

APPENDIX



// PREVENTATIVE AND OPERATOR'S
MAINTENANCE SCHEDULE (SUGGESTED)

PREVENTIVE MAINTENANCE

While operating the boiler, if anything happens where obvious damage may occur by continuing to operate, load should be reduced, and the unit taken out of service as soon as possible. Inspection should be made to assess the problem. If there are questions about the condition of the unit, contact the **INDECK** Service Department.

Problems which may arise during the operation of a boiler can be separated into two (2) categories: The first is "Operational Problems", the second is "Maintenance Problems". In this section, the second category will be dealt with. Keep in mind the basic axiom that preventive maintenance is the best tool towards avoiding problems that ultimately cause untimely shut down and loss of production.

REFRACTORY

Routine maintenance is normal with any refractory construction. When the boiler is subjected to cyclic operation, (fired and shut down frequently) the maintenance of the refractory increases. Since refractory is not ductile, any shock load can crack it. When cracking of the castable walls occurs, hot gases can seep into the wall and either destroy the backing insulation or overheat the casing. Once the backing insulation is destroyed, the casing becomes exposed to the flame temperature. Spalling, when a fragment of the refractory breaks loose, is not abnormal. Spalling can be tolerated, provided the loss of material is not over half of the thickness of the original pour.

Spalling should be patched with a compatible mortar at the next outage of the unit. Cracks in the refractory should be stuffed with high temperature ceramic fibre felt, but never patched with mortar. If high casing temperatures do arise, the boiler should be brought OFF-line as soon as possible for internal inspection and repair. A reputable refractory firm or the **INDECK** Service department should be consulted before any extensive refractory work is attempted.

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TUBES

Another routine maintenance problem is soot build up on the gas side of tube surfaces. As has been discussed earlier in this manual, soot or carbon build up can impede thermal transfer and is due to high soot build up, the most likely cause is the burning rate, or the air-fuel ratio is out of proportion. At every outage, if possible, check the water side of the tubes for scale build up. If a scale deposit is formed on the tube surfaces, heat cannot pass effectively into the water. The scale causes the steel tube to become overheated and they could blister or swell to a point of rupturing. Preventing scale build up requires close cooperation with a reputable water treatment laboratory, and close surveillance of the feedwater system. To remove this scale, build up from the tube surface, a mechanical tube cleaner can be used, but chemical cleaning has been found to be more effective. If the chemical cleaning is done, it must be closely supervised and it is advisable to hire professional personnel since the process, if done incorrectly, can cause irreparable damage to the tube metal.

COMBUSTION EQUIPMENT

The main component of the combustion equipment which requires maintenance, is the burner. This component will be covered in the "Burner Operating and Instruction" manual. The valves in the fuel system require routine maintenance, such as stem packing.

WATER COLUMN AND AUXILIARY FLOAT TYPE LEVEL CUT-OFF

The water column and water gauge glass should be blown down at the beginning of each shift. The three times a day schedule will insure two things: first, the sludge or sediment will not have a chance to accumulate in the column or glass. Any accumulation can cause an erroneous level indication. Second, the boiler attendant, by observing blowdown and return of liquid to glass, will be assured of proper actuation of one of the most important safety devices of the unit.

When the boiler is out of service for the annual inspection, dismantling the water column, gauge glass, etc. and clean the internals thoroughly.

OPERATOR'S MAINTENANCE

A conscientious maintenance program should be applied. The following list is by way of suggestion.

1. Each shift

- a) Check fuel pressures and temperatures at burner. Inspect flame pattern through burner and rear wall observation ports.
- b) Blowdown water column and gauge glass.
- c) Operate sootblowers. (The sootblowing sequence must follow the internal boiler gas flow).
- d) Check operation of continuous blowdown.

2. Daily

- a) Clean fuel strainers or filters.

3. Weekly

- a) Clean lens of scanner.

4. Periodically

- a) Clean and inspect inside of furnace for deterioration of refractory or insulation.
- b) Clean atomizing tip on oil gun.
- c) Remove pilot assembly for cleaning and resetting of spark gap.

Preventative Maintenance Schedule

PURPOSE AND SCOPE

The information presented provides guidance to those individuals responsible for maintenance of boiler plant equipment.

Preventive maintenance is the systematic and periodic inspection and servicing required for keeping equipment in proper operating condition. The life of the boiler plant equipment depends largely upon its maintenance. Boiler life is consistently higher in a well maintained plant than in a poorly maintained one.

The plant supervisor has the ultimate responsibility for boiler plant equipment, its proper operation, and the scheduling and performance of preventive maintenance. The plant supervisor should assign to themselves responsibility for all inspection and servicing required for plant safety. They will assign other operating or maintenance personnel the responsibility for maintenance of specific pieces of equipment, as required by the preventive maintenance plan. Some items listed for a daily inspection by an assigned individual also require hourly inspections by the operating personnel. These hourly inspections do not relieve the assigned operator of his responsibility to inspect, service, and record the equipment condition.

Inspection is the first step in a preventive maintenance program. The early detection of problems can greatly simplify maintenance, reduce the amount of damage, and prolong equipment life. The key to an effective inspection is a complete understanding of the equipments operating characteristics. The operator should know the condition, sound, temperature, pressure, speed, vibration, and performance characteristics of each piece of equipment in the plant and particularly those for which he/she is assigned responsibility. Any change in normal characteristics should be immediately reported, recorded, investigated, and corrected.

Preventive maintenance programs are effective only if careful, accurate, and complete records are kept. Each time a piece of equipment is inspected a record should be made detailing any noticeable change in normal characteristics. Each time a piece of equipment is worked upon, a detailed record should be made describing the work and type of work whether the work was a repair or preventative maintenance. It may also be helpful to record any useful manual references, the frequency of the same task, and the time required to complete the task.

SCHEDULING AND USE OF THE INFORMATION

The following sections provide suggested preventive maintenance schedules for the boiler plant equipment. The subparagraph designates the frequency for preventive maintenance: daily, weekly, monthly, quarterly, semiannually, and annually. The second subparagraph numbers are numbered consecutively and can be used as index numbers in the records. The lists or inspection and work presented here should not be considered to be complete. Review the manufacturer's operating and maintenance instructions and add additional required items as needed. Review the applicable ASME Code and the National Board Inspection Code published by the National Board of Boiler and Pressure Vessels Inspectors, for additional requirements and suggestions. Other equipment may be found which is not discussed in this section. Such equipment should be researched with the manufacturer and appropriate records prepared. The frequency suggested here is based on good practice and experience. Modify the suggested frequency to best match local conditions and experience.

I BOILERS

The successful operation and maintenance of a boiler is greatly dependent on the operation and maintenance of its auxiliaries. Boiler operation and boiler preventive maintenance both involve the inspection of the boiler operating conditions.

A. Daily

- (1) Check the following conditions and take action as required
 - (a) Water level.
 - (b) Water pressure or water temperature stability.
 - (c) Flue gas temperature at two loads, compared to clean boiler temperatures.
 - (d) Flue gas oxygen or carbon dioxide levels at two loads, compared with baseline data.
 - (e) Water or steam leaks.
 - (f) Air leaks in casing & ducts.
 - (g) Blowdown gauge glass
 - (h) Blowdown & test low water cut-off.
- (2) Take water samples and perform necessary tests. Adjust internal treatment and continuous blowdown.
- (3) Blowdown boilers through the bottom blowdown connection to remove sludge.
- (4) Clean boiler exterior
- (5) **WATER COLUMNS**
 - (a) Blowdown and inspect all water columns, gage glasses, level indicators, and level alarm devices for leaks, correct operation, correct level indication: and adequate lighting. Repair leaks immediately.
 - (b) Check to see that valves between boiler and gage glass are free and operational.
 - (c) When provided, test high and low automatic alarm to ensure that it is in perfect order. Repair when faulty.
- (6) **SAFETY VALVES**
 - (a) Check for steam leakage indicating damaged seat, defective parts or lodged scale. Correct immediately such faults as leaking, simmering or chattering.
 - (b) Check supports and anchors of discharge pipe.
 - (c) Check the drain line from safety valve outlet to insure that it is open and will function when needed.
- (7) Inspect boiler piping, valves and fitting for leaks.

B. Monthly

- (1) Lever test all safety valves. Check each safety valve by raising the valve off the seat by listing the lever. Keep the valve wide open for at last 10 seconds to blow dirt and scale clean from the seat. Close the valve by suddenly releasing the lever.
- (2) Inspect all boiler drain valves for proper opening and closing.
- (3) Inspect boiler room floor drains for proper function.
- (4) Inspect all safety controls for such problems as dirty switch contacts, defective diaphragms or sensing elements, loose wires, dirty flame scanner lens or flame rod. Clean or repair immediately.

C. Quarterly

One of the quarterly inspections should be timed to coincide with the annual inspection by the Authorized Inspector.

- (1) Internally and externally inspect the boiler. Reference semi-annual and annual procedures.

D. Semi-Annually

Semi-annually or as required an external inspection of the boiler by an Authorized Inspector is required. With the boiler operating, inspect for the following:

- (1) Any evidence of steam or water leakage.
- (2) Pressure gage accuracy and function.
- (3) Safety or safety relief valves.

- (4) Water level gage function.
- (5) Pressure controls function.
- (6) Low water fuel cutoff and level control function.
- (7) Steam, water and blowdown piping for leakage, vibration, proper rating, and freedom to expand.
- (5) Review the boiler log, maintenance records, and water treatment records to ensure that regular and adequate tests have been made.

E. Annually

Boiler inspections are to be made in accordance with Rule for Inspection in Section VII of the ASME Boiler and Pressure Vessel Code. An Authorized Inspector is required.

(1) Inspect the boiler for the following:

- (a) Water side of tubes and boiler for corrosion, grooving and cracks.
- (b) All manholes, manways, internals and connections to the boiler for cracks, corrosion, erosion and clean passages.
- (c) Tube sheets, tube ends and drums for signs of thinning, leaking, corrosion or cracks.
- (d) Boiler supports and setting for freedom of expansion.
- (e) Fire side of tubes for bulging, blistering, leaks, corrosion or erosion.
- (f) Settling for cracks, settlement, loose bricks, refractory spalling and leakage.

Safety valves and their connections and piping. Test the safety valves. Before and after the annual steam generator inspection and overhaul, test the operation of all safety valves. Testing is also required whenever the spring or blow back ring has been reset or adjusted.

II BURNERS

A1. Oil Burners

a. Daily

(1) Inspect for the following hourly:

- (a) Oil, steam, or air leaks. Repair immediately.
- (b) Unburned oil deposits and overheating of burner parts.
- (c) Burner flame for proper shape, color and stability.
- (d) Proper operating pressures and temperatures.
- (e) Check gas, oil, steam pressure readings to make sure conditions are normal.
- (f) Check lens of scanner & check flame failure cut-out.

b. Annually

- (1) Inspect all air register and burner parts for freedom of movement, warpage, and wear. Repair and/or replace as required. Adjust all parts for proper operation. The services of a burner/Indeck technician may be required.
- (2) Check/replace atomizer tips or nozzles that have been in normal service with new tips or nozzles.
- (3) Calibrate burner pressure and temperature gages.
- (4) Check/remove and clean the oil atomizer.
- (5) Check ignition electrode/pilot for proper gap/flame, adjust if necessary.
- (6) Inspect flame view lens ports, clean if necessary.
- (7) For electric ignition systems, test and record voltage readings on each side of the ignition transformer.
- (8) Visually inspect all control linkages and components for proper operation, lubricate moving parts, if necessary.

A2. Oil Handling Equipment

a. Daily

(1) Inspect for the following:

- (a) Oil, Steam water, or air leaks. Repair immediately.
 - (b) Proper operation of traps, controls, and instrumentation.
 - (c) Proper operating pressures, temperatures, and levels.
 - (2) Clean equipment as required.
 - (3) Establish a schedule for cleaning strainers.
 - (4) Inspect and maintain pumps.
 - b. Annually
 - (1) Inspect and clean tanks internally and externally. Inspect carefully for corrosion, erosion, pitting, plugged tubes, damaged baffles, sludge deposits, water accumulations, and scale deposits.
 - (2) Inspect for damage to protective coatings or paint. Repair or repaint as required.
 - (3) Test relief valve settings and operation.
 - (4) Clean, inspect, and calibrate all controls and instrumentation.
- B. Gas Burners
- a. Daily: Inspect for the following hourly:
 - (1) Gas or air leaks. Repair immediately.
 - (2) Proper gas and air pressures.
 - (3) Burner flame for proper shape, color, and stability.
 - (4) Overheating or binding of burner parts.
 - (5) Flame scanner, check flame signal strength.
 - b. Annually:
 - (1) Inspect all burner parts for freedom of movement, warpage and wear. Inspect gas nozzles. Repair or replace as required. Adjust all parts for proper operation. The services of a burner serviceman may be required.
 - (2) Calibrate burner pressure gages.
 - (3) Check ignition electrode/pilot for proper gap/flame, adjust if necessary.
 - (4) Inspect flame view ports, clean if necessary.
 - (5) Electric ignition systems, test and record voltage readings on each side of the ignition transformer.

III FUEL RACK

- a. Daily:
 - (1) Inspect natural gas and oil, isolation and control valves, air intake damper and damper drive linkages, adjust if necessary.
 - (2) Inspect for air, oil, gas and water leaks. Repair immediately.
 - (3) Blow down compressed air drip legs and filters.
- b. Monthly:
 - Inspect all fuel solenoid valves, full closure and proper operation.
 - Test valve settings and operation.
- c. Quarterly:
 - Clean and inspect all fuel oil strainers.
 - Check actuator motor for proper operation.
 - Inspect, and calibrate all controls and instrumentation. Inspect boiler fuel piping, valves, gaskets and fitting for leaks. Inspect and replace as necessary.
- d. Annually:
 - Inspect and test all fuel gas isolation valves to confirm proper fuel isolation and venting.
 - Check/confirm that fuel gas is vented to a safe location away from people, equipment and flame source, etc.

IV COMBUSTION CONTROLS

- a. Daily:
 - (1) Inspect for stable and proper operation.
 - (2) Clean exterior of controls cabinet.
- b. Monthly:

Replace or clean all system filters. Check boiler set points align with service and operation records.
- c. Semi-Annually:
 - (1) Perform hard drive maintenance requirements as outlined in Indeck's "Standard maintenance for HMIs"
- d. Annually:
 - (1) Inspect and completely clean all control devices. Replace any worn, corroded, or damaged parts.
 - (2) Test for correct calibration on instruments. Adjust as required.
 - (3) Obtain the assistance of a fully trained Indeck technician as required to calibrate, clean and adjust the controls.
 - (4) The Indeck technician should tune the boiler for operation on the primary fuel. A combustion gas analyzer should be used to check burner efficiency at 25%, 50%, 75%, and 100%. Firing rate.
 - (5) Other observations should be made during boiler tune-up such as fuel/air ration, flame color/spread, opacity, stack temperatures, and O₂/NO_x/CO/CO₂ concentrations.
 - (6) Check/test burner control panel/system for the following indication lights/safety devices/alarms; flame failure, high/low gas/oil pressure, air switch and alarms on HMI.

V OPERATIONAL TESTING OF BOILER SAFETY DEVICES:

- a. Monthly
 - (1) Low- water cutoff (slow drain) [Low water flow for hot water boilers]
 - (2) Fire each boiler & the pilot on the alternate fuel for 1 hour (if applicable)
 - (3) Low-water cutoff trip switch [Low water flow trip switch for hot water boilers]
 - (4) Auxiliary low-water cut-off (slow drain)
 - (5) Auxiliary low-water cut-off trip switch
 - (6) Steam safety valves (accumulation test at high fire)
 - (7) Steam safety valves (raise boiler pressure until valve pops)
 - (8) Low-water cutoff bypass switch
- b. Semi-Annually
 - (1) High-water alarm
 - (2) Low-water alarm
 - (3) High-steam pressure cut-out (recycle)
 - (4) High-steam pressure cut-out (non-recycle)
 - (5) Flame scanner
 - (6) Check gas vent for leaks
 - (7) High-gas fuel pressure cut-off
 - (8) Low-gas fuel pressure cut-off
 - (9) Gas fuel safety shut off valves proof of closure
 - (10) Leak test gas fuel safety shut off valves
 - (11) High-fuel oil temperature cut-off (heated fuel)
 - (12) Low-fuel oil temperature cut-off (heated fuel)
 - (13) Low-atomizing pressure for fuel oil
 - (14) High-fuel oil pressure cut-off

- (15) Low-fuel oil pressure cut-off
- (16) Fuel oil safety shut off valves proof of closure
- (17) Leak test fuel oil safety shut off valves
- (18) Check operation of Liquid Petroleum Gas pilot
- (19) Low-pilot gas pressure cut-out
- (20) Forced draft fan motor interlock
- (21) Forced draft fan damper limit switches
- (22) Boiler outlet damper limit switches
- (23) Purge air flow interlock
- (24) VIV damper limit switches
- (25) High water cutout switch
- (29) Main flame out; i.e., time to close valves
- (30) Ignition flame out; i.e., it is time to close valves
- (31) Minimum igniter flame test
- (32) Scanner not sensing ignition spark
- (33) Low-oxygen alarm and/or cut-out

VI FEEDWATER/DRUM LEVEL CONTROLS

- a. Daily:
 - (1) Inspect for water leaks. Repair immediately.
 - (2) Observe operation of feed-water control valve. Report and repair any malfunction immediately.
- b. Annually:
 - (1) During the boiler overhaul, or more often, if necessary, clean and inspect all control components. Look for signs of corrosion, erosion, or wear and for deposits, leaks, and defective parts. Repair as required.
 - (2) Check settings, adjustments, and operation of all components.

VII INSTRUMENTATION

- a. Daily:
 - (1) Inspect for leaks. Repair immediately.
 - (2) Check for proper operation. Report any malfunction. Only trained personnel should place in service, remove from service, calibrate, or maintain instruments.
 - (3) Inspect for undue vibration, broken glass, lighting, and readability.
- b. Annually:

Once a year, or more often if necessary, make a thorough inspection of all instruments and gages for corrosion, deposits, or other defects. Inspect carefully for the following:

 - (1) Ruptured or distorted pressure parts.
 - (2) Incorrect calibrations or adjustments.
 - (3) Badly worn pins or bushings.
 - (4) Damaged or burned thermocouple wire insulation.
 - (5) Leaking or damaged diaphragms, bellow and gaskets.
 - (6) Mercury separations in thermometers.
 - (7) Loose pointers.
 - (8) Broken balance-arm screws.
 - (9) Plugged piping or tubing.
 - (11) Broken or damaged adjustment assemblies.
 - (10) Defective mechanism or electric motor operation.

VIII ECONOMIZERS

- a. Daily:

Inspect for leaks in piping, valves, packings, gasketed joints, manway openings, casing, etc., make repairs as required.

b. Monthly:

Check the following under identical load conditions:

- (1) Water pressure drop through the economizer.
- (2) Draft losses across the economizer.
- (3) Gas temperature drop across the economizer. An increase in draft loss and a decrease in gas temperature drop normally indicates a fouling condition.

c. Annually:

During the annual boiler overhaul, clean and inspect the economizer.

- (1) Externally look for signs of overheating, leakage, wear, or corrosion in pressure parts.
Check the baffles and tubes in the area of soot blowers for signs of abrasion caused by steam cutting. Check the elements of the soot blower.
- (2) Internally look for corrosion, erosion, scale, sludge deposits, or oil in tubes and headers.

IX ELECTRIC MOTORS

a. Daily:

- (1) Inspect for the following:
 - (a) Cleanliness.
 - (b) Overheating.
 - (c) Hot bearings.
 - (e) Unusual noise or vibration.
 - (f) Establish lubrication and motor maintenance in accordance with manufacturers recommendations.

b. Quarterly:

Perform vibration tests of bearings and collect data to create baseline for future comparison.

c. Annually:

- (1) Check for loose or broken cooling fan blades.
- (2) Check coupling alignment.

X.FORCED DRAFT FANS

a. Daily:

- (1) Inspect for the following:
 - (a) Abnormal noises.
 - (b) Abnormal vibration.
 - (c) Overheating of drive.
 - (d) Abnormal bearing temperature.
 - (e) Condition of oil/grease and bearing oil level.
 - (f) Proper flow and temperature of bearing-cooling water (if required)
 - (g) Freedom of damper motion.
- (2) Establish lubrication requirements and schedule in accordance with manufacturers recommendations.
- (3) Check that actuators are secured/anchored correctly.
- (4) Confirm that damper positioners are operating correctly.

b. Monthly:

- (1) Inspect entire unit for unusual noise and/or vibration, insure that it is in good working order.
- (2) Check the damper linkages are properly connected and operating.
- (3) Inspect ductwork flexible connectors for abnormalities and leaks.
- (4) Inspect gaskets around access doors.
- (5) Lubricate fan bearings and motors, as necessary.
- (6) Lubricate all moving parts/connections, as necessary.
- (7) Operate dampers over the full modulation range, verify proper operation and position.

c. Quarterly:

- (1) Check: alignment of shaft and coupling; inspect coupling.
- (2) Check condition of foundation and tightness of bearing, actuators, fan and foundation bolts.
- (3) Inspect bearings, perform vibration testing and collect data to create baseline for future comparison.
- (4) Check access doors for tightness.
- (5) Inspect unit for unusual noise and/or vibration, ensure that it is in good working order.
- (6) If unit is not running or an identified problem requires the unit to be serviced, perform ALL Non-Critical Tasks listed below.
- (7) Inspect fan and motor assemble for proper alignment.
- (8) Provide lubrication, if necessary.
- (9) Check for bearing vibration, record levels at each bearing.

d. Semi-Annually:

Inspect the following:

- (1) All pneumatic/electrical connections, tighten if necessary.
- (2) All fan wiring for deterioration.
- (3) Motor-shaft coupling connection and ensure tightness.
- (4) Controls and cycle actuators to ensure proper operation.
- (5) Verify that dampers open and close fully.
- (6) Inspect all linkages and ensure proper positioning.

e. Annually:

Annually, or more often if required, inspect and performs the following maintenance work:

- (1) Complete by overhaul bearings.
- (2) Inspect all gauges and meters, ensure they are functional, replace if necessary.
- (3) Inspect all fan wiring for deterioration.
- (4) Check damper linkage, set screws and blade adjustment for proper tightness.
- (5) Inspect damper collar set screws and weld connection on shaft. Ensure tightness.
- (6) Ensure tightness of all electrical connections.
- (7) Inspect motor starter/control center.
- (8) Ensure that overload settings are proper.
- (9) Verify correct operation of starter.
- (10) Inspect electrical contact surfaces for pitting or wear.
- (11) Inspect fan assembly.

XI STEAM TRAPS

Establish a comprehensive and coordinated maintenance and inspection program for all steam traps, strainers, and separators. As a minimum, the following must be done for central boiler plants.

a. Daily: Inspect the traps, strainers, and separators for the following:

- (1) Piping leaks. Repair as necessary.
- (2) Correct operation.
- (3) Abnormal pressure drop across strainers.
- (4) Unusual accumulations of foreign matter in strainer baskets.
- (5) Unusual and excessive discharge of condensate and oil from separators.
- (6) Damage to insulation at traps. Repair as necessary.

b. Monthly:

- (1) Blowdown steam trap to eliminate dirt accumulations.
- (2) Open the air vents on float traps to vent accumulated air.
- (3) Test traps for correct operation.

c. Annually:

- (1) Completely disassemble all steam traps and inspect them carefully for the following:
 - (a) Cracked, corroded, broken, loose, or worn parts.

- (b) Excessive wear, grooving, and wire drawing of valves and seats.
- (c) Defective bellow, buckets, or floats.
- (2) Replace or repair all defective gaskets, linkages, and orifices.
- (3) Reassemble and test for proper operation.

XII DUCTWORK, EXPANSION JOINTS, DAMPERS, STACK, LADDER AND PLATFORMS

- a. Daily: Inspect for possible defects, leaks, damage or settlement in foundation.
Report promptly any such observation.
- b. Quarterly:
 - (1) Make a more thorough examination of the ductwork, expansion joints, dampers & stack to look for cracks, corrosion, loose hangers, damaged lightning rod and connectors, loose parts, etc.
 - (2) Check dampers to ensure free movement.
- c. Semi-Annually: Carefully examine supports for corrosion, cracking, or movement of anchor blocks. Check for corrosion of ladder and platforms.
- d. Annually: Inspect equipment internally and externally. Inspect lightning rod tips and ground connections. Paint.

XII AIR HEATERS

- a. Daily:
 - (1) Inspect the air heater for gas or air leaks in duct, casing, gasketed joints, etc.
 - (2) Inspect for abnormal air or gas temperatures.
- b. Monthly: Check the following under identical load conditions:
 - (1) Air and gas side draft losses.
 - (2) Gas temperature drop through the air heater.
- c. Annually:
 - (1) During the boiler overhaul, clean and inspect the air heater. Look for indication of corrosion, erosion, leakage, and wear.

XIII DEARATING HEATERS AND DEARATORS

- a. Daily:
 - (1) Check for correct operation of relief valve, steam pressure reducing valve, overflow, controls, alarms and steam pressure and temperature indicator. Report any malfunctions immediately.
 - (2) Inspect for steam and water leaks. Repair immediately.
 - (3) Check vent for proper operation.
 - (4) Check tank and water temperatures.
- b. Annually: Once a year, or more often under severe service conditions, clean the unit and inspect the following:
 - (1) Spray valves for corrosion, erosion, scaling and proper seating.
 - (2) Water discharge nozzles for clogging, corrosion, and wear.
 - (3) Trays (on tray type units). Remove and inspect for corrosion, warping, and scaling.
- c. Quarterly: Inspect for the following:
 - (1) Compressor valves for wear, dirt and improper seating.
 - (2) Operation of all safety valves.
 - (3) Cleanliness of air intake filter.
 - (4) Tightness of cylinder head bolts and gaskets.
- d. Annually:
 - (1) Check cylinders for wear, scoring corrosion and dirt.
 - (2) Inspect pistons and rings for leakage, wear, scoring, security to the piston rod and head clearances.

IX CENTERIFUGAL PUMPS

- a. Daily: Inspect for the following hourly.
 - (1) Abnormal vibration and noise.
 - (2) Abnormal pressure and flow conditions.
 - (3) Excessive or inadequate packing leakage.
 - (4) Hot bearings.
 - (5) Hot stuffing box.
- b. Semi-Annually:
 - (1) Check alignment of pump and driver with the unit at stand-still and normal operating temperature.
 - (2) Check shaft sleeves for scoring.
 - (3) Replace packing if required.
 - (4) Drain the oil from oil-lubricated bearings, flush, and refill with clean oil.
 - (5) Check grease-lubricated bearings. Do not overgrease the bearings. When adding grease, remove drain plug or use a safety fitting to prevent overgreasing.
 - (7) Check pump bearing vibration, bearing record vibration levels at each bearing.
- a. Daily: Check for the following:
 - (1) Shaft for scoring, corrosion, or wear at seals, alignment and coupling connection.
 - (2) Calibrate pressure gages, thermometers, and flowmeters.
 - (3) Suction and discharge strainers for cleanliness.

XV CENTERIFUGAL PUMPS

- b. Daily:
 - (1) Inspect for the following:
 - (a) Unusual noise or vibration.
 - (b) Abnormal temperature and pressure of compressed air, cooling water, or lubricating oil.
 - (c) Proper operation of unloader.
 - (d) Hot bearings and stuffing box.
 - (e) Correct lubricating oil level and oil consistency.
 - (2) Establish lubrication requirements and schedule in accordance with manufacturers recommendations.