

## CHAPTER 5

# INSPECTION AND PREVENTIVE MAINTENANCE

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### SECTION I. INTRODUCTION

#### 5-1. PURPOSE AND SCOPE.

This chapter is presented for the information and guidance of those responsible for maintenance of boiler plant equipment. It establishes a complete preventive maintenance system. The use of DA Form 4177, the Utilities Inspection and Service Record, is described. This system of maintenance assignments and records is sufficiently flexible to be applicable to most boiler plant installations. Although this manual schedules most of the maintenance called for by manufacturers, it is not intended to take the place of manufacturer's instruction sheets. Each plant must maintain for ready reference and use a manufacturer's instruction file on all installed equipment.

#### 5-2. TYPES OF MAINTENANCE.

**a. Forced Maintenance.** Forced outages for the repair or replacement of equipment parts that have failed in service can be, and often are, very costly. Through the application of proper operating procedures and careful inspection, it is possible to increase the length of time over which a boiler can be carried on the line before any repairs are required. This, in turn, will prolong the useful life of the equipment and minimize forced maintenance. The principal causes of forced outages and excessive maintenance are:

- Sustained and frequent overloading of fuel burning equipment
- Operating with improper air flow conditions
- Fouling of external heating surfaces
- Inadequate water conditioning
- Improper lubrication

Forced maintenance is outside the scope of this manual. Normally, forced maintenance and major overhauls are not performed by operating personnel, but rather by assigned maintenance personnel or outside contractors.

**b. Preventive Maintenance.** Preventive maintenance can be defined as the systemic and periodic inspection and servicing required to keep equipment in proper operating condition. It means fixing things before they break, thus keeping equipment in continuous service or ready for service. The life of boiler plant equipment depends largely upon its maintenance, and the cost of operation in a well-maintained plant is consistently lower than in a poorly maintained one. In addition, proper preventive maintenance results in improved working conditions and better worker

morale.

#### 5-3. RESPONSIBILITY

The chief operator or plant supervisor has the ultimate responsibility for boiler plant equipment, its proper operation, and the scheduling and performance of preventive maintenance. The chief operator should assign to himself responsibility for all inspection and servicing required for plant safety. He will assign other operating or maintenance personnel the responsibility for maintenance of specific pieces of equipment, as required by the preventive maintenance record card system. Some items listed for 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.

#### 5-4. INSPECTION.

Inspection is the first step in a preventive maintenance program. The early detection of a problem can greatly reduce the amount of damage, simplify maintenance, and prolong equipment life. The key to effective inspection is a complete understanding of the equipment's 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 is assigned responsibility. Any change in normal characteristics should be immediately reported, investigated, and corrected.

#### 5-5. HOUSEKEEPING.

A neat boiler plant generally indicates a well run plant. The boiler plant should be kept free of all unnecessary material and equipment. Good housekeeping should be encouraged and procedures established to maintain the desired level of cleanliness. Equipment should be kept clean. Sometimes cleaning is all that is required to keep equipment in trouble-free operation. Moisture, dirt, dust, cobwebs, bugs, and oil in the wrong place are all enemies of mechanical and electrical equipment. Stop leaks as soon as they are detected. Unrepaired leaks at best represent waste and at worst may cause extensive damage.

## 5-6. UTILITIES INSPECTION AND SERVICE RECORDS.

Preventive maintenance programs are effective only if careful, accurate, and complete records are kept. In no other way can the Director of Engineering and Housing ensure that all personnel are carrying out their responsibilities and that equipment is being properly maintained. DA Form 4177, shown in figure 5-1, is the basic card from which the record system is assembled. Two separate cards, a field card and a master card, are made up for each major piece of plant equipment. A complete set of master cards is kept in a loose-leaf binder in the plant office, which the field card becomes a written assignment of work for the operator. The record is complete within itself and is available for inspection by the Director of Engineering and Housing or Army command inspector. A copy of this manual should be kept in each plant to facilitate references to the items listed on the cards.

**a. Record Card Entries.** Care is required to initially fill in the cards properly. Each entry is discussed below.

(1) **Equipment Number.** The equipment number entry is made up of three parts separated by dashes. The first part is the boiler plant building number. The second part may refer to the paragraph in this chapter which discusses the equipment, or it may be a number assigned by the Director of Engineering and Housing, or an equipment classification code. The third part distinguishes between a number of identical or similar pieces of equipment.

(2) **Description.** Describe equipment briefly but in enough detail so that it can be readily identified.

(3) **Preventive Maintenance To Be Done By.** Show the job title and name of the person responsible for maintenance; this should normally be the person who actually operates the equipment. He is also responsible for reminding the chief operator, superintendent, or other supervisor of any special semiannual or annual inspections required, and for ensuring that the supervisor makes the appropriate entry on the card after the inspection is completed.

(4) **Work To Be Done.** Study this manual and the equipment manufacturers manual, noting all inspection and service required. Enter in this space the paragraph or subparagraph heading describing the operation. Add any operations not covered in the manual but needed to maintain the unit. Ensure that all necessary inspections and services are shown on the record card. List operations in order of frequency of performance, with daily service first.

(5) **Item Number.** Identify each operation with the proper item number. Usually the item number is the subparagraph number unless an item number is noted. Where the same item number is used to identify more

than one operation, differentiate between them by adding a letter to one of the numbers; thus, if "1" is used twice, write one of them as "1a".

(6) **Reference.** Insert paragraph numbers to facilitate reference to the appropriate manual.

(7) **Frequency.** Record frequency of operations, as shown in Time-Schedule columns. Modify suggested frequencies as required to fit local conditions.

(8) **Time.** Show specific day or month when service is due. Stagger quarterly, semiannual, and annual inspections so as to minimize rush periods and schedule conflicts. Choose the season when the work can be best accomplished.

(9) **Tab Index.** Mark an X at the top of the form alongside each month during which work is to be done or a report submitted. This helps to schedule operations, since overall work required in a given month can be quickly determined by reference to the tab index.

(10) **Service Record.** On the back of the card, record the date and item number whenever maintenance is performed, and initial. If service is required beyond the ability or authority of the inspector, he must request the proper help and enter the request in the Work Done column. For example, if inspection of a motor reveals a grooved commutator, the entry would read Electrician needed to complete Item 51 — commutator grooved. The work order number is entered under the column headed Signed and is initialed. When all spaces on the Service Record are filled in, a blank card should be stapled to the original.

**b. Assignment of Work.** Only general rules covering assignment of preventive maintenance work are given here. Actual assignments will necessarily depend upon the specific plant and the qualifications of operating personnel. Work loads of all personnel should be substantially equal, and duties assigned must be in keeping with the qualifications of the individual. A coal handler, for example, may inspect the stack and breeching for fly-ash accumulations, and examine guy wires, coal bunkers, elevators, and conveyors. He should not be expected to maintain and adjust flow meters or combustion controls.

(1) **Chief Operator/Supervisor.** The chief operator is charged with overall responsibility for the plant. Therefore, inspections having to do with safety of operation or the possibility of serious damage to equipment are assigned to him. These items must be checked at frequent intervals. Likewise, items of major importance such as internal inspection of boilers and furnaces should be under his personal supervision.

(2) **Regulag Operators.** Shift operators, firemen, or other qualified personnel usually have maintenance duties in addition to their regular assignments. The man to whom a given piece of equipment is assigned should perform the required maintenance during whatever shift he happens

to be working on a given day. During this man's time off, the relief operator or the chief operator performs the scheduled maintenance. Maintenance activity can sometimes be assigned entirely to day-shift operators. This arrangement necessitates close supervision to guard against neglect, but maintenance work during daylight hours is more pleasant and frequently more effective.

(3) **Maintenance Men.** In plants where regular maintenance men are available, assignment of preventive maintenance work is simplified. Here day-shift work is usual. However, certain special items should still be assigned to skillful operators.

c. **Record Card Example.** Figure 5-1 illustrates a Master Record Card for a typical boiler. In this example the boiler is the No. 2 boiler located in building NN11. A Field Record Card would be similar, but would also include initials for all daily inspection and servicing performed.

d. **Use of the Record Card System.** The Record Card System consists of duplicate sets of the DA Form 4177 card, one set making up a Field File and the other the Master File. The Field File is made up of the forms forwarded to the operator who maintains the equipment. A copy of this manual is maintained in the plant to explain duties. The assigned operator makes all service entries and keeps his copies of the forms up to date. Forms in the Field File are kept in the operator's possession except at the beginning of the month, when they are sent to the supervisor for transfer of consolidated data to the Master File. Record cards in the Master File are arranged by equipment number and kept in the work supervisor's office. A movable tab is placed on the tab index of each card, above the month during which maintenance for the unit is next scheduled. When operators turn in the Field File at the beginning of the month, entries are checked to ensure that all work was done and a summary of the entries is transferred to the Master File. The summary includes any special difficulties encountered by the operator, work orders required for maintenance, and the consolidated entry of items checked. After all entries are made, movable tabs are then shifted to the next month when maintenance is scheduled and Field File cards are returned to the operator. Any tabs in the Master File that are not moved are readily apparent. Since they indicate that a Field File card was not turned in or that work was not completed, immediate follow-up is essential. Careful supervision and attention to detail in setting up the system will pay dividends in accomplished maintenance and more efficient operation.

## 5-7. TOOLS.

Proper preventive maintenance requires proper tools and instruments. Review the operations listed on the maintenance cards and determine the tools required for

each operation. There is no single list of tools which will apply to all plants. However, each plant should be equipped with a workbench with a pipe vise, a machinists vise, and a tool board.

a. **Special Tools.** Some maintenance operations require tools which would be used too infrequently to justify their purchase for the central boiler plant. If possible, such tools should be borrowed from other departments on the post; otherwise, requisition them. Indicate on the maintenance card the department from which they may be borrowed.

b. **Care of Tools.** Maintain all tools in first-class condition. Take defective tools out of service immediately and repair or replace them. Use tools properly. If the proper tool for an operation is not available, immediate arrangements should be made for its procurement.

c. **Tool Board.** Keep all tools on a well-planned tool board or tool box, not in bins, benches, or drawers. Keeping tools on a tool board helps prevent loss and makes them instantly available when required. Locate the tool board in a conspicuous place, convenient to the majority of operators. Space should be provided on the board for additions to the tool supply. A board made of wood is especially satisfactory since it is easily constructed and special hangers and brackets required for the tools can easily be fastened to it. Steel tool boards are more durable and are also frequently used. The shape or size of a tool should not prevent its being installed on the tool board. Extension cords, oil cans, flashlights, and electric drills can be installed on the board by use of special brackets. The outline of each tool should be painted on the board in a contrasting color to assist in replacing tools in their proper place and to serve as a ready check on missing tools.

## 5-8. SPARE PARTS.

Preventive maintenance requires an adequate stock of spare parts. Service conditions, the importance of the part to service continuity, and the ease of procurement all help to determine the kind and number of spare parts kept in stock. Examine the equipment requirements in the plant and prepare a spare parts inventory. Do not neglect to include small parts such as nuts, bolts, shear pins, steam traps, gaskets, valve seats, packing, and cotter pins.

## 5-9. SPECIAL SUPPLIES.

Lubricants and cleaning solvents are needed for proper equipment operation and long life. Clean, properly lubricated equipment is required for successful plant operation.

a. **Lubricants.** Lubricants are frequently referred to in the Scheduled Preventive Maintenance section. Because of the extreme variations in equipment and service

JAN	2	FEB	MAR	APR	2	MAY	JUN	JUL	2	AUG	SEP	OCT	2	NOV	DEC
EQUIPMENT NUMBER NN11-511-2				DESCRIPTION IRON CITY BOILER #2, 350 HP FIRETUBE											
PREVENTIVE MAINTENANCE TO BE DONE BY C. JONES, CHIEF OPERATOR															
ITEM NR	WORK TO BE DONE		REFERENCE	FREQUENCY	TIME										
1	EXTERNAL INSPECTION		5-11a	Daily											
2	TEST BOILER WATER SAMPLES		5-11a	Daily	AM										
3	BOTTOM BLOWDOWN		5-11a	Daily	PM										
4	CLEAN BOILER EXTERIOR		5-11a	Daily											
5	LEVER TEST SAFETY VALVES		5-11b	Monthly	2nd Monday										
6, 7	CHECK BOILER DRAIN VALVES & FLOOR DRAINS		5-11b	Monthly											
8	INTERNAL & EXTERNAL INSPECTION		5-11c	Quarterly											
9	CLEAN FIRESIDE OF BOILER		5-11c	Quarterly											
10	EXTERNAL INSPECTION		5-11d AR420-49	Semi-Annual	APR										
11	ANNUAL INSPECTION		5-11e,f AR420-49	Annual	OCT										

DA FORM 4177  
OCT 73

REPLACES DA FORM 5-22.

UTILITIES INSPECTION AND SERVICE RECORD  
For use of this form, see TM 5-650 series, the proponent agency is Office of the Chief of Engineers.

RECORD OF INSPECTIONS AND SERVICE

FORM 1000 6-60(2)

DATE	WORK DONE	INITIAL	DATE	WORK DONE	INITIAL
1/11/82	Item 5,6 & 7	CJ	10/11/82	Item 5,6 & 7	CJ
1/13/82	Item 8 & 9	CJ	10/13/82	Item 9 & 11 Annual Inspection	CJ
2/8/82	Item 5,6 & 7	CJ	10/14/82	Brush & Wash Waterside	CJ
2/18/82	Reseat blowdown valve	CJ	10/14/82	Replace fusible plug	CJ
3/8/82	Item 5,6 & 7	CJ	11/8/82	Item 5, 6 & 7	CJ
4/12/82	Item 5,6,7 & 10	CJ	12/13/82	Item 5, 6 & 7	CJ
4/14/82	Item 8 & 9	CJ			
4/27/82	Repack mainsteam valve	CJ			
5/10/82	Item 5,6 & 7	CJ			
6/14/82	Item 5,6 & 7	CJ			
7/12/82	Item 5,6 & 7 J.T. 7/12/82	CJ			
7/15/82	Item 8 & 9 J.T. 7/15/82	CJ			
7/19/82	Repair refractory front wall	CJ			
7/20/82	Work Order No. 261	SB			
8/9/82	Item 5,6 & 7	CJ			
9/13/82	Item 5,6 & 7	CJ			

This illustrates a master recorder card which has consolidated the daily and other entries from the field record card.

FIGURE 5-1. RECORD CARD EXAMPLE

conditions, the types of lubricants required for a given plant must be determined locally. The equipment manufacturers instructions, advice from lubricant manufacturers, and advice of the Director of Engineering and Housing help to determine the lubricant requirements. Tables 5-1 and 5-2 are provided to list stock numbers and uses for standard Army lubricants.

**b. Cleaning Solvents.** Cleaning solvents such as mineral spirits, kerosene, and Varsol can be used in central boiler plants. Petroleum derivatives such as naphtha and gasoline present an explosion and fire danger and must never be used. Benzene especially must never be used, as it not only has a low flashpoint, but is also extremely toxic. Follow the precautions for use and storage that are provided with

the solvents. When using cleaning solvents, be sure the solvent is completely evaporated before placing the equipment back into service. When using solvents for cleaning electrical equipment, first remove all loose dirt and dust, then dip a rag into the solvent and wipe the insulation. When spraying solvents, extra precautions against fire or health hazards must be observed. When spraying solvents, extra precautions against fire or health hazards must be observed. When cleaning bearings or machined parts, place the cleaned parts on clean rags or paper, allow them to dry and immediately dip them in oil or apply lubricant. Do not allow rust-susceptible parts to remain exposed to air after cleaning.

## SECTION II. SCHEDULED PREVENTIVE MAINTENANCE

### 5-10. SCHEDULING AND USE OF THE INFORMATION.

The following sections provide suggested preventive maintenance schedules for many types of central 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 on the record cards. The lists of inspection and work presented here should not be considered to be complete. Review the manufacturers operating and maintenance instructions and add additional required items. Review the applicable ASME Code and the National Board Inspection Code published by the National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Avenue, Columbus, Ohio 43229, for additional requirements and suggestions. Other equipment will be found which is not discussed in this section. Such equipment should be researched with the manufacturer and appropriate record cards prepared. The frequency suggested here is based on good practice. Modify the suggested frequency to best match local conditions and experience.

### 5-11. 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) Steam 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, or setting.
- (2) Take water samples and perform necessary tests per chapter 4. Adjust internal treatment and continuous blowdown.
- (3) Blow down steam boilers through the bottom blowdown connection to remove sludge.
- (4) Clean boiler exterior.

#### b. Monthly.

- (1) Item 5. Lever test all safety valves. Reference paragraph 5-15.
- (2) Item 6. Check all boiler drain valves for proper opening and closing.
- (3) Item 7. Check boiler room floor drains for proper function.

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

(1) Item 8. Internally and externally inspect the boiler. Reference semi-annual and annual procedures.

(2) Item 9. Clean the fireside of the boiler.

**d. Semi-Annually.** Semi-annually or as required by AR 420-49 an external inspection of the boiler by an Authorized Inspector is required. Item 10. 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.

Table 5-1. Lubricating Oils, Greases, and Preservatives

Product	Military Specification Number	Symbol	Approximate SAE Grade(1)	National Stock Number(2)	Temperature Above
Lubricating oil, general purpose	MIL-L-15016A	2075	20W		-10°F
		2110(3)	10W-75W	9150-00-223-4137	0°F
		2135	20W-75W	9150-00-231-6664	0°F
		2190	30W	9150-00-231-6639	35°F
		2250	40W		35°F
		3050(3)	20W	9150-00-223-4138	0°F
		3065	30W-80W		5°F
		3080	40W-90W	9150-00-223-8890	15°F
		3150	140W	9150-00-240-2258	25°F
Lubricating oil, compounded	MIL-L-15019B	4065	40W	9150-00-243-3196	35°F
		6135	140W	9150-00-231-6645	60°F
		8190	30W	9150-00-231-9033	35°F
Lubricating oil, mineral, cylinder	MIL-L-15018B	5190	140W	9150-00-240-2260	60°F
Lubricating oil, steam turbine (noncorrosive)	MIL-L-17331B	2190TEP	30W	9150-00-235-9061	60°F
Lubricating oil, internal combustion engine, subzero	MIL-L-10295A	OES		9150-00-242-7603	-65° to 0°F
Lubricating oil, instrument jewel-bearing, nonspreading low temperature	MIL-L-3918	OCW		9150-00-2270-0063	-40°F
Lubricants; chain, exposed-gear and wire rope	VV-L-751A	CW-11B		9150-00-246-3276	All
Lubricating oil, internal combustion engine	MIL-L-2104A	OE-10	10W	9150-00-265-9425	20°F
		OE-30	30W	9150-00-265-9433	0°F
		OE-50	50W	9150-00-265-9440	15°F
Grease, automotive and artillery	MIL-G-10924A	GAA		9150-00-190-0907	-65° to 125°F
Grease, ball and roller bearing	MIL-G-18709	BR		9150-00-249-0908	125° to 200°F
Grease, graphite	VV-G-471C	GG-1		9150-00-272-7652	125° max.
Lubricating oil, internal combustion, preservative	MIL-L-21260	PE-1		9150-00-111-02-1	
				9150-00-111-0208	
Lubricating oil, preservative, medium	PL-MED			9150-00-231-2356	
Corrosive preventive, petroleum, hot application	MIL-G-11796A	CL-3		8030-00-231-2353	
Corrosion preventive, compound, solvent cutback, cold application	MIL-C-16173B	CT-1		8030-00-231-2362	

**NOTES**

- (1) SAE numbers 10W through 50W are for crankcase lubrication. SAE numbers 75W through 140W are for transmission lubrication.
- (2) National stock numbers are for 5-gallon containers for lubricating oils and 35-pound containers for grease, except 1/2-ounce can for MIL-L-3918. For other containers, see Federal Supply Catalog.
- (3) Quenched.

Table 5-2. Lubricating Oil and Grease Uses

Equipment	Oil or Grease Symbol	Equipment	Oil or Grease Symbol
Air compressors		Oilite bronze bushings	OE10, OE30
Vertical with splash lubrication		Pillow block	GAA
Gage pressure less than 100 psi	2110, 3030	Underwater-babbitted	GAA, CG 1
Gage pressure greater than 100 psi	2135, 2190, 3030	Universal joint, slip splines	BR
Horizontal	2135, 2190, 3030	Chain Drives	
External lubrication, sight feed, wick feed, hand oiling	2135, 2190, 3030	Roller	3080, GAA, CG 1
External lubrication, circulating systems or splash type crankcase	2110, 2135, 3030	Roller (enclosed)	Winter, 2075; Summer, 3065
Cylinders: Wet conditions	8190	Roller (semienclosed)	Winter, 3080; Summer, 6135
Dry conditions	2190, 2230, 3065	Slow-speed	CW-IIB
Bearings:		Medium-speed	5190
Ball, all temperatures to 200°F	BR	Chemical feeders	See manufacturer's instructions
Ball, low-pitch line speed		Clarifier equipment	Do.
Operating temperature below 32°F	2075	Couplings	6135
Operating temperature 32° to 150°F	2190, 2230, 3065	Drive jaw clutch	OE30
Ball, medium-pitch line speed		Gear case or gear head	Low temperature, 3080, high temperature, 5190
Operating temperature below 32°F	2075	Gears	Winter, 2075;
Operating temperature 32° to 150°F	2135, 3030	Herringbone	Summer, 3065
Ball, high-pitch line speed		Helical	Do.
Operating temperature below 32°F	2075	Motor reducers	Winter, 3030; Summer, 2135
Operating temperature 32° to 150°F	2135, 3030	Open	5190
Ring-oiled, small, miscellaneous	2110	Planetary	Winter, 2075, 2110; Summer, 2135
Kingsbury thrust bearing	2190TEP	Worm and pump transmission	Winter, 3080; Summer, 6135
Thrust (other than Kingsbury, subject to water)	4065	Instruments	OCW
Thrust (other than Kingsbury, not subject to water)	2135, 2190	Motors	See manufacturer's instructions
Bronze guide	GAA	Packing, Sludge Pumps	4065, 6135
Countershaft	CG 1	Pumps	See manufacturer's instructions
Differential (enclosed)	3150, 5190, 6135	Seal packings	GAA
Eccentric	3065	Shafting	
Guide	GAA, CG 1	Large	2190, 3065
		Small	2110, 2135, 3030
		Shear pins	WB
		Sheaves	CG 1, GAA
		Solenoid oilers	3030
		Valve stems	GAA

- (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.
- (8) Review the boiler log, maintenance records, and water treatment records to ensure that regular and adequate tests have been made.

**e. Annually.** Annual inspections are required by AR 420-49. Boiler inspections are to be made in accordance with Rules for Inspections in Section VII of the ASME Boiler and Pressure Vessel Code. An Authorized Inspector is required. Preparation for an annual inspection is discussed in the next subparagraph. The most recent copy of Boiler Inspection Report, DA Form 416, must be posted for each boiler in the plant.

(1) Item 11. Inspect the boiler for the following; clean and repair as required:

- (a) Water side of tubes for deposits caused by water treatment, scale, or oil. Remove excessive deposits by mechanical or chemical means.
- (b) Stays and stay bolts. Repair or replace as required.
- (c) Water side of tubes and boiler for corrosion, grooving, and cracks.
- (d) All manholes, internals, and connections to the boiler for cracks, corrosion, erosion and clean passages.
- (e) Fusible plugs. Replace annually.
- (f) Tube sheets, tube ends and drums for signs of thinning, leaking, corrosion, or cracks.
- (g) Boiler supports and setting for freedom of expansion.
- (h) Fire side of tubes for bulging, blistering, leaks, corrosion or erosion.
- (i) Setting for cracks, settlement, loose bricks, spalling, and leakage.
- (j) Safety valves and their connections and piping. Test the safety valves.
- (k) Baffles.
- (l) Blowdown piping.
- (m) Boiler appliances.
- (n) When required by the Authorized Inspector, hydrostatically test the boiler.
- (o) Review past inspection reports and plant records.
- (p) Make any other inspection required by the ASME Code or National Board Inspection Code.

(2) **Preparation for an Annual Inspection.** Make the following preparations for annual inspection. Other preparations may also be required by the ASME or National Board Inspection Codes.

- (a) Where sootblowers are installed, blow soot before reducing boiler load below 50 percent.

(b) Shut down the boiler per paragraph 3-33. Shut off fuel supply lines and lock when possible. Sufficiently cool the boiler before draining the water. Internally wash the boiler to remove sludge deposits, suspended solids sediment, and loose scale. Do not clean drums or tubes until after the inspection unless prior agreement has been reached with the Authorized Inspector.

(c) Before opening or entering any part of the boiler, ensure that the nonreturn and stop valves are closed, tagged, and preferably padlocked and drain valves between the two are opened. The feed and check valves must be closed, tagged, and padlocked and drain valves between the two must be opened. After draining the boiler blowoff valves must be closed and padlocked. All drain and vent lines should be opened.

(d) Proper low voltage lighting should be provided for internal inspection.

(e) The fire side walls, baffles, and tubes should be thoroughly swept and ash and soot removed.

(f) If the installation burns coal, remove the grate bars, and clean the firebox plates along the grate line until the bare metal is exposed. Take care not to damage the metal during the cleaning.

(g) Have available a supply of gaskets for manholes and handholes, and suitable wrenches for removing and replacing covers.

(h) Replace fusible plugs.

(i) If insulation conceals manufacturer's inscribed data, remove the lagging and clean the surface carefully so that die-cut letters and figures can be easily read.

(j) Assign a qualified boiler plant operator to assist the Inspector throughout the tests.

(k) Be prepared to run a hydrostatic pressure test. A hand pump should be provided for this test if required. Provide gags to prevent safety valves from lifting when test pressure is applied. If hydrostatic pressure tests on more than one boiler are contemplated, sufficient gags should be provided for all the boilers. If boiler gages and controls are not designed for the proposed test pressure, be prepared to isolate or remove them and plug the openings.

(l) Have boiler records available.

**f. Taking a Boiler Out of Service.** Whenever a boiler is to be out of service for more than two days, thoroughly clean the fire side of the boiler, flues, economizer and air heater. Ash and soot deposits must be removed. Dry ash and soot are not corrosive but moisture in combination with the ash and soot of sulfur bearing fuel is. To avoid acid attack and corrosion of the metal, ash and soot must be removed.

## 5-12. ECONOMIZERS.

Reference paragraph 2-7.

**a. Daily:** Inspect for leaks in piping, valves, packings, gasketed joints, handhole openings, casing, etc. Make repairs as required.

**b. Monthly.** Check the following under identical load conditions:

(1) Item 2. Water pressure drop through the economizer.

(2) Item 3. Draft losses across the economizer.

(3) Item 4. 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. AR 420-49 and ASME Boiler and Pressure Vessel Code requires inspection of the economizer in addition to the boiler.

(1) Item 5. Externally look for signs of overheating, leakage, wear, or corrosion in pressure parts. Check the baffles and tubes in the area of sootblowers for signs of abrasion caused by fly ash or steam cutting. Check the elements of the sootblower.

(2) Item 6. Internally look for corrosion, erosion, scale, sludge deposits, or oil in tubes and headers.

## 5-13. AIR HEATERS.

Reference paragraph 2-8.

**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.

(3) Inspect for mechanical drive problems on rotary air heaters, if supplied.

(4) Establish a lubrication schedule for rotary air heaters in accordance with the manufacturers recommendations.

**b. Monthly:** Item 5. Check the following under identical load conditions:

(1) Air and gas side draft losses.

(2) Gas temperature drop through the air heater.

(3) Inspect for mechanical drive problems on rotary air heaters, if supplied.

(4) Establish a lubrication schedule for rotary air heaters in accordance with the manufacturers recommendations.

**b. Monthly:** Item 5. Check the following under identical load conditions:

(1) Air and gas side draft losses.

(2) Gas temperature drop through the air heater.

(3) Air temperature rise through the air heater. An increase in gas side draft losses combined with a decrease in air temperature rise indicates excessive soot deposits

in the tubes or gas passages.

(4) Make an orsat or oxygen analysis of the flue gas at the air heater inlet and outlet. The difference in total air content between the analyses indicates air leakage. Repair if leakage is excessive.

**c. Annually.**

(1) Item 6. During the boiler overhaul, clean and inspect the air heater. Look for indications of corrosion, erosion, leakage, and wear.

(2) Item 7. In rotary regenerative air heaters, inspect the motor drive, speed reducer, auxiliary air motor if provided, lubricating system, cooling system, bearings, rotor seals, etc.

(3) Item 8. Check the condition of sootblowers and washing equipment.

## 5-14. WATER COLUMNS.

Reference paragraph 2-11.

**a. Daily.**

(1) Blow down 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.

(2) Check to see that valves between boiler and gage glass are free and operational.

(3) When provided, test high and low automatic alarm to ensure that it is in perfect order. Repair when faulty.

**b. Annually:** Item 4. During annual boiler overhaul, or more often if necessary, dismantle, clean, and inspect all parts such as valves, alarm linkages, floats, chains, alarms, glasses, diaphragms, or electrodes. Replace or repair damaged or worn parts are required to ensure proper functioning.

## 5-15. SAFETY VALVES.

Reference paragraph 2-13.

**a. Daily.**

(1) Check for steam leakage indicating damaged seat, defective parts or lodged scale. Correct immediately such faults as leaking, simmering or chattering.

(2) Check supports and anchors of discharge pipe.

(3) Check the drain line from safety valve outlet to ensure that it is open and will function when needed.

**b. Monthly:** Item 4. Check each safety valve by raising the valve off the seat by listing the lever. Keep the valve wide open for at least 10 seconds to blow dirt and scale clean from the seat. Close the valve by suddenly releasing the lever.

**c. Annually:** Item 5. 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.

## 5-16. FUSIBLE PLUGS.

Reference paragraph 2-16. These items should be put on the boiler record card where applicable.

**a. Quarterly:** Inspect fusible plugs during boiler inspections. Scrape the surface clean and bright. Replace if the metal does not appear sound.

**b. Annually:** Item 2. Replace fusible plugs at least once a year.

## 5-17. SOOTBLOWERS.

Reference paragraph 2-17b.

### **a. Daily.**

(1) Check for leaks. Repair if required.

(2) Check for correct operation of the system components.

### **b. Semi-Annually.**

(1) Item 3. During the boiler outages, inspect the following items and repair if required:

(a) Defective elements (warped, corroded, eroded, or otherwise damaged).

(b) Worn, loose, or defective nozzles. (c) Incorrect blowing and adjustment.

(d) Incorrect location of elements or nozzles.

(e) Alignment and tightness of the supporting bearings.

(f) Defective chains, control valves, and control system components.

(g) Condition of sootblower piping system.

(h) Evidence of abrasion caused by impingement of the jet.

(2) Item 4. Repack and adjust glands to prevent leakage.

## 5-18. STOKERS.

Reference paragraph 2-18.

### **a. Daily.**

(1) Clean exposed parts of the stoker.

(2) Inspect all accessible parts. Pay special attention to bolts and connections in shear pins or safety release mechanisms. Be sure there is no binding which may keep the protective devices from functioning. Operating personnel should inspect the following items hourly:

(a) Hot bearings.

(b) Foreign material in coal.

(c) Mechanical linkages.

(d) Damaged, overheated, or burned out parts.

(e) Oil leaks.

(f) Proper oil level and condition of hydraulic systems.

(g) Correct oil pressures and oil temperature.

(h) Clinkers.

(3) Establish lubrication requirements and a schedule in accordance with the manufacturers requirements.

**b. Quarterly.** Make the following general inspection and overhaul whenever a boiler is removed from service.

(1) Item 4. Inspect the complete stoker. Check for wear on surfaces of feeder-box sides, conveyor areas, and all moving parts. Check alignment and condition of the grates. Replace broken, warped, or distorted parts promptly. Check the following:

(a) Clearances between grate elements.

(b) Tightness of all nuts, bolts, and holding parts.

(c) Drive mechanism and drive unit. Clean and repair any damage to gears and other components.

(d) Bearings of drive unit. Lubricate as required.

(e) Electrical controls and connections.

(f) Fan and its bearings. Check and lubricate bearings.

(g) Fly-ash reinjection system. Look for worn areas and plugged lines. Repair if required.

(h) Air seals. Repair if required.

(2) Item 5. Remove slag from furnace walls adjacent to stoker or fuel-bed surface. Take care to avoid injury to the brickwork.

## 5-19. PULVERIZED COAL EQUIPMENT.

Preventive maintenance procedures for pulverized coal equipment may be found in manufacturers instructions and Navy Manual MO-205.

## 5-20. COAL HANDLING EQUIPMENT.

Reference paragraph 2-19.

### **a. Daily.**

(1) Inspect for the following hourly:

(a) Unusual noise or vibration.

(b) Motor overheating.

(c) Hot bearings.

(d) Coal accumulation. Clean as required.

(e) Correct chain or belt tension.

(f) Damaged or loose drag flights or buckets.

(g) Damaged chain, chain sprockets, or belts.

(h) Proper operating conditions.

(i) Oil or water leaks. Repair as required.

(j) Proper lubricant levels.

(2) Establish lubrication requirements and schedule as required by manufacturers instructions.

(3) Inspect scales for zero load balance.

### **b. Monthly:** Item 4. Inspect for the following:

(1) Gear boxes, sheaves, rollers, shafts for proper lubrication, freedom of movement and bearing play.

(2) Screens for holes or plugging. Repair or clean as required.

(3) Structural frame for broken or bent parts and

loose or damaged joints.

- (4) Proper alignment of pulleys and other parts.
- (5) Proper operation of control and safety devices.

**c. Semi-Annually:** Item 5. Inspect for the following:

- (1) Corrosion or erosion of hoppers, chutes, and gates.
- (2) Lining and protective coatings for damage.
- (3) Scale levers, knife edges, and bearings for wear or damage. Repair or replace as required.
- (4) Concrete structures for cracks or other damage.

**d. Annually:** Item 6. Prepare applicable metal surfaces and repaint.

## 5-21. ASH HANDLING EQUIPMENT.

Reference paragraph 2-20.

**a. Daily.**

(1) Inspect for the following:

- (a) Piping leaks. Repair immediately.
- (b) Proper operation of steam or mechanical exhauster.
- (c) Proper operation of air washer, if provided.
- (d) Proper operation of ash gates and clinker grinders.

(e) Proper operation of automatic steam valves and automatic controls, including maintenance of correct steam pressure.

**b. Quarterly.**

(1) Item 2. Inspect conveyor piping, especially at elbows, for accumulated ash and erosion. Rotate, repair, or replace as necessary.

(2) Item 3. Inspect steam exhauster for corrosion and erosion.

(3) Item 4. Inspect washer internals for wear, ash accumulation, and nozzle condition. Clean and repair as necessary.

## 5-22. OIL BURNERS.

Reference paragraphs 2-21 and 3-18.

**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.

(2) Remove and clean the oil atomizer.

(3) Clean burner exterior.

(4) Follow the established schedule for cleaning burner strainers.

**b. Annually.**

(1) Item 5. Completely remove and clean the burner and igniter.

(2) Item 6. Inspect all air register and burner parts for freedom of movement, warpage and wear. Repair or replace as required. Adjust all parts for proper operation. The services of a burner servicemen may be required.

(3) Item 7. Replace atomizer tips or nozzles that have been in normal service with new tips or nozzles.

(4) Item 8. Calibrate burner pressure and temperature gages.

## 5-23. OIL HANDLING EQUIPMENT.

Reference paragraphs 2-22 and 3-18.

**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 as outlined in paragraphs 5-34, 5-35, and 5-36.

**b. Annually.**

(1) Item 5. Inspect and clean heaters and tanks internally and externally. Inspect carefully for corrosion, erosion, pitting, plugged tubes, damaged baffles, sludge deposits, water accumulations, and scale deposits.

(2) Item 6. Inspect for damage to protective coatings or paint. Repair or repaint as required.

(3) Item 7. Test relief valve settings and operation.

(4) Item 8. Clean, inspect, and calibrate all controls and instrumentation.

## 5-24. GAS BURNERS.

Reference paragraphs 2-23 and 3-19.

**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.

**b. Annually.**

(1) Item 2. Completely remove and clean the burner and igniter.

(2) Item 3. 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.

(3) Item 4. Calibrate burner pressure gages.

## 5-25. FEEDWATER/DRUM LEVEL CONTROLS.

Reference paragraph 2-25. a. Daily.

- (1) Inspect for water leaks. Repair immediately.

(2) Observe operation of all control devices. Report and repair any malfunction immediately.

(3) Establish a lubrication schedule for all components in the control system in accordance with manufacturers recommendations.

**b. Annually.**

(i) Item 4. 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) Item 5. Check settings, adjustments, and operation of all components.

**5-26. COMBUSTION CONTROLS.**

Reference paragraphs 2-26 and 3-20.

**a. Daily.**

(1) Inspect for air, oil, gas and water leaks. Repair immediately.

(2) Blow down compressed air drip legs and filters.

(3) Check jackshafts, dampers and linkages for slippage and freedom of movement.

(4) Inspect for stable and proper operation.

(5) Clean exterior of controls.

(6) Establish lubrication requirements and schedule in accordance with the manufacturers instructions.

**b. Monthly:** Item 7. Replace or clean all system filters.

**c. Annually.**

(1) Item 8. Inspect and completely clean all control devices internally. Replace any worn, corroded, or damaged parts.

(2) Item 9. Test for correct calibration. Adjust as required.

(3) Item 10. Test control settings under operating conditions. Optimize control function to improve plant efficiency.

(4) Item 11. Obtain the assistance of a fully trained combustion control service engineer as required to calibrate, clean and adjust the controls.

**5-27. BOILER SAFETY CONTROLS.**

Reference paragraphs 2-27 and 3-21.

**a. Daily.**

(1) Inspect all safety controls for leaks and cleanliness. Repair and clean immediately.

(2) Blow down the water column, gage glass, and low water fuel cutoff each shift. Test function.

**b. Monthly.**

(1) Item 3. 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.

(2) Item 4. Test all safety controls for proper calibration

and operation.

**5-28. INSTRUMENTATION.**

Reference paragraph 2-28.

**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. Item 4. 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, bellows, and gaskets.

(6) Mercury separations in thermometers.

(7) Loose pointers.

(8) Broken balance-arm screws.

(9) Plugged piping or tubing.

(10) Broken or damaged adjustment assemblies.

(11) Defective clockwork mechanism or electric motor operation.

**5-29. MECHANICAL COLLECTORS.**

Reference paragraph 2-32.

**a. Daily.**

(1) Observe draft gage readings and compare with normal readings for that operating condition.

(2) Check dust level in hopper to ensure hoppers are being emptied on a regular basis.

**b. Quarterly.** At the time of boiler outage, inspect for the following:

(1) Item 3. Check all gasketed joints for leaks. Replace damaged or defective gaskets as required.

(2) Item 4. Check the interior of dust collector for caked deposits, corrosion, erosion, loose parts, and other damage. Clean and repair as required.

(3) Item 5. Check the exterior of dust collector for damaged parts, paint, corrosion, etc. Clean and repair as required.

**c. Annually:** Item 6. Paint the entire assembly.

**5-30. STACKS.**

Reference paragraph 2-40.

**a. Daily:** Inspect for possible defects, leaks, damage, deterioration of lining, cracks, or settlement in foundation.

Report promptly any such observation.

**b. Quarterly.**

(1) Item 2. Make a more thorough examination of the chimney exterior using high powered binoculars quarterly or after every severe storm to look for cracks, spalls, corrosion, loose guy wires (if provided), damaged lightning rod and connectors, loose parts, etc.

(2) Item 3. Remove soot and fly-ash accumulation from base of stack.

(3) Item 4. Clean accumulation of soot and fly ash from connecting flues and inspect them for corrosion, erosion, and moisture. If moisture is found, clean more frequently. Remove the cause of water formation if possible.

**c. Semi-Annually:** Item 5. Carefully examine stack supports for corrosion, cracking, or movement of anchor blocks, and proper guy wire tension. Check for corrosion of the ladder.

**d. Annually:** Item 6. Clean and inspect the stack internally and externally. Inspect lightning rod tips and ground connections. Paint.

### 5-31. ZEOLITE WATER SOFTENERS.

Reference paragraph 4-6a and 4-16b.

**a. Daily.**

(1) Check for the following:

(a) Flow rates. Service, backwash, regenerant solution, and rinse rates should be carefully maintained.

(b) Adherence to manufacturers instructions for length of time for backwash, regeneration, and rinse operations.

(c) Proper operation of flow regulators, meters, pressure gages, temperature indicators.

(d) Chemical or water leaks.

(e) Hardness of water leaving softener to determine when to regenerate.

(f) Density of brine.

(g) Sump for zeolite carryover.

(2) Establish lubrication requirements and schedule in accordance with manufacturers recommendations.

**b. Semi-Annually.**

(1) Item 3. Inspect ion exchange vessel, valves, and piping for corrosion, rust, and peeling of paint.

(2) Item 4. Drain and internally inspect the ion exchange vessel for loss of resin, dirt, slime, or oil fouling of the bed, uneven bed, or corrosion or erosion in distributor piping.

**c. Annually:** Item 5. Calibrate instruments annually or more often as required.

### 5-32. HOT LIME-SODA SOFTENERS.

Reference paragraph 4-6b and 4-16b.

**a. Daily.**

(1) Check for the following:

(a) Alkalinity and hardness several times each day to determine proper chemical additions.

(b) Chemical feed pump for operation.

(c) Plugging of feed lines.

(d) Chemical proportioner for operation.

(e) Temperature of water in reaction tank to verify heater function. Temperature should be greater than 212° F at sea level.

(f) Heater vent for proper venting.

(g) Live steam makeup valve for operation and pressure control.

(h) Pressure differential across filters to determine necessity of backwashing.

(i) Chemical solution tank. Add chemicals as required.

(j) All lines and valves for leakage. Repair or replace immediately.

(2) Blow down reaction tank daily or more often according to sludge accumulation.

(3) Lubricate motors and pumps according to manufacturers directions and schedule.

**b. Monthly.**

(1) Item 4. Clean chemical solution tank. Clean outlet strainer.

(2) Item 5. Clean and flush chemical feed pump.

(3) Item 6. Lubricate and adjust chemical proportioner.

**c. Semi-Annually.**

(1) Item 7. Open and clean heater. Level and adjust trays and spray nozzles. Clean and drain vent condenser. Repack and reseal live steam regulator valve. Check diaphragm in regulator and replace if worn. Adjust regulator. Repack and reseal water inlet control valve.

(2) Item 8. Open, examine, clean, and recharge filters in accordance with manufacturers recommendations.

**d. Annually.**

(1) Item 9. Drain, open, and clean reaction tank. Repair or replace damaged insulation. If corrosion is excessive on interior of tank, scrape thoroughly and apply protective paint or other similar coating. If exterior is exposed, paint after thoroughly cleaning.

(2) Item 10. Dismantle, clean, overhaul, and repack pumps.

(3) Item 11. Repack valves.

(4) Item 12. Paint exposed surfaces.

### 5-33. DEAERATING HEATERS AND DEAERATORS.

Reference paragraph 4-6h and 4-16c.

**a. Daily.**

(1) Check for correct operation of relief valve, steam pressure reducing valve, overflow, controls, alarms, and

steam pressure and temperature indicators. Report any malfunctions immediately.

(2) Inspect for steam and water leaks. Repair immediately.

**b. Annually:** Item 3. 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.

(4) Oil separator. Inspect interior of heater for evidence of oil, corrosion, or scaling.

(5) Condition of relief, steam pressure reducing, float, vent, and overflow valves.

(6) Condition of gage glass, controls, alarms, and instruments.

(7) Condition of piping and valves.

(8) Vent condenser. Open and check for corrosion, wear, clogging of tubes, and scaling.

(9) Condition of insulation. Check for cracks and peeling.

## 5-34. PUMPS.

Reference paragraph 2-37.

**a. Daily.** Inspect for the following hourly:

(1) Unusual noise or vibration.

(2) Electric motors for overheating.

(3) Hot bearings.

(4) Abnormal suction or discharge pressures.

(5) Hot stuffing box.

(6) Abnormal leakage through glands/seals.

**b. Monthly.** Item 2. Inspect all external gear and bearing housings for correct lubricant condition. Establish lubrication requirements and schedule in accordance with the manufacturers recommendations.

**c. Annually.** Item 3. Completely disassemble, clean, and inspect the pump. Check for the following:

(1) Excessive clearances.

(2) Hot and cold alignment.

(3) Corrosion or erosion of parts.

(4) Excessive wear of shafts, sleeves, bearings, and seals.

(5) Cracks, scrapes, wastage, or corrosion of gear teeth if provided.

## 5-35. CENTRIFUGAL PUMPS.

Reference paragraph 2-37b.

**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) Item 2. Check alignment of pump and driver with the unit at stand-still and normal operating temperature.

(2) Item 3. Check shaft sleeves for scoring.

(3) Item 4. Replace packing if required.

(4) Item 5. Drain the oil from oil-lubricated bearings, flush, and refill with clean oil.

(5) Item 6. Check grease-lubricated bearings. Do not overgrease the bearings. When adding grease, remove drain plug or use a safety fitting to prevent overgreasing.

**c. Annually:** Item 7. Completely disassemble, clean, and inspect the pump. Check for the following:

(1) Wearing ring clearances according to manufacturers instructions. Diametric clearance between 0.005 and 0.025 inch is usual.

(2) Bearing wear and clearances. Overhaul if required, according to manufacturers instructions.

(3) Shaft for scoring, corrosion, or wear at seals, and alignment.

(4) Impellers for corrosion, erosion, or excessive wear.

(5) Calibrate pressure gages, thermometers, and flowmeters.

(6) Suction and discharge strainers for cleanliness.

## 5-36. RECIPROCATING PUMPS.

Reference paragraph 2-37c.

**a. Daily.**

(1) Inspect for the following hourly:

(a) Abnormal speed.

(b) Improper stroke length.

(c) Defective operation of lubricator.

(d) Ineffective operation of governor.

(e) Improper action of the air chamber.

(f) Steam and water leaks.

(2) Establish lubrication requirements and schedule in accordance with manufacturers instructions.

**b. Monthly:** Item 3. Inspect for the following:

(1) Scoring of piston rods.

(2) Binding of valve operating mechanism.

(3) Lost motion.

(4) Tilted glands in stuffing boxes.

(5) Defective condition of strainers.

**c. Annually:**

(1) Item 4. Dismantle the pump once a year or more often if required; clean and inspect the pump.

(2) Item 5. Check the following in the liquid end:

(a) Condition of valves, springs, and retaining bolts.

(b) Condition of cylinder liner.

- (c) Piston rings or packings.
- (d) Piston rod packing.
- (e) Relief valve, if used, and setting.
- (f) Alignment.
- (g) Strainers, if used.

(2) Item 6. Also look for corrosion, erosion, or excessive wear of parts, and for transmission of strains from piping to pump.

(3) Item 7. Check the following in the steam end:

- (a) Condition of pistons and piston rings, slide valves and seals.
- (b) Alignment.
- (c) Clearance between piston and cylinder liner.
- (d) Lubricator.
- (e) Governor.

(4) Item 8. Check for plugged steam passages in steam chest, scoring of shoulders or cylinders, corrosion, erosion, and excessive wear of parts.

(5) Item 9. Calibrate instruments.

(6) Item 10. Replace packings.

## 5-37. STEAM INJECTORS.

Reference paragraph 2-37e.

### a. Daily.

(1) Inspect for steam and water leaks. Repair as required.

(2) Check for correct feedwater flow.

(3) Check for correct temperature and pressure readings.

(4) Check for erratic overflow.

b. Annually: Item 5. Dismantle injector. Clean and inspect for the following:

(1) Injectors for corrosion, erosion, excessive wear, and clogging passages. Pay particular attention to nozzles.

(2) Valves for corrosion, excessive wear, and leakage.

Check packing.

(3) Piping for corrosion, scaling, and erosion.

(4) Insulation.

## 5-38. STEAM TURBINES (NON-CONDENSING).

Reference paragraph 2-41. Institute preventive maintenance schedule in accordance with manufacturers recommendations. The following program is suggested for a single stage impulse non-condensing steam turbine typically used at Army installations to drive auxiliary equipment.

### a. Daily.

(1) Inspect for the following:

- (a) Proper oil levels, pressures, and temperatures.
- (b) Hot bearings.
- (c) Dirty or emulsified oil.
- (d) Unusual noise or vibration.

- (e) Steam, water and oil leaks. Repair as necessary.
- (f) Proper operation of governor under varying load.
- (g) Proper operation of all instruments, gages, and throttle valve.

(2) Establish lubrication requirements and schedule in accordance with manufacturers instructions.

### b. Weekly.

(1) Item 3. Blow down steam strainer connection.

(2) Item 4. Lubricate governor and overspeed trip linkages.

(3) Item 5. Trip emergency valve by hand trip lever to check its operability.

### c. Monthly.

(1) Item 6. Change bearing oil and clean reservoir.

(2) Item 7. Make visual inspection of governor parts, bearings, and linkage for lost motion.

(3) Item 8. Check coupling for looseness, wear, and alignment.

d. Annually: Item 9. Make a thorough inspection of the unit after the first year of operation. Subsequent internal inspection intervals should be based upon operating conditions and the operating record of the machine. Follow manufacturers recommendations for such inspections. The following may be adopted as guidelines for an annual overhaul:

(1) Dismantle speed governor and check and rectify play in linkage.

(2) Check overspeed trip governor for proper operation. Repair if necessary.

(3) Clean and examine governor valve, bushing, valve stem, etc. Replace stem packing.

(4) Check thrust bearing for end play.

(5) Clean and examine turbine blades and shrouds for cracks, damage, erosion, and debris.

(6) Clean steam strainer.

(7) Clean and inspect packing rings for damage and axial rubs.

(8) Inspect turbine bearings. Change if necessary.

## 5-39. AIR COMPRESSORS.

Reference paragraph 2-45.

### a. 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.

b. Quarterly: Item 3. Inspect for the following:

(1) Compressor valves for wear, dirt, and improper seating.

- (2) Operation of all safety valves.
- (3) Belts for tension, wear, and deterioration.
- (4) Cleanliness of air intake filter.
- (5) Tightness of cylinder head bolts and gaskets.

**c. Annually.**

(1) Item 4. Check cylinders for wear, scoring, corrosion, and dirt.

(2) Item 5. Inspect pistons and rings for leakage, wear, scoring, security to the piston rod, and head clearances.

(3) Item 6. Inspect crank shaft and crank shaft bearings for wear and proper operation.

(4) Item 7. Check alignment of the compressor with respect to the driver.

### 5-40. STEAM TRAPS.

Reference paragraph 2-46. 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) Item 2. Blow down steam trap to eliminate dirt accumulations.

(2) Item 3. Open the air vents on float traps to vent accumulated air.

(3) Item 4. Test traps for correct operation.

**c. Annually.**

(1) Item 5. 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 bellows, buckets, or floats.

(2) Item 6. Replace or repair all defective gaskets, linkages, and orifices.

(3) Item 7. Reassemble and test for proper operation.

### 5-41. ELECTRIC MOTORS.

Reference paragraph 2-42. Also reference TM 5-683 entitled Facilities Engineering Electrical Interior Facilities.

**a. Daily.**

(1) Inspect for the following:

- (a) Cleanliness.
- (b) Overheating.
- (c) Hot bearings.
- (d) Correct lubrication.
- (e) Proper operation of instruments and controls.
- (f) Unusual noise or vibration.
- (g) Continuous or excessive sparking at commutator or brushes.

(h) Loose belts, if provided.

(2) Establish lubrication and motor maintenance in accordance with manufacturers recommendations.

**b. Annually.**

(1) Item 3. Inspect squirrel cage rotors for broken or loose bars. Check for loose or broken fan blades.

(2) Item 4. Thoroughly inspect all ball, roller, and sleeve bearings for wear and dirt.

(3) Item 5. Check and record insulation resistance.

(4) Item 6. Check windings for dirt, moisture, cracks, and loose wedges.

(5) Item 7. Check coupling alignment.

### 5-42. FORCED DRAFT AND INDUCED-DRAFT FANS.

Reference paragraphs 2-38 and 2-39.

**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 and bearing oil level.
- (f) Proper flow and temperature of bearing-cooling water.

(g) Freedom of damper motion.

(2) Establish lubrication requirements and schedule in accordance with manufacturers recommendations.

**b. Quarterly.**

(1) Item 3. Examine water cooling system for corrosion and clogging.

(2) Item 4. Clean rotor and casing and inspect for corrosion, erosion, and damage. Check clearances between rotor and casing.

(3) Item 5. Check alignment of shaft and coupling; inspect coupling.

(4) Item 6. Check condition of foundation and tightness of bearing and foundation bolts. Defective foundation or loose bolts may promote heavy vibration.

(5) Item 7. Inspect bearings.

**c. Annually:** Item 8. Annually, or more often if required, inspect and perform the following maintenance work:

- (1) Complete by overhaul bearings.

- (2) Clean and flush cooling system.
- (3) Repair or replace fan blades, as required. After replacing blades, rebalance rotor.
- (4) Repair or replace defective parts.
- (5) Repair insulation.

### 5-43. COMMAND INSPECTIONS.

Command inspections are a function of commanding officers. They are made to determine the general condition and effective use of central boiler plant equipment, causes of neglect or carelessness, and need for additional instruction or training of operating personnel. Command inspections may be formal, informal, or spot checks.

**a. Procedure.** Command inspections are made on accessible central boiler plant equipment at any time that causes the least possible interference with boiler plant routine. All equipment, accessories, and connections are checked during formal inspections; equipment is selected at random for informal inspections and spot checks. Inspectors look for the following:

- (1) Cleanliness of equipment, pipes, walks, floors, walls, and instruments.
- (2) Any leaks from water, steam, oil, or air equipment.
- (3) Neat and orderly storage tools, spare parts, supplies, and fuel.
- (4) Deficiencies of equipment, working order of parts.
- (5) Prompt notification to the Director of Engineering and Housing of all operating deficiencies.
- (6) Methods and procedures used in hazardous operations.

**b. Follow-Up.** After inspections have been completed, personnel are advised of the deficiencies and irregularities noted.

### 5-44. TECHNICAL INSPECTION.

Technical inspections are made by the Director of Engineering and Housing or designated personnel of his organization to determine the general condition of boiler plant equipment, effectiveness of preventive maintenance, and need for additional instruction or training of maintenance personnel.

**a. Procedure.** Boiler plant equipment is selected at random and inspected without previous notification so that the overall condition of equipment and efficiency of maintenance personnel can be determined. Technical inspections are preferably made while equipment is being dismantled for routine inspection. In thoroughness, the technical inspection should equal inspections made by insurance or other authorized inspecting agencies. The following are checked at each piece of boiler plant equipment inspected.

- (1) All items included in command inspections. (See

paragraph 5-43.)

(2) Adequacy of preventive maintenance as it is being performed.

**b. Follow-Up.** On completion of the technical inspection, the Director of Engineering and Housing will take the steps necessary to correct indicated deficiencies in preventive maintenance inspection and service procedures. He will arrange to have any indicated maintenance work done at once.

### 5-45. MAJOR ARMY COMMAND INSPECTIONS.

Major Army Command Inspections are made by technical personnel to determine effectiveness of preventive maintenance and to ensure uniform procedures at all posts. They include examination of preventive maintenance inspection records.

**a. General Inspections.** Technical personnel make general inspections at least four times a year. Inspectors check the following:

- (1) Preventive maintenance record system.
- (2) Familiarity of maintenance personnel with equipment duties.
- (3) Promptness of corrective action when Director of Engineering and Housing is notified of defects.

**b. Follow-Up.** Errors and oversights are reported to the proper authority. The Major Army Command maintains suitable records of inspections. These records include a list of equipment inspected, findings, recommendations, and other pertinent data.