

CHAPTER 5

INSPECTION AND PREVENTIVE MAINTENANCE

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										
SCHEDULE INSPECTION AND SERVICE ON THIS SIDE. **CORD INSPECTION AND SERVICE ON REVERSE SIDE.															

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		This illustrates a master	
7/19/82	Repair refractory front wall	CJ		recorder card which has consoli-	
7/20/82	Work Order No. 261	SB		dated the daily and other	
8/9/82	Item 5,6 & 7	CJ		entries from the field record	
9/13/82	Item 5,6 & 7	CJ		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.