommended Frequency: 2 Years

1. Take a sample of oil from the pressure system and forward it to the laboratory for testing, or replace oil based on quantity of oil. See Technical Directive HO_____

   Procedure: **PM-4** Recommended Frequency: 5 Years

1. Remove and filter the oil in the pressure system in accordance with the approved procedure or as conditions warrant (sampling).

2. Check alignment of system oil pump(s) and motor(s) and lubricate coupling(s) as required.

3. Check timing between:
   (a) Motor start and unloader valve closing at start of pumping cycle.

   (b) Unloader valve opening and motor stopping at end of pumping cycle.

Butterfly Valve Operator
Hydraulic Cylinder Water Pressure System

Procedure: **PM-3** Recommended Frequency: 1 Year

1. Operate valve through a complete opening and closing sequence:

   (a) On manual control.

   (b) On remote control (control room).

   (c) On local remote control (at valve cabinet or control stand).

2. Check maximum and minimum operating pressures.

3. Check operating time and sequence timing on automatic:
   (a) For operation of bypass valve.

   (b) For operation of vent valve.

   (c) For opening stroke.

   (d) For closing stroke.

Procedure: **PM-4** Recommended Frequency: 5 to 10 Years

1. Dismantle control valves individually and check condition of:

   (a) Spool.

   (b) Bushing.

   (c) Seals.

   (d) Operating device (solenoid or manual).

   (e) Locks and sequence cams of manual controls.

Water System

Domestic Water
Note: See Plant Monthly Inspection which covers Domestic Water Systems.

Raw Water
Note: See Plant Monthly Inspection
Strainers

Procedure - **PM-4** Recommended Frequency: As required

1. Inspect and remove weeds or debris from intake grids or screens.

2. Clean suction strainer (if dual type, which permits changeover without shutdown).

3. Where applicable, carry out pump inspection as per the procedure entitled "Pumps" contained in this handbook.

4. Check the differential pressure across the filters or strainers (a 70 kPa (10 psi) pressure drop may indicate filter/strainer blockage).

5. Check all pressure gauges for deficiencies.